



# User Manual

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E-873.1AT DIGITAL CONTROLLER FOR Q-MOTION® PIEZO INERTIA DRIVES

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Auf der Roemerstrasse 1  
76228 Karlsruhe  
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[info@pi.de](mailto:info@pi.de)  
[www.pi.de](http://www.pi.de)

**Customer service department:**

Physik Instrumente (PI) GmbH & Co. KG  
Auf der Roemerstrasse 1  
76228 Karlsruhe  
Germany  
[service@pi.de](mailto:service@pi.de)  
[www.pi.de](http://www.pi.de)

## 2 About this Document

### 2.1 Objective and Target Group

This user manual contains the information needed for the intended use of the E-873.1AT. Basic knowledge of closed-loop systems, motion control concepts, and applicable safety measures is assumed.

### 2.2 Other Applicable Documents

The devices and software tools that are mentioned in this documentation are described in separate manuals.

Document number	Document type	Product
SM148E	Software Manual	PI MikroMove
SM146E	Software Manual	GCS Array Data Format Description
SM151E	Software Manual	PI GCS 2.0 DLL0
SM155E	Software Manual	PI MATLAB Driver GCS 2.0
SM156E	Software Manual	PIStages3Editor: Software for the managing the positioner database
A000T0028	Technical Note	PI Update Finder: Searching for and downloading updates

The latest versions of the user manuals can be [downloaded \(p. 9\)](#) at [www.pi.ws](http://www.pi.ws).

### 2.3 Explanation of Symbols

This chapter explains the symbols and markings used by PI in their user manuals.

#### 2.3.1 Typographic Conventions

Symbol / Label	Meaning
1.	Action consisting of several steps whose sequential order must be observed
2.	
■	List item
p. 5	Cross-reference to page 5
RS-232	Labeling of an operating element on the product (example: socket of the RS-232 interface)
<i>Start &gt; Settings</i>	Menu path in the PC software (example: to open the menu, the <i>Start</i> and <i>Settings</i> menus must be clicked successively)
POS?	Command line or a command from PI's General Command Set (GCS) (example: command to get the axis position)
<i>Device S/N</i>	Parameter name (example: parameter where the serial number is stored)
5	Value that must be entered or selected via the PC software

### 2.3.2 Symbols Used

Symbol / Label	Meaning
	General hazard symbol
	Electrical voltage



#### **CAUTION**

##### **Dangerous situation**

Failure to observe can lead to minor injury.

- Actions to take to avoid the risk.

#### **NOTICE**

##### **Dangerous situation**

Failure to observe can lead to material damage.

- Action to take to avoid the risk.

#### **Information**

Additional information on the E-873.1AT that can affect your application.

## 2.4 Figures

For better understandability, the colors, proportions and degree of detail in illustrations can deviate from the actual circumstances. Photographic illustrations may also differ and must not be seen as guaranteed properties.

## 2.5 Downloading Manuals

The latest versions of the user manuals can be [downloaded \(p. 9\)](#) at [www.pi.ws](http://www.pi.ws).

For products that are supplied with software (data storage device in the scope of delivery), access to the manuals is protected by a password. Protected content is only displayed on the website after entering the access data. You need the data storage device for the product to get the access data.

If a manual is missing or problems occur with downloading, contact our [customer service department \(p. 207\)](#).

#### **Downloading Manuals**

1. Open the website [www.pi.ws](http://www.pi.ws).
2. If the product was shipped with a data storage device: Log into the website:
  - a) Click **Login**.
  - b) Enter the login data.

The login data is in the **[...].Releasenews\_[...].pdf** on the product's data storage device (in the main directory or the **Manuals** directory).

If necessary: Follow the link and register yourself to get the login data.

- c) Click **Login** or press the **Enter** key.
3. Search for the product:
  - a) Click **Search**.

- b) Enter the product number up to the period (e.g., E-873) into the search field.
  - c) Click **Start search** or press the **Enter** key.
  - d) If necessary: Click **Load more results** at the bottom of the list.
4. Click the corresponding product in the list of search results.
  5. Click the **Downloads** tab.  
→ *The manuals are shown under Documentation.*
  6. Click the desired manual and save it.

## 3 Safety

### 3.1 Intended Use

The E-873.1AT is a laboratory device as defined by DIN EN 61010-1. It is intended for indoor use and use in an environment that is free of dirt, oil, and lubricants.

In accordance with its design, the E-873.1AT is intended for operating positioners with Q-Motion® piezo inertia drives. The E-873.1AT is intended for closed-loop operation with incremental position sensors. In addition, it can read and process the reference point and limit switch signals from the connected positioner.

The E-873.1AT may not be used for purposes other than those stated in this user manual. In particular, the E-873.1AT may not be used to drive ohmic or inductive loads.

### 3.2 General Safety Instructions

The E-873.1AT is built according to state-of-the-art technology and recognized safety standards. Improper use of the E-873.1AT may result in personal injury and/or damage to the E-873.1AT.

- ▶ Use the E-873.1AT only for its intended purpose and if it is in perfect condition.
- ▶ Read the user manual.
- ▶ Eliminate any faults and malfunctions that are likely to affect safety immediately.

The operator is responsible for correct installation and operation of the E-873.1AT.

- ▶ Install the E-873.1AT near the power adapter so that the power plug can be quickly and easily disconnected from the mains.
- ▶ Use the components supplied to connect the E-873.1AT to the power supply.
- ▶ If one of the supplied components for connecting to the power supply has to be replaced, use a sufficiently dimensioned component.
- ▶ Only use cables and connections that comply with local safety regulations.

### 3.3 Organizational Measures

#### 3.3.1 User Manual

- ▶ Always keep this user manual available with the E-873.1AT. The latest versions of the user manuals can be [downloaded \(p. 9\)](#) at [www.pi.ws](http://www.pi.ws).
- ▶ Add all information from the manufacturer such as supplements or technical notes to the user manual.
- ▶ If you give the E-873.1AT to a third party, also include this user manual as well as other relevant information provided by the manufacturer.
- ▶ Only use the device on the basis of the complete user manual. Missing information due to an incomplete user manual can result in minor injury and damage to equipment.
- ▶ Only install and operate the E-873.1AT after you have read and understood this user manual.

#### 3.3.2 General Personnel Qualification

The E-873.1AT may only be installed, started up, operated, maintained, and cleaned by authorized and appropriately qualified personnel.

## 4 Product Description

### 4.1 Front Panel



Figure 1: Front view of the E-873.1AT

Element	Labeling	Type	Function
	Power	Toggle switch	On/Off switch O: E-873.1AT switched off —: E-873.1AT switched on
	SPI	Display port	Serial connection to a serial peripheral interface (SPI) master unit If you want to use the SPI connection, contact our <a href="#">customer service department (p. 207)</a> .
	Ethernet	RJ45	Ethernet interface for communication via TCP/IP
	RS-232	D-sub 9 (m) (p. 214)	Serial connection to PC
	24 VDC 2.5 A	<a href="#">Barrel connector-socket (p. 214)</a>	Connector for the supply voltage
	Status	LED	Controller state: Green - lights up continuously: E-873.1AT ready for normal operation Green - flashing: E-873.1AT in firmware update mode Red: Error

Element	Labeling	Type	Function
			Off: E-873.1AT not connected to the supply voltage
		Mini-B USB	Universal serial bus for connection to the PC
	I / O	<a href="#">Mini-DIN 9 (f) (p. 213)</a>	Digital inputs/outputs, analog inputs
	Joystick	Mini-DIN 6 (f)	Connector for analog HID (Human Interface Device), e.g., joystick
	Motor & Sensor 0 V to 100 V	<a href="#">D-sub 15 (f) (p. 212)</a>	Connector for the positioning axis

The [protective earth connector \(p. 45\)](#) is on the right-hand rear mounting rail:

Element	Labeling	Type	Function
		Threaded pin	Threaded pin with mounting hardware for protective earth conductors The threaded pin must be connected to a protective earth conductor because the E-873.1AT is not grounded via the power adapter connector.

## 4.2 Type Plate

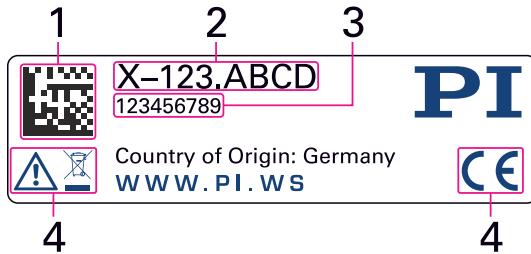


Figure 2: Type plate of the E-873.1AT

1. Data matrix code (example; contains the serial number)
2. Product number (example)
3. Serial number (example), individual for each E-873.1AT  
Meaning of the position (counting from the left):  
1 = internal information,  
2 and 3 = year of manufacture,  
4 to 9 = consecutive numbers
4. Warning and conformity symbols ([old equipment disposal \(p. 211\)](#), [CE mark \(p. 215\)](#))

## 4.3 Scope of Delivery

Product number	Description
E-873.1AT	Digital controller according to the order
C-501.24050H	Wide range input power supply 24 V, 50 W
3763	Power cord
MS242EK	Short instructions for digital motor controllers and drivers
000036360	USB cable (type A to Mini-B) for connection to the PC
E-873.CD	Product CD for the E-873.1AT with software and user manuals

## 4.4 Accessories

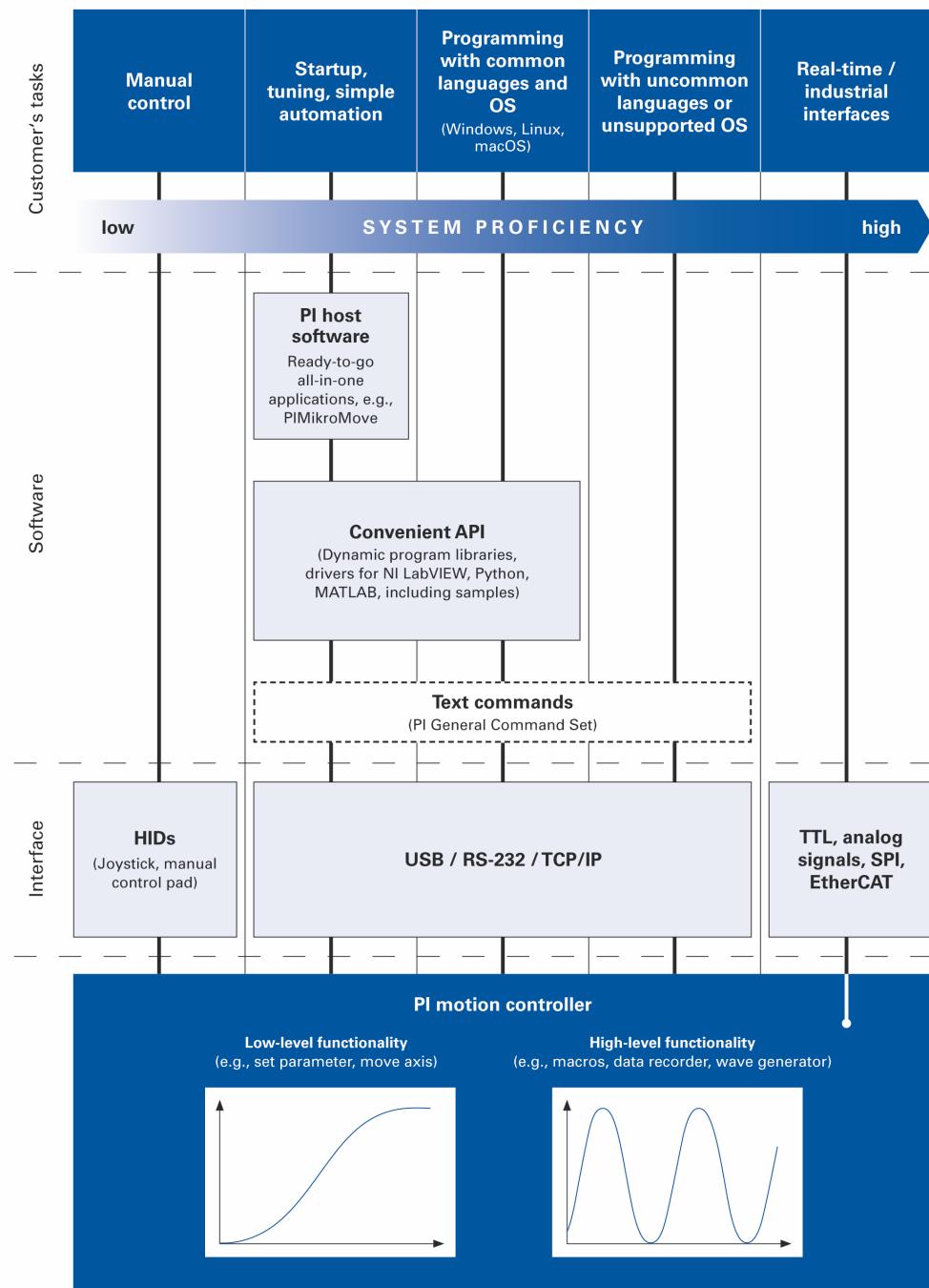
Product number	Description
C-815.553	Straight-through network cable for connecting the PC via a TCP/IP network
C-815.563	Crossover network cable for direct connection to the PC via TCP/IP
C-815.34	RS-232 null modem cable, 3 m, 9/9-pin
C-819.JA	Analog joystick for 2 axes, 3 programmable buttons
C-819.20	Analog joystick for 2 axes
C-819.20Y	Y cable for 2 controllers to C-819.20 joystick
C-819.30	Analog joystick for 3 axes
C-170.PB	Pushbutton box with 4 buttons and 4 LEDs
C-170.IO	<a href="#">I/O cable, 2 m, open end (p. 213)</a>

To order, contact our [customer service department \(p. 207\)](#).

## 4.5 Communication Interfaces

### 4.5.1 Controlling PI Systems

Basically, PI systems can be controlled as follows:



#### 4.5.2 E-873.1AT Interfaces

The E-873.1AT can be controlled via the following communication interfaces:

## Communication interfaces

PC interfaces, via [software \(p. 16\)](#) or PI General Command Set:

TCP/IP
RS-232
USB
SPI

The interface parameters in the E-873.1AT's volatile memory can be queried with the [IFC?](#) command and changed with [IFC](#) command. The [IFS?](#) and [IFS](#) commands are available for querying and changing the interface parameters in the E-873.1AT's nonvolatile memory.

### TCP/IP

Interface parameters of the E-873.1AT for TCP/IP communication:

Interface property	Factory setting	Note
IP address format: <IP-Adresse>:<Portnummer> (IPADR)	000.000.000.000: 50000	Is not used when an IP address is assigned to the E-873.1AT by a DHCP server (IPSTART = 1). <Portnummer> cannot be changed.
Subnet mask (IPMASK)	24	Bit mask for subnet (24 = subnet mask 255.255.255.0)
Startup behavior for configuring the IP address for TCP/IP communication (IPSTART)	1	0: The address defined by IPADR is used. 1: DHCP is used to get the E-873.1AT's address. The default setting of the startup behavior only needs to be changed if the network devices are to use static addresses instead.
MAC level address (MACADR)		Invariable, unique network hardware address

### RS-232

E-873.1AT's interface settings for RS-232 communication:

Interface setting	Factory setting	Note
Baud rate (RSBAUD)	115200	Possible values: 9600, 19200, 38400, 115200 To establish communication successfully, the baud rates of the E-873.1AT and PC must match.

## 4.6 Software Overview

The following table shows the PC software on the product CD. The specified operating systems stand for the following versions:

- Windows: Versions 7, 8, 10 (32 Bit, 64 Bit)
- Linux: Kernel 2.6, GTK 2.0, from glibc 2.15

**Libraries, drivers**

PC software	Operat-ing sys-tem	Short description	Recommended use
Dynamic program-libraries for GCS	Win-dows,Li-nux	Allows software pro-gramming of the E-873.1AT with pro-gramming languages such as C++. The func-tions in dynamic pro-gram libraries are based on the PI General Com-mand Set (GCS).	For users who would like to use a dynamic program li-brary for their application. Is required for PIMikroMove. Is required for NI LabVIEW drivers if communication is to be established via USB (with Linux only via virtual COM port) or a daisy chain network.
NI LabVIEW drivers	Win-dows,Li-nux	NI LabVIEW is a soft-ware for data acquisi-tion and process control (must be ordered sepa-rately from National In-struments). The E-873.1AT NI LabVIEW software of PI is a col-lection of virtual instru-ment drivers (VI drivers) for the E-873.1AT con-troller. These drivers support the GCS.	For users who want to use NI LabVIEW to program their ap-plication.
MATLAB drivers	Win-dows	MATLAB is a develop-ment environment and programming language for numerical calcu-lations (must be ordered separately from Math-Works).  The PIMATLAB driver consists of a MATLAB class that can be inclu-ded in any MATLAB script. This class sup-ports the PI General Command Set.  The PI MATLAB driver does not require any additional MATLAB tool boxes.	For users who want to use MATLAB to program their ap-plication.
USB driver	Win-dows	Driver for the USB inter-face	For users who want to connect the controller to the PC via the USB interface.

**User Software**

PC software	Operat-ing sys-tem	Short description	Recommended use
PIMikroMove	Win-dows	<p>Graphical user interface for Windows, which can be used for controllers from PI:</p> <ul style="list-style-type: none"> <li>■ Start the system without programming effort</li> <li>■ Graphic representation of the motion</li> <li>■ Macro functionality for storing command sequences on the PC (host macros)</li> <li>■ Complete environment for command entry</li> </ul> <p>PIMikroMove uses the dynamic program library to supply commands to the controller.</p>	<p>For users who want to perform simple automation tasks or test their equipment before or instead of programming an application.</p> <p>No command knowledge is necessary to operate PIMikroMove.</p> <p>A log window showing the commands sent makes it possible to learn how to use the commands.</p>
NI LabVIEW Merge Tool	Win-dows	The NI LabVIEW Merge Tool allows you to combine product-specific NI LabVIEW drivers from PI with each other.	For users who want to operate several products from PI at the same time while using NI LabVIEW.
PIStages3Editor	Win-dows	Program opening and editing positioner databases in .db format.	For users who want to deal with the contents of positioner databases more intensively.
PITerminal	Win-dows,Li-nux	Simple user interface that can be used for nearly all PI controllers.	For users who want to send GCS commands directly to the controller.
PI Firmware Updater	Win-dows	Program for updating the firmware of the E-873.1AT.	For users who want to update the firmware.
PIUpdateFinder	Win-dows	Checks the PI software installed on the PC. If newer versions of the PC software are available on the PI server, they are offered for download.	For users who want to update the PC software.

**4.7 Positioner Database**

You can select a parameter set appropriate for your positioner from a positioner database in the PC software from PI. The software transfers the values of the selected parameter set to the volatile or nonvolatile memory of the controller.

Database file name	Description
PISTAGES3.DB	Delivery includes parameter sets for all standard positioners from PI and PI miCos, and is saved to the PC automatically during installation of the PC software. New parameter sets can be created, edited, and saved.
Product code.db	Includes the parameter set for the custom positioner "product code". In order for the parameter set to be selectable in the PC software, it must be imported into PISTAGES3.DB first.

The positioner database only contains some of the information that is required to operate a positioner with the E-873.1AT. When the positioner connected to the E-873.1AT is equipped with an ID chip: Further information is loaded as parameter values from the ID chip to the volatile memory of the E-873.1AT when the E-873.1AT is switched on or rebooted.

## 4.8 ID Chip Detection

PI positioners with DC motor have an ID chip in the connector where the following data is stored as parameters:

- Information on the positioner: Type, serial number, date of manufacture, version of the hardware
- Signal type output by the position sensor

The data of the connected positioner is loaded from the ID chip into the volatile memory of the E-873.1AT when the E-873.1AT is switched on or rebooted.

The ID chip only contains some of the information that is required to operate the positioner with the E-873.1AT. When you use the PC software from PI, further information is loaded as parameter values from a positioner database into the volatile memory of the E-873.1AT.

The parameter values in the E-873.1AT's volatile memory can be queried and written to the nonvolatile memory (see: [Adapting Settings \(p. 94\)](#)).

## 4.9 Functional Principles of the E-873.1AT

### 4.9.1 Block Diagram

The E-873.1AT controls the motion of a positioner's logical axis. The following block diagram shows how the E-873.1AT generates the piezo voltage for the axis connected:

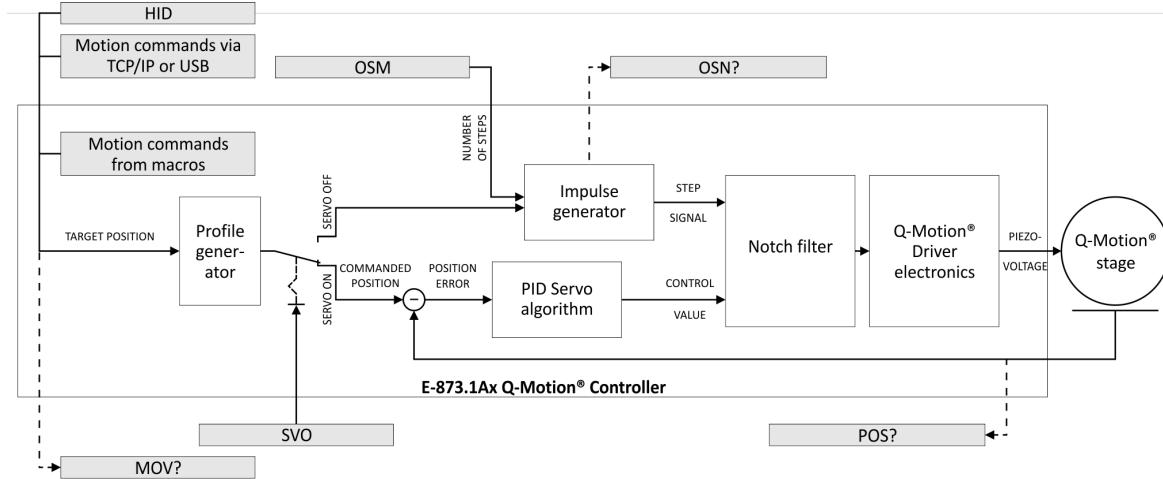


Figure 3: E-873.1AT: Generating the piezo voltage

The E-873.1AT supports positioners with piezo inertia drive and incremental sensor.

#### 4.9.2 Important Firmware Components

The functional units of the E-873.1AT's firmware are described in the following.

The firmware can be updated with a tool. The current firmware version can be ascertained with the [VER?](#) command.

Component	Description
Parameters	<p>Parameters reflect the properties of the positioner connected (e.g., travel range) and specify the behavior of the E-873.1AT (e.g., settings for the servo algorithm).</p> <p>The parameters can be divided into the following categories:</p> <ul style="list-style-type: none"> <li>■ Protected parameters whose default settings cannot be changed</li> <li>■ Parameters that must be set by the user to adapt to the application</li> </ul> <p>In the case of positioners with ID chip, the values of some parameters are stored on the ID chip. They are loaded to the volatile memory when switching on or rebooting the E-873.1AT.</p> <p>Write permission for the parameters is determined at command level. The current command level can be queried with the <a href="#">CCL?</a> command and changed with the <a href="#">CCL</a> command. This may require entering a password.</p> <p>The list of parameters available in the E-873.1AT can be queried with the <a href="#">HPA?</a> command.</p> <p>For more information on parameters, see: <a href="#">Adapting Settings (p. 94)</a></p>
ASCII commands (GCS)	<p>Communication with the E-873.1AT can be made with commands from the PI General Command Set (GCS). The GCS syntax version can be queried with the <a href="#">CSV?</a> command.</p> <p>Examples of the use of GCS:</p> <ul style="list-style-type: none"> <li>■ Configuring the E-873.1AT</li> <li>■ Setting the operating mode</li> <li>■ Starting motion of the positioner</li> <li>■ Getting system and position values</li> </ul> <p>The list of commands available in the E-873.1AT can be queried with the <a href="#">HLP?</a> command.</p>
Profile Generator	<p>The profile generator does calculations in closed-loop operation to specify the target position, velocity, and acceleration of an axis for each point in time during motion. The result is the dynamics profile.</p> <p>For information, see: <a href="#">Generating the Dynamics Profile (p. 30)</a></p>
Servo algorithm	<p>Closed-loop operation: The position error that results from the difference between the commanded target position and the actual position (sensor feedback) runs through a servo algorithm.</p> <p>For information, see: <a href="#">Servo Algorithm and Other Control Value Corrections (p. 34)</a></p>
Data recorder	<p>The E-873.1AT contains a real-time data recorder. The data recorder can record various signals (e. g., position, control value) from different data sources (e. g., logical axes).</p> <p>For information, see: <a href="#">Data Recorder (p. 73)</a></p>

Component	Description
Macros	<p>The E-873.1AT can save macros. Command sequences can be defined and stored permanently in the nonvolatile memory of the device via the macro function. A startup macro can be defined that runs each time the E-873.1AT is switched on or rebooted. The startup macro simplifies stand-alone operation (operation without a connection to the PC).</p> <p>For information, see: <a href="#">Controller Macros (p. 83)</a></p>

### Commands

C	Page
CCL	Set Command Level
CCL?	Get Command Level
CSV?	Get Current Syntax Version
H	Page
HLP?	Get List Of Available Commands
HPA?	Get List Of Available Parameters
V	Page
VER?	Get Versions Of Firmware And Drivers

### Parameters

#### 4.9.3 Commandable Items

The following table contains the elements that can be commanded with the GCS commands for the E-873.1AT.

Element	Quan- tity	ID	Description
Logical axis	1	1*	<p>A logical axis represents the motion of the mechanics in E-873.1AT's firmware. It corresponds to the axis of a linear coordinate system. Motion for logical axes is commanded in the firmware of the E-873.1AT (i.e., for the directions of motion of a positioner).</p> <p>The axis identifier can be queried with the <a href="#">SAI?</a> command and modified with the <a href="#">SAI</a> command. It can consist of up to 8 characters; valid characters are:</p> <p>1234567890ABCDEFGHIJKLMNOPQRSTUVWXYZ_-</p> <p>The positioner type connected to an axis can be queried with the <a href="#">CST?</a> command. If the <b>Stage Name</b> parameter (0x3C) has the value NOSTAGE, the axis is "deactivated". A deactivated axis is not accessible for axis-related commands (e.g., motion commands or position queries). The identifier of a deactivated axis can only be queried with <a href="#">SAI? ALL</a>.</p>
Analog inputs	8	1 to 8	<p>The analog input lines with the identifiers 1 to 4 are the inputs 1 to 4 of the <i>I/O</i> socket. Their number is displayed with the <a href="#">TAC?</a> command and their values can be queried with the <a href="#">TAV?</a> command. Note that these lines can also be used as digital inputs (see below).</p> <p>Additional analog input lines are located at the <i>Joystick</i> socket. These lines are not output via <a href="#">TAC?</a> and <a href="#">TAV?</a>.</p> <p>The values of all inputs can be recorded via record option 81 of the <a href="#">DRC</a> command.</p> <p>For information, see: <a href="#">Analog Input Signals (p. 75)</a></p>
Digital outputs	4	1 to 4	<p>1 to 4 identify digital output lines 1 to 4 of the <i>I/O</i> socket.</p> <p>For information, see: <a href="#">Digital Output Signals</a></p>
Digital inputs	4	1 to 4	<p>1 to 4 identify digital input lines 1 to 4 of the <i>I/O</i> socket, which can also be used as analog inputs (see above).</p> <p>For information, see: <a href="#">Digital Input Signals</a></p>
HID (Human Interface Device)	1	1	<p>The HID (e.g., joystick) is used for HID control of the E-873.1AT's logical axis. Information on the HID's axes and buttons can be queried with the <a href="#">HIS?</a> command.</p> <p>For information, see: <a href="#">Controlling with an HID (p. 77)</a></p>
HID axes	4	1 to 4	<p>Two of the HID's axes can be connected to the <i>Joystick</i> socket. Connection options:</p> <ul style="list-style-type: none"> <li>■ Pin 4 (0 to 3.3 V): Command as axis 1 of the HID</li> <li>■ Pin 2 (0 to 3.3 V): Command as axis 2 of the HID</li> </ul>

Element	Quan- tity	ID	Description
			Two further axes of the HID can be connected to the <b>I/O</b> socket. Connection options: <ul style="list-style-type: none"><li>■ Pins 1 and 2 (TTL signals): Command as axis 3 of the HID</li><li>■ Pins 3 and 4 (TTL signals): Command as axis 4 of the HID</li></ul>
HID buttons	2	1, 2	The two buttons of the human interface device can be connected to the <b>Joystick</b> socket. Connection options: <ul style="list-style-type: none"><li>■ Pin 5 (0 or 3.3 V): Command as button 1 of the HID</li><li>■ Pin 6 (0 or 3.3 V): Command as button 2 of the HID</li></ul>
Data recorder tables	4	1 to 4	The E-873.1AT has 4 data recorder tables (query with <a href="#">TNR?</a> ) with 8192 data points per table. For information, see: <a href="#">Data Recorder (p. 73)</a>
Overall system	1	1	E-873.1AT as an overall system  Information on name, serial number, and firmware version of the E-873.1AT can be queried with the <a href="#">*IDN?</a> command.  The ready state of the E-873.1AT can be queried with the <a href="#">#7</a> command.

\* modifiable

## Commands

#		Page
<b>#7</b>	Request Controller Ready Status	108
*		Page
<b>*IDN?</b>	Get Device Information	109
<b>C</b>		Page
<b>CST?</b>	Get Assignment Of Stages To Axes	112
<b>D</b>		Page
<b>DRC</b>	Set Data Recorder Configuration	119
<b>H</b>		Page
<b>HIS?</b>	Get Configuration Of HI Device	132
<b>S</b>		Page
<b>SAI</b>	Set Current Axis Identifiers	150
<b>SAI?</b>	Get List Of Current Axis Identifiers	150
<b>T</b>		Page
<b>TAC?</b>	Tell Analog Channels	156
<b>TAV?</b>	Get Analog Input Voltage	156

TNR?	Get Number Of Record Tables	157
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### Parameters

0x3C	Stage Name	Positioner name. Default value: NOSTAGE String up to 20 characters
------	------------	--

## 4.9.4 Operating Modes

The following operating modes of the E-873.1AT can be distinguished:

- Servo mode: Closed-loop/open-loop operation
- Drive mode: Step mode/linear mode

### Servo mode

The servo mode determines whether the motion is performed in closed-loop operation or in open-loop operation.

- Closed-loop operation (servo mode On)
 

A profile generator calculates the dynamics profile from the values specified for target position, velocity, acceleration, and deceleration. The position error resulting from the difference between the dynamics profile generated and the actual position (sensor feedback) runs through a PID servo algorithm (proportional-integral-derivative). Additional corrections can be made as well. The result is the control value that is converted into the control voltage for the Q-Motion® drive electronics integrated in the E-873.1AT.
- Open-loop operation (servo mode Off)
 

There is no servo control via a servo algorithm in open-loop operation. The E-873.1AT does not evaluate the position sensor's signals.

### Information

The E-873.1AT is intended for closed-loop operation with position sensors (servo mode On). After switch-on, open-loop operation is active by default (servo mode Off).

- ▶ Query the current operating mode with the [SV0?](#), [#4](#) or [SRG?](#) commands.
- ▶ Enable closed-loop operation with the [SV0](#) command.
- ▶ If necessary, program a startup macro that starts the E-873.1AT in closed-loop operation via the [SV0](#) command.
- ▶ Avoid motion in open-loop operation.

### Drive mode

Piezo inertia drives are piezo-based drives with virtually unlimited travel range. They use the stick-slip effect (inertia effect) – a cyclical alternation of static and sliding friction between a moving runner and the piezo actuator generated by the piezo element – for a continuous feed of the runner. The operating voltage is therefore output by the E-873.1AT as a modified sawtooth signal with a maximum frequency of 25 kHz.

The output of one period of the modified sawtooth signal generates one "step" of the runner. At rest, the drive is self-locking, requires no current, and does not generate any heat. It holds the position with maximum force.

In the case of a piezo inertia drive, a piezo actuator acts on a moving runner to generate motion. The E-873.1AT supports the following drive modes for piezo inertia drives in open-loop operation:

### Step mode

The drive electronics of the E-873.1AT convert the control value to a modified sawtooth signal with a maximum frequency of 25 kHz and output the corresponding piezo voltage. The piezo voltage generates a cyclic alternation of static and sliding friction between the moving rod and the piezo actuator and therefore a continuous feed of the rod. The output of one period of the modified sawtooth signal generates one "step" of the rod.

The travel range is only limited by the physical limits of the positioner.

#### **Linear mode**

The drive electronics of the E-873.1AT convert the control value to an analog signal. The output piezo voltage corresponds to 10 times this analog signal. The feed of the rod is generated by the expansion of the piezo actuator caused by the piezo voltage. The piezo actuator achieves its maximum expansion when the E-873.1AT outputs the maximum permitted piezo voltage.

The travel range is limited by the maximum expansion of the piezo actuator.

#### **Motion in closed-loop operation**

Motion is done in closed-loop operation as follows:

Can the target position be reached in linear mode?		Motion sequence
Yes		Linear mode with control value correction via PID servo algorithm and notch filter
No		<p>Sequence of the following four steps:</p> <ol style="list-style-type: none"><li>1. Linear mode</li><li>2. Fast step mode</li><li>3. Slow individual steps</li><li>4. Linear mode (analog step-and-settle at the target position)</li></ol> <p>Step mode is switched over to linear mode at the end of motion to allow controlled approach to the target position. Control value correction via the PID servo algorithm and the notch filter is only done in linear mode during step 4 of the motion.</p>

The motion sequence consisting of linear and step mode carried out in closed-loop operation can be configured with the following parameters:

Parameters	Description
<b>PIShift Step Size (Phys. Unit)</b> (0x1F000700)	<p>Size of the slow individual steps</p> <p>Serves as criterion for switching between the following phases of the motion sequence:</p> <ul style="list-style-type: none"> <li>■ Fast step mode &gt; slow individual steps: Switching threshold: 4 x parameter value</li> <li>■ Slow individual steps &gt; linear mode Switching threshold: Position error &lt; parameter value</li> </ul>
<b>PIShift Delay (ms)</b> (0x1F000701)	<p>Delay time when switching between two operating modes (e.g., step mode and linear mode)</p> <p>Specifies the following:</p> <ul style="list-style-type: none"> <li>■ Length of time between the end of the linear mode in step 1 and the beginning of fast step mode</li> <li>■ Length of time between the end of fast step mode and the beginning of the slow individual steps</li> <li>■ Length of time between slow individual steps</li> <li>■ Length of time between the last slow individual step and the beginning of linear mode</li> </ul>

#### Further parameters for configuring the drive mode

Applies to closed-loop and open-loop operation:

- [PIShift Upper Supply Voltage \(V\)](#) (0x1F000000)
- [PIShift Lower Supply Voltage \(V\)](#) (0x1F000100)
- [PIShift Forward Current \(A\)](#) (0x1F000200)
- [PIShift Backward Current \(A\)](#) (0x1F000300)
- [PIShift Charge Cycle](#) (0x1F000500)
- [PIShift Offset Current \(A\)](#) (0x1F000703)

#### Commands

#		Page
<b>#4</b>	Request Status Register	107
S		Page
<b>SRG?</b>	Query Status Register Value	153
<b>SVO</b>	Set Servo Mode	155
<b>SVO?</b>	Get Servo Mode	156

#### Parameters

<b>0x1F000700</b>	<a href="#">PIShift Step Size (Phys. Unit)</a>	Size of the slow individual steps in closed-loop operation
<b>0x1F000701</b>	<a href="#">PIShift Delay (ms)</a>	Delay time when switching between two operating modes (e.g., step mode and linear mode). 0 to 2000 [ms]

<b>0x1F000000</b>	PIShift Upper Supply Voltage (V)	Maximum output voltage for piezo inertia drives. The value depends on the type of the drive.
<b>0x1F000100</b>	PIShift Lower Supply Voltage (V)	Minimum output voltage for piezo inertia drives. The value depends on the type of the drive.
<b>0x1F000200</b>	PIShift Forward Current (A)	Maximum output current for piezo inertia drives during forward motion. The value depends on the type of the drive.
<b>0x1F000300</b>	PIShift Backward Current (A)	Maximum output current for piezo inertia drives during backward motion. The value depends on the type of the drive.
<b>0x1F000500</b>	PIShift Charge Cycle	Duty cycle of the current source during output of a step. Specified as part of a period which the current source is switched on for. 0 to 1 The value depends on the type of the drive.
<b>0x1F000703</b>	PIShift Offset Current (A)	Offset current in open-loop operation - 0.05 to 0.05 The preset value should not be changed.

#### 4.9.5 Triggering Motion

Motion is triggered in **closed-loop** operation either by commands or an HID, e.g., a joystick. HID control is not possible in **open-loop** operation.

The motion status of the axes connected to the E-873.1AT can be queried with the [#5](#) command.

Motion triggered by commands can be **stopped** with the following commands:

- [#24, STP](#): Abrupt stop
- [HLT](#): Gentle stop

In both cases, the error code 10 is set for information.

##### Motion in closed-loop operation

Motion is triggered in closed-loop operation either by commands or an HID, e.g., a joystick. Motion commands for an axis are not permitted when HID control is activated for the axis.

Trigger of the motion	Commands	Description
Commands for point-to-point motion sent from the command line or via the PC software	<a href="#">MOV</a> , <a href="#">MVR</a>	Motion to absolute or relative target position
	<a href="#">STE</a>	Jumps a specified distance and records the response
	<a href="#">FNL</a> , <a href="#">FPL</a> , <a href="#">FRF</a>	Starts reference moves
	<a href="#">FED</a>	Starts moves to signal edges
Controller macros with motion commands	<a href="#">MAC</a>	<p>Calls a macro function. Permits recording, deleting, and running macros on the controller.</p> <p>Any commands can be sent from the command line while a macro is running on the controller. The macro content and motion commands received from the command line can overwrite each other.</p>
HID control	<a href="#">HIN</a>	Activates or deactivates control of the E-873.1AT's axes via the HID's axes.
	<a href="#">HIA</a>	<p>Configures HID control for the axes of the E-873.1AT. The following motion parameters of the E-873.1AT's axes can be controlled via the HID's axes:</p> <ul style="list-style-type: none"> <li>■ Absolute target position</li> <li>■ Relative target position (frequency with which the controlled axis of the mechanics is moved)</li> <li>■ Velocity of the axis</li> <li>■ Maximum velocity of the axis</li> </ul>

## Information

Absolute target positions can only be commanded for positioners with incremental position sensor when the reference point definition was determined for the axis, see [Reference Point Definition \(p. 40\)](#).

### Motion in open-loop operation

HID control is not possible in open-loop operation.

Motion is triggered by the following commands:

Commands	Description
<a href="#">STE</a>	Initiates a jump by a specified number of steps and records the response.
<a href="#">OSM</a>	Moves an axis by a particular number of steps The number of steps that the axis still must do can be queried with the <a href="#">OSN?</a> command.

## Commands

#		Page
#24	Stop All Axes	109
#5	Request Motion Status	108

F	Page	
<b>FED</b>	Find Edge	123
<b>FNL</b>	Fast Reference Move To Negative Limit	124
<b>FPL</b>	Fast Reference Move To Positive Limit	124
<b>FRF</b>	Fast Reference Move To Reference Switch	125
H	Page	
<b>HIA</b>	Configure Control Done By HID Axis	129
<b>HIN</b>	Set Activation State For HID Control	131
<b>HLT</b>	Halt Motion Smoothly	134
M	Page	
<b>MAC</b>	Call Macro Function	140
<b>MOV</b>	Set Target Position	144
<b>MVR</b>	Set Target Relative To Current Position	145
O	Page	
<b>OSM</b>	Open-Loop Step Moving	146
<b>OSN?</b>	Read Number Steps	146
S	Page	
<b>STE</b>	Start Step And Response Measurement	155
<b>STP</b>	Stop All Axes	155

### Parameters

#### 4.9.6 Generation of Dynamics Profile

The profile generator does calculations in closed-loop operation to specify the target position, velocity, and acceleration/deceleration of the axis for each point in time during motion (dynamics profile). The values calculated are called commanded values.

The dynamics profile generated by the profile generator of the E-873.1AT depends on the motion variables that are specified by parameters and/or HID.

##### Acceleration (A)

Com-mands	Parameters	Remarks
<a href="#">ACC</a>	0xB	Is limited by the <b>Maximum Closed-Loop Acceleration (Phys. Unit/s<sup>2</sup>)</b> parameter (0x4A).
<a href="#">ACC?</a>	<b>Closed-Loop Acceleration (Phys. Unit/s<sup>2</sup>)</b> Change using the ACC command or <a href="#">SPA</a> / <a href="#">SEP</a> ; query with ACC?	The maximum acceleration during HID control is specified by the Closed-Loop Acceleration For HI Control (Phys. Unit/s <sup>2</sup> ) parameter (0x75).

### Deceleration (D)

Com-mands	Parameters	Remarks
<u>DEC</u>	0xC	Is limited by the <u>Maximum Closed-Loop Deceleration (Phys. Unit/s<sup>2</sup>)</u> parameter (0x4B).
<u>DEC?</u>	<u>Closed-Loop Deceleration (Phys. Unit/s<sup>2</sup>)</u> Change with the DEC command or with SPA / SEP; query with DEC?	The maximum deceleration during HID control is specified by the Closed-Loop Deceleration For HI Control (Phys. Unit/s <sup>2</sup> ) parameter (0x76).

### Velocity (V)

Com-mands	Parameters	Remarks
<u>VEL</u>	0x49	Is limited by the <u>Maximum Closed-Loop Velocity (Phys. Unit/s)</u> (0xA) parameter.
<u>VEL?</u>	<u>Closed-Loop Velocity (Phys. Unit/s)</u> Change with the VEL command or with SPA / SEP; query with VEL?	The maximum velocity during HID control is always specified by the Closed-Loop Velocity For HI Control (Phys. Unit/s) parameter (0x74).

### Target position at the end of the motion

Com-mands	Parameters	Remarks
<u>MOV</u>	--	The soft limits are set as the respective target position during HID control of the velocity.
<u>MVR</u>		
<u>MVE</u>		
<u>STE</u>		The E-873.1AT sets the target position to the current position of the axis in the following cases: <ul style="list-style-type: none"> <li>■ Disabling HID control for the axis</li> <li>■ Switching on the servo mode with the SV0 command</li> <li>■ Stopping the motion with the #24, STP, or HLT commands</li> </ul>

The profile generator of the E-873.1AT only supports trapezoidal velocity profiles: The axis accelerates linearly (based on the acceleration value specified) until it reaches the specified velocity. It continues to move with this velocity until it decelerates linearly (based on the deceleration value specified) and stops at the specified target position.

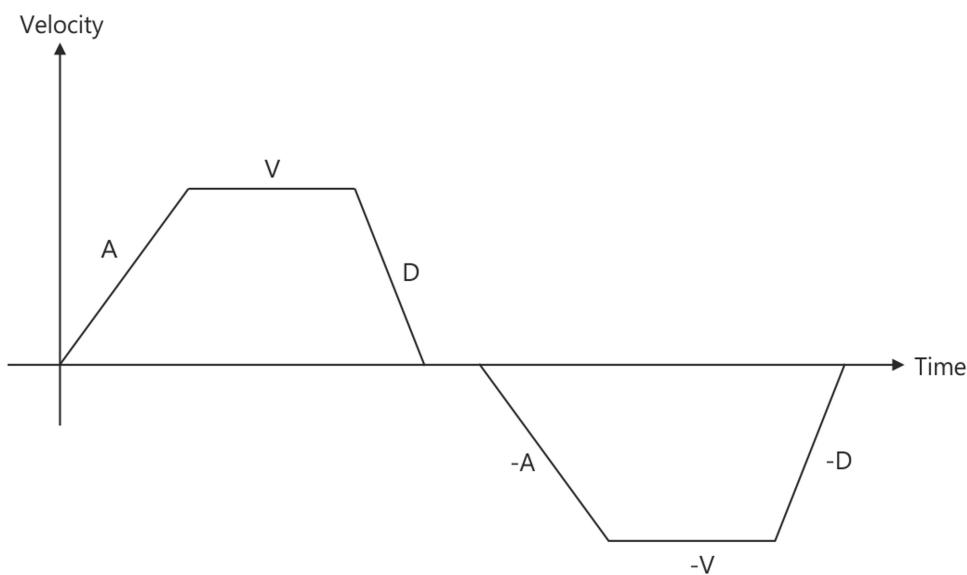


Figure 4: Basic trapezoidal velocity profile; A = acceleration, D = deceleration, V = velocity  
If the deceleration has to begin before the axis reaches the specified velocity, the profile will not have a constant velocity portion and the trapezoid becomes a triangle.

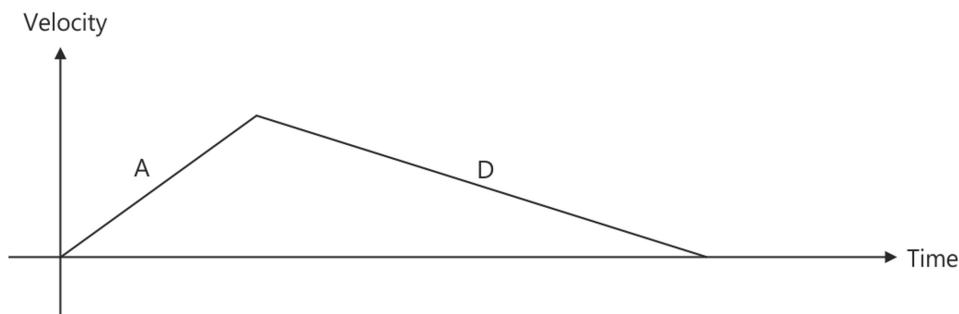


Figure 5: Basic trapezoidal velocity profile; A = acceleration, D = deceleration, no constant velocity

The edges for acceleration and deceleration can be symmetrical (acceleration = deceleration) or asymmetrical (acceleration  $\neq$  deceleration). The acceleration value is always used at the start of the motion. After that, the acceleration value is used during an increase in the absolute velocity and the deceleration value during a decrease in the absolute velocity. If none of the motion variables are changed during the course of motion, the acceleration value is used until the maximum velocity is reached and the deceleration value is used for decreasing the velocity down to zero.

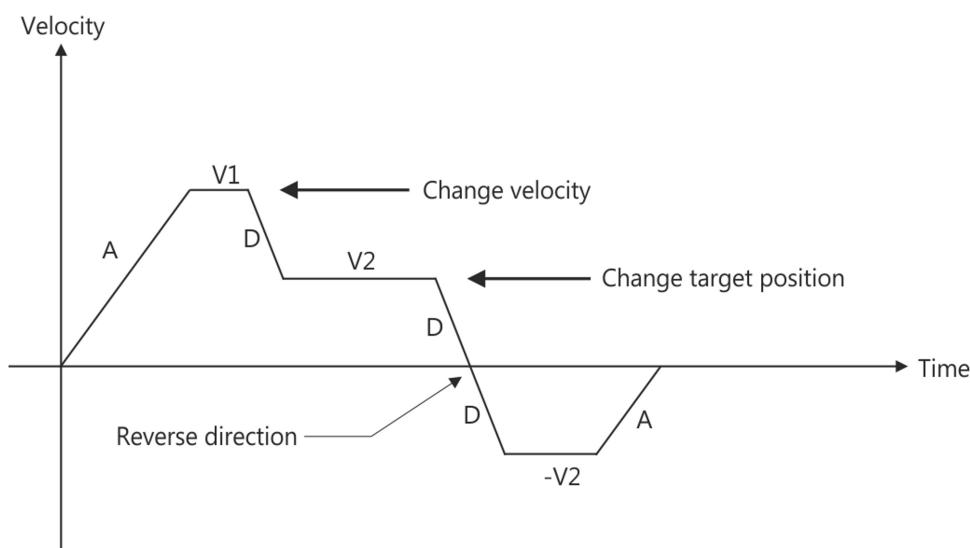


Figure 6: Complex trapezoidal profile with parameter changes; A = acceleration; D = deceleration; V1, V2, -V2 = velocities

All motion variables can be changed while the axis is in motion. The profile generator will always attempt to stay within the permissible motion limits specified by the motion variables. If the target position is changed during motion so that overshooting is unavoidable, the profile generator will decelerate to a complete stop and reverse the direction of motion in order to reach the specified position.

### Commands

		Page
<b>A</b>		
ACC	Set Closed-Loop Acceleration	110
ACC?	Get Closed-Loop Acceleration	110
<b>D</b>		Page
DEC	Set Closed-Loop Deceleration	116
DEC?	Get Closed-Loop Deceleration	116
<b>M</b>		Page
MOV	Set Target Position	144
MVR	Set Target Relative To Current Position	145
<b>S</b>		Page
SEP	Set Nonvolatile Memory Parameters	150
SPA	Set Volatile Memory Parameters	151
STE	Start Step And Response Measurement	155
<b>V</b>		Page
VEL	Set Closed-Loop Velocity	159
VEL?	Get Closed-Loop Velocity	160

### Parameters

<b>0xB</b>	Closed-Loop Acceleration (Phys. Unit/s <sup>2</sup> )	Acceleration with dynamics profile in closed-loop operation. Limited by parameter 0x4A. 0 to value of 0x4A [phys. units. / s <sup>2</sup> ]
<b>0x4A</b>	Maximum Closed-Loop Acceleration (Phys. Unit/s <sup>2</sup> )	Maximum acceleration in closed-loop operation with dynamics profile. Specifies the maximum value for parameter 0xB.
<b>0xC</b>	Closed-Loop Deceleration (Phys. Unit/s <sup>2</sup> )	Deceleration with dynamics profile in closed-loop operation. Limited by parameter 0x4B.
<b>0x4B</b>	Maximum Closed-Loop Deceleration (Phys. Unit/s <sup>2</sup> )	Maximum deceleration in closed-loop operation with dynamics profile. Specifies the maximum value for parameter 0xC.
<b>0x49</b>	Closed-Loop Velocity (Phys. Unit/s)	Velocity in closed-loop operation with dynamics profile. Limited by parameter 0xA. 0 to value of 0xA [phys. units / s]
<b>0xA</b>	Maximum Closed-Loop Velocity (Phys. Unit/s)	Maximum velocity with dynamics profile in closed-loop operation. Specifies the maximum value for parameter 0x49.

#### 4.9.7 Servo Algorithm and Other Control Value Corrections

The control value for the drive electronics integrated in the E-873.1AT and therefore the system's settling behavior is optimized in closed-loop operation by a PID (proportional-integral-differential) servo algorithm. Independent of the servo mode, the control value is also corrected by a notch filter in linear mode.

**Settings for the servo algorithm**

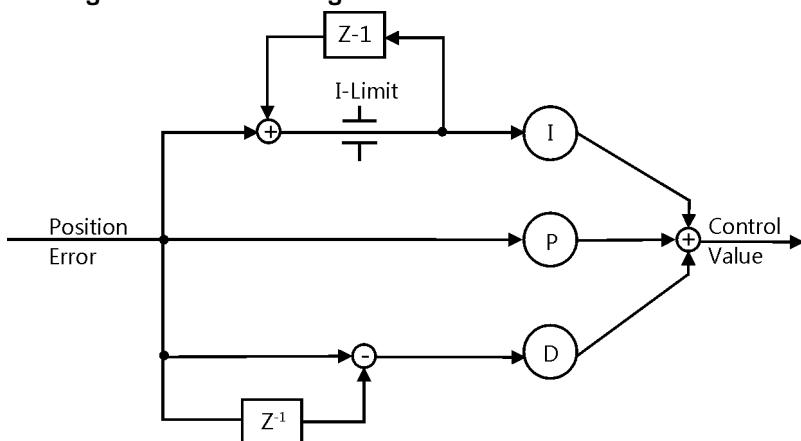


Figure 7: PID algorithm

The control value for the drive electronics integrated in the E-873.1AT and therefore the systems' settling behavior is optimized in closed-loop operation by the following corrections:

- **Servo algorithm:** The position error that results from the difference between the commanded position and the actual position (sensor feedback) runs through a PID servo algorithm.

The servo algorithm uses the following servo control parameters:

- **P Term (0x1)**

- I Term (0x2)
- D Term (0x3)
- I-Limit (0x4)
- D-Term Delay (No. Of Servo Cycles) (0x71)

The input of the servo algorithm can be configured for the E-873.1AT with the following parameters:

- Numerator Of The Servo-Loop Input Factor (0x5A)
- Denominator Of The Servo-Loop Input Factor (0x5B)

The servo-loop input factor decouples the servo control parameters from the encoder resolution. The servo-loop input factor is independent of the factor for counts per physical length unit (0xE and 0xF). Numerator and denominator of the servo-loop input factor should not be changed.

#### **Settings for the Notch Filter**

The notch filter corrects the control value in linear mode. The corrections by the notch filter take place in closed-loop and open-loop operation. The notch filter can be configured with the following parameters: (see: [Setting the Notch Filter \(p. 62\)](#)):

- Notch Filter Frequency 1 (Hz) (0x94)
- Notch Filter Edge 1 (0x95)

#### **Commands**

#### **Parameters**

<b>0x1</b>	P term	Proportional constant of the PID servo algorithm. Is used for fast correction of the position error. 0 to 32767
<b>0x2</b>	I term	Integration constant of the PID servo algorithm. Used for reducing static position error. 0 to 32767
<b>0x3</b>	D term	Differential constant of the PID servo algorithm. Used for damping rapid control oscillation. The D term can be calculated as a floating average over several servo cycles. The parameter 0x71 (D-Term Delay) specifies how many values (i.e., servo cycles) are to be used for calculating the average. 0 to 32767 The preset value of this parameter should not be changed.
<b>0x4</b>	I limit	Limit of the integration constant. 0 to 32767
<b>0x71</b>	D Term Delay (No. Of Servo Cycles)	D term delay. Determines how many values (i.e., servo cycles) are used for calculating the mean value of the D term. The preset value of this parameter should not be changed.
<b>0x5A</b>	Numerator Of The Servo Loop Input Factor	Input factor numerator for the servo loop. Decimal number

<b>0x5B</b>	Denominator Of The Servo Loop Input Factor	Input factor denominator for the servo loop. Decimal number
<b>0x94</b>	Notch Filter Frequency 1 (Hz)	Frequency of the first notch filter. The appropriate frequency component is reduced in the control value to compensate for undesired resonances in the mechanics. 40 to 20,000 [Hz]
<b>0x95</b>	Notch Filter Edge 1	Edge steepness of the first notch filter. The greater the value of this parameter, the narrower the notch filter bandwidth. 0.1 to 10 (dimensionless)

#### 4.9.8 On-Target State

In closed-loop operation, the on-target state can be used to check whether the target position has been reached:

- On-target state = true (1): The target position is considered as reached
- On-target state = false (0): The target position is considered as not reached

The E-873.1AT determines the on-target state on the basis of the following criteria:

- Settling window around the target position ([Settling Window \(Encoder Counts\)](#) parameter (0x36))
- Delay time for setting the on-target state ([Settling Time \(s\)](#) parameter (0x3F))

The on-target state has the value true in the following cases:

- The current position is inside the settling window and stays there at least for the duration of the delay time.
- If the value for the delay time is set to 0: The current position is in the settling window.

The on-target state can be read with the [ONT?](#), #4 and [SRG?](#) commands.

##### Commands

#		Page
<b>#4</b>	Request Status Register	107
<b>O</b>		Page
<b>ONT?</b>	Get On-Target State	145
<b>S</b>		Page
<b>SRG?</b>	Query Status Register Value	153

##### Parameters

<b>0x36</b>	Settling Window (Encoder Counts)	Settling window around the target position. Presets the window limits (half of the window width). If the current position exits the settling window, the target position is no longer considered as reached. Can be changed only if the servo mode is switched off. 0 to 231 [encoder counts]
-------------	----------------------------------	---

<b>0x3F</b>	Settling Time (s)	Delay time for setting the on-target state. 0.000 to 1.000 [s]
-------------	-------------------	---

#### 4.9.9 Reference Switch Detection

The E-873.1AT receives signals from the reference switch at its [axis connector \(p. 212\)](#). The [TRS?](#) command can be used to determine whether an axis has a reference switch with direction sensing.

The signal from the reference switch of the positioner can be used for reference moves. The controller knows the absolute axis position after a reference move ([reference point definition \(p. 40\)](#)).

The following parameters can be used to configure how the E-873.1AT detects the reference switch:

- [Invert Reference? \(0x31\)](#)
- [Has Reference? \(0x14\)](#)
- [Reference Signal Type \(0x70\)](#)

##### Commands

T		Page
<a href="#">TRS?</a>	Indicate Reference Switch	158

##### Parameters

<b>0x31</b>	Invert Reference?	Should the reference signal be inverted? Inverts the signal of the reference switch or a digital input that is used instead of the reference switch. 0 Reference signal not inverted 1 Reference signal inverted
<b>0x14</b>	Has Reference?	Do the mechanics have a reference switch? Activates respectively deactivates reference moves to the installed reference switch. 0 No reference switch 1 Reference switch available
<b>0x70</b>	Reference Signal Type	Reference signal type.

#### 4.9.10 Limit Switch Detection

The E-873.1AT receives signals from the limit switch at its [axis connector \(p. 212\)](#). The [LIM?](#) command can be used to determine whether an axis has limit switches.

The signals from the limit switches (also end-of-travel sensors) of a linear stage are used to stop the motion prior to the hard stop at both ends of the travel range. In addition, [soft limits \(p. 38\)](#) can be set via parameters of the E-873.1AT.

The limit switch signals can also be used for reference moves. The controller knows the absolute axis position after a reference move to a limit switch ([reference point definition \(p. 40\)](#)).

The following parameters can be used to configure how the E-873.1AT detects the limit switches:

- [Limit Mode \(0x18\)](#)
- [Has No Limit Switches? \(0x32\)](#)

■ [Use Limit Switches Only For Reference Moves? \(0x77\)](#)

**Commands**

L		Page
LIM?	Indicate Limit Switches	139

**Parameters**

0x18	Limit Mode	Signal logic of the limit switches. 0 pos-HI, neg-HI 1 pos-LO, neg-HI 2 pos-HI, neg-LO 3 pos-LO, neg-LO
0x32	Has No Limit Switches?	Do the mechanics not have limit switches? Activates motion stop at the installed limit switches. 0 Mechanics have limit switches 1 Mechanics do not have limit switches
0x77	Use Limit Switches Only For Reference Moves?	Should the limit switches only be used for reference moves? Is intended for use with rotation stages. Only evaluated when parameter 0x32 has the value 0.

#### 4.9.11 Travel Range and Soft Limits

The physical limits of the travel range can be represented by the following items of a positioner:

- Limit switches
- If the positioner does not have integrated limit switches: Hard stops

##### Settings for the travel range

The following parameters of the E-873.1AT reflect the physical travel range of the positioner:

- [Value At Reference Position \(Phys. Unit\) \(0x16\)](#)
- [Distance From Negative Limit To Reference Position \(Phys. Unit\) \(0x17\)](#)
- [Distance From Reference Position To Positive Limit \(Phys. Unit\) \(0x2F\)](#)

##### Settings for the soft limits

The E-873.1AT supports two parameter pairs for establishing soft limits. They are intended for different applications:

- [Maximum Travel In Positive Direction \(Phys. Unit\) \(0x15\)](#) und [Maximum Travel In Negative Direction \(Phys. Unit\) \(0x30\)](#):
  - The limits establish the permissible travel range in closed-loop operation.
  - Motion commands are executed only if the commanded position is within these soft limits.
  - The limits always refer to the current zero position.
  - Appropriate values are loaded when the positioner is selected from the positioner database.
- [Range Limit Min \(0x7000000\)](#) und [Range Limit Max \(0x7000001\)](#):
  - The limits define additional soft limits for the positive and negative direction of movement.

- The limits apply both in closed-loop and open-loop operation.
- Using these limits is recommended only if open-loop motion is required. For logical reasons, the values are outside the soft limits specified via 0x15 and 0x30.
- Motion is stopped abruptly once the current position reaches a limit.
- The limits are independent of the current zero position.
- The values are not loaded from the positioner database and are set in the default settings so that the limits are deactivated.

## Commands

### Parameters

<b>0x16</b>	Value At Reference Position (Phys. Unit)	Position value at the reference switch. The current position is set to this value if the axis has performed a reference move to the reference switch. The parameter value is also used for calculating the position values set after reference moves to the limit switches; this also applies when the mechanics do not have a reference switch.
<b>0x17</b>	Distance From Negative Limit To Reference Position (Phys. Unit)	Gap between reference switch and negative travel range limit. The current position is set to the difference between the values of parameters 0x16 and 0x17 if the axis has done a reference move to the negative travel range limit.
<b>0x2F</b>	Distance From Reference Position To Positive Limit (Phys. Unit)	Gap between the reference switch and the positive travel range limit. If the axis has done a reference move to the positive travel range limit, the current position is set to the sum of the values of parameters 0x16 and 0x2F.
<b>0x15</b>	Maximum Travel In Positive Direction (Phys. Unit)	Soft limit in positive direction, in relation to the zero position. The positive travel range limit cannot be used for reference moves if this value is smaller than the position value for the positive travel range limit (that results from the sum of parameters 0x16 and 0x2F). The value can be negative.
<b>0x30</b>	Maximum Travel In Negative Direction (Phys. Unit)	Soft limit in a negative direction, in relation to the zero position. The negative travel range limit cannot be used for reference moves if this value is greater than the position value for the negative travel range limit (that results from the difference between parameters 0x16 and 0x17). The value can be negative.

## 4.9.12 Reference Point Definition

Whether a reference point definition is necessary for the axis depends on the signal type of the position sensor:

- Absolute measuring position sensor: Reference point definition is not necessary.
- Incremental position sensor: Reference point definition is necessary.

Incremental sensors only supply relative motion information. When the positioner is equipped with an incremental position sensor, the controller therefore does not know the absolute position of the axis during switch-on or reboot. So that absolute target positions can be commanded and reached, a reference point definition must be performed beforehand.

### Reference point definition options

The reference point definition can be performed in different ways:

- **Reference move (default):** A reference move moves the axis to a specifically defined point, e.g., to the reference switch, to a limit switch or to a hard stop. At this point, the current position is set to a defined value. The controller now knows the absolute axis position. The reference move can be started with one of the following commands:
  - [FRF](#): Starts a reference move to the reference switch. The approach depends on the value of the [Reference Signal Type](#) parameter (ID 0x70).
  - [FNL](#): Starts a reference move to the negative limit switch
  - [FPL](#): Starts a reference move to the positive limit switch
- **Setting the absolute position manually:** If this type of reference point definition was activated by the [RON](#) command, you can set the current position of the axis to an arbitrary value at an arbitrary point using the [POS](#) command. Here the axis is not moved. The controller knows the absolute axis position afterwards.

[FRF?](#) can be used to query whether an axis is referenced. [RON?](#) can be used to query the reference point definition mode for an axis.

The [Use Hard Stops For Referencing?](#) parameter (0x7A) sets whether hard stops may be used for reference moves. The set parameter value can be queried with the [HAR?](#) command.

During startup using PIMikroMove, the reference point definition is performed via a reference move by default. Knowledge of the commands and parameters described here is not needed for reference point definition using PIMikroMove.

### Reference Move Procedures

To achieve maximum repeatability of the reference point definition, every reference move comprises the following steps:

1. First move to the selected switch.  
The maximum velocity is specified by the [Closed-Loop Velocity \(Phys. Unit/s\)](#) parameter (0x49) and the default direction for the reference move by the [Reference Travel Direction](#) parameter (0x47).
2. Stop when the switch edge has been reached.  
The higher the velocity on approach, the farther the axis overruns the edge of the switch (overshooting).
3. Move in the opposite direction to compensate for the overshoot.
4. Second move to the selected switch.  
The maximum velocity is specified by the [Velocity For Reference Moves \(Phys. Unit/s\)](#) parameter (0x50).
5. Stop on reaching the switch edge.
6. Move in the opposite direction to compensate for the overshoot.
7. Setting the current position to a defined value.  
The reference point definition is finished.

The lower the velocity is when approaching the switch, the less the overshoot will be and the higher the repeatability. Therefore, the value of parameter 0x50 should be maximally as great as the value of parameter 0x49, though ideally substantially less.

The actual velocities during the reference move are calculated from the values of the following parameters and can be lower than the maximum values:

- **Closed-Loop Velocity (Phys. Unit/s)** parameter (0x49) or **Velocity For Reference Moves (Phys. Unit/s)** parameter (0x50)
- **Distance Between Limit And Hard Stop (Phys. Unit)** parameter (0x63)
- **Closed-Loop Deceleration (Phys. Unit/s<sup>2</sup>)** parameter (0xC)

The **Distance From Limit To Start Of Ref. Search (Phys. Unit)** parameter (0x78) and **Distance For Reference Search (Phys. Unit)** parameter (0x79) are used for reference moves when both of the following conditions are met:

- The reference move is started with **FRF**.
- The **Reference Signal Type** parameter (0x70) has the value 2 or 3.

Sequence of the reference move:

1. The axis moves to the corresponding limit switch.
2. The axis moves the distance specified by the parameter 0x78 away from the limit switch.
3. The axis moves to the index pulse and therefore travels the distance specified by the parameter 0x79 at the maximum.

## Commands

F		Page
<b>FNL</b>	Fast Reference Move To Negative Limit	124
<b>FPL</b>	Fast Reference Move To Positive Limit	124
<b>FRF</b>	Fast Reference Move To Reference Switch	125
<b>FRF?</b>	Get Referencing Result	125
H		Page
<b>HAR?</b>	Indicate Hard Stops	126
P		Page
<b>POS</b>	Set Real Position	147
R		Page
<b>RON</b>	Set Reference Mode	148
<b>RON?</b>	Get Reference Mode	148

## Parameters

<b>0x70</b>	Reference Signal Type	Reference signal type.
<b>0x7A</b>	Use Hard Stops For Referencing?	Should the hard stops be used for reference moves?
<b>0x49</b>	Closed-Loop Velocity (Phys. Unit/s)	Velocity in closed-loop operation with dynamics profile. Limited by parameter 0xA. 0 to value of 0xA [phys. units / s]

<b>0x47</b>	Reference Travel Direction	Default direction for the reference move. 0 Automatic detection 1 Negative direction 2 Positive direction
<b>0x50</b>	Velocity For Reference Moves (Phys. Unit/s)	Maximum velocity for reference moves. 0 to value of parameter 0x49 [phys. units / s]
<b>0x63</b>	Distance Between Limit And Hard Stop (Phys. Unit)	Gap between internal limit switch and hard stop. Determines the maximum stopping distance during reference moves. The actual velocities during a reference move are calculated on the basis of this value, the set deceleration (0xC) and set velocities (0x49 and 0x50).
<b>0xC</b>	Closed-Loop Deceleration (Phys. Unit/s <sup>2</sup> )	Deceleration with dynamics profile in closed-loop operation. Limited by parameter 0x4B.
<b>0x78</b>	Distance From Limit To Start Of Ref Search (Phys. Unit)	Gap between the limit switch and the starting position for the reference move to the index pulse. Used for FRF when parameter 0x70 has the value 2.
<b>0x79</b>	Distance For Reference Search (Phys. Unit)	Maximum distance for motion to the index pulse.
<b>0x70</b>	Reference Signal Type	Reference signal type.

## 5 Unpacking / Transportation

### 5.1 Unpacking

#### Unpacking the E-873.1AT

1. Unpack the E-873.1AT with care.
2. Compare the contents with the scope of delivery according to the contract and the delivery note.
3. Inspect the contents for signs of damage. If any parts are damaged or missing, contact our [customer service department \(p. 207\)](#) immediately.
4. If the E-873.1AT was supplied with ESD protective caps on the connectors: Do **not** remove the ESD protective caps.
5. Keep all packaging materials in case the product needs to be returned.

### 5.2 Transportation

#### Preparing the E-873.1AT for Transportation

1. Pay attention to the [ambient conditions and classifications \(p. 209\)](#).
2. Pack the E-873.1AT in the original packaging.
3. If the E-873.1AT is to be sent, use a stable outer box.

## 6 Installation

### 6.1 Mounting the E-873.1AT

The E-873.1AT can be used as a benchtop device or mounted on a surface in any orientation or installed in a control cabinet.

#### Overview

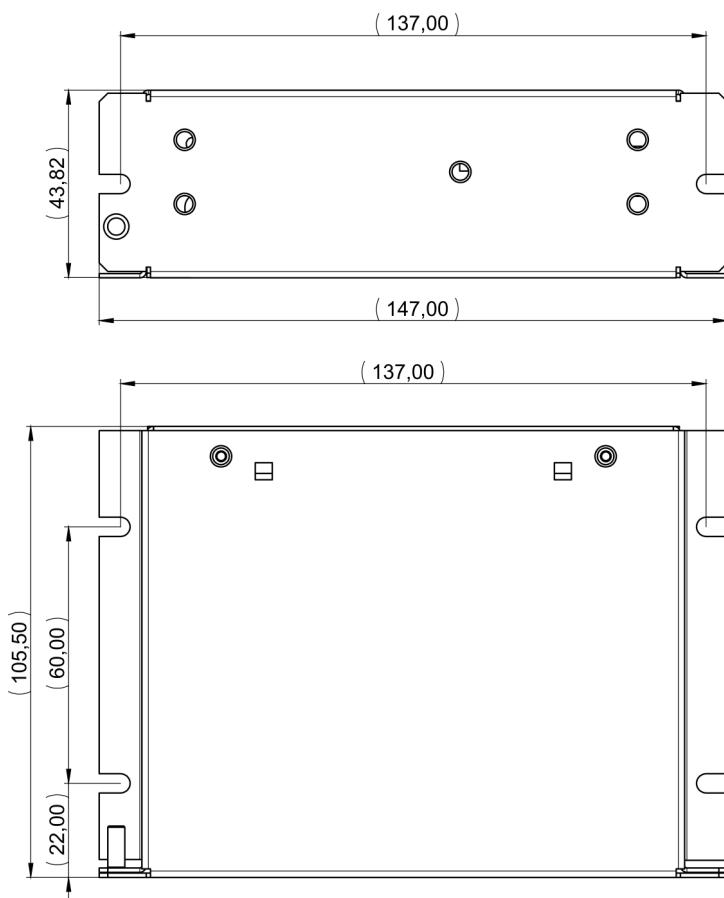


Figure 8: E-873.1AT: Dimensions and position of the recesses for mounting

#### Tools and Accessories

- Suitable screws
- Suitable screwdriver

#### Requirements

- ✓ You have read and understood the [general safety instructions \(p. 11\)](#).

#### **NOTICE**

##### Heating up of the E-873.1AT during operation!

High temperatures can overheat the E-873.1AT.

- ▶ Install the E-873.1AT with a gap of at least 10 cm to the top and rear panels and at least 5 cm to its sides. If this is not possible, make sure that the surroundings are cooled sufficiently.
- ▶ Ensure sufficient ventilation at the place of installation.
- ▶ Keep the ambient temperature at a noncritical level.

### Mounting the E-873.1AT on a Surface

1. Drill the holes required into the surface.  
The arrangement of the recesses in the mounting rails of the E-873.1AT can be seen in the figure.
2. Tighten the E-873.1AT to the recesses provided with suitable screws.

## 6.2 Connecting the E-873.1AT to the Protective Earth Conductor

The E-873.1AT is not grounded via the voltage connection and must therefore be connected to the protective earth conductor. The protective earth connector is on the right-hand rear mounting rail of the E-873.1AT.

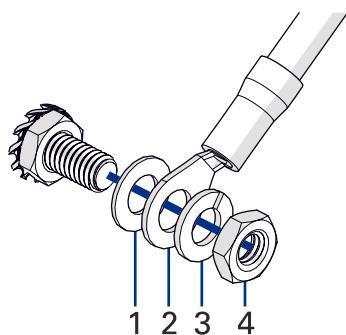


Figure 9: Connecting the protective earth conductor to the threaded bolt

1. Flat washer
2. Cable lug of the protective earth conductor
3. Spring washer
4. Nut

### Tools and Accessories

- Suitable protective earth conductor with cable lug:
  - Cable cross section  $\geq 0.75 \text{ mm}^2$
  - Contact resistance  $< 0.1 \text{ ohm}$  at 25 A at all connection points relevant for attaching the protective earth conductor
- Suitable wrench

### Requirements

- ✓ You have read and understood the [general safety instructions \(p. 11\)](#).
- ✓ The E-873.1AT is **not** connected to the power supply.

### Information

- Observe the applicable standards for connecting the protective earth conductor.

### Connecting the E-873.1AT to the Protective Earth Conductor

1. Remove the outer nut and the spring washer from the threaded bolt of the protective earth connector.
2. Push the cable lug of the protective earth conductor and the spring washer onto the threaded bolt.
3. Screw the nut onto the threaded bolt again.  
→ *The cable lug of the protective earth conductor is clamped between the flat washer and the spring washer.*
4. Tighten the nut with at least three turns and a torque of 1.2 Nm to 1.5 Nm.

## 6.3 Connecting the Power Supply to the E-873.1AT

### Tools and Accessories

- Included power adapter (alternative: Sufficiently rated power adapter)
- Included power cord (alternative: Sufficiently rated power cord)

### Requirements

- ✓ The power supply is **not** connected to the power socket via the power cord.
- ✓ The E-873.1AT is installed near the power supply so that the power plug can be quickly and easily disconnected from the mains.

#### Connect the Power Adapter to the E-873.1AT

1. Connect the power adapter's barrel connector to the E-873.1AT's barrel connector socket (**24 VDC 2.5 A**).
2. Connect the power cord to the power adapter.

## 6.4 Connecting the Positioner to the E-873.1AT

### Tools and Accessories

- Compatible positioner with piezo inertia drive
- If necessary: Suitable adapter cable from PI, available as optional accessory for the positioner.
- If the distance between the E-873.1AT and the positioner is too large: Suitable extension cable from PI

### Requirements

- ✓ The power supply is **not** connected to the power socket via the power cord or the E-873.1AT is switched off.
- ✓ You have read and understood the user manual of the positioner.

### NOTICE



#### Damage if a wrong drive type is connected!

Connecting a positioner with incompatible drive type can cause irreparable damage.

- Connect the E-873.1AT only to positioners with Q-Motion® piezo inertia drive.

#### Connecting the Stage to the E-873.1AT

1. If necessary: Connect a suitable adapter to the positioner's drive connector.
2. Connect the positioner's drive connector or the adapter to the E-873.1AT's **Motor & Sensor** socket.
3. Use the integrated screws to secure the connections against accidental disconnection.

## 6.5 Installing the PC Software

### 6.5.1 Installing the PC Software for the First Time

#### Tools and Accessories

- PC with Windows (7, 8, 10; 32 bit, 64 bit) or Linux operating system and at least 30 MB free memory
- Product CD (in the scope of delivery)

- Optional for custom positioners: Data storage device with the following content:
  - *Import PI CustomStage* program
  - Custom positioner database with the parameter set for the positioner

### Installing the PC software in Windows

1. Insert the product CD.
2. Start the **PI\_E-873.CD\_Setup.exe** installation assistant.  
→ *The InstallShield Wizard window for the installation of programs and manuals for the E-873.1AT opens.*
3. Follow the instructions on the screen.

You can choose between default installation (**Complete**) and user-defined installation (**Custom**).

With default installation (recommended), all components are installed. These include among others:

- Driver for use with NI LabVIEW software
- dynamic program library for GCS
- PIMikroMove
- PC software for updating the firmware of the E-873.1AT
- PI Update Finder for updating the PC software

With user-defined installation, you have the option of excluding individual components from the installation.

### Installing a Custom Positioner Database in Windows

If you have a **custom positioner database**, this must also be installed on the PC.

1. Connect the data storage device provided with your custom positioner to your PC.
2. Start the installation assistant for the custom positioner database by opening the **Import\_PI\_CustomStage.exe** file.  
→ *The Import PI Custom Stage program is run and the parameter set is imported from the custom positioner database into PIStages3.*
3. If a message appears that installation of the custom positioner database failed:
  - a) [Update the PIStages3 positioner database on your PC \(p. 48\)](#).
  - b) Repeat the installation of the custom positioner database.

### Installing the PC Software in Linux

1. Insert the product CD.
2. Unzip the tar archive from the **/linux** directory on the product CD into a directory on your PC.
3. Open a terminal and go to the directory to which you have unpacked the tar archive.
4. Log in as a superuser (root rights).
5. Enter **./INSTALL** to start the installation.
6. Pay attention to lower and upper case when entering commands.
7. Follow the instructions on the screen.  
You can select individual components for installation.
8. If you have received a **custom positioner database**: Copy the positioner database file into the following directory: **/usr/local/PI/pi\_gcs\_translator/**

## 6.5.2 Updating the PC Software

PI is constantly improving the PC software. Always install the latest version of the PC software and the positioner database.

The PI Update Finder is a program which helps you find updates for your PI software. It identifies the PI software installed on your computer and compares it with the software available on the PI server. This comparison is made using the Internet. If more up-to-date software is available on the PI server, the PI Update Finder will offer you a download link which directs you to the relevant software.

The comparison of software versions does not involve the transmission of confidential customer data. The following information is transmitted:

- Software component and version
- Internet browser
- Operating system
- IP address

### **Updating the PC Software and Positioner Database in Windows**

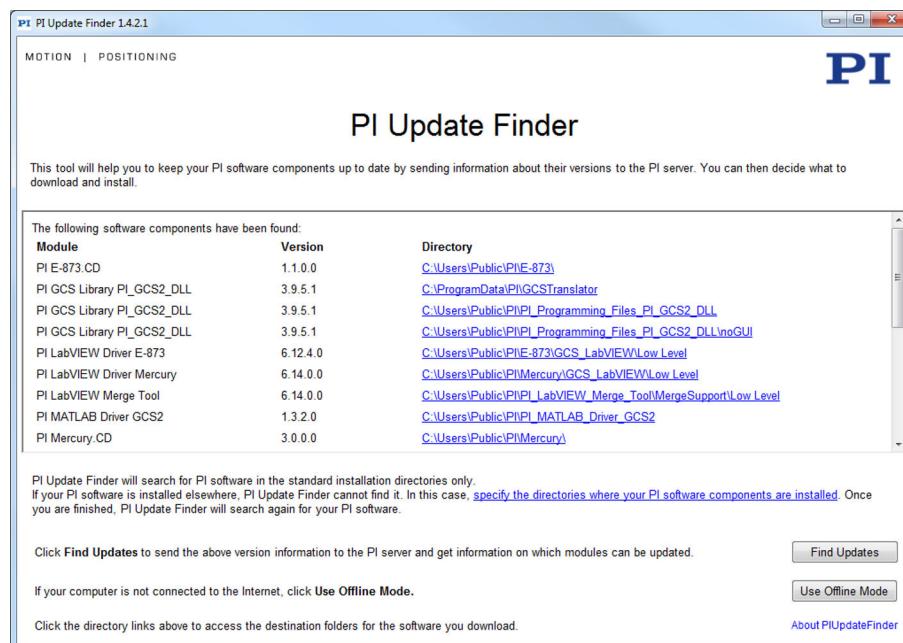
#### **Requirements**

- ✓ Active connection to the Internet.
- ✓ You have installed the PI Update Finder from the product CD.

#### **Updating the Software on a PC with Internet Connection**

##### **1. Run the PI Update Finder.**

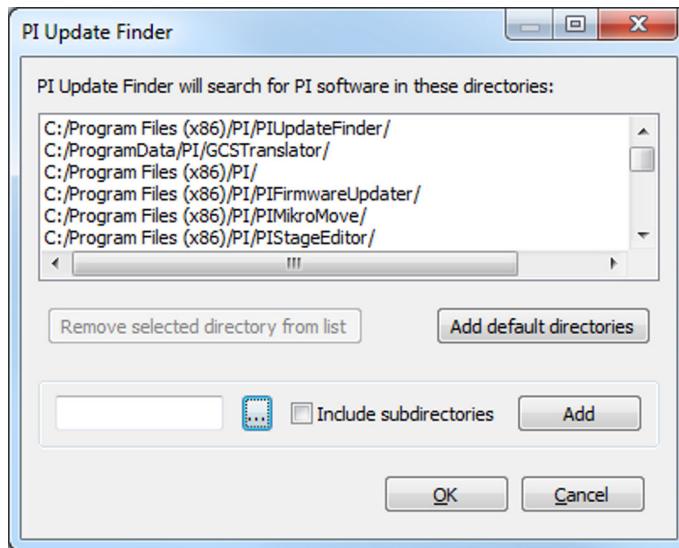
→ A table is displayed with information on the PI software installed on your computer.



If the table is empty or incomplete, proceed as follows:

- Click **specify the directories where your PI software components are installed**.

→ A dialog window is opened, in which all directories are listed that PI Update Finder finds while searching for and comparing the software versions.



- b) Click the **...** button and select the directory on your hard disk, where the PI software is installed.  
 → *The directory is displayed in the input field at the bottom left of the window. You can also manually enter directories there.*
- c) Activate the **Include subdirectories** check box to include subdirectories as well.
- d) Click the **Add** button.  
 → *The directory, and any subdirectories, appear at the end of the list.*
- e) Click **OK** to finalize input of the installation directory.  
 → *If PI software is found in the specified directories, it will be displayed in the table on the initial screen of the PI Update Finder.*
2. Click the **Find Updates** button.  
 → *A browser window opens and a table is displayed with the software information. If available, the updates are offered via the PI server link in the Download Link column.*

PI Software Found on Your System					
Name	Installed Version	Version on PI Server	Release Notes	Download Link	
PI E-873.CD	V1.1.0.0	V0.0.0.0		✓ Up to date	
PI GCS Library PI_GCS2_DLL (ZIP file, please extract and run Install.bat)	V2.9.0.31	V3.9.3.1	Release note	PI server	
PI LabVIEW Driver E-873	V6.12.4.0	V6.12.4.0		✓ Up to date	
PI LabVIEW Driver Mercury	V6.14.0.0	V6.0.2.2		✓ Up to date	
PI LabVIEW Merge Tool	V6.14.0.0	V6.13.0.0		✓ Up to date	
PI MATLAB Driver GCS2	V1.3.2.0	V1.3.0.0		✓ Up to date	
PI Mercury.CD	V3.0.0.0	V2.0.0.0		✓ Up to date	
PI Stage Database PIStages2	2011/03/16 15:14:27	2016/10/28 11:49:31		PI server	
PI Stage Database PIStages3	V3.0.12.0	V3.0.10.0		✓ Up to date	
PI USB Driver	V2.2.10.0	V2.2.10.0		✓ Up to date	
PIFirmwareUpdater	V1.4.2.3	V1.4.2.3		✓ Up to date	
PIMikroMove	V2.8.0.3	V2.25.1.3	Release note	PI server	
PIStageEditor (Application)	V4.9.0.0	V4.9.0.0		✓ Up to date	
PIStages3Editor	V1.1.1.1	V1.1.1.1		✓ Up to date	
PITerminal	V6.8.0.1	V6.8.0.1		✓ Up to date	
PIUpdateFinder	V1.4.2.1	V1.4.2.1		✓ Up to date	

**Important note:**  
 Before downloading and installing your update, read the corresponding release note to check if there are any known compatibility issues.

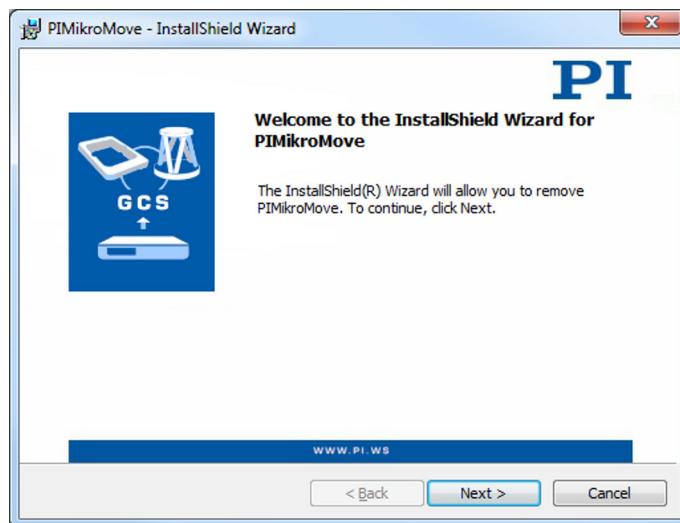
3. To download an update, click **PI server** in the **Download Link** column.

- You are then asked to specify whether the file is to be downloaded or run directly. Depending on the browser settings, it is possible that the update file is downloaded directly. It is then in the download directory of your computer.
4. Select the save file to hard disk option when asked by the browser.

→ The file is saved to the download directory of your computer. Depending on the browser settings, it is also possible to run the file directly or open it. In this case, continue with step 6.

  5. Install the update:
    - Executable setup files (.exe): Run the downloaded update file.
    - File archive (.zip): Unpack the archive and run the Install.bat file.
    - It is possible that you must confirm execution of the file.

→ The InstallShield Wizard is opened, e.g. for PIMikroMove:



6. Follow the instructions in the InstallShield Wizard.

#### Updating the Software on a PC without Internet Connection

1. Connect a portable data storage device, e.g., a USB stick, to your PC.
2. Run the PI Update Finder.
3. In the main window, click the **Use Offline Mode** button.
4. Click the **Save Version Information** button to save the software version information to a HTML file on your portable data storage device.
5. Transfer the HTML file to a computer with Internet connection.
6. Open the HTML file in a web browser.
7. Download your updates and store them on your portable data storage device.
8. Transfer the updates to the PC without Internet connection.
9. Install the updates.

#### Updating the PC Software and Positioner Database in Linux

##### Requirements

- ✓ Active connection to the Internet.
- ✓ You have the user name and password for the E-873.1AT. See the "E-873\_Releasenews\_V\_x\_x\_x.pdf" (x\_x\_x: CD version number) in the main directory or **Manuals** directory on the product CD.

### Updating the PC software in Linux

1. Open the website [www.pi.ws](http://www.pi.ws).
2. Log onto the website:
  - a) Click **Login**.
  - b) Log in with the user name and password for the E-873.1AT.
3. Search for the product:
  - a) Click **Search**.
  - b) Enter the product number up to the period (e.g., E-873) or the product family (e.g., PICMA® bender) into the search field.
  - c) Click **Start search** or press the **Enter** key.
  - d) If necessary: Click **Load more results** at the bottom of the list.
4. Click the corresponding product in the list of search results.
5. Scroll down to the **Downloads** section on the product detail page.  
→ *The software files are shown under Software Downloads.*
6. Click the "CD Mirror" archive file and save it.
7. Unpack the archive file into a separate installation directory.
8. Go to the "linux" subdirectory in the directory with the unpacked files.
9. Unpack the archive file in the **linux** directory.
10. Read the accompanying information on the software update (readme file and/or "<Releasenews>" file) and decide whether the update makes sense for your application.
  - If no: Stop the update procedure.
  - If yes: Go through the following steps.
11. Log into the PC as superuser (root privileges).
12. Install the update.
13. If you also received an updated PISTAGES3.DB database from our customer service department: Install that update onto the PC.

## 6.6 Connecting the PC

For details on the interface parameters and their default settings, see "[Communication Interfaces \(p. 14\)](#)".

### Information

The E-873.1AT's communication interfaces are active at the same time. Commands are executed in the order in which the complete command lines arrive. However, simultaneous use of several communication interfaces can cause problems with the PC software.

- Always only use one interface of the E-873.1AT.

### 6.6.1 Connecting the E-873.1AT to a PC

#### Tools and Accessories

- Suitable cable for the selected communication interface (e.g., USB cable, in the [scope of delivery \(p. 14\)](#) or available as [optional accessory \(p. 14\)](#))

#### Requirements

- ✓ The PC has a connection available for the selected communication interface.
- ✓ If necessary: The [interface parameters of the PC have been adapted for the E-873.1AT \(p. 14\)](#).

### Connecting the E-873.1AT to the PC

1. Connect the cable to the selected communication interface of the E-873.1AT.
2. Connect the cable to an unused port on the PC.

## 6.6.2 Integrating into E-873.1AT a Network

### Tools and Accessories

- Suitable network cable (in the [scope of delivery \(p. 14\)](#) or available as [optional accessory \(p. 14\)](#))

### Requirements

- ✓ A network access point is available for the E-873.1AT.
- ✓ The [default settings of the TCP/IP interface \(p. 16\)](#) do not collide with the settings of other devices in the network.

### Integrating the E-873.1AT into a TCP/IP Network

1. Connect the RJ45 socket of the E-873.1AT to the network cable.
2. Connect the network cable to the network access point.

# 7 Startup / Operation

## 7.1 Switching on the E-873.1AT

### Requirements

- ✓ You have read and understood the [general safety instructions \(p. 11\)](#).
- ✓ The E-873.1AT has been installed [properly \(p. 44\)](#).



### CAUTION



#### Risk of electric shock if the protective earth conductor is not connected!

If the protective earth conductor is missing or not properly connected, risk of dangerous touch voltages on the E-873.1AT in the event of malfunction or failure of the system. If there are touch voltages, touching the E-873.1AT can lead to minor injury due to electric shock.

- Connect the E-873.1AT to a [protective earth conductor \(p. 45\)](#) before startup.
- Do **not** remove the protective earth conductor during operation.
- If the protective earth conductor has to be removed temporarily (e.g., for modifications), reconnect the E-873.1AT to the protective earth conductor before restarting.

### Switching the E-873.1AT On

1. Connect the power cord of the power adapter to the power socket.
2. Move the toggle switch on the front panel to the — position to switch the E-873.1AT on.  
→ *The E-873.1AT boots the firmware and loads information from the nonvolatile memory to the volatile memory.*
3. Wait until the **Status** LED lights up green.  
→ *The information has loaded and the E-873.1AT is ready for normal operation.*
4. If the **Status** LED does not light up a few seconds after switching on, contact our [customer service department \(p. 207\)](#).

## 7.2 Establishing Communication with the PC

The procedure for PIMikroMove is described in the following.

The figures show the procedure for any electronics; the procedure for the E-873.1AT corresponds.

### 7.2.1 Establishing Communication via RS-232

To establish communication successfully the PC's and [E-873.1AT's baud rates \(p. 16\)](#) must match.

### Requirements

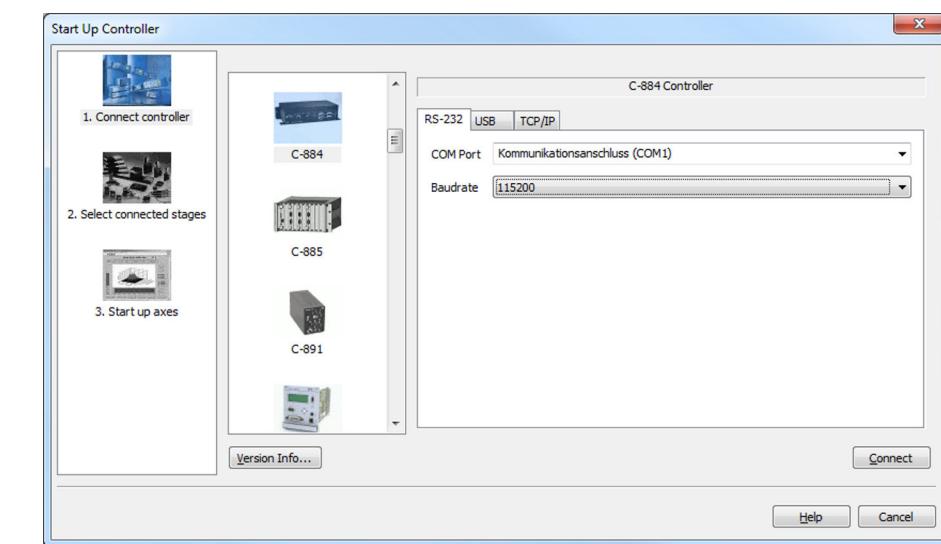
- ✓ The E-873.1AT is connected to the [RS-232 interface of the PC \(p. 51\)](#).
- ✓ The E-873.1AT is [switched on \(p. 53\)](#).
- ✓ The PC is switched on.
- ✓ The required software and drivers are [installed \(p. 46\)](#) on the PC.
- ✓ You have read and understood the manual for the PC software used. The software manuals are on the product CD.

### Establishing Communication via RS-232

1. Start PIMikroMove.

→ The **Start up controller** window opens with the **Connect controller** step.

2. If the **Start up controller** window does not automatically open, select the **Connections > New...** menu item in the main window.
3. Select **E-873** in the field for controller selection.
4. Select the **RS-232** tab on the right-hand side of the window.
5. Make the following settings in the **RS-232** tab:
  - a) In the **COM Port** field, select the COM port of the PC to which you have connected the E-873.1AT.
  - b) In the **Baudrate** field, set the value that is set for the E-873.1AT.



6. Click **Connect** to establish communication.

→ If communication could not be established, look for a solution to the problem in the "[Troubleshooting \(p. 204\)](#)" chapter.

→ If communication was established successfully, PI MikroMove guides you through the configuration of the E-873.1AT for the connected positioner, see "[Starting Motion \(p. 58\)](#)".

## 7.2.2 Establishing Communication via USB

If the controller is connected via the USB connection and switched on, the USB interface in the PC software is also shown as a COM port.

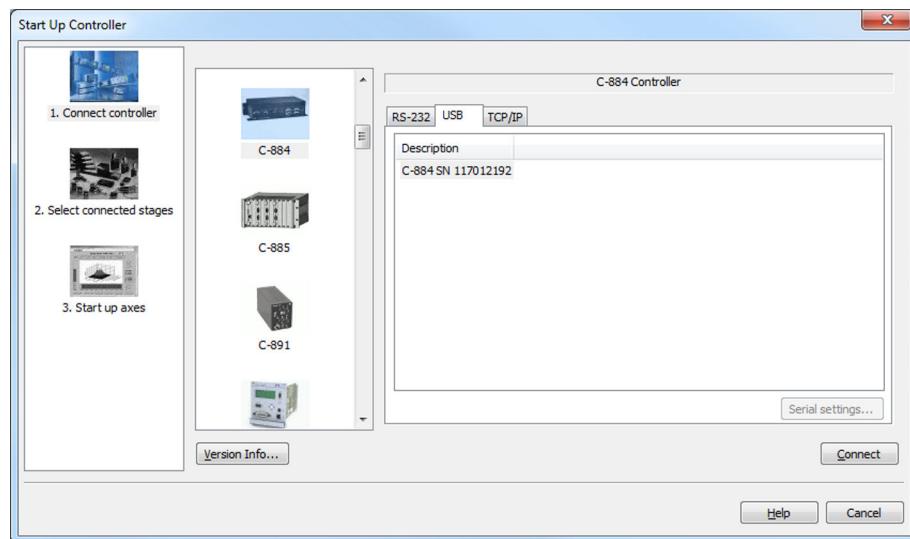
### Requirements

- ✓ The E-873.1AT is connected to the USB interface of the PC.
- ✓ The E-873.1AT is [switched on \(p. 53\)](#).
- ✓ The PC is switched on.
- ✓ The required software and drivers are [installed \(p. 46\)](#) on the PC.
- ✓ You have read and understood the manual for the PC software used. The software manuals are on the product CD.

### Establishing Communication via USB

1. Start PI MikroMove.
- The **Start up controller** window opens with the **Connect controller** step.
2. If the **Start up controller** window does not automatically open, select the **Connections > New...** menu item in the main window.

3. Select **E-873** in the field for controller selection.
4. Select the **USB** tab on the right-hand side of the window.



5. Select the connected E-873.1AT in the **USB** tab.
  6. Click **Connect** to establish communication.
- If communication could not be established, look for a solution to the problem in the "[Troubleshooting \(p. 204\)](#)" chapter.
- If communication was established successfully, PI MikroMove guides you through the configuration of the E-873.1AT for the connected positioner, see "[Starting Motion \(p. 58\)](#)".

### 7.2.3 Establishing Communication via TCP/IP

Before communication is established, it can be necessary to adapt the interface parameters once, depending on the type of networking:

- Network with DHCP server: No adjustment of the factory settings of the E-873.1AT interface parameters is required. You can [begin with setup of the communication \(p. 57\)](#).
- Network without DHCP server or direct connection of the E-873.1AT to the PC's Ethernet socket: it is necessary to [adapt the E-873.1AT's interface parameters \(p. 55\)](#). Make the necessary adaptations before establishing communication.

#### Requirements

- ✓ The E-873.1AT is [connected \(p. 52\)](#) to the network or directly to the PC via the RJ45 Ethernet socket.
- ✓ If several E-873.1ATs are connected to the same network via their TCP/IP interfaces: You have the serial number of the E-873.1AT ready with which the communication is to be established. The serial number can be found on the [type plate of the E-873.1AT \(p. 13\)](#).
- ✓ The E-873.1AT is [switched on \(p. 53\)](#).
- ✓ The PC is switched on.
- ✓ The required software and drivers are [installed \(p. 46\)](#) on the PC.
- ✓ You have read and understood the manual for the PC software used. The software manuals are on the product CD.

#### Adapting the TCP/IP Interface Parameters of the E-873.1AT

If you need to adapt the interface parameters of the E-873.1AT to use the E-873.1AT in a network, proceed as follows.

1. Establish communication between the E-873.1AT and the PC via a different interface (e.g., [USB \(p. 54\)](#)).
2. Select the **E-873.1AT > Configure interface** menu item in the main window of PIMikroMove.  
→ *The Configure Interface window opens.*
3. Select the **TCP/IP** tab in the **Stored Settings** area in the **Configure Interface** window.

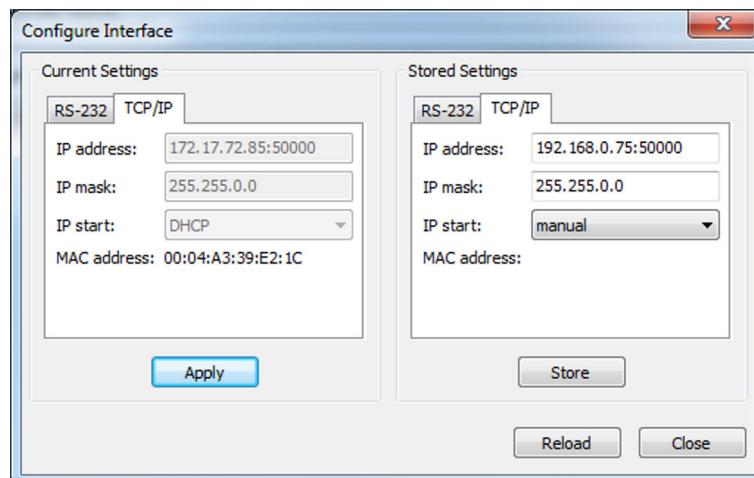


Figure 10: "Configure Interface" window with examples of settings

4. Make the necessary adaptations in the **TCP/IP** tab in the **Stored Settings** area:
  - a) **IP address** field: E-873.1AT's IP address in format xxx.xxx.xxx.xxx:50000
  - b) **IP mask** mask: Network's subnet mask
  - c) **IP start** field: E-873.1AT's startup behavior
    - manual:** Manually specified, static IP address is used
    - DHCP:** IP address is assigned automatically by a DHCP server.
5. Save the changed settings to the nonvolatile memory of the E-873.1AT by clicking **Store**.  
→ *The Store interface settings dialog opens.*
6. Click **Store settings** in the **Store interface settings** dialog.  
→ *The dialog closes. The settings were stored in the nonvolatile memory of the E-873.1AT.*
7. Close the **Configure Interface** window.
8. Close the connection with the E-873.1AT by selecting the **Connections > Close > E-873.1AT** menu item in the main window of PIMikroMove.
9. Switch the E-873.1AT off and on again via its toggle switch.



### CAUTION

#### Risk of crushing from unexpected motion!

When the communication between the E-873.1AT and the PC is established via TCP/IP, the PC software offers all electronics for selection that are available in the same network. After selecting a E-873.1AT for the connection, all commands are transmitted to this device. If the wrong device is selected, unexpected motion could be commanded and result in bruising injuries to the operating and maintenance staff of the positioner connected.

- If several E-873.1AT entries are displayed in the PC software, make sure that you select the right E-873.1AT.

## Information

Communication via TCP/IP can fail if the network cable was connected to the Ethernet socket of the E-873.1AT while the E-873.1AT was switched on.

- If communication cannot be established, switch the E-873.1AT off, connect the network cable, and switch the E-873.1AT on again.

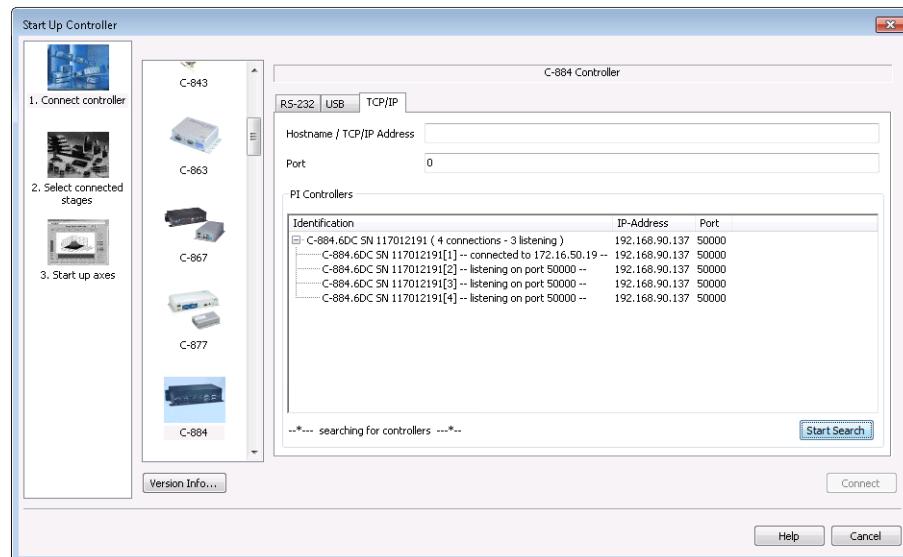
## Information

For communication via TCP/IP, the E-873.1AT only has one unchangeable port (50000) available that cannot be used for more than one connection at a time.

### Establishing Communication via TCP/IP

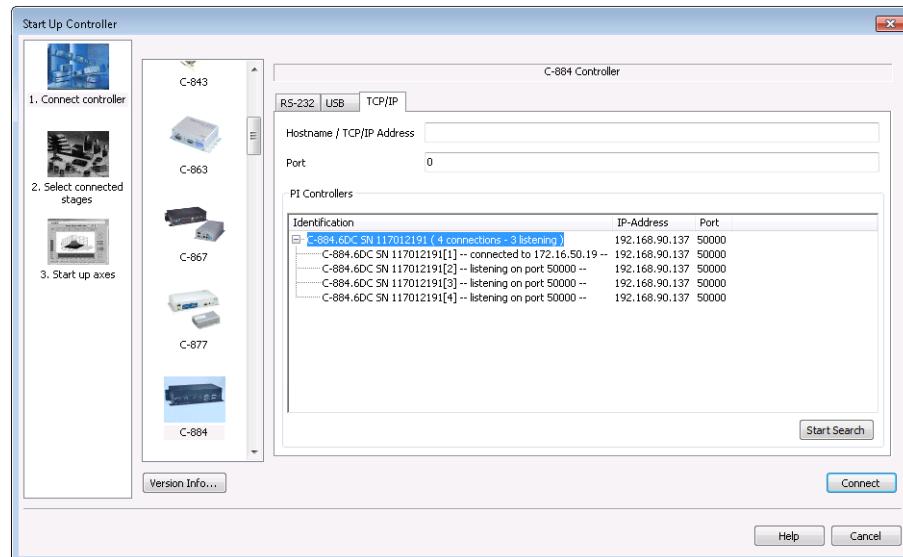
1. Start PI MikroMove.
  - *The Start up controller window opens with the Connect controller step.*
  2. If the **Start up controller** window does not open automatically, select the **Connections > New...** menu item in the main window.
  3. Select **E-873** in the controller selection field.
  4. Select the **TCP/IP** tab on the right-hand side of the window.
  - *The software now searches the network for all controllers of the E-873 type.*
- Click **Start Search** if the search for E-873 type controllers does not start automatically.  
 → *Searching the network for the E-873 type of controller has started.*

*As long as the search is running, the Connect button is deactivated. If the search was successful, all E-873 controllers in the same network are displayed in the PI Controllers field.*



5. Click the entry for your E-873.1AT found in the list of controllers. This must show the status "listening on port 50000".
  - Do not select a controller that is already connected via TCP/IP (status "connected to ..."). Otherwise, an error message will be displayed as soon as you try to establish communication with this controller.
  - If several entries with the same name are shown, identify your E-873.1AT on the basis of its nine-digit serial number.
  - If the E-873.1AT is not displayed in the list of the controllers found, check the network settings. Consult your network administrator if necessary.

→ After a controller is selected in the list, its data is shown in the **Hostname / TCP/IP Address** and **Port** fields.



6. Click **Connect** to establish communication.

- If communication could not be established, look for a solution to the problem in the "[Troubleshooting \(p. 204\)](#)" chapter.
- If communication was established successfully, PIMikroMove guides you through the configuration of the E-873.1AT for the connected positioner, see "[Starting Motion \(p. 58\)](#)".

## 7.3 Starting Motion

The procedure for PIMikroMove is described in the following.

After communication has been established between the E-873.1AT and the PC, PIMikroMove guides you through the configuration of the E-873.1AT for the positioner. It is then possible to run the first motion tests of the positioner.

Selection of the configuration steps offered by PIMikroMove is based on evaluation of the following parameter values in the volatile memory of the E-873.1AT:

- **Stage Name** (0x3C): The value is used by PIMikroMove as criterion for finding a suitable parameter set in the positioner databases.
- **Stage Type** (0xF000100): The value was loaded from the ID chip of the connected positioner when the E-873.1AT was switched on.

Possible configuration steps:

- If the values of the parameters 0x3C and 0xF000100 are not identical, the **Stage Type Configuration** window opens. A corresponding message is displayed when a suitable parameter set is not in the positioner database.
- If the value of parameter 0xF000100 is empty, e.g., because the positioner does not have an ID chip, the **Start up controller** window switches to the **Select connected stages** step.
- When the values of the parameters 0x3C and 0xF000100 are identical, PIMikroMove assumes that all parameters of the E-873.1AT have already been adapted to the connected positioner. The **Start up controller** window goes directly to the **Start up axes** step, where the reference move can be started.

The figures show the procedure for any electronics; the procedure for the E-873.1AT corresponds.

## Requirements

- ✓ PI MikroMove is [installed on the PC \(p. 46\)](#).
- ✓ You have [installed the latest version of the PISTAGES3.DB database onto your PC \(p. 46\)](#).
- ✓ If PI provided a custom positioner database for your positioner, the [dataset was imported into PIStages3 \(p. 47\)](#).
- ✓ You have installed the positioner in the same way as it will be used in your application (corresponding load, orientation, and mounting).
- ✓ You have connected the [positioner to the E-873.1AT \(p. 46\)](#).
- ✓ You have [established communication between the E-873.1AT and the PC with PI MikroMove \(p. 53\)](#).

## NOTICE

### Damage due to disabled limit switch evaluation!

The collision of a moving part at the end of the travel range, or with an obstacle, as well as high accelerations, can cause damage to or considerable wear on the stage.

- Avoid motion in open-loop operation.
- If motion is necessary in open-loop operation: Stop the positioner in time. For this purpose, use the #24, STP or HLT command, or set the control value to zero with the SMO command.
- Do **not** choose parameter settings that would deactivate limit switch evaluation by the electronics.
- Check the function of the limit switches at about 10 % to 20 % of the maximum velocity.
- In the event of a malfunction of the limit switches, stop the motion immediately.

## NOTICE

### Selection of an incorrect positioner type!

Selection of an incorrect positioner type in the PC software can cause damage to the positioner.

- Make sure that the positioner type selected in the PC software matches the positioner connected.

## NOTICE

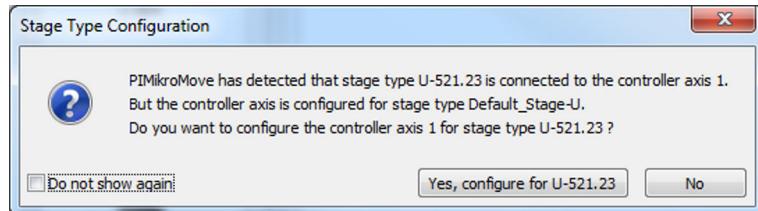
### Oscillation!

Unsuitable settings of the notch filter and the E-873.1AT's servo control parameters can cause the positioner to oscillate. Oscillation can damage the positioner and/or the load fixed to it.

- Secure the positioner and all loads adequately.
- If the stage is oscillating (unusual operating noise), switch off servo mode or the E-873.1AT immediately.
- Switch servo mode back on only after you have changed the E-873.1AT's notch filter settings and servo control parameters; see "[Adjusting the Notch Filter \(p. 62\)](#)" and "[Optimizing the Servo Control Parameters \(p. 67\)](#)".
- If a very high load causes oscillation during the reference move, follow the instructions on the reference move under "[Troubleshooting](#) (p. 204)".

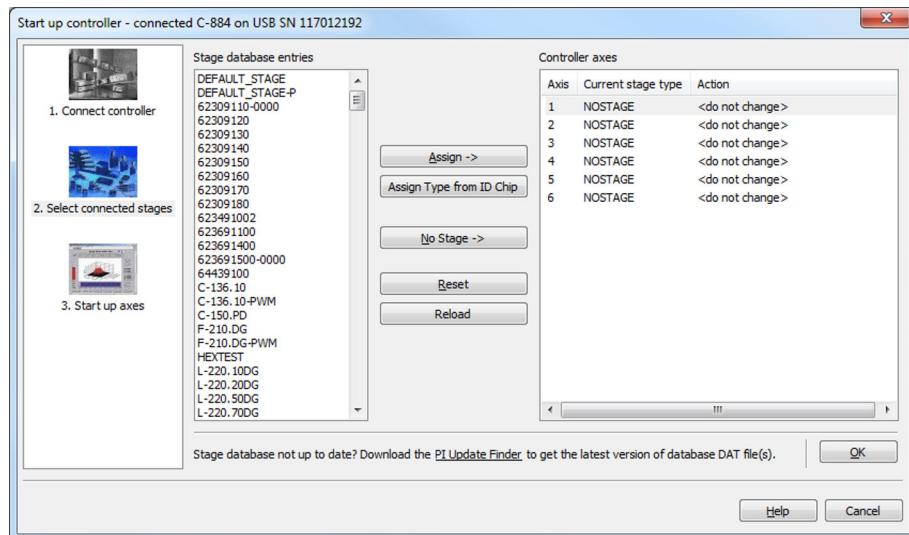
## Starting motion with PI MikroMove

1. When the **Stage Type Configuration** dialog has opened: Click the **Yes, configure for ...** button to load the matching parameter set from a positioner database into the E-873.1AT.



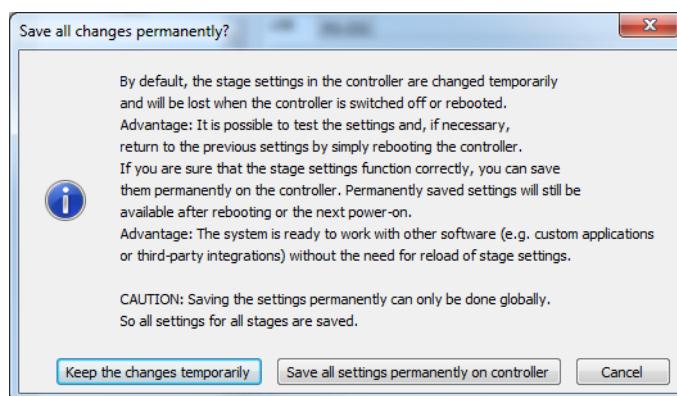
→ The **Save all changes permanently?** dialog is opened.

- If the **Select connected stages** step is displayed in the **Start up controller** window:



- Select the appropriate positioner type: Click either **Assign Type from ID Chip** or mark the matching positioner type in the **Stage database entries** list and click **Assign**.
- Confirm selection with **OK** to load the parameter settings for the selected positioner type from the positioner database into the E-873.1AT.

→ The **Save all changes permanently?** dialog is opened.

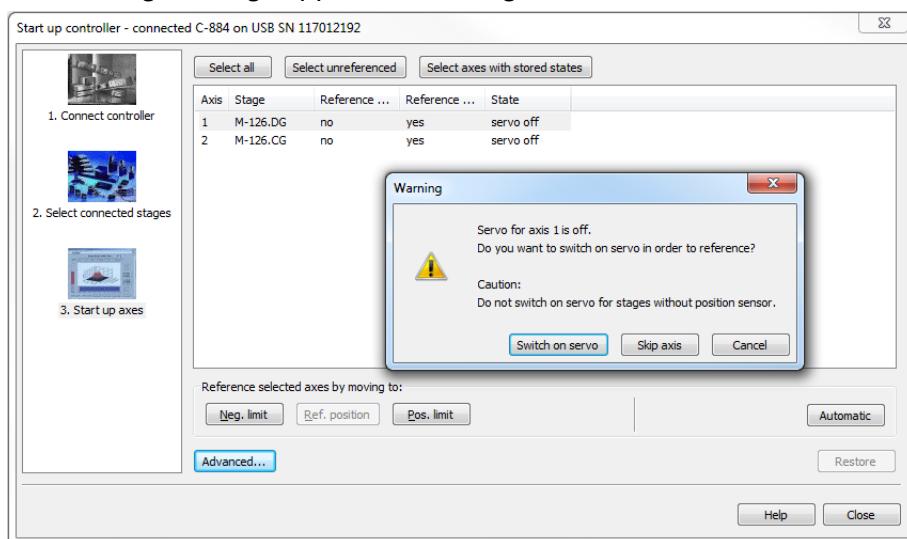


- Specify how you want to load the parameter settings into the E-873.1AT in the **Save all changes permanently?** dialog box:

- Temporary load: Click **Keep the changes temporarily** to load the parameter settings into the volatile memory of the E-873.1AT. The settings are lost when the E-873.1AT is switched off or rebooted.
- Load as default values: Click **Save all settings permanently on controller** to load the parameter settings into the nonvolatile memory of the E-873.1AT. The settings are available immediately after switching on or rebooting the E-873.1AT and do not need to be reloaded.

→ The **Start up controller** window with the **Start up axes** step is displayed.

4. During the **Start up axes** step, do a reference move for the axis so that the controller knows the absolute axis position: You have the following options (options not supported by the positioner/controller either do not exist or cannot be activated):
  - Start the reference move to the reference switch: Click **Ref. position**.
  - Start the reference move to the negative limit switch: Click **Neg. limit**.
  - Start the reference move to the positive limit switch: Click **Pos. limit**.
5. If a warning message appears indicating that servo mode is switched off:



Switch on the servo mode by clicking on the **Switch on servo** button in the warning message.

→ The **Reference Axes** dialog appears after switching servo mode on:

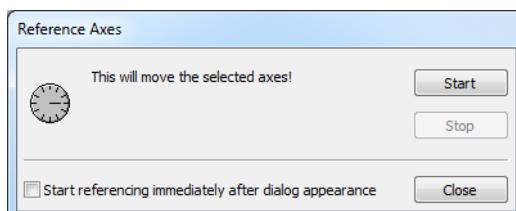


Figure 11: The figure shows example settings that may not necessarily be suitable for your system.

6. Click the **Start** button in the **Reference Axes** dialog.

→ The axis performs the reference move. The **All axes referenced** message is displayed after a successful reference move:

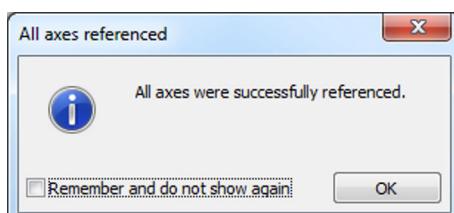
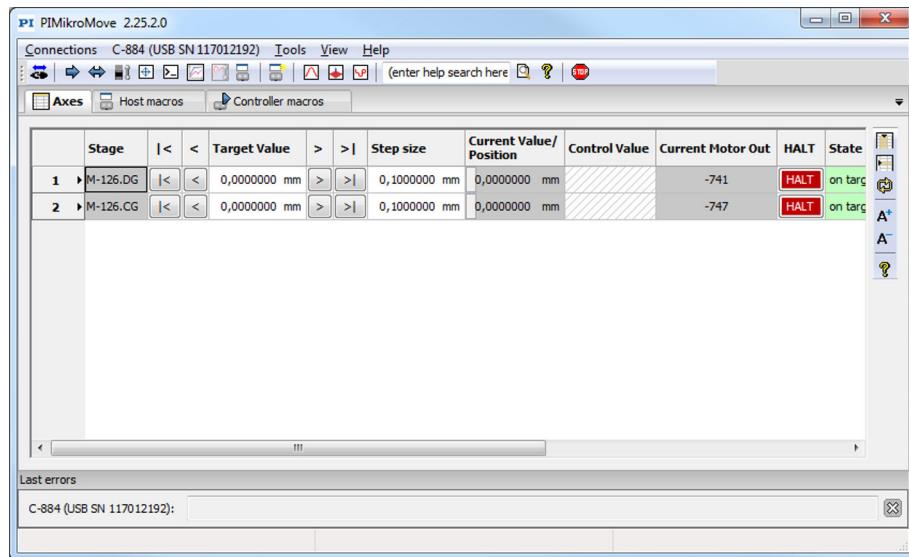


Figure 12: The figure shows example settings that may not necessarily be suitable for your system.

7. Close the **All axes referenced** message with **OK**.

8. After a successful reference move, close the **Start up controller** window by clicking **Close**.  
→ The main window of PI MikroMove opens.



9. Start testing axis motion: You can start motion by clicking the arrow keys for the corresponding axis in the PIMikroMove main window:

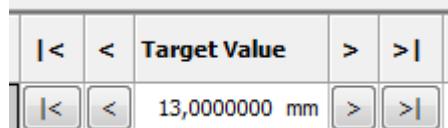


Figure 13: The figure shows example settings that may not necessarily be suitable for your system.

- |< or >|: Motion to the negative or positive limit of the travel range
- < or >: Motion along a certain path (specification in the **Step size** column)

## 7.4 Adapting the Dynamic Characteristics of the System

### 7.4.1 Adjusting the Notch Filter

The notch filter corrects the control value for the drive of the positioner connected to the E-873.1AT. The corrections by the notch filter take place in closed-loop and open-loop operation.

The frequency component in the control value that would cause natural oscillation of the mechanics is reduced by the notch filter. Adjusting the notch filter frequency can be useful, particularly in the case of high loads.

To set the notch filter, a step response is recorded in open-loop operation. Adapting the notch filter is done via the following parameters:

- **Notch Filter Frequency 1 (0x94):** Frequency component to be filtered out
- **Notch Filter Edge 1 (0x95):** Bandwidth of the notch filter

The procedure for PIMikroMove is described in the following.

#### Requirements

- ✓ You have installed the positioner in the same way as it will be used in your application (corresponding load, orientation, and fastening).
- ✓ Initial motion [was started \(p. 58\)](#) in PIMikroMove.
- ✓ All devices are still ready for operation.

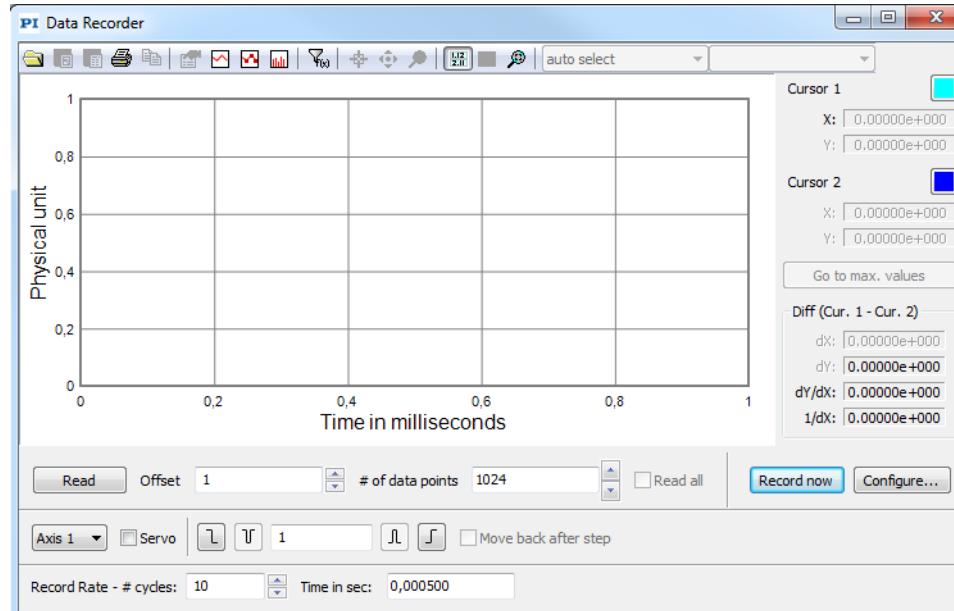
## Information

The settling behavior of the axis in closed-loop operation is influenced by the notch filter settings.

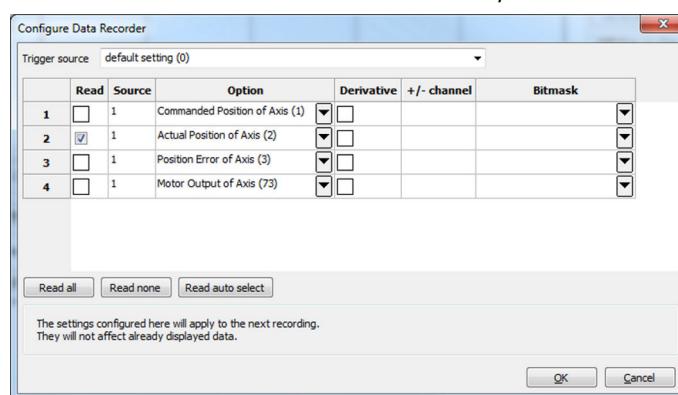
- Set the notch filter before you optimize the servo-control parameters.

## Recording the step response

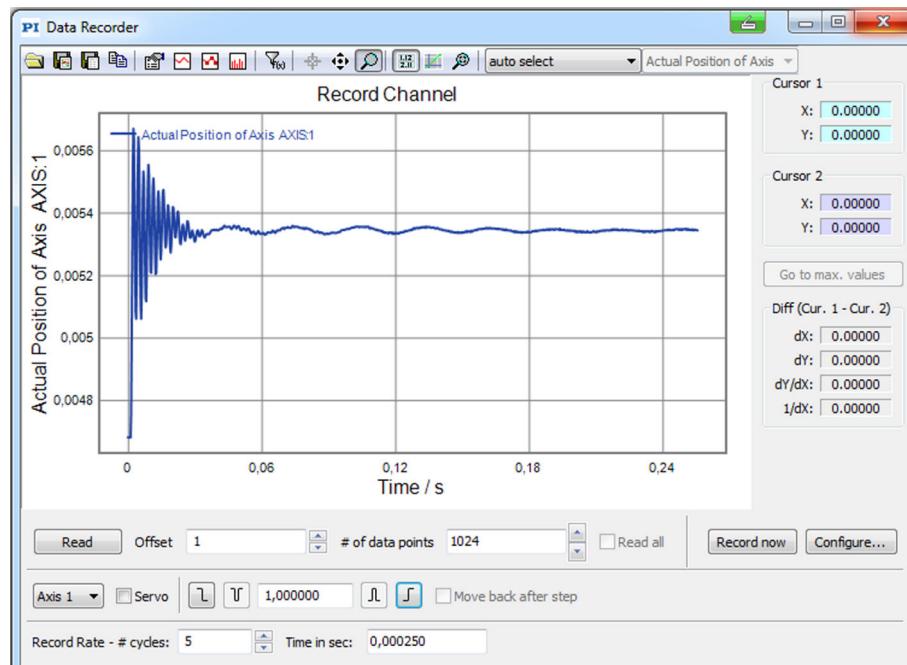
1. Open the **Data Recorder** window in PI MikroMove via the **E-873.1AT > Show data recorder** menu item.  
→ *The Data Recorder window is opened.*



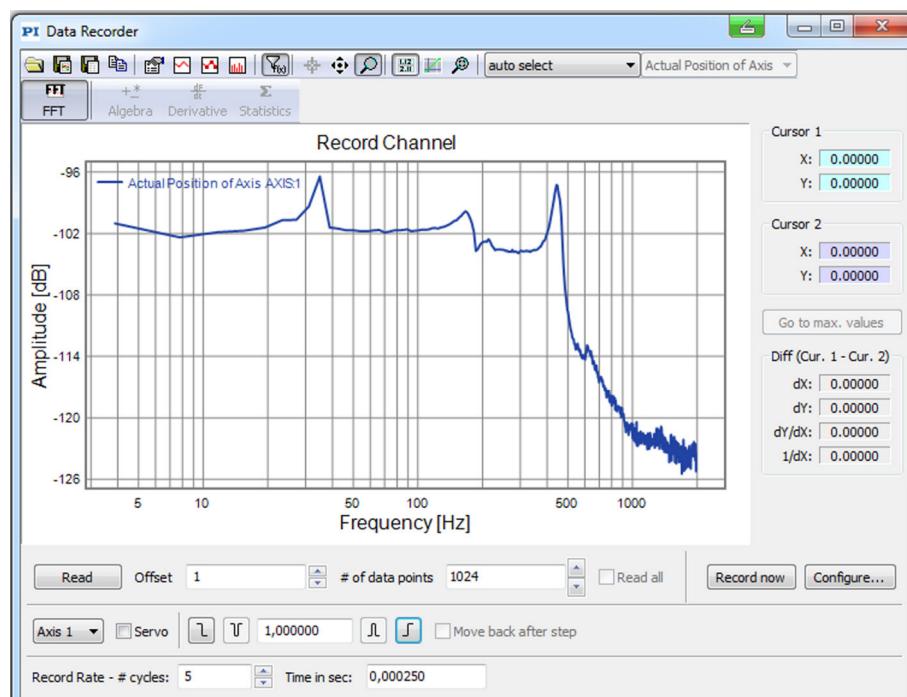
2. Make the following settings in the **Data Recorder** window:
  - a) Use the **Servo** checkbox to make sure that servo mode is switched off: If the **Servo** checkbox is checked, uncheck to switch servo mode off.
  - b) Set the number of data points to be read for the graphical display (max. 8192) in the **# of data points** field.
  - c) Set the amplitude of the step to be performed to a value that is typical for your application (specified as physical units).
  - d) Set the number of servo cycles to be recorded in the **Record Rate - # cycles** field.
3. Click the **Configure...** button to open the window for configuring the data recorder.  
→ *The Configure Data Recorder window is opened.*
4. In the **Configure Data Recorder** window, make sure that the "Actual Position of Axis" is selected as the variable to be recorded, and close the window with **OK**.



5. Start the jump in the positive direction as well as the recording by clicking the  button in the **Data Recorder** window.  
 → The axis performs the step and the step response is recorded and displayed graphically.



6. Calculate the FFT (Fast Fourier Transformation) of the step response:  
 a) Display the Data Toolbar via the  button.  
 b) Click the  button to calculate the FFT.  
 → The FFT of the step response is displayed graphically.



7. Determine the resonant frequency of the axis from the step response:  
 If necessary, enlarge the view: Click the  button, press and hold down the left mouse button, and drag the magnifying glass symbol over an area in the graphical display

(clicking with the right mouse button in the graphic field returns the view to its original size).

- Display the cursors in the graphical display by clicking the button.
  - Activate the cursor movement with the mouse by clicking the button.
  - Click the **Go to max. values** button to position cursors 1 and 2 over the resonant frequencies.
- The resonant frequencies are recognizable at the distinct maximum in the FFT diagram and are displayed in the respective X: field of the **Cursor 1** and **Cursor 2** areas on the right next to the graphical display.

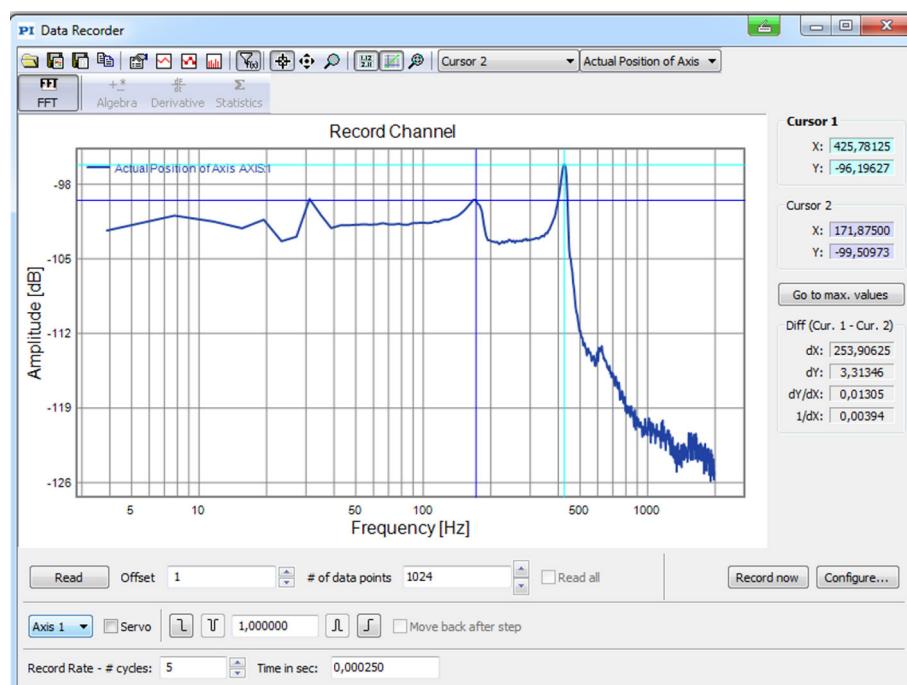
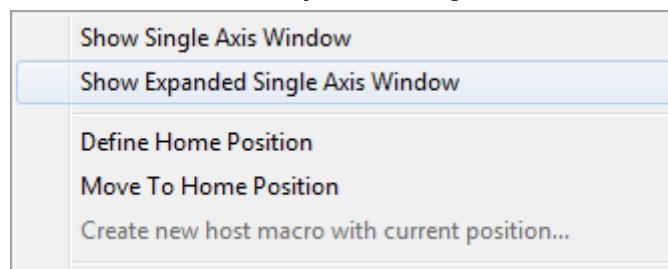


Figure 14: In the example, the first resonant frequency can be seen at 425 Hz, a second at 171 Hz.

### Adjusting the Notch Filter

- Open the expanded single axis window of the connected positioner in the main window of PIMikroMove: Click the corresponding line of the **Axes** tab with the right mouse button and select the **Show Expanded Single Axis Window** in the context menu.



- Adapt the parameter values for the notch filter in the expanded single axis window:
  - If the **Notch Filter Frequency 1** and **Notch Filter Edge 1** parameters are not in the list on the right-hand side of the window, click **Configure View -> Select parameters...** and add them to the list.
  - Type the new parameter value into the corresponding input field in the **Active Value** column of the list.

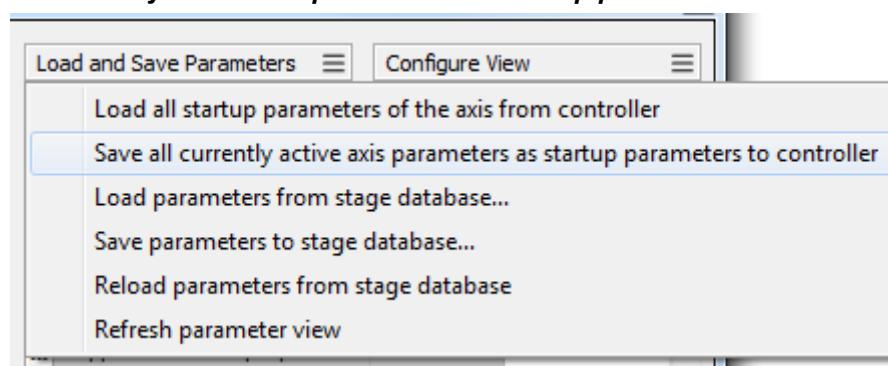
The value of the **Notch Filter Frequency 1** parameter must be set to the previously determined resonant frequency. If two resonant frequencies were determined, it should be set to a value that is roughly in the middle between both resonant frequencies. In this case, the value of the **Notch Filter Edge 1** parameter must be reduced to a value in a range of 0.3 to 0.2 in order to increase the bandwidth of the notch filter.

- Press the **Enter** key on the PC keyboard or click outside the input field with the mouse to transfer the parameter value to the volatile memory of the controller. Note: If a parameter value in the volatile memory (**Active Value** column) is different to the parameter value in the nonvolatile memory (**Startup Value** column), the line in the list is highlighted in color.

	Name	ID	Active Value	CCL
...	D-Term Delay (No. Of Servo Cycles)	0x71	0 0	
...	Use Limit Switches Only For Referencing	0x77	0 0	
...	Distance From Limit To Start Of Ref Search (Phys. Unit)	0x78	10,000000000 0	
...	Distance For Reference Search (Phys. Unit)	0x79	0,000000000 0	
...	Use Hard Stops For Referencing?	0x7A	1 0	
...	Notch Filter Frequency 1 (Hz)	0x94	298,000000000 0	
...	Notch Filter Edge 1 0.1 to 10	0x95	0,200000000 0	
...	Sensor Interpolation	0x300330	20000,000000000	2
...	Sensor Hysteresis (Deg)	0x300330	0,010000000	2
...	Sensor Digital Gain	0x300330	1,000000000	2
...	Sensor Digital Offset 0 (V)	0x300330	0,000000000	2
...	Sensor Digital Offset 1 (V)	0x300330	0,000000000	2
...	Sensor Digital Phase (Deg)	0x300330	0,000000000	2
...	Sensor Analog Gain (dB)	0x300330	6,000000000	2
...	Sensor Analog Offset 0 (V)	0x300330	0,000000000	2

- Save the new settings. You have the following options:

- Save a parameter set to the positioner database on the PC, see "[Saving the Parameter Set to the Positioner Database \(p. 70\)](#)".
- Transfer the current values of the listed parameters from the volatile memory to the nonvolatile memory of the E-873.1AT by clicking **Load and Save Parameters -> Save all currently active axis parameters as startup parameters to controller**.



### 7.4.2 Optimizing the Servo Control Parameters

Adjusting the PID controller optimizes the dynamic properties of the system (overshoot and settling time). The optimum PID controller setting depends on your application and your requirements.

Typically, optimization is determined empirically, i.e., the behavior of the positioner is monitored with different values in closed-loop operation.

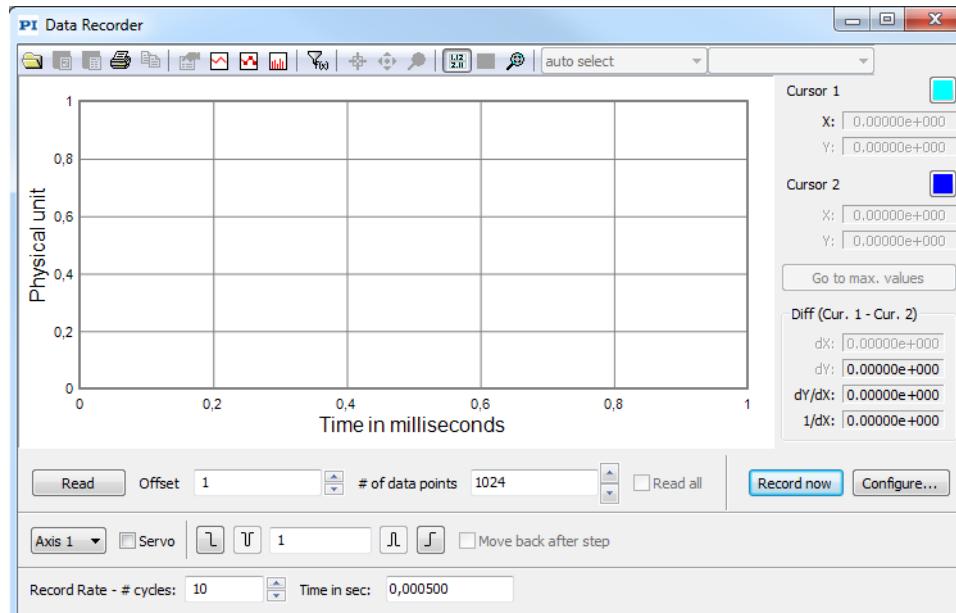
The following describes the procedure for optimizing the servo control parameters in PIMikroMove.

#### Requirements

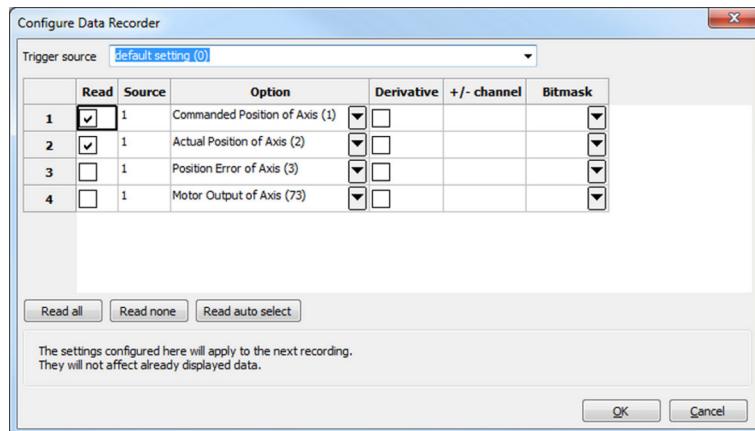
- ✓ You have installed the positioner in the same way as it will be used in your application (corresponding load, orientation, and mounting).
- ✓ You have started initial [motion \(p. 58\)](#) with PIMikroMove.
- ✓ If necessary, you have set the [notch filter \(p. 62\)](#).
- ✓ All devices are still ready for operation.

#### Checking the Servo Control Parameters: Recording the Step Response

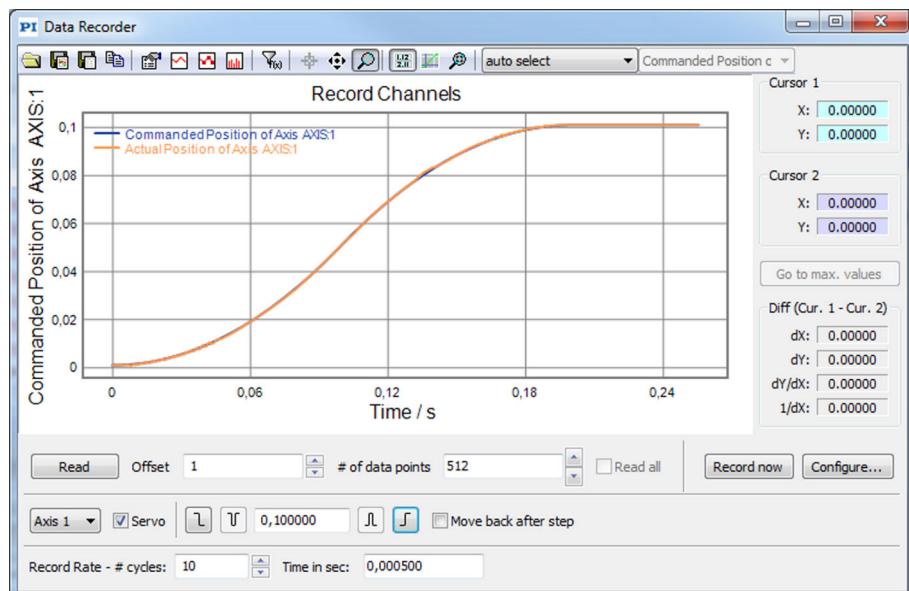
1. Open the **Data Recorder** window in PIMikroMove via the **E-873.1AT > Show data recorder** menu item.  
→ *The Data Recorder window is opened.*



2. Make the following settings in the **Data Recorder** window:
  - a) If necessary, switch on servo mode by checking the **Servo** checkbox.
  - b) Set the number of data points to be read for the graphical display (max. 8192) in the **# of data points** field.
  - c) Set the amplitude of the step to be performed to a value that is typical for your application (specified as physical units).
  - d) Set the number of servo cycles to be recorded in the **Record Rate - # cycles** field.
3. Click the **Configure...** button to open the window for configuring the data recorder.  
→ *The Configure Data Recorder window is opened.*
4. Make sure that "Commanded Position of Axis" and "Actual Position of Axis" are selected as variables to be recorded in the **Configure Data Recorder** window and click **OK** to close the window.



5. Start the jump in the positive direction as well as the recording by clicking the button in the **Data Recorder** window.  
→ *The axis performs the step and the step response is recorded and displayed graphically.*



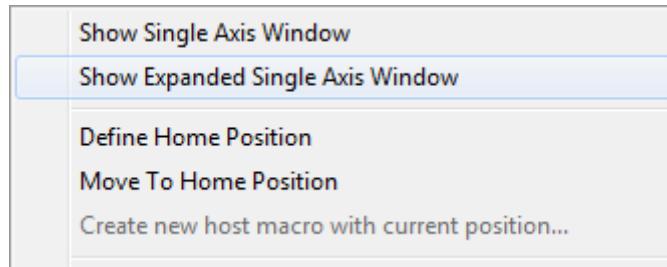
6. Check the displayed step response.

If necessary, enlarge the view: Click the button, press and hold down the left mouse button, and drag the magnifying glass symbol over an area in the graphical display (clicking with the right mouse button in the graphic field returns the view to its original size).

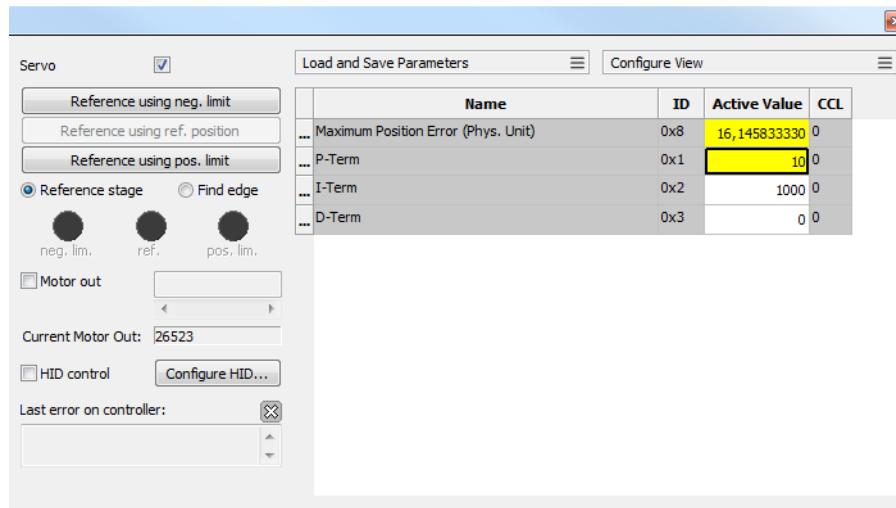
- If the result is satisfactory (i.e., minimum overshoot, settling time not too long): You already have optimum parameter settings and do not have to do anything further.
- If the result is not satisfactory: Optimize the servo control parameters, see below.

#### Setting the Servo Control Parameters

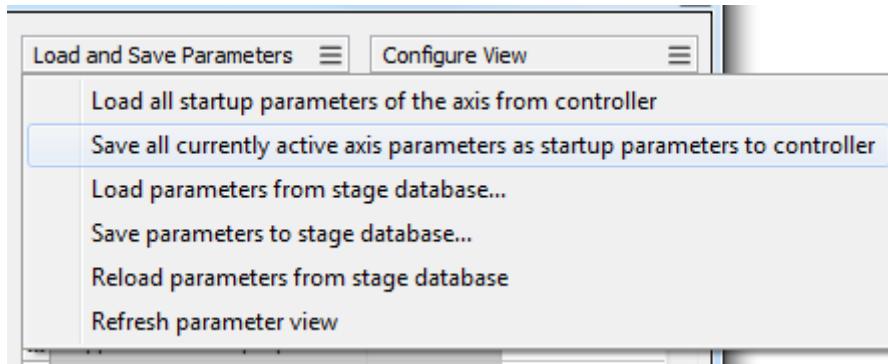
1. Open the expanded single axis window of the connected positioner in the main window of PIMikroMove: Click on the corresponding line of the **Axes** tab with the right mouse button and select the **Show Expanded Single Axis Window** in the context menu.



2. Enter new values for the parameters to be adapted into the expanded single axis window:
  - a) If the parameters to be changed are not included in the list on the right side of the window, click on **Configure View -> Select parameters...** and add them to the list.
  - b) Type the new parameter value into the corresponding input field in the **Active Value** column of the list.
  - c) Press the **Enter** key on the PC keyboard or click outside the input field with the mouse to transfer the parameter value to the volatile memory of the controller. Note: If a parameter value in the volatile memory (**Active Value** column) is different to the parameter value in the nonvolatile memory (**Startup Value** column), the line in the list is highlighted in color.



3. In the **Data Recorder** window, record the step response of the positioner again. If the result is not satisfactory, enter different values for the servo control parameters and record the step response again.
4. If you are satisfied with the result and want to keep the changed parameter settings, save the new settings. You have the following options:
  - Save a parameter set to the positioner database on the PC, see "[Saving the Parameter Set to the Positioner Database \(p. 70\)](#)".
  - Transfer the current values of the listed parameters from the volatile memory to the nonvolatile memory of the E-873.1AT by clicking **Load and Save Parameters -> Save all currently active axis parameters as startup parameters to controller**.



## 7.5 Making Data Backups

### Saving the Parameter Set to the Positioner Database

1. Click **Load and Save Parameters** -> **Save parameters to stage database...** in the expanded single axis window in PIMikroMove.  
→ *The Save Parameters as User Stage Type dialog opens.*
2. Save the changed parameter values as new positioner type in the **Save Parameters as User Stage Type** dialog:
  - a) Leave the entry in the **Parameters of axis** field unchanged.
  - b) Enter the name for the new positioner type into the **Save as** field.
  - c) Click **OK**.

→ *The new positioner type was saved to the PISTAGES3.DB database. The display of the connected positioner type was updated in the single axis window and in the main window of PIMikroMove.*

### 7.5.1 Saving Parameter Values

The E-873.1AT is configured via parameters, e.g., for adapting to the connected positioner. The parameter values can be saved to a text file so that they can be restored at a later time.

#### Information

Changing parameter values can cause undesirable results.

- Create a backup copy on the PC before changing the parameter settings of the E-873.1AT. You can then restore the original settings at any time.
- Create an additional backup copy with a new file name each time after optimizing the parameter values or adapting the E-873.1AT to a particular positioner.

Parameter values saved in a text file on the PC can be loaded back to the E-873.1AT in PIMikroMove or PITerminal. The **Send file...** button is available for this purpose in the send command window. Before loading into the E-873.1AT, the individual lines of the text files must be converted into command lines that contain the corresponding SPA or SEP commands.

#### Requirements

- ✓ You have established [communication between the E-873.1AT and the PC with PIMikroMove \(p. 53\)](#) or PITerminal.

#### Saving Parameter Values in a Text File

1. If you are using PIMikroMove, open the window for transmitting commands: Select **Tools** > **Command entry** in the main window or press F4 on the keyboard.

- After communication has been established, the main window is opened in PI Terminal automatically and commands can then be sent.
2. Query the parameter values that you want backup.
    - If you want to save the parameter values from the volatile memory of the E-873.1AT: Send the **SPA?** command.
    - If you want to save the parameter values from the nonvolatile memory of the E-873.1AT: Send the **SEP?** command.
  3. Click the **Save...** button.  
→ The **Save content of terminal as textfile** window opens.
  4. Save the queried parameter values to a text file on your PC in the **Save content of terminal as textfile** window.

## 7.5.2 Saving Controller Macros

For example, making backups of controller macros on the PC can be useful before updating the firmware.

The procedure for PIMikroMove is described in the following.

### Saving Controller Macros on the PC

1. Select the **Controller macros** tab in PIMikroMove's main window.
2. Select the macros in the **Macros on controller** list that you want to back up to the PC:
  - Click the desired entry in the list to select a macro.
  - To select several macros, hold down the Shift button and click the desired entries in the list.
  - To deselect, click an open area in the list.  
→ By selecting one or more macros, the  (Save selected macros to PC) button becomes active.
3. Save the selected macros on the PC:
  - a) Click the  button to open a directory selection window.
  - b) Select the directory on the PC where you want to save the macros.
  - c) Click **Save**.  
→ The macros are saved as text files (<macroname>.txt) in the selected directory of the PC.

### Loading Controller Macros from the PC to the E-873.1AT

1. Select the **Controller macros** tab in PIMikroMove's main window.
2. Load macros from the PC to the E-873.1AT:
  - a) Click the  button to open a file selection window.
  - b) Select the text files (<Makroname>.txt) in the file selection window whose contents you want to load as a macro from the PC to the E-873.1AT.
  - c) Click **Open**.  
→ For each selected text file (<Makroname>.txt), the content is loaded as a macro <Makroname> into the E-873.1AT.

## 8 E-873.1AT Functions

### 8.1 Protective Functions of the E-873.1AT

The E-873.1AT has functions that are intended to protect it against damage.

#### 8.1.1 Protection Against Overheating

If a certain internal temperature is reached, the E-873.1AT reacts as follows to protect the system against damage:

- The control value is set to zero for the axis concerned.
- The servo mode is switched off for the axis concerned.
- Error code 603 is output.

Then restore the [operational readiness \(p. 73\)](#) for the E-873.1AT.

#### 8.1.2 Behavior with Motion Errors

Motion errors can be caused for example, by malfunctions of the drive or the position sensor of the positioner.

There is a motion error when the position error (i.e., the difference between the current and commanded position) exceeds the specified maximum value in closed-loop operation. The range in which the deviation may lie is specified by the [Maximum Position Error \(Phys. Unit\)](#) parameter (0x8).

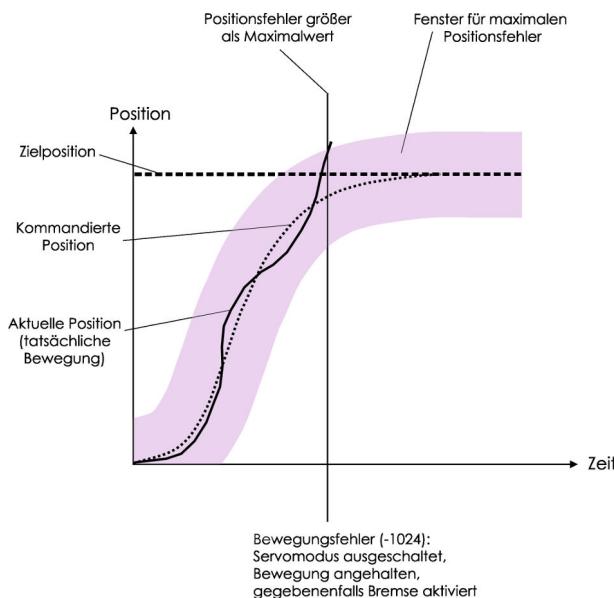


Figure 15: Determining motion errors

Motion errors can have the following causes, for example:

- Malfunction of the drive
- Malfunction of the position sensor
- Fault in the mechanics

If motion error occurs, the E-873.1AT reacts as follows to protect the system against damage:

- Servo mode is switched off for the axis.
- If applicable, the brake is activated for the axis in question.
- All motion is stopped.

- Error code -1024 is output.
- Then restore the [operational readiness \(p. 73\)](#) for the E-873.1AT.

### 8.1.3 Behavior During System Errors

There is a system error when E-873.1AT is not responsive.

For example, the cause of a system error can be a buffer overflow in the firmware of the E-873.1AT.

If a system error occurs the E-873.1AT reacts as follows:

- After a certain delay, the safety function of the Watchdog Timer initiates a reboot of the E-873.1AT.

### 8.1.4 Restoring Operational Readiness

#### Restoring the E-873.1AT's Operational Readiness

1. Send the [ERR?](#) command to read out the error code.  
→ *ERR? resets the error code to zero during the query.*
2. Check your system and make sure that the following points are fulfilled:
  - The axis can be moved without danger.
  - The E-873.1AT has not overheated.
3. If the servo mode was switched off after an error or overheating:  
Switch on the servo mode for the axis with the [SVO command](#).  
→ *When the servo mode is switched on, the target position is set to the current axis position.*

### 8.1.5 Commands

E	Page
ERR?	Get Error Number
S	Page
SVO	Set Servo Mode

### 8.1.6 Parameters

0x8	Maximum Position Error (Phys. Unit)	Maximum position error. Used by controllers that support a dynamic profile (parameter 0x1B < > 5) for detecting motion error.
-----	-------------------------------------	--

## 8.2 Data Recorder

The E-873.1AT contains a real-time data recorder. The data recorder can record different variables, e.g., the current position of an axis.

The recorded data is stored temporarily in data recorder tables. Each data recorder table contains the data of one data source.

The E-873.1AT has 4 data recorder tables with 8192 data points each.

You can configure the data recorder for example, by defining the data type to be recorded and the data sources, and by specifying how the recording is to be started.

## 8.2.1 Setting up the Data Recorder

### Reading general information from the data recorder

1. Send the [HDR?](#) [command](#).

→ *The options available for recording and triggering are displayed together with the information on additional parameters and commands for data recording.*

### Determining the data to be recorded

1. Configure the data recorder with the [DRC](#) [command](#).

→ *This assigns the data sources and the recording options to the data recorder tables. The current configuration can be read out with the [DRC?](#) command.*

Data recorder tables with the record option 0 are deactivated, i.e., nothing is recorded. By default, the data recorder tables of the E-873.1AT record the following:

- Data recorder table 1: Record option 1: Commanded position of the axis
- Data recorder table 2: Record option 2: Current position of the axis
- Data recorder table 3: Record option 3: Position error of the axis
- Data recorder table 4: Record option 73: Control value of the axis

### Setting the trigger for recording

1. Set the trigger option with the [DRT](#) command.

The trigger specifies how the recording is to be triggered. The current trigger option can be queried with the [DRT?](#) command.

→ *The trigger option applies to all data recorder tables whose record option is not set to 0.*

### Setting the record table rate

1. Send the [RTR](#) command to set the recording rate of the data recorder.

The parameter indicates the number of servo cycles required for recording each data point. The recording rate can be read out with the [RTR?](#) command.

As the record table rate increases, the maximum duration of the data recording is increased.

### Configuring data processing

1. Configure recorded data processing with the following parameters:

- [Recorded Points Per Trigger](#) (0x16000001)

## 8.2.2 Starting Data Recording

### Starting the Recording

1. Start the recording with the trigger option set with [DRT](#).

Irrespective of the set trigger option, data recording is always triggered when step response measuring is started with [STE](#).

The data recording always takes place for all data recorder tables whose record option is not set to 0. It ends when the data recorder tables are full.

### 8.2.3 Reading Out Recorded Data

#### Information

Reading the recorded data can take some time, depending on the number of data points.  
The data can also be read out while data is being recorded.

#### Reading data out

1. Read the last recorded data out with the [DRR?](#) command.  
→ *The data is output in GCS array format.*
2. Query the number of points contained in the last recording with the [DRL?](#) command.

### 8.2.4 Commands

D		Page
<a href="#">DRC</a>	Set Data Recorder Configuration	119
<a href="#">DRC?</a>	Get Data Recorder Configuration	120
<a href="#">DRL?</a>	Get Number Of Recorded Points	120
<a href="#">DRR?</a>	Get Recorded Data Values	120
<a href="#">DRT</a>	Set Data Recorder Trigger Source	121
<a href="#">DRT?</a>	Get Data Recorder Trigger Source	122
H		Page
<a href="#">HDR?</a>	Get All Data Recorder Options	127
R		Page
<a href="#">RTR</a>	Set Record Table Rate	149
<a href="#">RTR?</a>	Get Record Table Rate	149
S		Page
<a href="#">STE</a>	Start Step And Response Measurement	155

### 8.2.5 Parameters

<b>0x16000001</b>	Recorded Points Per Trigger	Number of data points recorded per trigger impulse. 0 Unlimited (default) n>0 n data points are recorded
-------------------	-----------------------------	--

### 8.3 Analog Input Signals

The analog inputs of the E-873.1AT are available on the **I/O** socket. The number of input lines available on the E-873.1AT can be queried with the [TAC?](#) command. The voltage at the analog inputs can be queried with the [TAV?](#) command. The analog input signals can be recorded with the data recorder ([DRC](#) command with recording option 81).

Potential applications:

- Use in macros ([CPY](#), [JRC](#), [MEX](#), [WAC](#))
- Scan applications with PI MiroMove

### 8.3.1 Connecting Analog Signal Sources

#### Overview



Analog input signals (0 V to + 5 V) can be fed into the E-873.1AT via pins 1, 2, 3, and 4 of the *I/O* socket.

#### Tools and Accessories

- Suitable signal source
- If necessary: Suitable cable, e.g., C-170.IO IO cable with open end (available as an optional accessory)

#### Information

The analog inputs of the *I/O* socket can also be used as digital inputs.

- Analog: 0 to +5 V
- Digital: TTL

#### Connecting an Analog Signal Source

1. Connect an appropriate signal source to one of pins 1, 2, 3 or 4 of the *I/O* socket of the E-873.1AT.

### 8.3.2 Commands

C	Page
CPY                   Copy Into Variable	111
D	Page
DRC                   Set Data Recorder Configuration	119
J	Page
JRC                   Jump Relatively Depending On Condition	139
M	Page
MEX                   Stop Macro Execution Due To Condition	143
T	Page
TAC?                  Tell Analog Channels	156
TAV?                  Get Analog Input Voltage	156
W	Page
WAC                   Wait For Condition	161

### 8.3.3 Parameters

## 8.4 Controlling with HID

HID (Human Interface Device) denotes an input or output device that is connected to the E-873.1AT and is intended for operating it manually. Typical HIDs are joysticks and gamepads.

HID control means controlling motion variables of a mechanics' axis connected to the E-873.1AT by displacing an axis of the HID.

### 8.4.1 Operating Principle

An HID's axis can control the following motion variables of a mechanics' axis connected to the E-873.1AT:

- Absolute target position: The relationship between the displacement of the axis of the human interface device and the target position of the mechanical axis is created from a lookup table by the E-873.1AT.
- Relative target position: The displacement of the HID axis determines the frequency for moving the controlled positioner axis: The further the HID axis is displaced, the higher the frequency and therefore the velocity of the positioner axis.
- Velocity: Product of the lookup table value that corresponds to the current displacement of the axis of the HID and the currently valid maximum velocity of the controller axis.
- Maximum velocity: Product from the lookup table value corresponding to the current displacement of the HID axis and the value of the Closed-Loop Velocity For HI Control (0x74).

#### Information

Motion commands are not permitted when HID control is enabled for the axis.

HID control is not possible in open-loop operation (servo mode Off).

### 8.4.2 HID Control Configuration

Control of the axis/axes connected to the E-873.1AT by the HID's axes is configured via the [HIA](#) command. The current HID control configuration can be queried with the [HIA?](#) command. The direction of motion of HID-controlled axes can be inverted via the [Invert Direction Of Motion For Joystick-Controlled Axis?](#) parameter (0x61).

Assigning a lookup table to an HID axis is done with the [HDT](#) command. The current lookup table assignments to HID axes can be queried with the [HDT?](#) command. The values in the lookup table are factors that are applied to the motion parameter to be controlled during HID control. The E-873.1AT's firmware gives a choice of two predefined lookup table types (linear and parabolic) and allows four customer-specific lookup tables to be filled with individual values. Lookup tables can be filled with values with the [HIT](#) command. [HIT?](#) queries the values of the points in the lookup tables.

Use the [HIN](#) command to activate/deactivate HID control of the axes connected to the E-873.1AT. The [HIN?](#) command queries the activation state of HID control. When HID control is deactivated, the target position is set to the current position of the controlled axis.

The [HIS?](#) command queries the properties of the HID's operating elements. The current status of the HID buttons can be queried with [HIB?](#) and the current displacement of HID axes with [HIE?](#).

### 8.4.3 Programming HID Control

HID output units (e.g., buttons and LEDs) can be used for example, in controller macros to program HID control.

## 8.4.4 Connecting an HID

### Overview



E-873.1AT's connector for a manually operated device such as a joystick or gamepad

### Tools and Accessories

- Analog joystick for operating with 0 to 3.3 V, (e.g., C-819.20 or C-819.30 available as [optional accessory \(p. 14\)](#))
- If a C-819.20 joystick is to be connected to two controllers: C-819.20Y Y cable (available as optional accessory)

### Connecting an HID to the E-873.1AT

1. If you want to use axis 1 and/or axis 2 of the HID, connect the following to the E-873.1AT's **Joystick** socket:
  - If you want to operate a C-819.20 joystick with this controller only, connect it directly to the controller.
  - If you want to operate a C-819.20 joystick with two controllers (i.e., two axes), connect the joystick to the C-819.20Y cable and connect both controllers to the X and Y branches of the cable. The power is supplied to the joystick via the X branch. For this reason, the X branch has to be connected to a controller even if HID control is not to be enabled for this controller.
  - If you want to connect an axis of a C-819.30 joystick, connect the corresponding cable of the joystick to the controller.
2. If you want to use axis 3 and/or 4 of the HID, connect an HID to the E-873.1AT's **I/O** socket. First of all, we recommend testing the HID's operating elements after connecting it to the E-873.1AT. If the response behavior of the HID's axes does not meet your requirements, it is possible to calibrate its axes.  
HID control can be set up and activated after testing and optional calibration of the axes. The procedure for PIMikroMove is described in the following.

## 8.4.5 Testing the HID and Calibrating the Axes

The mechanics do not need to be connected to the E-873.1AT for testing the HID and calibrating its axes.

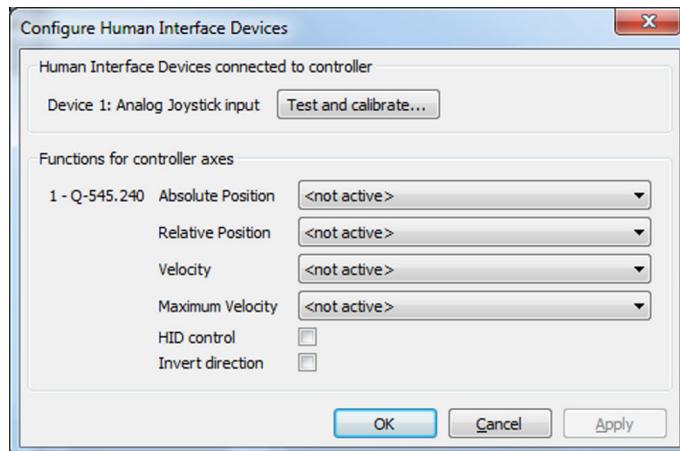
When calibrating the HID's axes in PIMikroMove, the appropriate lookup table must be selected. The parabolic lookup table allows greater sensitivity at lower velocity. Lookup tables named "User Table" are intended to be filled with individual values.

### Requirements

- ✓ PIMikroMove is [installed on the PC \(p. 46\)](#).
- ✓ PIMikroMove has established communication between the E-873.1AT and the [PC \(p. 53\)](#).
- ✓ The E-873.1AT has been connected to the [HID \(p. 78\)](#).

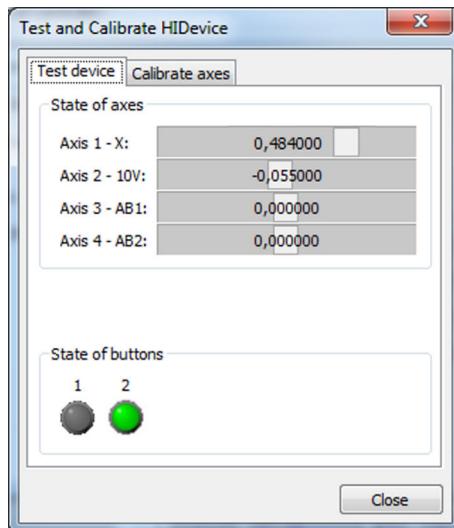
### Testing the HID

1. Open the window for configuring HID control via the **E-873.1AT > Configure controller HIDDevice(s)...** menu item in PIMikroMove's main window.  
→ The **Configure Human Interface Devices** window opens.



2. Open the window for testing and calibrating the HID by clicking **Test and calibrate....**  
→ *The Test and Calibrate HIDDevice window opens.*
3. Select the **Test device** tab in the **Test and Calibrate HIDDevice** window and test the HID's operating elements:
  - a) Move the HID's axes and at the same time, watch the status indicators in the **State of axes** area.
  - b) Press the HID's buttons and at the same time, watch the status indicators in the **State of buttons** area.
  - c) Enter various values into the fields in the **State of LEDs** area (if any) and at the same time, watch the behavior of the corresponding operating elements on the HID.

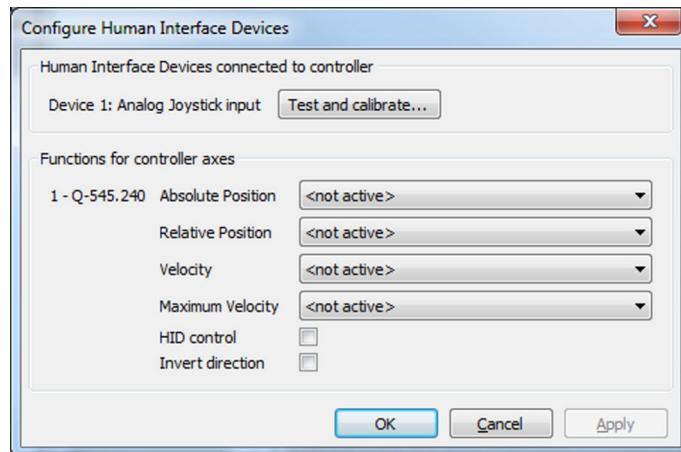
→ *In the example shown, a C-819.20 joystick is connected to the Joystick socket of the E-873.1AT. The E-873.1AT supports one axis of this joystick. The identifier of the axis is 1, the name is X. The two buttons of the C-819.20 joystick are available on the E-873.1AT via the identifiers 1 and 2. Current status in the figure: The axis of the joystick is displaced in the positive direction, and button 2 is pressed.*



4. Depending on what is next, do the following:
  - If you want to calibrate the HID's axes directly afterwards, proceed as [described below \(p. 80\)](#).
  - If you want to set up and activate HID control for the E-873.1AT directly afterwards, close the **Test and Calibrate HIDDevice** window with **Close** and continue as described in "[Setting up and Activating HID Control \(p. 81\)](#)".
  - If you do not want to make any further settings at this point, close **Test and Calibrate HIDDevice** with **Close** and the **Configure Human Interface Devices** window with **OK**.

### Calibrating HID Axes

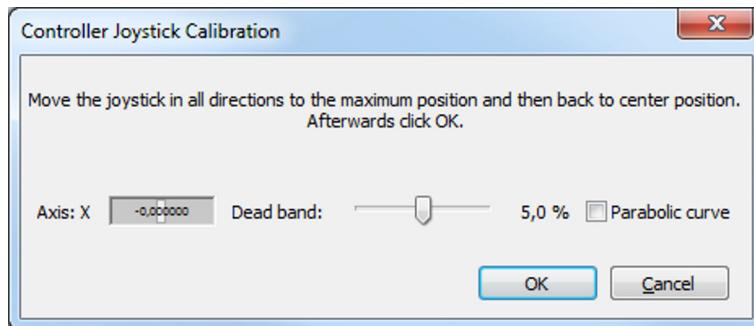
1. If necessary, open the window for configuring HID control via the **E-873.1AT > Configure controller HIDDevice(s)...** menu item in PI MikroMove's main window.  
 → *The Configure Human Interface Devices window opens.*



2. If necessary, open the window for calibrating the HID and click the **Test and calibrate...** button.  
 → *The Test and Calibrate HIDDevice window opens.*
3. Select the **Calibrate axes** tab in the **Test and Calibrate HIDDevice** window.
4. Select the respective lookup tables to be used for the HID's axes via the selection fields in the **Calibrate axes** tab.  
 → *The example shows that a user-defined lookup table was selected for axis 1. The respective predefined parabolic lookup table was retained for axes 2 to 4.*



5. If you have selected a user-defined lookup table and want to fill the table with values:
  - a) Click the corresponding **Calibrate...** button to open the **Controller Joystick Calibration** window.



- b) Move the HID's axes to all extreme positions. The custom lookup table values are determined in this way.
  - c) Let go of the axis.
  - d) If you want to change the neutral area of the axis (i.e., the area around the center position of the axis where no change in the controlled motion variable is triggered), set the **Dead band** slider accordingly.
  - e) If the values in the user-defined lookup table are to describe a parabolic waveform, click the **Parabolic curve** checkbox.
  - f) Click **OK** in the **Controller Joystick Calibration** window to copy the appropriate values from the lookup table.  
→ *The lookup table values are written to the E-873.1AT's volatile memory. The writing progress is indicated in a separate window. The window for the writing process and the Controller Joystick Calibration window automatically close after the writing process has finished.*
6. Close the **Test and Calibrate HIDDevice** window with **Close**.
  7. Depending on what is next, do the following:
    - If you want to set up and activate HID control for the E-873.1AT directly afterwards, continue as described in "[Setting up and Activating HID Control \(p. 81\)](#)".
    - If you want to save the lookup table assignments to the HID's axes and the content of user-defined lookup table to the E-873.1AT's nonvolatile memory directly afterwards, close the **Configure Human Interface Devices** window with **OK** and continue as described in "[Saving the Configuration of HID Control Permanently \(p. 83\)](#)".
    - If you do not want to make any further settings at this point, close the **Configure Human Interface Devices** window with **OK**.

#### 8.4.6 Setting Up and Activating HID Control

The following motion variables of the E-873.1AT's axes can be controlled via HID:

- Absolute Position - Motion of the axis to an absolute position
- Relative Position - Motion of the axis relative to the current position
- Velocity - Velocity for motion of the axis
- Maximum Velocity - Maximum velocity for motion of the axis

Before activating HID control, the following steps are recommended:

- Testing the HID
- Calibrating the HID axes

See "[Testing the HID and Calibrating the Axes \(p. 78\)](#)" for a description of these steps.

##### Requirements

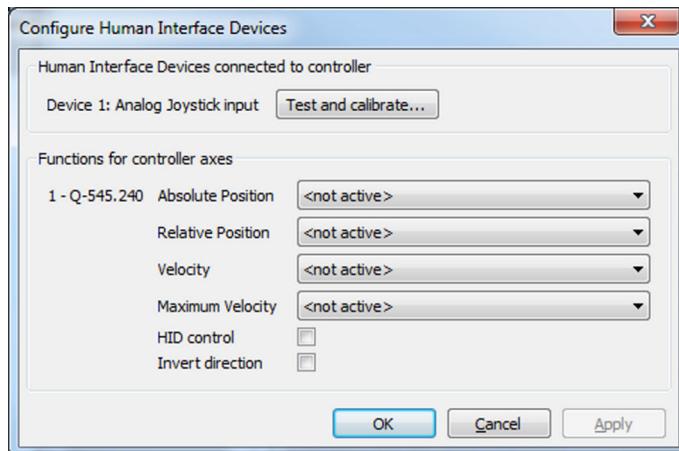
- ✓ If necessary, you have done a successful respective [reference move \(p. 58\)](#) for the axes of the E-873.1AT.
- ✓ You have [connected the HID to the E-873.1AT \(p. 78\)](#).

- ✓ All devices are still ready for operation.

### Setting Up and Activating HID Control

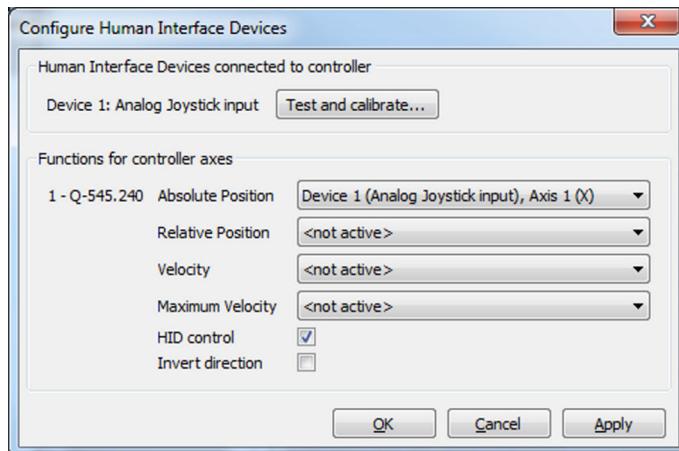
1. If necessary, open the window for configuring HID control via the **E-873.1AT > Configure controller HIDDevice(s)...** menu item in PIMikroMove's main window.

→ The **Configure Human Interface Devices** window opens.



2. Make the following respective settings for the E-873.1AT's axes displayed in the **Functions for controller axes** area:

- a) Select the HID's axis in the corresponding field that is to be used for the motion variable to be controlled.
  - b) Activate HID control by clicking the **HID control** checkbox.
  - c) If the direction of motion is to be inverted during HID control, click the **Invert direction** checkbox.
- In the example shown, the X axis of HID 1 is set and HID control is activated for the controller's axis 1.



3. Click the **Apply** button in the **Configure Human Interface Devices** window to activate the settings.
4. Send the settings for setting up HID control to the E-873.1AT by clicking the **OK** button.  
→ The **Configure Human Interface Devices** window closes.
5. Make sure that servo mode for the E-873.1AT's axes is switched on in PIMikroMove (e.g., by clicking the **Servo** checkbox in the **Axes** tab in PIMikroMove's main window).  
→ The E-873.1AT's axes can now be controlled by the HID according to the settings made.

6. If you want to save the new settings for HID control to the E-873.1AT's nonvolatile memory, continue as described in "[Saving the Configuration of HID Control Permanently \(p. 83\)](#)".

#### Saving the Configuration of the HID Control Permanently

Select the **E-873.1AT > Save parameters to non-volatile memory** menu item in PIMikroMove's main window.

→ The **Save Parameters to Non-Volatile Memory dialog** opens.

1. Enter either the password HID in the selection field of the **Save Parameters to Non-Volatile Memory** dialog, or select the **Settings of HDT, HIA, HIT (HID)** entry.
2. Click **OK** to save and to close the dialog.

### 8.4.7 Commands

H		Page
<b>HDT</b>	Set HID Default Lookup Table	127
<b>HDT?</b>	Get HID Default Lookup Table	128
<b>HIA</b>	Configure Control Done By HID Axis	129
<b>HIA?</b>	Get Configuration Of Control Done By HID Axis	130
<b>HIB?</b>	Get State Of HID Button	130
<b>HIE?</b>	Get Deflection Of HID Axis	131
<b>HIN</b>	Set Activation State For HID Control	131
<b>HIN?</b>	Get Activation State Of HID Control	131
<b>HIS?</b>	Get Configuration Of HI Device	132
<b>HIT</b>	Fill HID Lookup Table	133
<b>HIT?</b>	Get HID Lookup Table Values	133

### 8.4.8 Parameters

<b>0x61</b>	Invert Direction Of Motion For Joystick-Controlled Axis?	Inverts the direction of motion for HID-controlled axes. 0 Direction of motion not inverted (default) 1 Direction of motion inverted
-------------	--	--

### 8.5 Controller Macros

The E-873.1AT can save and process command sequences as macros.

The following functionalities make macros an important tool in many application areas:

- Several macros can be stored at the same time.
- Any macro can be defined as the startup macro. The startup macro runs each time the E-873.1AT is switched on or rebooted.
- Processing a macro and stopping a macro can be linked to conditions. In this way, loops can be realized as well.
- Macros can call up themselves or other macros at several nesting levels.
- Variables can be set for the macro and in the macro itself and used in different operations.

- Input signals can be evaluated for conditions and variables.

### Working with Macros

- The E-873.1AT can save up to 32 macros simultaneously.
- Up to 10 nesting levels are possible in macros.
- Local and global variables can be used in macros.
- A macro is overwritten if a macro with the same name is rerecorded.
- For working with controller macros, it is recommended to use the **Controller macros** tab in PIMikroMove. There you can conveniently record, start, and manage controller macros.
- The PI Terminal or the PIMikroMove's **Command entry** window can be used for entering commands, e.g., for starting macros.

### GCS commands in macros

Basically all GCS commands can be included in a macro. Exceptions:

- **RBT** for rebooting the E-873.1AT
- **MAC BEG** and **MAC END** for macro recording
- **MAC DEL** for deleting a macro

Query commands can be used in macros in conjunction with the **CPY**, **JRC**, **MEX**, and **WAC** commands. Otherwise they have no effect because macros do not send responses to interfaces.

## 8.5.1 Recording Macros

The **MAC BEG** and **MAC END** commands may not be specified when macros are recorded in the **Controller macros** tab in PIMikroMove.

A macro is overwritten if a macro with the same name is rerecorded.

If you record a macro on a controller whose address differs from 1, pay attention to the following when entering commands that need to be an integral part of the macro:

- If you are working with PI Terminal and have established communication via the **Connect...** button, the target address must be typed into every command line.
- If you are working with PIMikroMove or have established PI Terminal communication via the **GCS DLL...** button, the target address is sent automatically and may not be typed in.

Recording macros for PI Terminal and PIMikroMove is described in the following.

1. Start the macro recording.
  - If you are working with PI Terminal or in the **Command entry** in the PIMikroMove's window: Send the **MAC BEG** macroname command where "macroname" is the name of the macro.
  - If you are working in PIMikroMove in the **Controller macros** tab: Click the **Create new empty macro** icon to create a tab for entering a new macro.
2. Enter the commands to be included in the "macroname macro" line-by-line using the normal command syntax.  
Macros can call up themselves or other macros at several nesting levels.
3. End the macro recording.
  - If you are working with PI Terminal or in PIMikroMove's **Command entry** window: Send the **MAC END** command.
  - If you are working in PIMikroMove in the **Controller macros** tab: Click the **Send macro to controller** symbol and enter the macro name into a separate dialog window.

→ *The macro has been stored in the nonvolatile memory of the E-873.1AT.*
4. If you want to check in PI Terminal or in the PIMikroMove's **Command entry** window whether the macro was recorded correctly:
  - a) Query which macros are saved in the E-873.1AT by sending the **MAC?** command.
  - b) Query the content of "macroname" macro with the **MAC? macroname** command.

5. If you want to check PI MikroMove's **Controller macros** tab to see whether the macro was recorded correctly:
  - a) Click the **Read list of macros from controller** icon.
  - b) Mark the macro to be checked in the list on the left-hand side and click the **Load selected macro from controller** icon.

#### **Example Macro: Moving the Axis Back and Forth**

The axis <axis> is to move back and forth. 3 macros are recorded for this purpose. Macro 1 starts the motion in the positive direction and waits until the axis has reached the target position. Macro 2 performs this task for the negative direction of motion. Macro 3 calls up macro 1 and 2.

Record the macros by sending:

```
MAC BEG macro1
MVR <axis> 12.5
WAC ONT? <axis> = 1
MAC END
MAC BEG macro2
MVR <axis> -12.5
WAC ONT? <axis> = 1
MAC END
MAC BEG macro3
MAC START macro1
MAC START macro2
MAC END
```

### **8.5.2 Running the Macros**

Any commands can be sent from the command line while a macro is running on the controller. The macro content and motion commands received from the command line can overwrite each other.

It is not possible to run several macros simultaneously. Only one macro can be run at a time. You can link the conditions for running the macro with the [JRC](#) and [WAC](#) commands. The commands must be included in the macro.

A delay time for running the macro can be specified with [DEL](#).

Variables can be used in macros. Setting is done via the [VAR](#) command and querying variable values via [VAR?](#). Responses to query commands can be copied into variables with [CPY](#) and values can be added and saved to variables with [ADD](#).

In the following, PI Terminal or PI MikroMove's **Command entry** window is used to enter commands.

1. If the macro should continue running despite an error: Set the [Ignore Macro Error?](#) parameter (0x72) accordingly: Send the [SPA 1 0x72 Status](#) command where "Status" can take the value 0 (stop macro on error [standard]) or 1 (ignore macro error).
2. Start the macro:
  - If the macro is to be run once, send the [MAC START](#) macroname string where "macroname" is the name of the macro.
  - If the macro is to be run n times, send the [MAC NSTART](#) macroname n string command where "macroname" is the name of the macro and "n" indicates the number of times to be run.

Specifying "string" is optional and stands for the values of local variables. The values only need to be specified when the macro contains corresponding local variables. The sequence of the values in the input must correspond to the numbering of the appropriate

local variables, starting with the value of the local variable 1. The individual values must be separated from each other by spaces.

3. If you want to check that the macro is running:

- Query whether a macro is running on the controller by sending the [#8](#) command.
- Query the name of the macro currently running on the controller by sending the [RMC?](#) command.

**Example Macro: Moving an Axis with Variable Travel Range Back and Forth**

The axis <axis> is to move back and forth. The travel to the left and to the right is to be variably adjustable without having to change the macros used. Local and global variables are therefore used.

Create the global variables LEFT and RIGHT by sending:

```
VAR LEFT 5
```

```
VAR RIGHT 15
```

LEFT therefore has the value 5, and RIGHT has the value 15. These values can be changed at any time, e.g., by sending the [VAR](#) command again.

Create the global variables again each time that the E-873.1AT is switched on or rebooted, since they are only written to the volatile memory of the E-873.1AT.

Record the MOVLR macro by sending:

```
MAC BEG movlr
MAC START movwai ${LEFT}
MAC START movwai ${RIGHT}
MAC END
```

MOVLR successively starts the MOVWAI macro (which is still to be recorded) for both directions of motion. The values of the global variables LEFT and RIGHT are used when MOVWAI is started, to set the value of the local variable 1 contained in MOVWAI (dollar signs and braces are necessary for the local variable 1 in the macro to actually be replaced by the value of the global variable and not by its name).

Record the MOVWAI macro by sending:

```
MAC BEG movwai
MOV <axis> $1
WAC ONT? <axis> = 1
MAC END
```

MOVWAI moves axis <axis> to the target position which is specified by the value of the local variable 1 and waits until the axis has reached the target position.

Start the execution of the MOVLR macro by sending:

```
MAC NSTART movlr 5
```

The MOVLR macro is executed five times in succession, i.e., axis <axis> alternately moves to the positions 5 and 15 five times. You can also select any other value for the number of executions.

**Example macro: Realizing multiple calls of a macro in a loop**

The TESTDION macro checks the status of the digital input lines on the I/O socket. It uses a local variable to identify the digital input line (1 to 4). A further macro is recorded with a loop so that the TESTDION macro does not have to be called separately for each input line.

Record the LOOPDION macro by sending:

```
MAC BEG loopdion
VAR COUNTER 1
MAC START TESTDION ${COUNTER}
ADD COUNTER ${COUNTER} 1
```

```
JRC -2 VAR? COUNTER < 5
```

```
MAC END
```

The COUNTER variable is created with the value 1. After this, the TESTDION macro is started for the input line whose identifier is specified via the COUNTER variable. Then the value of the COUNTER is increased by 1. As long as the value of the COUNTER is less than 5, the macro line pointer subsequently jumps 2 lines back, so that TESTDION can be started for the next digital input line.

### 8.5.3 Stopping the Macros

Stopping the macro can be linked to a condition with the [MEX](#) command. The command must be included in the macro.

1. Stop the macro with the [#24](#) or [STP](#) commands.
2. If you want to check whether an error occurred while the macro was running, send the [MAC\\_ERR?](#) command. The response shows the last error that has occurred.

### 8.5.4 Configuring a Startup Macro

Any macro can be defined as the startup macro. The startup macro runs each time the E-873.1AT is switched on or rebooted.

Deleting a macro does **not** delete its selection as a startup macro.

1. Set a macro as the startup macro:
  - Send the [MAC\\_DEF](#) macroname command to set a macro as startup macro where "macroname" is the name of the macro.
  - If you want to cancel the selection of the startup macro and do not want to define another macro as the startup macro, send [MAC\\_DEF](#) only.
2. Query the name of the currently defined startup macro by sending the [MAC\\_DEF?](#) command.

#### Example Macro: Preparing an Axis for Closed-Loop Operation via a Startup Macro

The STARTCL macro switches the HID control off and the servo mode on for axis 1 and starts a reference move to the negative physical limit of the travel range. As STARTCL is defined as the startup macro, axis 1 is ready for closed-loop operation immediately after switch-on.

Send:

```
MAC BEG startcl  
HIN 1 0  
SVO 1 1  
DEL 1000  
FRF 5  
MAC END  
MAC DEF startcl
```

When this macro is used, the E-873.1AT's parameter settings should be adapted to the connected positioner in the nonvolatile memory. Alternatively, the parameter settings can also be configured in the volatile memory via the startup macro.

### 8.5.5 Deleting Macros

A macro cannot be deleted while it is running.

Deleting a macro does not delete its selection as a startup macro.

1. Delete a macro with the [MAC\\_DEL](#) macroname command where "macroname" is the name of the macro.

## 8.5.6 Saving and Loading Macros

For example, making backups of controller macros on the PC can be useful before updating the firmware.

The use of the **Controller macros** tab in PIMikroMove is recommended for backing up and loading controller macros.

Saving and loading controller macros with PIMikroMove is described in the following.

### Saving Controller Macros on the PC

1. Select the **Controller macros** tab in PIMikroMove's main window.
  2. Select the macros in the **Macros on controller** list that you want to back up to the PC:
    - Click the desired entry in the list to select a macro.
    - To select more than one macro, press and hold down the **shift** key and click the desired entries in the list.
    - To deselect, click an open area in the list.
- *The Save selected macros to PC button becomes active when selecting one or more macros.*
- 
3. Save the selected macros on the PC:
    - a) Click the  button to open a directory selection window.
    - b) Select the directory on the PC where you want to save the macros.
    - c) Click **Save**.
- *The macros are saved as text files (<macroname>.txt) in the selected directory of the PC.*

### Loading Controller Macros from the PC to the E-873.1AT

1. Select the **Controller macros** tab in PIMikroMove's main window.
  2. Load macros from the PC to the E-873.1AT:
    - a) Click the  button to open a file selection window.
    - b) Select the text files (<macroname>.txt) in the file selection window whose contents you want to load as a macro from the PC to the E-873.1AT.
    - c) Click **Open**.
- *For each selected text file (<macroname>.txt), the content is loaded as a macro <macroname> into the E-873.1AT.*

## 8.5.7 Example Macros

### Example Macro: Stopping Motion by Pushbutton

1. Connect digital input line 1 on the **I/O** socket to an appropriate signal source.  
The digital input signal can be used e. g. for a conditional jump of the macro execution pointer.
2. Record the HALT macro on the controller.

```
MAC BEG halt
MVR 1 5
JRC 2 DIO? 1 = 1
JRC -1 ONT? 1 = 0
HLT 1
MAC END
```

→ *The macro has the following tasks:*

### *Start relative motion of axis 1*

*Set condition: If digital input line 1 has the high state, the macro execution pointer jumps two lines forward. This stops the axis. Otherwise, the macro continues to the next line.*

*Set condition: As long as axis 1 has not yet reached the target position, the macro execution pointer jumps back one line. A loop is established as a result.*

3. Start the HALT macro on the controller.

```
MAC START halt
```

→ Axis 1 starts to move. It is stopped by switching digital input line 1 to the high state (e. g. by pushbutton). Regardless of whether the axis has reached the target position or was halted previously, the error code is set to 10 via the HLT command.

4. If error code 10 interferes: Record alternative HALTVAR macro which uses a variable.

```
MAC BEG haltvar
MVR 1 5
JRC 2 DIO? 1 = 1
JRC -1 ONT? 1 = 0
CPY TARGET POS? 1
MOV 1 ${TARGET}
VAR TARGET
MAC END
```

→ The macro has the same tasks as the HALT macro. However, axis 1 is not stopped by pushbutton via the HLT command; instead the result of the POS? 1 query is copied to the TARGET variable. Then this variable is used as the target position for the MOV command. As a result, the axis stays right where it was. To clean up, TARGET is defined as empty with the VAR command which deletes the variable.

5. Start the HALTVAR macro on the controller.

```
MAC START haltvar
```

→ Axis 1 starts to move. It is stopped by switching digital input line 1 to the high state (e. g. by pushbutton). Error code 10 is not set because no halt or stop command is used.

### **Example Macro: HID Control Alternating with Relative Motion**

The identifier of axis 1 was changed in X with the SAI command. The absolute target position of axis X is to be controlled by axis 1 of the HID (e.g., a joystick axis). The buttons of a connected C-170.PB pushbutton box are to be used for the following tasks:

- Button 1: Starting a relative motion in the positive direction when HID control is disabled
  - Button 2: Starting a relative motion in the negative direction when HID control is disabled
  - Button 3: Disabling HID control
  - Button 4: Active HID control
1. Connect C-170.PB pushbutton box from PI to the I/O socket.  
→ Digital input lines 1 to 4 are switched to high state as long as the respective button is pressed.
  2. Connect C-819.20 or C-819.30 joystick to the Joystick socket.  
→ For commands, the connected joystick axis is accessible as axis 1 HID 1.
  3. Record the STARTUP macro on the controller.
- ```
MAC BEG startup
HIN X 0
SVO X 1
FRF X
WAC ONT? X = 1
HIA X 0 0 0
```

```
HIA X 1 1 1  
HIN X 1  
MAC START LOOP  
MAC END
```

The macro has the following tasks:

- Switch on the servo mode for axis X.
- Start a reference move for axis X.
- Configure HID control for axis X: The absolute target position is to be controlled by axis 1 of HID 1.
- Activate HID control for axis X
- Start the LOOP macro for the main loop

4. Record the LOOP macro on the controller.

```
MAC BEG loop  
MAC START button3  
MAC START loop  
MAC END
```

The macro has the following tasks:

- Start BUTTON3 macro
- Call itself to set up the main loop

5. Record the BUTTON3 macro on the controller.

```
MAC BEG button3  
MEX DIO? 3 = 0  
HIN X 0  
MAC START pbloop  
MAC END
```

The macro has the following tasks:

- If button 3 is not pressed: End the execution of BUTTON3
- If button 3 is pressed: Disable HID control and start the loop for checking buttons 1, 2 and 4

6. Record the PBLOOP macro on the controller.

```
MAC BEG pbloop  
MAC START button1  
MAC START button2  
MAC START button4  
MAC START pbloop  
MAC END
```

The macro has the following tasks:

- Start the BUTTON1, BUTTON2 and BUTTON4 macros in succession
- Call itself up to create the loop to check buttons 1, 2 and 4

7. Record the BUTTON1 macro on the controller.

```
MAC BEG button1  
MEX DIO? 1 = 0  
MVR X 1  
WAC ONT? X = 1  
MAC END
```

The macro has the following tasks:

- If button 1 is not pressed: End the execution of BUTTON1
- If button 1 is pressed: Start a motion of axis X over distance 1 in the positive direction and pause the macro execution until axis X is at the target position

8. Record the BUTTON2 macro on the controller.

```
MAC BEG button2
MEX DIO? 2 = 0
MVR X -1
WAC ONT? X = 1
MAC END
```

The macro has the following tasks:

- If button 2 is not pressed: End the execution of BUTTON2
- If button 2 is pressed: Start a motion of axis X over distance 1 in the negative direction and pause the macro execution until axis X is at the target position

#### 9. Record the BUTTON4 macro on the controller.

```
MAC BEG button4
MEX DIO? 4 = 0
HIN X 1
MAC START LOOP
MAC END
```

The macro has the following tasks:

- If button 4 is not pressed: End the execution of BUTTON4
- If button 4 is pressed: Enable HID control and start the main loop

#### 10. Start the STARTUP macro on the controller.

```
MAC START startup
```

Axis X starts a reference move to the reference switch. HID control is then enabled for axis X, so that the absolute target position can be controlled with the joystick. As long as HID control is enabled, buttons 1 and 2 have no effect. HID control is disabled by pressing button 3. Relative motion of axis X can then be started with buttons 1 and 2, and HID control can be enabled again with button 4.

### 8.5.8 Commands

| #               |                                        | Page |
|-----------------|----------------------------------------|------|
| <b>#24</b>      | Stop All Axes                          | 109  |
| <b>#8</b>       | Query If Macro Is Running              | 109  |
| <b>A</b>        |                                        | Page |
| <b>ADD</b>      | Add And Save To Variable               | 110  |
| <b>C</b>        |                                        | Page |
| <b>CPY</b>      | Copy Into Variable                     | 111  |
| <b>D</b>        |                                        | Page |
| <b>DEL</b>      | Delay The Command Interpreter          | 116  |
| <b>J</b>        |                                        | Page |
| <b>JRC</b>      | Jump Relatively Depending On Condition | 139  |
| <b>M</b>        |                                        | Page |
| <b>MAC BEG</b>  | Call Macro Function: BEG               | 140  |
| <b>MAC DEF</b>  | Call Macro Function: DEF               | 140  |
| <b>MAC DEF?</b> | Call Macro Function: DEF?              | 140  |
| <b>MAC DEL</b>  | Call Macro Function: DEL               | 141  |

|            |                                       |      |
|------------|---------------------------------------|------|
| MAC END    | Call Macro Function: END              | 141  |
| MAC ERR?   | Call Macro Function: ERR?             | 141  |
| MAC NSTART | Call Macro Function: NSTART           | 141  |
| MAC START  | Call Macro Function: START            | 142  |
| MAC?       | List Macros                           | 142  |
| MEX        | Stop Macro Execution Due To Condition | 143  |
| R          |                                       | Page |
| RBT        | Reboot System                         | 147  |
| RMC?       | List Running Macros                   | 148  |
| S          |                                       | Page |
| STP        | Stop All Axes                         | 155  |
| V          |                                       | Page |
| VAR        | Set Variable Value                    | 159  |
| VAR?       | Get Variable Values                   | 159  |
| W          |                                       | Page |
| WAC        | Wait For Condition                    | 161  |

### 8.5.9 Parameters

|      |                     |                                                                          |
|------|---------------------|--------------------------------------------------------------------------|
| 0x72 | Ignore Macro Error? | Ignore macro error?<br>0 Stop macro on error (default)<br>1 Ignore error |
|------|---------------------|--------------------------------------------------------------------------|

## 8.6 Working with GCS Commands

### 8.6.1 GCS Command Syntax

#### Notation

The following notation is used to define the GCS syntax and to describe the commands:

|               |                                                                                                                                         |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <...>         | Angle brackets indicate an argument of a command, can be an element identifier or a command-specific parameter.                         |
| [...]         | Square brackets indicate an optional entry                                                                                              |
| {...}         | Braces indicate repeated specifications, i.e., it is possible to access more than one element (e.g., several axes) in one command line. |
| $\text{L}_F$  | Line Feed (ASCII character 10), default termination character (character at the end of a command line)                                  |
| $\text{U}$    | Space (ASCII character 32), empty space                                                                                                 |
| $\rightarrow$ | Horizontal tab (ASCII character 9)                                                                                                      |
| #...          | Single-character command, "... indicates the ASCII character in decimal notation, e.g., #7 for ASCII character $\text{E}_L$ .           |

### Syntax

A GCS command consists of three letters, e.g., **CMD**, or three letters and a question mark, e.g., **CMD?**.

#### Exceptions:

- Single-character commands consist of only one ASCII character. In this manual, the ASCII character is written as combination of # and the character code in decimal format, e.g., as #24.
- \*IDN? (for GPIB compatibility).

The command mnemonic is not case sensitive. The command mnemonic and all arguments (e.g., axis and channel identifiers, parameters etc.) must be separated from each other by a space ( $\text{U}$ ). The command line ends with the termination character ( $\text{L}_F$ ).

- **CMD[{{U}<Argument>}] $\text{L}_F$**
- **CMD?[{{U}<Argument>}] $\text{L}_F$**

#### Exception:

- Single-character commands are not followed by a termination character. However, the response to a single-character command is followed by a termination character.

More than one command mnemonic per line is not allowed. Several groups of arguments following a command mnemonic are allowed.

When all arguments are optional and not specified, the command is executed for all possible argument values.

### Sending a Command

The axis identified with "1" is to be moved to position 10.0. The unit depends on the controller (e.g.,  $\mu\text{m}$  or mm).

1. Send

**MOV\_U1\_10.0 $\text{L}_F$**

→ Axis 1 moves to position 10.0 (physical unit).

### Sending the Command with Several Arguments

Two axes are to be moved that are connected to the same controller: The axis with axis identifier "1" is to be moved to position 17.0 and the axis with axis identifier "2" is to be moved to position 2.05. The unit depends on the controller (e.g.,  $\mu\text{m}$  or mm).

## Information

Wenn ein Teil der Befehlszeile nicht ausgeführt werden kann, wird die gesamte Zeile nicht ausgeführt.

1. Send

`MOV_1_17.3_2_2.05lf`

→ Axis 1 moves to position 17.0 (physical unit), axis 2 moves to position 2.05 (physical unit).

### Sending commands without arguments

The position of all axes is to be queried.

1. Send

`POS?lf`

→ Outputs the position of all axes. The response syntax is as follows:

`{[<Argument>[{\_<Argument>}]"="]<Wert>lf}`

`[<Argument>[{\_<Argument>}]"="]<Wert>lf` (for the last line)

## 8.6.2 Variables

The electronics support variables for more flexible programming. While global variables are always available, local variables are only valid for a specified macro. Typically, variables are used when working with macros.

Variables are in volatile memory (RAM) only. The variable values are the STRING data type.

The following conventions apply to variable names:

- Variable names may not contain special characters (especially not "\$").
- The maximum number of characters is 8.
- Names of global variables can consist of characters A to Z and 0 to 9. They must begin with a letter.
- Names of local variables must not contain alphabetic characters. Possible characters are 0 to 9.
- The variable name can also be specified via the value of another variable.

If the value of a variable is to be used, the notation must be as follows:

- The variable name must be preceded by the dollar sign (\$).
- Variable names consisting of multiple characters must be put in braces.

If the variable name consists of a single character, no braces are necessary.

Note that when braces are omitted for multicharacter variable names, the first character after the "\$" is interpreted as the variable name.

## 8.7 Adapting Settings

The properties of the E-873.1AT and the mechanics connected are stored in the E-873.1AT as parameter values.

The parameters can be divided into the following categories:

- Protected parameters whose default settings cannot be changed
- Parameters that can be set by the user to adapt to the application

Write permission for the parameters is determined by command levels.

Each parameter is in the E-873.1AT's volatile and nonvolatile memory. The values in the nonvolatile memory are loaded to the volatile memory as default values when switching on or rebooting the E-873.1AT. The values in the volatile memory determine the current behavior of the system.

The designation "Active Values" is used for the parameter values in the volatile memory and "Startup Values" is used for the parameter values in the nonvolatile memory in the PC software from PI.

Use the [HPA?](#) command to query the parameters available in the E-873.1AT.

### **NOTICE**



#### **Unsuitable parameter settings!**

The values in the nonvolatile memory are loaded to the volatile memory as default values when switching on or rebooting the E-873.1AT and take effect immediately. Unsuitable parameter settings can cause damage to the mechanics.

- ▶ Change parameter values only after careful consideration.
- ▶ Save the current parameter values to the PC before you make changes in the nonvolatile memory.

## **8.7.1 Parameter Commands**

The following general commands are available for changing parameters:

| Command              | Function                                                                                                        |
|----------------------|-----------------------------------------------------------------------------------------------------------------|
| <a href="#">CCL</a>  | Change to another command level                                                                                 |
| <a href="#">CCL?</a> | Query active command level                                                                                      |
| <a href="#">HPA?</a> | Query available controller parameters                                                                           |
| <a href="#">RPA</a>  | Copy a parameter value from the nonvolatile to the volatile memory                                              |
| <a href="#">SEP</a>  | Modify parameter value in nonvolatile memory                                                                    |
| <a href="#">SEP?</a> | Query parameter values from the nonvolatile memory                                                              |
| <a href="#">SPA</a>  | Modify parameter value in volatile memory                                                                       |
| <a href="#">SPA?</a> | Query parameter values from the volatile memory                                                                 |
| <a href="#">WPA</a>  | Copy a current parameter value from the volatile to the nonvolatile memory. Here it is used as a default value. |

The following special commands only change the corresponding parameters in the volatile memory. When necessary, the changed values must be written to the nonvolatile memory with the [WPA](#) command.

| Command | Adaptable parameters                        |
|---------|---------------------------------------------|
| ACC     | Acceleration in closed-loop operation (0xB) |
| DEC     | Deceleration in closed-loop operation (0xC) |
| VEL     | Velocity in closed-loop operation (0x49)    |

## **8.7.2 Saving Parameter Values in a Text File**

### **Overview**

The E-873.1AT is configured via parameters, e.g., for adapting to the mechanics. Changing parameter values can cause undesirable results.

- ▶ Create a backup copy on the PC before changing the parameter settings of the E-873.1AT. You can then restore the original settings at any time.
- ▶ Create an additional backup copy with a new file name each time after optimizing the parameter values or adapting the E-873.1AT to specific mechanics.

Parameter values saved in a text file on the PC can be loaded back to the E-873.1AT in PIMikroMove or PIterminal. The **Send file...** button is available for this purpose in the send command window. Before loading into the E-873.1AT, the individual lines of the text files must be converted into command lines that contain the corresponding SPA or SEP commands.

### Requirements

- ✓ You have [established communication between the E-873.1AT and the PC \(p. 53\)](#) with PIMikroMove or PIterminal.

### Saving Parameter Values in a Text File

1. If you are using PIMikroMove, open the window for transmitting commands: Select **Tools > Command entry** in the main window or press F4 on the keyboard.  
After communication has been established, the main window is opened PIterminal automatically and commands can be sent.
2. Query the parameter values that you want to create a backup.
  - If you want to save the parameter values from the volatile memory of the E-873.1AT: Send the [SPA?](#) command.
  - If you want to save the parameter values from the nonvolatile memory of the E-873.1AT: Send the [SEP?](#) command.
3. Click the **Save...** button.
4. The **Save content of terminal as textfile** window opens.
5. Save the queried parameter values to a text file on your PC in the **Save content of terminal as textfile** window.

## 8.7.3 Changing Parameter Values

### Overview

The following procedure is generally recommended for changing parameter values:

1. Change the parameter values in the volatile memory.
2. Check whether the E-873.1AT works correctly with the changed parameter values.
  - If so:
    - Write the changed parameter values into the nonvolatile memory.
  - If not:
    - Change and check the parameter values in the volatile memory again.

### Requirements

- ✓ If you want to change parameter values in the E-873.1AT's nonvolatile memory: You have saved the E-873.1AT's parameter values in a text file [on the PC \(p. 95\)](#).
- ✓ You have [established communication between the E-873.1AT and the PC \(p. 53\)](#) with PIMikroMove or PIterminal.

### Information

Write access for the parameters of the E-873.1AT is defined by command levels. After the controller is switched on or rebooted, the active command level is always 0. On command levels > 1, write access is only available to PI service personnel.

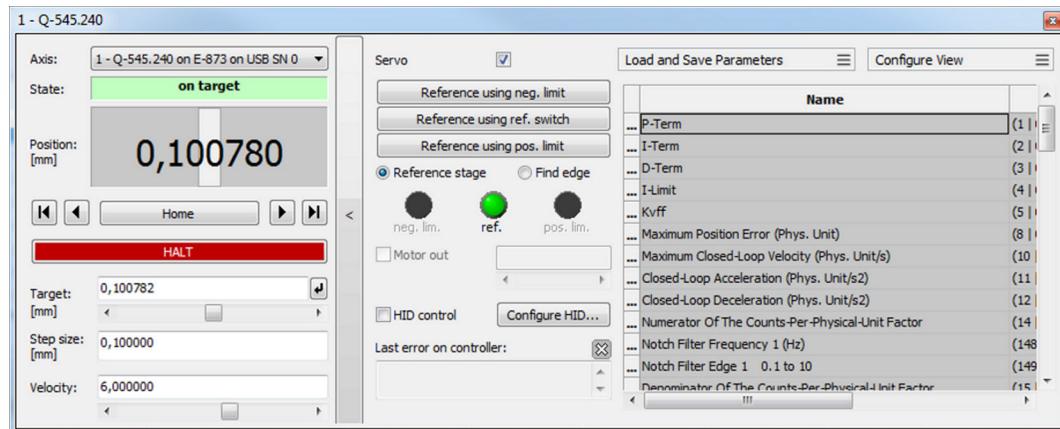
### Changing Parameter Values

1. If you want to change the axis-related parameters of the E-873.1AT:
  - a) Open the expanded single axis window for the connected positioner in the main window of PIMikroMove by clicking the right mouse button on the corresponding line

of the **Axes** tab and selecting **Show Expanded Single Axis Window** in the context menu.

- b) If the parameter to be modified is not included in the list on the right-hand side of the window, click **Configure View > Select parameters...** and add it to the list. You can also display certain groups of parameters or all axis-related parameters.

→ The list of axis-related parameters is displayed.



2. If you want to change the system-related parameters of the E-873.1AT:

- a) Open the window for the system-related parameters of the E-873.1AT in the main window of PI MikroMove by selecting **E-873.1AT > Show system parameters** in the menu.

→ The list of system-related parameters is displayed.

| Load and Save Parameters |           |              |     |
|--------------------------|-----------|--------------|-----|
| Name                     | ID        | Active Value | CCL |
| ... Ignore Macro Error?  | 0x72      | 0 0          |     |
| ... Servo Update Time    | 0xE000200 | 0,000050     | 2   |

3. If you want to change the parameter values in the E-873.1AT's **volatile memory**, you have the following options:

- a) Type the new parameter values into the corresponding input field in the **Active Value** column and press the enter key on the PC's keyboard or click the mouse button outside of the input field.

→ The modified parameter value is transferred to the E-873.1AT's volatile memory.

- b) Click **Load and Save Parameters -> Load all startup parameters of the axis / system from controller**.

→ The values of all axis-related / system-related parameters are loaded from the E-873.1AT's nonvolatile memory.

- c) Click **Load and Save Parameters -> Load parameters from stage database...** in the expanded single axis window.

You can use **Load and Save Parameters > Reload parameters from stage database...** to reload the currently loaded parameter set.

→ A selected parameter set for the axis is loaded from the positioner database.

4. If you want to change parameter values in the E-873.1AT's **nonvolatile memory**, you have the following options:

- a) Type the new parameter value into the corresponding input field in the list's **Startup Value** column and press the enter key on the PC's keyboard or click the mouse button outside of the input field.

- The changed parameter value is transferred to the E-873.1AT's volatile memory.
- b) Click **Load and Save Parameters -> Save all currently active axis / system parameters as startup parameters to controller.**

You can skip parameters that do not have write access on the current command level.

- The values of all axis-related / system-related parameters are written from the E-873.1AT's volatile memory to the nonvolatile memory.

If a parameter value in the volatile memory (**Active Value** column) is different from the parameter value in the nonvolatile memory (**Startup Value** column), the line in the list is highlighted in color.

## 8.7.4 Creating or Changing Parameter Sets for Positioners

### Overview

You can create and edit new parameter records in the PIStages3 database. This can be required in the following cases, for example:

- You want to operate a positioner with different servo control parameter settings than the one from the default parameter set.
- You want to adapt the soft limits of the positioner to your application.
- You have a custom positioner.

Possibilities for creating and editing parameter sets in the PISTAGES3.DB database:

- You can create a new positioner type easily by changing an existing parameter set in PIMikroMove and saving it under a new name.
- You can open and edit the positioner database directly with PIStages3Editor, which is included on the product CD, .

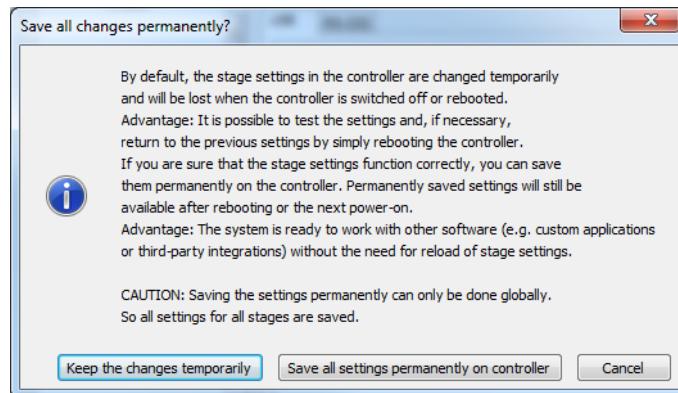
The following describes how to use to PIMikroMove create and change a parameter set for a positioner.

### Requirements

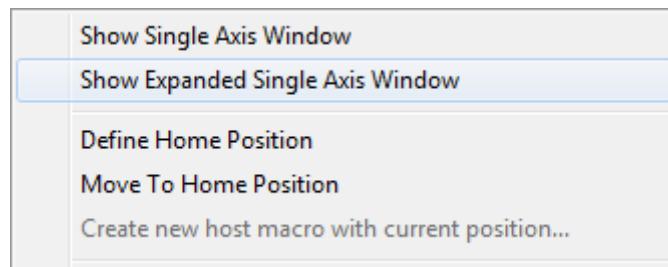
- ✓ You have installed the latest version of the PISTAGES3.DB database onto your PC.
- ✓ If PI provided a custom positioner database for your positioner, the dataset was imported into PIStages3.
- ✓ PIMikroMove has established communication between the E-873.1AT and the PC.

### Creating a Parameter Set for Positioners

1. Select the **E-873.1AT > Select connected stages...** menu item in the main window of PIMikroMove.  
→ The **Start up stages/axes for E-873.1AT** window opens and the **Select connected stages** step is active.
  2. Select an appropriate type of positioner during the **Select connected stages** step:
    - a) Click **Assign Type from ID Chip**.
    - or
    - a) Highlight the positioner in the **Stage database entries** list.
    - b) Click **Assign**.
    - c) Confirm the selection with **OK**.
- The **Save all changes permanently?** dialog is opened.



3. Click **Keep the changes temporarily** in the **Save all changes permanently** dialog to load the parameter settings into the volatile memory of the E-873.1AT.  
→ *The Start up stages/axes window changes to the Start up axes step.*
4. Click **Close** to close the **Start up stages/axes** window.
5. Open the expanded single axis window for the selected positioner in the main window of PIMikroMove by clicking the right mouse button on the corresponding line of the **Axes** tab and selecting **Show Expanded Single Axis Window** in the context menu.



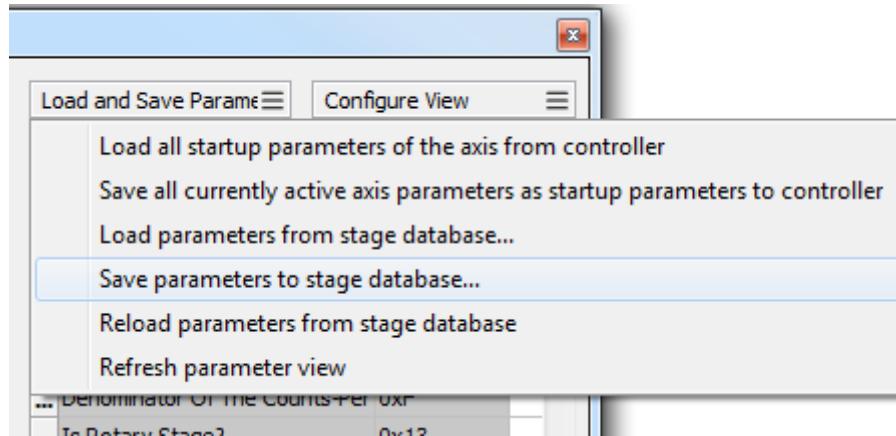
6. Enter new values for the parameters to be changed:

| Load and Save Parameters |                                                    | Configure View |              |     |
|--------------------------|----------------------------------------------------|----------------|--------------|-----|
|                          | Name                                               | ID             | Active Value | CCL |
| ...                      | P-Term                                             | 0x1            | 5            | 0   |
| ...                      | I-Term                                             | 0x2            | 1000         | 0   |
| ...                      | D-Term                                             | 0x3            | 0            | 0   |
| ...                      | I-Limit                                            | 0x4            | 2000         | 0   |
| ...                      | Kvff                                               | 0x5            | 0            | 0   |
| ...                      | Maximum Position Error (Phys. Unit)                | 0x8            | 16,145833330 | 0   |
| ...                      | Maximum Motor Output                               | 0x9            | 2000         | 0   |
| ...                      | Numerator Of The Counts-Per-Physical-Unit Factor   | 0xE            | 11520000     | 0   |
| ...                      | Denominator Of The Counts-Per-Physical-Unit Factor | 0xF            | 1            | 0   |
| ...                      | Is Rotary Stage?                                   | 0x13           | 1            | 0   |

- a) If the parameter to be modified is not included in the list on the right-hand side of the window, click **Configure view > Select parameters...** and add it to the list. You can also display certain groups of parameters or all axes-related parameters.
- b) Type the new parameter value into the corresponding input field in the **Active Value** column of the list.
- c) Press the Enter key on the PC keyboard or click outside the input field with the mouse to transfer the parameter value to the volatile memory of the controller. Note: If a parameter value in the volatile memory (**Active Value** column) is different to the

parameter value in the nonvolatile memory (**Startup Value** column), the line in the list is highlighted in color.

7. Click **Load and Save Parameters > Save parameters to stage database....**



8. The **Save Parameters as User Stage Type** dialog opens.
9. Save the changed parameter values as new positioner type in **Dialog Save Parameters as User Stage Type**:
  - a) Leave the entry in the **Parameters of axis** field unchanged.
  - b) Enter the name for the new positioner type into the **Save as** field.
  - c) Click **OK**.

→ The new positioner type was saved in the positioner database. The displayed positioner type was updated in PI MikroMove. The new positioner type is also available immediately for selection in the **Select connected stages** step.

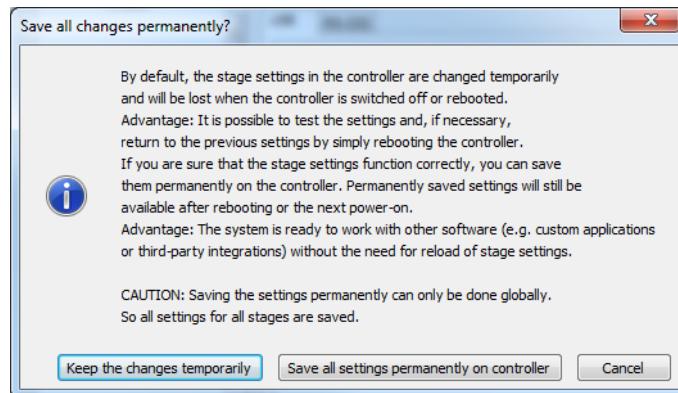
#### Changing a Positioner's Parameter Set

1. Select the **E-873.1AT > Select connected stages...** menu item in the main window of PI MikroMove.

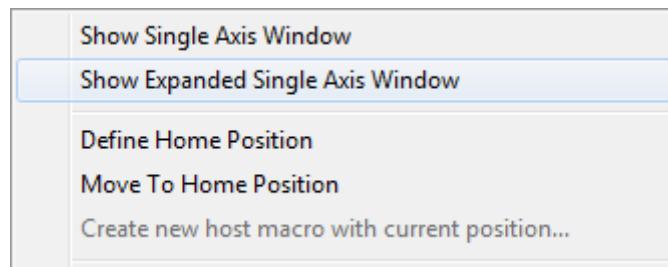
→ The **Start up stages/axes for E-873.1AT** window opens and the **Select connected stages** step is active.

2. Select a positioner type that you created during the **Select connected stages** as described above:
  - a) Click **Assign Type from ID Chip**.
  - or
  - a) Highlight the positioner in the **Stage database entries** list.
  - b) Click **Assign**.
  - c) Confirm the selection with **OK**.

→ The **Save all changes permanently?** dialog is opened.



3. Click **Keep the changes temporarily** in the **Save all changes permanently** dialog to load the parameter settings into the volatile memory of the E-873.1AT.  
→ *The Start up stages/axes window changes to the Start up axes step.*
4. Click **Close** to close the **Start up stages/axes** window.
5. Open the expanded single axis window for the selected positioner in the main window of PIMikroMove by clicking the right mouse button on the corresponding line of the **Axes** tab and selecting **Show Expanded Single Axis Window** in the context menu.



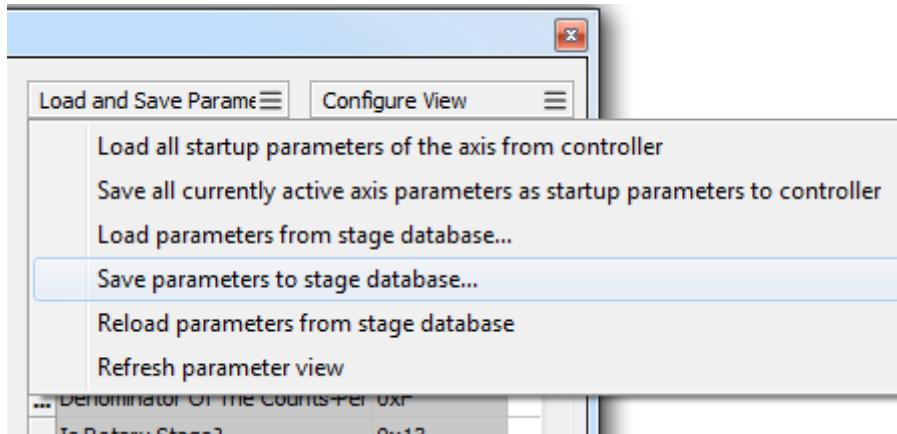
6. Enter new values for the parameters to be changed:

| Load and Save Parameters |                                                    | Configure View |              |     |
|--------------------------|----------------------------------------------------|----------------|--------------|-----|
|                          | Name                                               | ID             | Active Value | CCL |
| ...                      | P-Term                                             | 0x1            | 5            | 0   |
| ...                      | I-Term                                             | 0x2            | 1000         | 0   |
| ...                      | D-Term                                             | 0x3            | 0            | 0   |
| ...                      | I-Limit                                            | 0x4            | 2000         | 0   |
| ...                      | Kvff                                               | 0x5            | 0            | 0   |
| ...                      | Maximum Position Error (Phys. Unit)                | 0x8            | 16,145833330 | 0   |
| ...                      | Maximum Motor Output                               | 0x9            | 2000         | 0   |
| ...                      | Numerator Of The Counts-Per-Physical-Unit Factor   | 0xE            | 11520000     | 0   |
| ...                      | Denominator Of The Counts-Per-Physical-Unit Factor | 0xF            | 1            | 0   |
| ...                      | Is Rotary Stage?                                   | 0x13           | 1            | 0   |

- a) If the parameter to be modified is not included in the list on the right-hand side of the window, click **Configure view > Select parameters...** and add it to the list. You can also display certain groups of parameters or all axes-related parameters.
- b) Type the new parameter value into the corresponding input field in the **Active Value** column of the list.
- c) Press the Enter key on the PC keyboard or click outside the input field with the mouse to transfer the parameter value to the volatile memory of the controller. Note: If a parameter value in the volatile memory (**Active Value** column) is different to the

parameter value in the nonvolatile memory (**Startup Value** column), the line in the list is highlighted in color.

7. Click **Load and Save Parameters > Save parameters to stage database....**



8. The **Save Parameters as User Stage Type** dialog opens.
  9. Save the modified parameter values of the positioner type in the **Save Parameters as User Stage Type** dialog:
    - a) Leave the entry in the **Parameters of axis** field unchanged.
    - b) Leave the entry in the **Save as** field unchanged.
    - c) Click **OK**.
    - d) Click **Change settings** in the **Stage type already defined** dialog. The **Save Parameters as User Stage Type** dialog closes automatically after a short time.
- The parameter values of the positioner type were updated in the positioner database and in the main window of PI MikroMove.

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| <b>ONT?</b>       | Get On-Target State                     | 145         |
| <b>OSM</b>        | Open-Loop Step Moving                   | 146         |
| <b>OSN?</b>       | Read Number Steps                       | 146         |
| <b>P</b>          |                                         | <b>Page</b> |
| <b>POS</b>        | Set Real Position                       | 147         |
| <b>POS?</b>       | Get Real Position                       | 147         |
| <b>R</b>          |                                         | <b>Page</b> |
| <b>RBT</b>        | Reboot System                           | 147         |
| <b>RMC?</b>       | List Running Macros                     | 148         |
| <b>RON</b>        | Set Reference Mode                      | 148         |
| <b>RON?</b>       | Get Reference Mode                      | 148         |
| <b>RPA</b>        | Reset Volatile Memory Parameters        | 149         |
| <b>RTR</b>        | Set Record Table Rate                   | 149         |
| <b>RTR?</b>       | Get Record Table Rate                   | 149         |
| <b>S</b>          |                                         | <b>Page</b> |
| <b>SAI</b>        | Set Current Axis Identifiers            | 150         |
| <b>SAI?</b>       | Get List Of Current Axis Identifiers    | 150         |
| <b>SEP</b>        | Set Nonvolatile Memory Parameters       | 150         |
| <b>SEP?</b>       | Get Nonvolatile Memory Parameters       | 151         |
| <b>SPA</b>        | Set Volatile Memory Parameters          | 151         |
| <b>SPA?</b>       | Get Volatile Memory Parameters          | 152         |
| <b>SRG?</b>       | Query Status Register Value             | 153         |
| <b>SST</b>        | Set Step Size                           | 154         |
| <b>SST?</b>       | Get Step Size                           | 154         |
| <b>STE</b>        | Start Step And Response Measurement     | 155         |

|             |                                               |             |
|-------------|-----------------------------------------------|-------------|
| <b>STP</b>  | Stop All Axes                                 | 155         |
| <b>SVO</b>  | Set Servo Mode                                | 155         |
| <b>SVO?</b> | Get Servo Mode                                | 156         |
| <b>T</b>    |                                               | <b>Page</b> |
| <b>TAC?</b> | Tell Analog Channels                          | 156         |
| <b>TAV?</b> | Get Analog Input Voltage                      | 156         |
| <b>TIO?</b> | Tell Digital I/O Lines                        | 156         |
| <b>TMN?</b> | Get Minimum Commandable Position              | 157         |
| <b>TMX?</b> | Get Maximum Commandable Position              | 157         |
| <b>TNR?</b> | Get Number Of Record Tables                   | 157         |
| <b>TRO</b>  | Set Trigger Output State                      | 158         |
| <b>TRO?</b> | Get Trigger Output State                      | 158         |
| <b>TRS?</b> | Indicate Reference Switch                     | 158         |
| <b>TVI?</b> | Tell Valid Character Set For Axis Identifiers | 158         |
| <b>V</b>    |                                               | <b>Page</b> |
| <b>VAR</b>  | Set Variable Value                            | 159         |
| <b>VAR?</b> | Get Variable Values                           | 159         |
| <b>VEL</b>  | Set Closed-Loop Velocity                      | 159         |
| <b>VEL?</b> | Get Closed-Loop Velocity                      | 160         |
| <b>VER?</b> | Get Versions Of Firmware And Drivers          | 160         |
| <b>W</b>    |                                               | <b>Page</b> |
| <b>WAC</b>  | Wait For Condition                            | 161         |
| <b>WPA</b>  | Save Parameters To Nonvolatile Memory         | 162         |

## #4 Request Status Register

*Used in: (25), On-Target State (36)*

|                  |                                                                                                                                                                                                                    |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Requests system status information.                                                                                                                                                                                |
| Long description | This command is identical in function to <a href="#">SRG? (p. 153)</a> except that only one character is sent via the interface. Therefore, #4 can also be used when the controller is doing time-consuming tasks. |
| Format:          | <b>#4</b>                                                                                                                                                                                                          |
|                  | #4 corresponds to the EOT control character in ISO/IEC 6429.                                                                                                                                                       |
| Response:        | <StatusRegister><br><StatusRegister>    System status information (HEX)                                                                                                                                            |

<StatusRegister> is bit-mapped. Includes per axis:

| Bit | Description                           |
|-----|---------------------------------------|
| 15  | On-target state                       |
| 14  | Reference point definition is running |
| 13  | In motion                             |
| 12  | Servo mode activated                  |
| 11  |                                       |
| 10  | Sensor signal valid                   |
| 9   | Reference edge found                  |
| 8   | Error                                 |
| 7   | Digital input 4 active                |
| 6   | Digital input 3 active                |
| 5   | Digital input 2 active                |
| 4   | Digital input 1 active                |
| 3   | Sensor is referenced                  |
| 2   | Positive limit switch active          |
| 1   | Reference switch active               |
| 0   | Negative limit switch active          |

Deactivated axes are not included in the response.

## #5 Request Motion Status

*Used in:* Triggering Motion (28)

- Description: Queries the motion status of the axes.
- Format: #5  
#5 corresponds to the ENQ control character in ISO/IEC 6429.
- Response: <MotionStatus>  
<MotionStatus> motion status (HEX)  
<MotionStatus> is bit-mapped. Each axis corresponds to one bit and the bit value corresponds to the axis number, e.g.,

| Response | Description             |
|----------|-------------------------|
| 1        | Axis 1 is moving        |
| 2        | Axis 2 is moving        |
| 5        | Axis 3 and 1 are moving |

## #7 Request Controller Ready Status

*Used in:* (23)

- Description: Queries the controller's ready state.
- Long description: The controller is ready as soon as a new command can be executed.
- Format: #7  
#7 corresponds to the  $\text{^E_L}$  control character in ISO/IEC 6429.
- Response: <ReadyStatus>  
<ReadyStatus> ready state (HEX)

Possible answers:

| Response from controller | Character in ISO/IEC 8859-1 | Description             |
|--------------------------|-----------------------------|-------------------------|
| 0xB1                     | $\pm$                       | Controller is ready     |
| 0xB0                     | $\circ$                     | Controller is not ready |

- Troubleshooting: The response characters may be displayed differently in other character sets.

## #8 Query If Macro Is Running

*Used in:* (85)

Description: Tests if a macro is running on the controller.

Format: #8

#8 corresponds to the BS control character in ISO/IEC 6429.

Response: <MacroRunning>

|                |                         |
|----------------|-------------------------|
| <MacroRunning> | Macro is running (UINT) |
|----------------|-------------------------|

| <MacroRunning> | Description          |
|----------------|----------------------|
| 1              | A macro is running.  |
| 0              | No macro is running. |

## #24 Stop All Axes

*Used in:* (87), Triggering Motion (28)

Description: Stops all axes abruptly.

Long description: Stops all motion started by motion commands (e.g., [MOV \(p. 144\)](#), [MVR \(p. 145\)](#), MVE, [STE \(p. 155\)](#), SMO), reference point definition commands ([FNL \(p. 124\)](#), [FPL \(p. 124\)](#), [FRF \(p. 125\)](#)), and macros.

Also stops the macro.

Sets the error code to 10.

After the axes are stopped, their target positions are set to their current positions.

The function of this command is identical to [STP \(p. 155\)](#) except only one character is sent via the interface. Therefore, #24 can also be used when the controller is doing time-consuming tasks.

Format: #24

#24 corresponds to the CAN control character in ISO/IEC 6429.

## \*IDN? Get Device Identification

*Used in:* (23)

Description: Queries the device identification string.

Format: \*IDN?

Response: <DeviceInformation> <sub>LF</sub>

|                     |                                                                                                     |
|---------------------|-----------------------------------------------------------------------------------------------------|
| <DeviceInformation> | Device identification string with controller name, serial number, and firmware version.<br>(STRING) |
|---------------------|-----------------------------------------------------------------------------------------------------|

## ACC Set Closed-Loop Acceleration

*Used in:* (30)

|                  |                                                                                                                                                                                       |          |         |                |                                                         |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|----------------|---------------------------------------------------------|
| Description:     | Sets acceleration of specified axes.                                                                                                                                                  |          |         |                |                                                         |
| Long description | Changes the value of parameter <a href="#">0xB (p. 172)</a> in the volatile memory.<br>The maximum value that can be set with ACC and is specified by <a href="#">0x4A (p. 182)</a> . |          |         |                |                                                         |
|                  | The acceleration set with ACC is only taken into account when the respective axis is in closed-loop operation (servo mode on).                                                        |          |         |                |                                                         |
| Format:          | <b>ACC{._&lt;AxisID&gt;._&lt;Acceleration&gt;}</b>                                                                                                                                    |          |         |                |                                                         |
| Arguments:       | <table> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;Acceleration&gt;</td> <td>Acceleration in physical units / s<sup>2</sup> (FLOAT)</td> </tr> </table>         | <AxisID> | Axis ID | <Acceleration> | Acceleration in physical units / s <sup>2</sup> (FLOAT) |
| <AxisID>         | Axis ID                                                                                                                                                                               |          |         |                |                                                         |
| <Acceleration>   | Acceleration in physical units / s <sup>2</sup> (FLOAT)                                                                                                                               |          |         |                |                                                         |
| Troubleshooting: | Illegal axis identifier                                                                                                                                                               |          |         |                |                                                         |

## ACC? Get Closed-Loop Acceleration

*Used in:* (30)

|                                          |                                                                                                                                                                                                                                                                |                                          |         |          |                                                                       |                |                                                         |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|---------|----------|-----------------------------------------------------------------------|----------------|---------------------------------------------------------|
| Description:                             | Queries the acceleration value set with <a href="#">ACC (p. 110)</a> .                                                                                                                                                                                         |                                          |         |          |                                                                       |                |                                                         |
| Format:                                  | <b>ACC?[._&lt;AxisID&gt;]</b>                                                                                                                                                                                                                                  |                                          |         |          |                                                                       |                |                                                         |
| Arguments:                               | <table> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td></td> <td>The value for all axes will be queried if no arguments are specified.</td> </tr> </table>                                                                                       | <AxisID>                                 | Axis ID |          | The value for all axes will be queried if no arguments are specified. |                |                                                         |
| <AxisID>                                 | Axis ID                                                                                                                                                                                                                                                        |                                          |         |          |                                                                       |                |                                                         |
|                                          | The value for all axes will be queried if no arguments are specified.                                                                                                                                                                                          |                                          |         |          |                                                                       |                |                                                         |
| Response:                                | <table> <tr> <td>{&lt;AxisID&gt;=&lt;Acceleration&gt;<sub>LF</sub>}</td> <td></td> </tr> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;Acceleration&gt;</td> <td>Acceleration in physical units / s<sup>2</sup> (FLOAT)</td> </tr> </table> | {<AxisID>=<Acceleration> <sub>LF</sub> } |         | <AxisID> | Axis ID                                                               | <Acceleration> | Acceleration in physical units / s <sup>2</sup> (FLOAT) |
| {<AxisID>=<Acceleration> <sub>LF</sub> } |                                                                                                                                                                                                                                                                |                                          |         |          |                                                                       |                |                                                         |
| <AxisID>                                 | Axis ID                                                                                                                                                                                                                                                        |                                          |         |          |                                                                       |                |                                                         |
| <Acceleration>                           | Acceleration in physical units / s <sup>2</sup> (FLOAT)                                                                                                                                                                                                        |                                          |         |          |                                                                       |                |                                                         |
| Troubleshooting:                         | Illegal axis identifier                                                                                                                                                                                                                                        |                                          |         |          |                                                                       |                |                                                         |

## ADD Add and Save To Variable

*Used in:* Running the Macros (85)

|              |                                                                                                                                                                                                                                                                    |            |                                                            |            |                       |            |                        |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------------------------------------------------------|------------|-----------------------|------------|------------------------|
| Description: | Adds two summands (as variable or specified directly) and saves the sum as variable.                                                                                                                                                                               |            |                                                            |            |                       |            |                        |
| Format:      | <b>ADD_&lt;Variable&gt;._&lt;Summand1&gt;._&lt;Summand2&gt;</b>                                                                                                                                                                                                    |            |                                                            |            |                       |            |                        |
| Arguments:   | <table> <tr> <td>&lt;Variable&gt;</td> <td>Name of the variable where the sum is to be saved (STRING)</td> </tr> <tr> <td>&lt;Summand1&gt;</td> <td>First summand (FLOAT)</td> </tr> <tr> <td>&lt;Summand2&gt;</td> <td>Second summand (FLOAT)</td> </tr> </table> | <Variable> | Name of the variable where the sum is to be saved (STRING) | <Summand1> | First summand (FLOAT) | <Summand2> | Second summand (FLOAT) |
| <Variable>   | Name of the variable where the sum is to be saved (STRING)                                                                                                                                                                                                         |            |                                                            |            |                       |            |                        |
| <Summand1>   | First summand (FLOAT)                                                                                                                                                                                                                                              |            |                                                            |            |                       |            |                        |
| <Summand2>   | Second summand (FLOAT)                                                                                                                                                                                                                                             |            |                                                            |            |                       |            |                        |

## CCL Set Command Level

*Used in: (21), Parameter Commands (95)*

|                  |                                                                                                                                                                                            |  |         |                                 |        |                                                          |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------|---------------------------------|--------|----------------------------------------------------------|
| Description:     | Changes the active command level.                                                                                                                                                          |  |         |                                 |        |                                                          |
| Long description | The command level determines the availability of commands and write access to system parameters.<br>The active command level is always 0 when the electronics are switched on or rebooted. |  |         |                                 |        |                                                          |
| Format:          | <b>CCL_&lt;Level&gt;[_&lt;PSWD&gt;]</b>                                                                                                                                                    |  |         |                                 |        |                                                          |
| Arguments:       | <table><tr><td>&lt;Level&gt;</td><td>Controller command level (UINT)</td></tr><tr><td>&lt;PSWD&gt;</td><td>Password for changing to the corresponding command level</td></tr></table>      |  | <Level> | Controller command level (UINT) | <PSWD> | Password for changing to the corresponding command level |
| <Level>          | Controller command level (UINT)                                                                                                                                                            |  |         |                                 |        |                                                          |
| <PSWD>           | Password for changing to the corresponding command level                                                                                                                                   |  |         |                                 |        |                                                          |
| Troubleshooting: | Wrong password                                                                                                                                                                             |  |         |                                 |        |                                                          |

## CCL? Get Command Level

*Used in: (21), Parameter Commands (95)*

|                       |                                                                                                                                  |  |                       |  |         |                      |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------|--|-----------------------|--|---------|----------------------|
| Description:          | Queries the active command level.                                                                                                |  |                       |  |         |                      |
| Format:               | <b>CCL?</b>                                                                                                                      |  |                       |  |         |                      |
| Response:             | <table><tr><td>&lt;Level&gt;<sub>LF</sub></td><td></td></tr><tr><td>&lt;Level&gt;</td><td>Command level (UINT)</td></tr></table> |  | <Level> <sub>LF</sub> |  | <Level> | Command level (UINT) |
| <Level> <sub>LF</sub> |                                                                                                                                  |  |                       |  |         |                      |
| <Level>               | Command level (UINT)                                                                                                             |  |                       |  |         |                      |
|                       |                                                                                                                                  |  |                       |  |         |                      |

## CPY Copy Into Variable

*Used in: Analog Input Signals (75), Running the Macros (85)*

|              |                                                                                                                                                                                      |  |            |                                      |        |                                                 |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|------------|--------------------------------------|--------|-------------------------------------------------|
| Description: | Copies the response to a command into a variable.                                                                                                                                    |  |            |                                      |        |                                                 |
| Format:      | <b>CPY_&lt;Variable&gt;_&lt;CMD?&gt;</b>                                                                                                                                             |  |            |                                      |        |                                                 |
| Arguments:   | <table><tr><td>&lt;Variable&gt;</td><td>Name of the variable to be copied to</td></tr><tr><td>&lt;CMD?&gt;</td><td>Query command that responds with a single value</td></tr></table> |  | <Variable> | Name of the variable to be copied to | <CMD?> | Query command that responds with a single value |
| <Variable>   | Name of the variable to be copied to                                                                                                                                                 |  |            |                                      |        |                                                 |
| <CMD?>       | Query command that responds with a single value                                                                                                                                      |  |            |                                      |        |                                                 |
|              |                                                                                                                                                                                      |  |            |                                      |        |                                                 |

## CST? Get Assignment Of Stages To Axes

*Used in:* (23)

|                  |                                                                                                                                               |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Queries the name of the positioner type that is configured for the specified axis.                                                            |
| Long description | The positioner name is read from parameter <a href="#">0x3C (p. 180)</a> . If the parameter has the value "NOSTAGE", the axis is deactivated. |
| Format:          | <b>CST? [{&lt;AxisID&gt;}]</b>                                                                                                                |
| Arguments:       | <AxisID> Axis ID                                                                                                                              |
| Response:        | {<AxisID>=<String> <sub>LF</sub> }                                                                                                            |
|                  | <AxisID> Axis ID                                                                                                                              |
|                  | <String> Name of the positioner type (STRING)                                                                                                 |

## CSV? Get Current Syntax Version

*Used in:* (21)

|              |                                                      |
|--------------|------------------------------------------------------|
| Description: | Get current GCS syntax version used in the firmware. |
| Format:      | <b>CSV?</b>                                          |
| Response:    | <SyntaxVersion>                                      |
|              | <SyntaxVersion> GCS syntax version (STRING)          |

| <SyntaxVersion> | Description            |
|-----------------|------------------------|
| 1.0             | GCS syntax version 1.0 |
| 2.0             | GCS syntax version 2.0 |

## CTO Set Configuration Of Trigger Output

**Description:** Configures the trigger output conditions for the specified digital output line.

**Long description** Available CTO parameters:

| <CTO - Pam> | Parameters  | Possible values for <Value> | Description                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------|-------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1           | TriggerStep | 0                           | Distance                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 2           | Axis        | (Axis identifier)           | Selects the axis that the trigger output is configured for.                                                                                                                                                                                                                                                                                                                                                                                              |
| 3           | TriggerMode | 0                           | PositionDistance<br>A trigger pulse is output each time the axis has traveled the distance set with <b>TriggerStep</b> (<CTOPam> 1).                                                                                                                                                                                                                                                                                                                     |
|             |             | 2                           | OnTarget<br>The on-target status of the selected axis is transferred to the selected digital output line.                                                                                                                                                                                                                                                                                                                                                |
|             |             | 5                           | MotionError<br>The selected digital output line becomes active when a motion error occurs. The line remains active until the error code is reset to 0 (by a query with <a href="#">ERR? (p. 122)</a> ).                                                                                                                                                                                                                                                  |
|             |             | 6                           | InMotion<br>The selected digital output line is active as long as the selected axis is in motion.                                                                                                                                                                                                                                                                                                                                                        |
|             |             | 7                           | Position+Offset<br>The first trigger pulse is output when the axis has reached the position specified with <b>TriggerPosition</b> (<CTOPam> 10). The next trigger pulses are output respectively when the axis position equals the sum of the last valid trigger position and the distance specified by <b>TriggerStep</b> (<CTOPam> 1).<br>Trigger output ends when the axis position exceeds the value specified by <b>StopThreshold</b> (<CTOPam> 9). |

| <CTO - Parameters<br>Pam> | Possible val-<br>ues for <Val-<br>ue>                                                                                                                                                                       | Description                                                                                                                                                                                                                                                                                    |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           |                                                                                                                                                                                                             | The sign of the <b>TriggerStep</b> value determines which motion direction trigger pulses are to be output for.                                                                                                                                                                                |
| 8                         | SinglePosition<br><br>The selected digital output line is active when the axis position has reached or exceeded the position specified by <b>TriggerPosition</b> (<CTOPam> 10).                             |                                                                                                                                                                                                                                                                                                |
| 9                         | HardwareTrigger<br><br>Basically corresponds to the Position+Offset trigger mode but is done by the electronics (shorter processing time). Assignment of the axes to the digital output lines can be fixed. |                                                                                                                                                                                                                                                                                                |
| 7                         | Polarity                                                                                                                                                                                                    | 0 Sets the signal polarity to "active low"                                                                                                                                                                                                                                                     |
|                           |                                                                                                                                                                                                             | 1 Sets the signal polarity to "active high" (default value)                                                                                                                                                                                                                                    |
| 8                         | StartThreshold                                                                                                                                                                                              | (Position - value)<br><br>Trigger output start position for the following trigger modes: <ul style="list-style-type: none"><li>■ <b>PositionDistance</b> (Trigger-Mode 0)</li></ul>                                                                                                            |
| 9                         | StopThreshold                                                                                                                                                                                               | (Position - value)<br><br>Trigger output stop position for the following trigger modes: <ul style="list-style-type: none"><li>■ <b>PositionDistance</b> (Trigger-Mode 0)</li><li>■ <b>Position+Offset</b> (Trigger-Mode 7)</li><li>■ <b>HardwareTrigger</b> (Trigger-Mode 9)</li></ul>         |
| 10                        | TriggerPosition                                                                                                                                                                                             | (Position - value)<br><br>Position of the (first) trigger output for the following trigger modes: <ul style="list-style-type: none"><li>■ <b>Position+Offset</b> (Trigger-Mode 7)</li><li>■ <b>SinglePosition</b> (Trigger-Mode 8)</li><li>■ <b>HardwareTrigger</b> (Trigger-Mode 9)</li></ul> |

| <CTO - Parameters<br>Pam> | Possible val-<br>ues for <Val-<br>ue> | Description                                                                                                                                 |
|---------------------------|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 11                        | PulseWidth<br>(Integer fac-<br>tor)   | Factor that determines the<br>pulse width for the Hardware-<br>Trigger mode (TriggerMode 9).<br><br>Pulse width = 33.3 ns × Pulse-<br>Width |

Format: **CT0{,\_<TrigOutID>,\_<CTOPam>,\_<Value>}**

Arguments:

|             |                                        |
|-------------|----------------------------------------|
| <TrigOutID> | Digital output of the electronics      |
| <CTOPam>    | CTO parameter ID                       |
| <Value>     | Value that the CTO parameter is set to |

## CTO? Get Configuration Of Trigger Output

Description: Queries the value that is configured for the specified trigger output line and the specified CTO parameter.

Format: **CT0?[,\_<TrigOutID>,\_<CTOPam>]**

Arguments:

|             |                                   |
|-------------|-----------------------------------|
| <TrigOutID> | Digital output of the electronics |
| <CTOPam>    | CTO parameter ID                  |

If no arguments are specified, the response contains the values for all parameters and all output lines.

Response:

|                                    |                                                       |
|------------------------------------|-------------------------------------------------------|
| {<TrigOutID>,_<CTOPam>=<Value> LF} |                                                       |
| <TrigOutID>                        | Digital output of the electronics                     |
| <CTOPam>                           | CTO parameter ID                                      |
| <Value>                            | Value of <CTOPam> that was configured for <TrigOutID> |

## DEC Set Closed-Loop Deceleration

*Used in:* (30)

|                  |                                                                                                                                                                                              |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Sets the deceleration for the specified axis.                                                                                                                                                |
| Long description | Changes the value of parameter <a href="#">0xC (p. 172)</a> in the volatile memory.<br>The maximum value that can be set with DEC, is specified by parameter <a href="#">0x4B (p. 182)</a> . |
|                  | The deceleration set with DEC is only taken into account when the respective axis is in closed-loop operation (servo mode on).                                                               |
| Format:          | <b>DEC{._&lt;AxisID&gt;._&lt;Deceleration&gt;}</b>                                                                                                                                           |
| Arguments:       | <AxisID>                    Axis ID<br><br><Deceleration>              Deceleration in physical units / s <sup>2</sup> (FLOAT)                                                               |
| Troubleshooting: | Illegal axis identifier                                                                                                                                                                      |

## DEC? Get Closed-Loop Acceleration

*Used in:* (30)

|                  |                                                                                                                                                      |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Queries the deceleration value set with <a href="#">DEC (p. 116)</a> .                                                                               |
| Format:          | <b>DEC? [{&lt;AxisID&gt;}]</b>                                                                                                                       |
| Arguments:       | <AxisID>                    Axis ID<br><br>The value for all axes will be queried if no arguments are specified.                                     |
| Response:        | {<AxisID>=<Acceleration>LF}<br><br><AxisID>                    Axis ID<br><br><Acceleration>              Acceleration in physical units / s (FLOAT) |
| Troubleshooting: | Illegal axis identifier                                                                                                                              |

## DEL Delay The Command Interpreter

*Used in:* Running the Macros (85)

|                  |                                                                                                                              |
|------------------|------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Delays running the macro for a fixed period of time.                                                                         |
| Long description | DEL can only be used in macros.<br>Note: Do not mix up DEL (delayed) with <a href="#">MAC DEL (p. 141)</a> (deletes macros). |
| Format:          | <b>DEL_&lt;uint&gt;</b>                                                                                                      |
| Arguments:       | <uint>                      Delay time span in milliseconds [UINT]                                                           |

## DFH Define Home Position

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Redefines the zero position of the specified axis by setting the position value to zero at the current position.                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Long description | Sets the current position of the axis to zero and saves the position value that was valid when the command was called as offset in the volatile memory. By adding this offset to the response, the output values of the following commands are adapted to the new zero position: <ul style="list-style-type: none"> <li>■ <a href="#">POS? (p. 147)</a></li> <li>■ <a href="#">TMN? (p. 157)</a></li> <li>■ <a href="#">TMX? (p. 157)</a></li> </ul> Does <b>not</b> change the parameter values for the definition of travel range and soft limits. |
|                  | The offset is reset to zero in the following cases: <ul style="list-style-type: none"> <li>■ When switching on and rebooting the E-873.1AT: For all axes</li> <li>■ During reference point definition: For the affected axis</li> </ul>                                                                                                                                                                                                                                                                                                              |
| Format:          | <b>DFH[{_&lt;AxisID&gt;}]</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Arguments:       | <AxisID>                    Axis ID<br><br>The zero positions for all axes will be newly defined if no arguments are specified.                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Troubleshooting: | Illegal axis identifier                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

## DFH? Get Home Position Definition

|                  |                                                                                                                                                                                                                                                                                                                  |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Queries the position value that is configured for the specified axis as offset for shifting the zero position.                                                                                                                                                                                                   |
| Long description | The offset for shifting the zero position is in the volatile memory.<br>The offset is reset to zero in the following cases: <ul style="list-style-type: none"> <li>■ When switching on or rebooting the Electronics: For all axes</li> <li>■ During reference point definition: For the affected axis</li> </ul> |
| Format:          | <b>DFH?[{_&lt;AxisID&gt;}]</b>                                                                                                                                                                                                                                                                                   |
| Arguments:       | <AxisID>                    Axis ID<br><br>The value for all axes will be queried if no arguments are specified.                                                                                                                                                                                                 |
| Response:        | {<AxisID>=<PositionOffset> <sub>LF</sub> }                                                                                                                                                                                                                                                                       |
|                  | <AxisID>                    Axis ID                                                                                                                                                                                                                                                                              |
|                  | <PositionOffset>            Axis position that was valid when executing<br><a href="#">DFH (p. 117)</a>                                                                                                                                                                                                          |
| Troubleshooting: | Illegal axis identifier                                                                                                                                                                                                                                                                                          |

## DIO Set Digital Output Lines

Description: Switches a digital output line to the specified state.

Long description All digital output lines with a bit-mapped hexadecimal number for <OutputOn> can be switched with <DIOID> = 0.  
Use [TIO? \(p. 156\)](#) to query the number of available digital I/O lines.

Format: **DIO{\_.<DIOID>.\_<OutputOn>}**

Arguments: <DIOID> Digital output of the electronics  
<OutputOn> Status of the digital output line (BOOL)

## DIO? Get Digital Input Lines

Description: Queries the status of a digital input line.

Long description Use [TIO? \(p. 156\)](#) to query the number of available digital I/O lines.

Format: **DIO?[{\_.<DIOID>}]**

Arguments: <DIOID> Digital input line of the electronics  
The state of all digital input lines is queried and output as bit-mapped hexadecimal number if no arguments are specified.

Response: {<DIOID>=<InputOn><sub>LF</sub>}

<DIOID> Digital input line of the electronics  
<InputOn> Digital input line state (HEX)

## DRC Set Data Recorder Configuration

*Used in: (23), Analog Input Signals (75), Determining the data to be recorded (74)*

Description: Determines the data source to be used and the data type to be recorded for a data recorder table.

Long description Possible recording options:

| <Source> | Source of data                 |
|----------|--------------------------------|
| 0        | Nothing is recorded            |
| 1        | Commanded position of axis     |
| 2        | Actual position of axis        |
| 3        | Position error of axis         |
| 44       | Timestamp (TIM?)               |
| 70       | Commanded velocity of axis     |
| 71       | Commanded acceleration of axis |
| 73       | Motor output of axis           |
| 74       | Kp of axis                     |
| 75       | Ki of axis                     |
| 76       | Kd of axis                     |
| 80       | Signal status register of axis |
| 81       | Analog input                   |
| 86       | Number of fifo values          |
| 87       | Interpolation data             |
| 91       | Motor current                  |

Use [HDR? \(p. 127\)](#) to query a list of all available recording and trigger options.

Use [TNR? \(p. 157\)](#) to query the number of available data recorder tables.

Format: **DRC{,\_<RecTableID>,\_<Source>,\_<RecOption>}**

Arguments: <RecTableID> Data recorder table

<Source> Data source ID

<RecOption> Record option, data type to be recorded

## DRC? Get Data Recorder Configuration

*Used in: Determining the data to be recorded (74)*

|              |                                                                                                                                                                          |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description: | Gets the settings specified with <a href="#">DRC (p. 119)</a> .                                                                                                          |
| Format:      | <b>DRC?[{_,&lt;RecTableID&gt;}]</b>                                                                                                                                      |
| Arguments:   | <RecTableID> Data recorder table<br>If no arguments are specified, the settings for all data recorder tables will be queried.                                            |
| Response:    | {<RecTableID>=<Source>_<RecOption> <sub>LF</sub> }<br><RecTableID> Data recorder table<br><Source> Data source ID<br><RecOption> Record option, data type to be recorded |

## DRL? Get Number Of Recorded Points

*Used in: Reading data out (75)*

|              |                                                                                                                  |
|--------------|------------------------------------------------------------------------------------------------------------------|
| Description: | Queries the number of points stored by the last recording.                                                       |
| Format:      | <b>DRL?[{_,&lt;RecTableID&gt;}]</b>                                                                              |
| Arguments:   | <RecTableID> Data recorder table                                                                                 |
| Response:    | {<RecTableID>=<uint> <sub>LF</sub> }<br><RecTableID> Data recorder table<br><uint> Number of saved points (UINT) |

## DRR? Get Recorded Data Values

*Used in: Reading data out (75)*

|                  |                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Gets the last recorded data.                                                                                                                                                                                                                                                                                                                                                        |
| Long description | Can be used during recording.<br>Querying can take some time depending on the number of points to be read.                                                                                                                                                                                                                                                                          |
| Format:          | <b>DRR?[_&lt;StartPoint&gt; &lt;NumberOfPoints&gt; [{&lt;RecTableID&gt;}]]</b>                                                                                                                                                                                                                                                                                                      |
| Arguments:       | <StartPoint> First point to be read (UINT >0)<br><NumberOfPoints> Number of points to be read per table<br><RecTableID> Data recorder table<br>If <RecTableID> is not specified, all data from all tables is read whose recording option is different to zero.<br>If no arguments are specified, the data is read from all recorder tables with recording option not equal to zero. |
| Response:        | (Data in GCS array format)                                                                                                                                                                                                                                                                                                                                                          |

## DRT Set Data Recorder Trigger Source

*Used in: Setting the trigger for recording (74), Starting the Recording (74)*

- Description: Defines a trigger source for the specified data recorder table.
- Long description Irrespective of the trigger option set, the data recording is always triggered when a step response measurement is carried out with [STE \(p. 155\)](#).
- Trigger options:

| <Trigger-Source> | Description                                                                                                                                                                                                                 |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0                | <b>default setting</b><br>Data recording is triggered with <a href="#">STE (p. 155)</a> .<br><Value> is a dummy.                                                                                                            |
| 1                | <b>any command changing target position</b><br>Data recording is triggered by commands that influence the target position (e.g., <a href="#">MVR (p. 145)</a> , <a href="#">MOV (p. 144)</a> , MVE).<br><Value> is a dummy. |
| 2                | <b>next command</b><br>Resets the trigger afterwards.<br><Value> is a dummy.                                                                                                                                                |
| 3                | <b>external trigger</b><br>Data recording is triggered with a digital output line.<br><Value> is the ID of the digital output line.                                                                                         |
| 6                | <b>any command changing target position</b><br>Corresponds to <TriggerSource> = 1, resets the trigger afterwards.<br><Value> is a dummy.                                                                                    |
| 7                | <b>SMO command</b><br>Data recording is triggered with SMO, resets the trigger afterwards.<br><Value> is a dummy.                                                                                                           |

Use [HDR? \(p. 127\)](#) to query a list of all available recording and trigger options.

- Format: **DRT\_<RecTableID>\_<TriggerSource>\_<Value>**
- Arguments:
- |                 |                                                                                                               |
|-----------------|---------------------------------------------------------------------------------------------------------------|
| <RecTableID>    | Data recorder table ID<br><RecTableID> = 0 defines the trigger source for all available data recorder tables. |
| <TriggerSource> | ID of the trigger source                                                                                      |
| <Value>         | Depends on the trigger source                                                                                 |

## DRT? Get Data Recorder Trigger Source

*Used in: Setting the trigger for recording (74)*

|              |                                                                                                                                      |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Description: | Queries the trigger source for the data recorder tables.                                                                             |
| Format:      | <b>DRT?[{_,&lt;RecTableID&gt;}]</b>                                                                                                  |
| Arguments:   | <RecTableID> data recorder table<br>If no arguments are specified, the trigger sources for all data recorder tables will be queried. |
| Response:    | {<RecTableID>=<TriggerSource>_<Value> <sub>LF</sub> }                                                                                |
|              | <RecTableID> Data recorder table ID<br><RecTableID> = 0 defines the trigger source for all available data recorder tables.           |
|              | <TriggerSource> ID of the trigger source                                                                                             |
|              | <Value> Depends on the trigger source                                                                                                |

## ERR? Get Error Number

*Used in: Restoring the E-873.1AT's Operational Readiness (73)*

|                  |                                                                                                                 |
|------------------|-----------------------------------------------------------------------------------------------------------------|
| Description:     | Queries the error code of the last error that occurred and resets the error code to 0.                          |
| Long description | Only the last error is buffered; therefore, in the case of a problem, ERR? should be called after each command. |
| Format:          | <b>ERR?</b>                                                                                                     |
| Response:        | <ErrorNumber><br><ErrorNumber> Code for the last error (INT)                                                    |
| Troubleshooting: | Communication breakdown                                                                                         |

## FED Find Edge

*Used in: Motion in closed-loop operation (28)*

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |         |          |                                         |         |                                                               |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|----------|-----------------------------------------|---------|---------------------------------------------------------------|
| Description:     | Moves an axis to a specified signal edge.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |         |          |                                         |         |                                                               |
| Long description | <p>FED does not set a specific position value at the selected edge (in contrast to <a href="#">FNL (p. 124)</a>, <a href="#">FPL (p. 124)</a>, and <a href="#">FRF (p. 125)</a>); i.e., the axis is not referenced after using FED.</p> <p>Servo mode must be switched on for the specified axis (axes) (closed-loop operation). HID control may not be activated for the corresponding axis.</p> <p>If multiple axes are specified in the command, they are moved synchronously.</p> <p>The following settings influence what type of motion is possible with FED:</p> <ul style="list-style-type: none"><li>■ Is there a reference switch (parameter <a href="#">0x14 (p. 174)</a>)?</li><li>■ Are there limit switches (parameter <a href="#">0x32 (p. 179)</a>)?</li><li>■ If the reference switch outputs an index pulse: How is the move to the index pulse to be done (parameters <a href="#">0x70 (p. 186)</a>, <a href="#">0x78 (p. 188)</a>, <a href="#">0x79 (p. 189)</a>)?</li></ul> <p>You can use the digital input lines instead of the switches as source of the switch signals for FED.</p> <p>FED can be used to measure the physical travel range of a new mechanics and therefore determine the values for the corresponding parameters:</p> <ul style="list-style-type: none"><li>■ Distance from the negative to the positive limit switch</li><li>■ Gap between the negative limit switch and the reference switch (parameter ID <a href="#">0x17 (p. 176)</a>)</li><li>■ Gap between the reference switch and the positive limit switch (parameter ID <a href="#">0x2F (p. 177)</a>).</li></ul> |          |         |          |                                         |         |                                                               |
| Format:          | <b>FED{_&lt;AxisID&gt;_&lt;EdgeID&gt;_&lt;Param&gt;}</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |          |         |          |                                         |         |                                                               |
| Arguments:       | <table><tr><td>&lt;AxisID&gt;</td><td>Axis ID</td></tr><tr><td>&lt;EdgeID&gt;</td><td>Edge type, which the axis is to move to</td></tr><tr><td>&lt;Param&gt;</td><td>Depends on the selected edge and determines it more precisely</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <AxisID> | Axis ID | <EdgeID> | Edge type, which the axis is to move to | <Param> | Depends on the selected edge and determines it more precisely |
| <AxisID>         | Axis ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |         |          |                                         |         |                                                               |
| <EdgeID>         | Edge type, which the axis is to move to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |         |          |                                         |         |                                                               |
| <Param>          | Depends on the selected edge and determines it more precisely                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |         |          |                                         |         |                                                               |
| Troubleshooting: | <p>If multiple axes are specified in the command, they are moved synchronously.</p> <p>Illegal axis identifier</p> <p>Limit and/or reference switch deactivated</p> <p>Servo mode not active (<a href="#">SVO? (p. 156)</a> responds with the value "0")</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |         |          |                                         |         |                                                               |

## FNL Fast Reference Move To Negative Limit

*Used in: Motion in closed-loop operation (28), Reference point definition options (40)*

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Starts a reference move to the negative physical travel range limit respectively to the negative limit switch.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Long description | <p>FNL sets the current position to the difference between <a href="#">0x16 (p. 175)</a> and <a href="#">0x17 (p. 176)</a>. If the reference move was successful, absolute motion will then be possible in closed-loop operation.</p> <p>Limit switches cannot be used for reference moves if soft limits (parameter <a href="#">0x15 (p. 175)</a> and <a href="#">0x30 (p. 178)</a>) are set.</p> <p>The motion can be stopped by <a href="#">#24 (p. 109)</a>, <a href="#">STP (p. 155)</a>, and <a href="#">HLT (p. 134)</a>.</p> <p>Servo mode must be switched on for the specified axis (axes) (closed-loop operation).</p> |
| Format:          | <b>FNL[{_&lt;AxisID&gt;}]</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Arguments:       | <p>&lt;AxisID&gt;                    Axis ID</p> <p>If multiple axes are specified in the command, they are moved synchronously.</p> <p>If no arguments are specified, all axes are moved synchronously.</p>                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Troubleshooting: | <p>Illegal axis identifier</p> <p>Servo mode not active (<a href="#">SVO? (p. 156)</a> responds with the value "0")</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## FPL Fast Reference Move To Positive Limit

*Used in: Motion in closed-loop operation (28), Reference point definition options (40)*

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Starts a reference move to the positive physical travel range limit respectively to the positive limit switch.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Long description | <p>FPL sets the current position to the sum of <a href="#">0x16 (p. 175)</a> and <a href="#">0x2F (p. 177)</a>. If the reference move was successful, absolute motion will then be possible in closed-loop operation.</p> <p>Limit switches cannot be used for reference moves if soft limits (parameter <a href="#">0x15 (p. 175)</a> and <a href="#">0x30 (p. 178)</a>) are set.</p> <p>The motion can be stopped by <a href="#">#24 (p. 109)</a>, <a href="#">STP (p. 155)</a>, and <a href="#">HLT (p. 134)</a>.</p> <p>Servo mode must be switched on for the specified axis (axes) (closed-loop operation).</p> |
| Format:          | <b>FPL[{_&lt;AxisID&gt;}]</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Arguments:       | <p>&lt;AxisID&gt;                    Axis ID</p> <p>If multiple axes are specified in the command, they are moved synchronously.</p> <p>If no arguments are specified, all axes are moved synchronously.</p>                                                                                                                                                                                                                                                                                                                                                                                                          |
| Troubleshooting: | <p>Illegal axis identifier</p> <p>Servo mode not active (<a href="#">SVO? (p. 156)</a> responds with the value "0")</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## FRF Fast Reference Move To Reference Switch

*Used in:* Motion in closed-loop operation (28), Reference point definition options (40)

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Starts a reference move to the reference switch.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Long description | <p>FRF sets the current position to the value of <a href="#">0x16 (p. 175)</a>. If the reference move was successful, absolute motion will then be possible in closed-loop operation.</p> <p>The motion can be stopped by <a href="#">#24 (p. 109)</a>, <a href="#">STP (p. 155)</a>, and <a href="#">HLT (p. 134)</a>.</p> <p>Servo mode must be switched on for the specified axis (axes) (closed-loop operation).</p> <p>Use <a href="#">FNL (p. 124)</a> or <a href="#">FPL (p. 124)</a> to do a reference move for an axis that does not have a reference switch but instead, only limit switches.</p> |
| Format:          | <b>FRF[{_&lt;AxisID&gt;}]</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Arguments:       | <p>&lt;AxisID&gt;                    Axis ID</p> <p>If multiple axes are specified in the command, they are moved synchronously.</p> <p>If no arguments are specified, all axes are moved synchronously.</p>                                                                                                                                                                                                                                                                                                                                                                                                |
| Troubleshooting: | <p>Illegal axis identifier</p> <p>Servo mode not active (<a href="#">SVO? (p. 156)</a> responds with the value "0")</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

## FRF? Get Referencing Result

*Used in:* Reference point definition options (40)

| Description:     | Queries whether the specified axis is referenced.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |             |   |                              |   |                     |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------------|---|------------------------------|---|---------------------|
| Format:          | <b>FRF?[{_&lt;AxisID&gt;}]</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |        |             |   |                              |   |                     |
| Arguments:       | <p>&lt;AxisID&gt;                    Axis ID</p> <p>The value for all axes will be queried if no arguments are specified.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |             |   |                              |   |                     |
| Response:        | <p>{AxisID&gt;=&lt;uint&gt; LF}</p> <p>&lt;uint&gt; Reference state of the axis (BOOL)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr style="background-color: #4f81bd; color: white;"> <th style="text-align: left; padding: 2px;">&lt;uint&gt;</th> <th style="text-align: left; padding: 2px;">Description</th> </tr> </thead> <tbody> <tr style="background-color: #e0e0e0;"> <td style="text-align: center; padding: 2px;">1</td> <td style="text-align: left; padding: 2px;">Axis referenced successfully</td> </tr> <tr> <td style="text-align: center; padding: 2px;">0</td> <td style="text-align: left; padding: 2px;">Axis not referenced</td> </tr> </tbody> </table> | <uint> | Description | 1 | Axis referenced successfully | 0 | Axis not referenced |
| <uint>           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |             |   |                              |   |                     |
| 1                | Axis referenced successfully                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |             |   |                              |   |                     |
| 0                | Axis not referenced                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |             |   |                              |   |                     |
| Troubleshooting: | Illegal axis identifier                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        |             |   |                              |   |                     |

## GOH Go To Home Position

|                  |                                                                                                                                                                                                                                                                                                                                                                    |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Moves the specified axis to the zero position.                                                                                                                                                                                                                                                                                                                     |
| Long description | GOH{,_<AxisID>} identical to <a href="#">MOV{,_&lt;AxisID&gt;,0}</a> (p. 144).<br>The motion can be stopped by <a href="#">#24</a> (p. 109), <a href="#">STP</a> (p. 155), and <a href="#">HLT</a> (p. 134).<br>Servo mode must be switched on for the specified axis (axes) (closed-loop operation). HID control may not be activated for the corresponding axis. |
| Format:          | <b>GOH[{_&lt;AxisID&gt;}]</b>                                                                                                                                                                                                                                                                                                                                      |
| Arguments:       | <AxisID> Axis ID<br><br>If multiple axes are specified in the command, they are moved synchronously.<br>If no arguments are specified, all axes are moved synchronously.                                                                                                                                                                                           |
| Troubleshooting: | Illegal axis identifier<br>Servo mode not active ( <a href="#">SVO?</a> (p. 156) responds with the value "0")                                                                                                                                                                                                                                                      |

## HAR? Indicate Hard Stops

*Used in: Reference point definition options (40)*

|                  |                                                                                                                                                                                                                                                                                                                       |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Queries whether the hard stops of the specified axis can be used for reference moves.                                                                                                                                                                                                                                 |
| Long description | The E-873.1AT's firmware uses the <a href="#">Use Hard Stops for Referencing</a> (p. 189) parameter (0x7A) to determine whether the hard stops of the axis can be used for reference moves. Depending on the value of this parameter, the E-873.1AT activates or deactivates reference moves that use the hard stops. |
| Format:          | <b>HAR?[{_&lt;AxisID&gt;}]</b>                                                                                                                                                                                                                                                                                        |
| Arguments:       | <AxisID> Axis ID<br><br>Response:<br>{<AxisID>=<uint><br><AxisID> Axis ID<br><br><uint> Can hard stops of the axis be used for reference moves? (BOOL)                                                                                                                                                                |
| Troubleshooting: | Illegal axis identifier                                                                                                                                                                                                                                                                                               |

## HDR? Get All Data Recorder Options

*Used in: Reading general information from the data recorder (74)*

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Shows a help text that contains all available information on data recording.                                                                                                                                                                                                                                                                                                                                                           |
| Long description | Shows information on: <ul style="list-style-type: none"> <li>■ Recording options</li> <li>■ Trigger options</li> <li>■ Additional parameters and commands for data recording</li> </ul>                                                                                                                                                                                                                                                |
| Format:          | <b>HDR?</b>                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Response:        | <pre>#RecordOptions_LF {&lt;RecOption&gt;=&lt;DescriptionString&gt;[_of,_&lt;Channel&gt;]_LF } #TriggerOptions_LF [&lt;TriggerOption&gt;=&lt;DescriptionString&gt;_LF }] #Parameters_to_be_set_with_SPA_LF [&lt;ParameterID&gt;=&lt;DescriptionString&gt;_LF }] #Additional_information_LF [&lt;CommandDescription&gt;(&lt;Command&gt;)_LF }] #Sources_for_Record_Options_LF [&lt;RecOption&gt;=&lt;Source&gt;_LF }] end_of_help</pre> |

## HDT Set HID Default Lookup Table

*Used in: HID Control Configuration (77)*

|                |                                                                                                                                                                                                                                                                  |              |                                                   |                |          |              |                         |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|---------------------------------------------------|----------------|----------|--------------|-------------------------|
| Description:   | Assigns a lookup table to the specified axis of the specified HID.                                                                                                                                                                                               |              |                                                   |                |          |              |                         |
| Format:        | <b>HDT{,_&lt;HIDeviceID&gt;,_&lt;HIDeviceAxis&gt;,_&lt;HIDTableID&gt;}</b>                                                                                                                                                                                       |              |                                                   |                |          |              |                         |
| Arguments:     | <table border="0"> <tr> <td>&lt;HIDeviceID&gt;</td> <td>Identifier of an HID connected to the electronics</td> </tr> <tr> <td>&lt;HIDeviceAxis&gt;</td> <td>HID axis</td> </tr> <tr> <td>&lt;HIDTableID&gt;</td> <td>Lookup table identifier</td> </tr> </table> | <HIDeviceID> | Identifier of an HID connected to the electronics | <HIDeviceAxis> | HID axis | <HIDTableID> | Lookup table identifier |
| <HIDeviceID>   | Identifier of an HID connected to the electronics                                                                                                                                                                                                                |              |                                                   |                |          |              |                         |
| <HIDeviceAxis> | HID axis                                                                                                                                                                                                                                                         |              |                                                   |                |          |              |                         |
| <HIDTableID>   | Lookup table identifier                                                                                                                                                                                                                                          |              |                                                   |                |          |              |                         |

## HDT? Get HID Default Lookup Table

*Used in: HID Control Configuration (77)*

|                                                            |                                                                                                                                                                                                                                                                                                                                                    |                                                            |                                                   |                |                                                   |                |          |              |                         |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|---------------------------------------------------|----------------|---------------------------------------------------|----------------|----------|--------------|-------------------------|
| Description:                                               | Queries the currently assigned lookup table for the specified axis of an HID.                                                                                                                                                                                                                                                                      |                                                            |                                                   |                |                                                   |                |          |              |                         |
| Format:                                                    | <b>HDT?[{_&lt;HIDeviceID&gt;,_&lt;HIDeviceAxis&gt;}]</b>                                                                                                                                                                                                                                                                                           |                                                            |                                                   |                |                                                   |                |          |              |                         |
| Arguments:                                                 | <br><table><tr><td>&lt;HIDeviceID&gt;</td><td>Identifier of an HID connected to the electronics</td></tr><tr><td>&lt;HIDeviceAxis&gt;</td><td>HID axis</td></tr></table>                                                                                                                                                                           | <HIDeviceID>                                               | Identifier of an HID connected to the electronics | <HIDeviceAxis> | HID axis                                          |                |          |              |                         |
| <HIDeviceID>                                               | Identifier of an HID connected to the electronics                                                                                                                                                                                                                                                                                                  |                                                            |                                                   |                |                                                   |                |          |              |                         |
| <HIDeviceAxis>                                             | HID axis                                                                                                                                                                                                                                                                                                                                           |                                                            |                                                   |                |                                                   |                |          |              |                         |
| Response:                                                  | <br><table><tr><td>{&lt;HIDeviceID&gt;,_&lt;HIDeviceAxis&gt;=&lt;HIDTableID&gt; <sub>LF</sub>}</td><td></td></tr><tr><td>&lt;HIDeviceID&gt;</td><td>Identifier of an HID connected to the electronics</td></tr><tr><td>&lt;HIDeviceAxis&gt;</td><td>HID axis</td></tr><tr><td>&lt;HIDTableID&gt;</td><td>Lookup table identifier</td></tr></table> | {<HIDeviceID>,_<HIDeviceAxis>=<HIDTableID> <sub>LF</sub> } |                                                   | <HIDeviceID>   | Identifier of an HID connected to the electronics | <HIDeviceAxis> | HID axis | <HIDTableID> | Lookup table identifier |
| {<HIDeviceID>,_<HIDeviceAxis>=<HIDTableID> <sub>LF</sub> } |                                                                                                                                                                                                                                                                                                                                                    |                                                            |                                                   |                |                                                   |                |          |              |                         |
| <HIDeviceID>                                               | Identifier of an HID connected to the electronics                                                                                                                                                                                                                                                                                                  |                                                            |                                                   |                |                                                   |                |          |              |                         |
| <HIDeviceAxis>                                             | HID axis                                                                                                                                                                                                                                                                                                                                           |                                                            |                                                   |                |                                                   |                |          |              |                         |
| <HIDTableID>                                               | Lookup table identifier                                                                                                                                                                                                                                                                                                                            |                                                            |                                                   |                |                                                   |                |          |              |                         |

## HIA Configure Control Done By HID Axis

*Used in: HID Control Configuration (77), Motion in closed-loop operation (28)*

Description: Configures control of electronics' axes via HID axes (HID control).

Long description Assigns an HID axis to the specified motion variable.

The configuration of the HID control is saved only to the volatile memory (RAM) of the electronics.

HID control may not be activated for the corresponding axis.

Motion variables that can be controlled via HID:

| <MotionPar- am> | Description                                                                                                                                                                                                |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0               | Deletes the current configuration of the HID control.<br>Can be sent from <HIDeviceID> and <HIDeviceAxis> without specification.                                                                           |
| 3               | Velocity of the axis<br>Product from a lookup table value that corresponds to the current displacement and maximum velocity (parameter 0x74 or <a href="#">0x49 (p. 181)</a> if the value of 0x74 is "0"). |
| 4               | Maximum velocity of the axis<br>Product from a lookup table value that corresponds to the current displacement and maximum velocity (0x74 or <a href="#">0x49 (p. 181)</a> if the value of 0x74 is "0").   |

Format: **HIA{\_{<AxisID>}\_{<MotionParam>}\_{<HIDeviceID>}\_{<HIDeviceAxis>}}**

Arguments: **<AxisID>** Axis ID

**<MotionParam>** Axis motion variable

**<HIDeviceID>** Identifier of an HID connected to the electronics

**<HIDeviceAxis>** HID axis

Troubleshooting: **<MotionParam>** has the value zero, i.e., function to be controlled has not been selected for the axis

**<HIDeviceID>** has the value zero, i.e., HID has not been selected

**<HIDeviceAxis>** has the value zero, i.e., HID's axis has not been selected for HID control

## HIA? Get Configuration Of Control Done By HID Axis

*Used in: HID Control Configuration (77)*

|                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                       |         |               |                      |               |                      |              |                                                   |                |          |
|-----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|---------|---------------|----------------------|---------------|----------------------|--------------|---------------------------------------------------|----------------|----------|
| Description:                                                          | Queries an HID's axis assigned to the specified motion variable of the specified motion variable.                                                                                                                                                                                                                                                                                                                        |                                                                       |         |               |                      |               |                      |              |                                                   |                |          |
| Format:                                                               | <b>HIA?[{_,&lt;AxisID&gt;_,&lt;MotionParam&gt;}]</b>                                                                                                                                                                                                                                                                                                                                                                     |                                                                       |         |               |                      |               |                      |              |                                                   |                |          |
| Arguments:                                                            | <table> <tr> <td>&lt;AxisID&gt;</td><td>Axis ID</td></tr> <tr> <td>&lt;MotionParam&gt;</td><td>Axis motion variable</td></tr> </table>                                                                                                                                                                                                                                                                                   | <AxisID>                                                              | Axis ID | <MotionParam> | Axis motion variable |               |                      |              |                                                   |                |          |
| <AxisID>                                                              | Axis ID                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                       |         |               |                      |               |                      |              |                                                   |                |          |
| <MotionParam>                                                         | Axis motion variable                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                       |         |               |                      |               |                      |              |                                                   |                |          |
| Response:                                                             | <table> <tr> <td>{&lt;AxisID&gt;_,&lt;MotionParam&gt;=&lt;HIDeviceID&gt;_,&lt;HIDeviceAxis&gt; <sub>LF</sub>}</td><td></td></tr> <tr> <td>&lt;AxisID&gt;</td><td>Axis ID</td></tr> <tr> <td>&lt;MotionParam&gt;</td><td>Axis motion variable</td></tr> <tr> <td>&lt;HIDeviceID&gt;</td><td>Identifier of an HID connected to the electronics</td></tr> <tr> <td>&lt;HIDeviceAxis&gt;</td><td>HID axis</td></tr> </table> | {<AxisID>_,<MotionParam>=<HIDeviceID>_,<HIDeviceAxis> <sub>LF</sub> } |         | <AxisID>      | Axis ID              | <MotionParam> | Axis motion variable | <HIDeviceID> | Identifier of an HID connected to the electronics | <HIDeviceAxis> | HID axis |
| {<AxisID>_,<MotionParam>=<HIDeviceID>_,<HIDeviceAxis> <sub>LF</sub> } |                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                       |         |               |                      |               |                      |              |                                                   |                |          |
| <AxisID>                                                              | Axis ID                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                       |         |               |                      |               |                      |              |                                                   |                |          |
| <MotionParam>                                                         | Axis motion variable                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                       |         |               |                      |               |                      |              |                                                   |                |          |
| <HIDeviceID>                                                          | Identifier of an HID connected to the electronics                                                                                                                                                                                                                                                                                                                                                                        |                                                                       |         |               |                      |               |                      |              |                                                   |                |          |
| <HIDeviceAxis>                                                        | HID axis                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                       |         |               |                      |               |                      |              |                                                   |                |          |

## HIB? Get State Of HID Button

*Used in: HID Control Configuration (77)*

|                                                                  |                                                                                                                                                                                                                                                                                                                                                                   |                                                                  |                                                   |                  |                                                   |                  |            |                  |                     |
|------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------|------------------|---------------------------------------------------|------------------|------------|------------------|---------------------|
| Description:                                                     | Queries the current state of the specified button of the specified HID.                                                                                                                                                                                                                                                                                           |                                                                  |                                                   |                  |                                                   |                  |            |                  |                     |
| Format:                                                          | <b>HIB?[{_,&lt;HIDeviceID&gt;_,&lt;HIDeviceButton&gt;}]</b>                                                                                                                                                                                                                                                                                                       |                                                                  |                                                   |                  |                                                   |                  |            |                  |                     |
| Arguments:                                                       | <table> <tr> <td>&lt;HIDeviceID&gt;</td><td>Identifier of an HID connected to the electronics</td></tr> <tr> <td>&lt;HIDeviceButton&gt;</td><td>HID button</td></tr> </table>                                                                                                                                                                                     | <HIDeviceID>                                                     | Identifier of an HID connected to the electronics | <HIDeviceButton> | HID button                                        |                  |            |                  |                     |
| <HIDeviceID>                                                     | Identifier of an HID connected to the electronics                                                                                                                                                                                                                                                                                                                 |                                                                  |                                                   |                  |                                                   |                  |            |                  |                     |
| <HIDeviceButton>                                                 | HID button                                                                                                                                                                                                                                                                                                                                                        |                                                                  |                                                   |                  |                                                   |                  |            |                  |                     |
| Response:                                                        | <table> <tr> <td>{&lt;HIDeviceID&gt;_,&lt;HIDeviceButton&gt;=&lt;HIDButtonState&gt; <sub>LF</sub>}</td><td></td></tr> <tr> <td>&lt;HIDeviceID&gt;</td><td>Identifier of an HID connected to the electronics</td></tr> <tr> <td>&lt;HIDeviceButton&gt;</td><td>HID button</td></tr> <tr> <td>&lt;HIDButtonState&gt;</td><td>Button status (INT)</td></tr> </table> | {<HIDeviceID>_,<HIDeviceButton>=<HIDButtonState> <sub>LF</sub> } |                                                   | <HIDeviceID>     | Identifier of an HID connected to the electronics | <HIDeviceButton> | HID button | <HIDButtonState> | Button status (INT) |
| {<HIDeviceID>_,<HIDeviceButton>=<HIDButtonState> <sub>LF</sub> } |                                                                                                                                                                                                                                                                                                                                                                   |                                                                  |                                                   |                  |                                                   |                  |            |                  |                     |
| <HIDeviceID>                                                     | Identifier of an HID connected to the electronics                                                                                                                                                                                                                                                                                                                 |                                                                  |                                                   |                  |                                                   |                  |            |                  |                     |
| <HIDeviceButton>                                                 | HID button                                                                                                                                                                                                                                                                                                                                                        |                                                                  |                                                   |                  |                                                   |                  |            |                  |                     |
| <HIDButtonState>                                                 | Button status (INT)                                                                                                                                                                                                                                                                                                                                               |                                                                  |                                                   |                  |                                                   |                  |            |                  |                     |

Any possible values of <HIDButtonState> depend on the button type. The value range can be queried with [HIS? \(p. 132\)](#).

## HIE? Get Deflection Of HID Axis

*Used in: HID Control Configuration (77)*

|              |                                                                                                                                                                                                                         |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description: | Queries the current displacement of the specified axis of the specified HID.                                                                                                                                            |
| Format:      | <b>HIE?[{_.&lt;HIDDeviceID&gt;_.&lt;HIDDeviceAxis&gt;}]</b>                                                                                                                                                             |
| Arguments:   | <HIDDeviceID> Identifier of an HID connected to the electronics<br><HIDDeviceAxis> HID axis                                                                                                                             |
| Response:    | {<HIDDeviceID>.<HIDDeviceAxis>=<HIDDeflection> <sub>LF</sub> }                                                                                                                                                          |
|              | <HIDDeviceID> Identifier of an HID connected to the electronics                                                                                                                                                         |
|              | <HIDDeviceAxis> HID axis                                                                                                                                                                                                |
|              | <HIDDeflection> Displacement of the HID's axis (FLOAT)                                                                                                                                                                  |
|              | <HIDDeflection> is a value between -1.0 and 1.0. A value almost equal to 0.0 corresponds to the axis' center position, -1.0 respectively 1.0 of the maximum displacement in a negative respectively positive direction. |

## HIN Set Activation State For HID Control

*Used in: HID Control Configuration (77), Motion in closed-loop operation (28)*

|                  |                                                                                                                                                                                  |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Sets the status of HID control for the specified axis.                                                                                                                           |
| Long description | Servo mode must be switched on for the specified axis (axes) (closed-loop operation).                                                                                            |
| Format:          | <b>HIN{_.&lt;AxisID&gt;_.&lt;HIDControlState&gt;}</b>                                                                                                                            |
| Arguments:       | <AxisID> Axis ID<br><HIDControlState> HID control's activation state (BOOL)                                                                                                      |
| Troubleshooting: | Illegal axis identifier<br>Servo mode not active ( <a href="#">SVO? (p. 156)</a> responds with the value "0")<br><a href="#">HID control is not suitably configured (p. 129)</a> |

## HIN? Get Activation State Of HID Control

*Used in: HID Control Configuration (77)*

|              |                                                         |
|--------------|---------------------------------------------------------|
| Description: | Queries status of HID control for the specified axis.   |
| Format:      | <b>HIN?[{_.&lt;AxisID&gt;}]</b>                         |
| Arguments:   | <AxisID> Axis ID                                        |
| Response:    | {<AxisID>=<HIDControlState> <sub>LF</sub> }             |
|              | <AxisID> Axis ID                                        |
|              | <HIDControlState> HID control's activation state (BOOL) |

## HIS? Get Configuration Of HI Device

*Used in: (23), HID Control Configuration (77)*

|              |                                                                                                       |                                                                     |  |
|--------------|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|--|
| Description: | Queries the specified property for the specified operating element of an HID.                         |                                                                     |  |
| Format:      | <b>HIS?[{_,&lt;HIDDeviceID&gt;_,&lt;HIDItemID&gt;_,&lt;HIDPropID&gt;}]</b>                            |                                                                     |  |
| Arguments:   | <HIDDeviceID>                                                                                         | Identifier of an HID connected to the electronics                   |  |
|              | <HIDItemID>                                                                                           | HID operating element                                               |  |
|              | <HIDPropID>                                                                                           | Property of the operating element                                   |  |
|              | If no arguments are specified, information is queried on the supported operating elements of all IDs. |                                                                     |  |
| Response:    | {<HIDDeviceID>_,<HIDItemID>_,<HIDPropID>=<HIDPropValue> <sub>LF</sub> }                               |                                                                     |  |
|              | <HIDDeviceID>                                                                                         | Identifier of an HID connected to the electronics                   |  |
|              | <HIDItemID>                                                                                           | HID operating element                                               |  |
|              | <HIDPropID>                                                                                           | Property of the operating element                                   |  |
|              | <HIDPropValue>                                                                                        | The property of the operating element is set to this value (STRING) |  |

Possible values:

| <HID-<br>PropID> | <HID-<br>Prop-<br>Value> | Description                                                                          |
|------------------|--------------------------|--------------------------------------------------------------------------------------|
|                  | Ax-<br>is_<x>            | HID axis, e.g., joystick axis or continuous slider, <x> indicates the identifier     |
|                  | But-<br>ton_<x>          | HID button, <x> indicates the identifier                                             |
|                  | Led_<x<br>>              | Output unit, e.g., LED or vibration motor on/off time, <x> indicates the identifier  |
| 2                | <FLOAT<br>>              | Operating element status, e.g., axis displacement or LED activation status           |
| 3                | <STRIN<br>G>             | Name of the operating element                                                        |
| 4                | <STRIN<br>G>             | Name of the HID                                                                      |
| 5                | <INT>                    | Smallest possible value for the status of a "button"-type operating element or "LED" |
| 6                | <INT>                    | Largest possible value for the status of a "button"-type operating element or "LED"  |

## HIT Fill HID Lookup Table

*Used in: HID Control Configuration (77)*

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |              |                         |                |                                      |                 |                                                                         |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------|----------------|--------------------------------------|-----------------|-------------------------------------------------------------------------|
| Description:     | Fills the specified lookup table with values.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |                         |                |                                      |                 |                                                                         |
| Long description | HIT can only be used to fill user-defined tables. Tables with identifier $\leq 100$ are predefined and write-protected.<br><br>The first point of a lookup table corresponds to the maximum axis displacement of the HID in the negative direction; the 256th point corresponds to the maximum displacement in the positive direction. The values for points 1 to maximally 127 have a negative sign by default, while the remaining values have a positive sign. The sign of the values determines the direction of motion of the HID-controlled axis. Parameter <a href="#">0x61 (p. 185)</a> can be used to reverse the assigned direction that is specified by the values in the lookup table for an HID-controlled axis.<br><br>The <a href="#">HDT (p. 127)</a> command assigns the lookup tables to HID axes. |              |                         |                |                                      |                 |                                                                         |
| Format:          | <b>HIT{._&lt;HIDTableID&gt;._&lt;HIDTableAddr&gt;._&lt;HIDTableValue&gt;}</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |                         |                |                                      |                 |                                                                         |
| Arguments:       | <table border="0"> <tr> <td>&lt;HIDTableID&gt;</td> <td>Lookup table identifier</td> </tr> <tr> <td>&lt;HIDTableAddr&gt;</td> <td>Index of a point in the lookup table</td> </tr> <tr> <td>&lt;HIDTableValue&gt;</td> <td>Value of the point with the index &lt;HIDTableAddr&gt;<br/>(FLOAT, -1.0...1.0)</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <HIDTableID> | Lookup table identifier | <HIDTableAddr> | Index of a point in the lookup table | <HIDTableValue> | Value of the point with the index <HIDTableAddr><br>(FLOAT, -1.0...1.0) |
| <HIDTableID>     | Lookup table identifier                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                         |                |                                      |                 |                                                                         |
| <HIDTableAddr>   | Index of a point in the lookup table                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |                         |                |                                      |                 |                                                                         |
| <HIDTableValue>  | Value of the point with the index <HIDTableAddr><br>(FLOAT, -1.0...1.0)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |                         |                |                                      |                 |                                                                         |

## HIT? Get HID Lookup Table Values

*Used in: HID Control Configuration (77)*

|                  |                                                                                                                                                                                                                                                                                                  |              |                                          |                  |                                                 |              |                         |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------------------------------------|------------------|-------------------------------------------------|--------------|-------------------------|
| Description:     | Queries the values of the specified points in the specified lookup table.                                                                                                                                                                                                                        |              |                                          |                  |                                                 |              |                         |
| Format:          | <b>HIT?[_&lt;StartPoint&gt;[_&lt;NumberOfPoints&gt;[{_&lt;HIDTableID&gt;}]]]</b>                                                                                                                                                                                                                 |              |                                          |                  |                                                 |              |                         |
| Arguments:       | <table border="0"> <tr> <td>&lt;StartPoint&gt;</td> <td>Index of the first point that is queried</td> </tr> <tr> <td>&lt;NumberOfPoints&gt;</td> <td>Number of points to be queried per lookup table</td> </tr> <tr> <td>&lt;HIDTableID&gt;</td> <td>Lookup table identifier</td> </tr> </table> | <StartPoint> | Index of the first point that is queried | <NumberOfPoints> | Number of points to be queried per lookup table | <HIDTableID> | Lookup table identifier |
| <StartPoint>     | Index of the first point that is queried                                                                                                                                                                                                                                                         |              |                                          |                  |                                                 |              |                         |
| <NumberOfPoints> | Number of points to be queried per lookup table                                                                                                                                                                                                                                                  |              |                                          |                  |                                                 |              |                         |
| <HIDTableID>     | Lookup table identifier                                                                                                                                                                                                                                                                          |              |                                          |                  |                                                 |              |                         |
| Response:        | (Data in GCS array format)                                                                                                                                                                                                                                                                       |              |                                          |                  |                                                 |              |                         |

## HLP? Get List Of Available Commands

*Used in: (21)*

|              |                                                            |
|--------------|------------------------------------------------------------|
| Description: | Lists a help string which contains all commands available. |
| Format:      | <b>HLP?</b>                                                |
| Response:    | (List of available commands)                               |

## HLT Halt Motion Smoothly

*Used in: Triggering Motion (28)*

|                  |                                                                                                                                               |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Stops motion for the specified axis while considering the maximum set deceleration.                                                           |
| Long description | Sets the error code to 10.<br>Does not apply to trajectories: HLT also triggers an abrupt stop of motion when a trajectory is being followed. |
| Format:          | <b>HLT[{_,&lt;AxisID&gt;}]</b>                                                                                                                |
| Arguments:       | <AxisID>      Axis ID                                                                                                                         |
| Troubleshooting: | Illegal axis identifier                                                                                                                       |

## HPA? Get List Of Available Parameters

*Used in: (21), Adapting Settings (94), Parameter Commands (95)*

|              |                                                                                    |
|--------------|------------------------------------------------------------------------------------|
| Description: | Shows a help text that contains all available parameters with a short description. |
| Format:      | <b>HPA?</b>                                                                        |
| Response:    | (List of available parameters)                                                     |

## IFC Set Interface Parameters Temporarily

*Used in: E-873.1AT Interfaces (15)*

**Description:** Configures the interface parameters in the volatile memory.

**Long description** The changed interface parameters are active immediately. The PC's interface configuration may also have to be changed and the connection to the electronics re-established.

The configuration of the interface parameters is saved only to the volatile memory (RAM) of the electronics. Use [IFS \(p. 137\)](#) to change interface parameters in the nonvolatile memory.

**Possible values:**

| <InterfacePam> | <PamValue>                          | Description                                                                                                           |
|----------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| RSBAUD         | 9600, 19200, 38400, 57600 or 115200 | Baud rate for the RS-232 interface                                                                                    |
| IPADR          | <UINT>.<UINT>.<UINT>.<UINT>:50000   | IP address and port for the TCP/IP interface<br>Port 50000 cannot be changed.<br>IPADR is only used when IPSTART = 0. |
| IPSTART        | 0, 1                                | <PamValue> = 0: The IP address defined by IPADR is used<br><PamValue> = 1: DHCP is used (default)                     |
| IPMASK         | <UINT>.<UINT>.<UINT>.<UINT>         | TCP/IP interface subnet mask                                                                                          |

**Format:** **IFC{ „<InterfacePam> „<PamValue> }**

**Arguments:** <InterfacePam>      Interface parameters (STRING)

                  <PamValue>      Parameter value

## IFC? Get Current Interface Parameters

*Used in: E-873.1AT Interfaces (15)*

Description: Queries the interface parameter values in the volatile memory.

Format: **IFC?[{\_,<InterfacePam>}]**

Arguments: <InterfacePam> Interface parameters (STRING)

Response: {<InterfacePam>=<PamValue><sub>LF</sub>}

<InterfacePam> Interface parameters (STRING)

<PamValue> Parameter value

in the volatile memory

Possible values for <InterfacePam>:

| <InterfacePam> | Description                                            |
|----------------|--------------------------------------------------------|
| RSBAUD         | Baud rate for the RS-232 interface                     |
| IPADR          | IP address and port for the TCP/IP interface           |
| IPSTART        | Startup behavior (DHCP status) of the TCP/IP interface |
| IPMASK         | TCP/IP interface subnet mask                           |
| MACADDR        | Mac address (unique network hardware address)          |

## IFS Set Interface Parameters As Default Values

*Used in: E-873.1AT Interfaces (15)*

Description: Configures the interface parameters in the nonvolatile memory.

Long description The changed interface parameters are active after the next reboot.  
The PC's interface configuration may also have to be changed.

Notice: Note that the number of write cycles in the nonvolatile memory is limited. Therefore, save to the nonvolatile memory only when necessary.

Use [IFC \(p. 135\)](#) to change the interface parameters in the volatile memory (RAM).

Possible values:

| <InterfacePam> | <PamValue>                          | Description                                                                                                                   |
|----------------|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| RSBAUD         | 9600, 19200, 38400, 57600 or 115200 | Baud rate for the RS-232 interface                                                                                            |
| IPADR          | <UINT>.<UINT>.<UINT>.<UINT>:50000   | IP address and port for the TCP/IP interface<br><br>Port 50000 cannot be changed.<br><br>IPADR is only used when IPSTART = 0. |
| IPSTART        | 0, 1                                | <PamValue> = 0: The IP address defined by IPADR is used<br><br><PamValue> = 1: DHCP is used (default)                         |
| IPMASK         | <UINT>.<UINT>.<UINT>.<UINT>         | TCP/IP interface subnet mask                                                                                                  |

Format: **IFS <Pswd>{<InterfacePam>.<PamValue>}**

Arguments: **<Pswd>** Password for writing to the nonvolatile memory

Default value is "100".

**<InterfacePam>** Interface parameters (STRING)

**<PamValue>** Parameter value

## IFS? Get Interface Parameters As Default Values

*Used in: E-873.1AT Interfaces (15)*

Description: Queries the values of the interface parameters in the nonvolatile memory.

Format: **IFS?[{\_<InterfacePam>}]**

Arguments: <InterfacePam> Interface parameters (STRING)

Response: {<InterfacePam>=<PamValue> <sub>LF</sub>}

<InterfacePam> Interface parameters (STRING)

<PamValue> Parameter value

in the nonvolatile memory

Possible values for <InterfacePam>:

| <InterfacePam> | Description                                            |
|----------------|--------------------------------------------------------|
| RSBAUD         | Baud rate for the RS-232 interface                     |
| IPADR          | IP address and port for the TCP/IP interface           |
| IPSTART        | Startup behavior (DHCP status) of the TCP/IP interface |
| IPMASK         | TCP/IP interface subnet mask                           |
| MACADR         | Mac address (unique network hardware address)          |

## JRC Jump Relatively Depending On Condition

*Used in: Analog Input Signals (75), Running the Macros (85)*

- Description: Jumps relative to a specified number of program lines within a macro.
- Long description Jumps irrespective of a specified condition.  
Can only be used in macros.  
Possible relational operators:

| <OP> | Description           |
|------|-----------------------|
| =    | Equal                 |
| !=   | Not equal             |
| <=   | Smaller than or equal |
| <    | Smaller than          |
| >=   | Larger than or equal  |
| >    | Larger than           |

- Format: **JRC\_<Jump>\_<CMD?>\_<OP>\_<Value>**
- Arguments:
- <Jump> Size of relative jump
  - <CMD?> Query command that responds with a single value
  - <OP> Relational operator
  - <Value> Relational value with <CMD?>
- Troubleshooting:
- Wrong jump target (<Jump>) specified
  - Wrong relational operator (<OP>) specified

## LIM? Indicate Limit Switches

*Used in: Limit Switch Detection (37)*

- Description: Queries whether the specified axis has limit switches.
- Long description Limit switch is detected by [0x32 \(p. 179\)](#).
- Format: **LIM?[\_<AxisID>]**
- Arguments:
- <AxisID> Axis ID
- The value for all axes will be queried if no arguments are specified.
- Response:
- {<AxisID>=<uint> <sub>LF</sub>}
  - <AxisID> Axis ID
  - <uint> Limit switches available? (BOOL)
- Troubleshooting:
- Illegal axis identifier

## MAC Call Macro Function

*Used in: Motion in closed-loop operation (28)*

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                       |             |                               |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------------|-------------|-------------------------------|
| Description:     | Calls a macro function.                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                       |             |                               |
| Long description | Possible macro functions are described separately: <ul style="list-style-type: none"><li>■ <a href="#">MAC BEG (p. 140)</a></li><li>■ <a href="#">MAC DEF (p. 140)</a></li><li>■ <a href="#">MAC DEF? (p. 140)</a></li><li>■ <a href="#">MAC DEL (p. 141)</a></li><li>■ <a href="#">MAC END (p. 141)</a></li><li>■ <a href="#">MAC ERR? (p. 141)</a></li><li>■ <a href="#">MAC NSTART (p. 141)</a></li><li>■ <a href="#">MAC START (p. 142)</a></li></ul> |           |                       |             |                               |
| Format:          | <b>MAC_&lt;Keyword&gt;{_&lt;Parameter&gt;}</b>                                                                                                                                                                                                                                                                                                                                                                                                            |           |                       |             |                               |
| Arguments:       | <table border="0"> <tr> <td>&lt;Keyword&gt;</td> <td>Macro function called</td> </tr> <tr> <td>&lt;Parameter&gt;</td> <td>Function-dependent parameters</td> </tr> </table>                                                                                                                                                                                                                                                                               | <Keyword> | Macro function called | <Parameter> | Function-dependent parameters |
| <Keyword>        | Macro function called                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |                       |             |                               |
| <Parameter>      | Function-dependent parameters                                                                                                                                                                                                                                                                                                                                                                                                                             |           |                       |             |                               |
| Troubleshooting: | Macro recording is active                                                                                                                                                                                                                                                                                                                                                                                                                                 |           |                       |             |                               |

## MAC BEG Call Macro Function: BEG

*Used in: (84)*

|                  |                                                                                       |             |            |
|------------------|---------------------------------------------------------------------------------------|-------------|------------|
| Description:     | Start recording a macro.                                                              |             |            |
| Long description | Recording is stopped by <a href="#">MAC END (p. 141)</a> .                            |             |            |
| Format:          | <b>MAC_BEG_&lt;MacroName&gt;</b>                                                      |             |            |
| Arguments:       | <table border="0"> <tr> <td>&lt;MacroName&gt;</td> <td>Macro name</td> </tr> </table> | <MacroName> | Macro name |
| <MacroName>      | Macro name                                                                            |             |            |

## MAC DEF Call Macro Function: DEF

*Used in: (87)*

|                                                              |                                                                                                                                 |             |                                                      |
|--------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-------------|------------------------------------------------------|
| Description:                                                 | Specifies a macro as startup macro.                                                                                             |             |                                                      |
| Format:                                                      | <b>MAC_DEF_&lt;MacroName&gt;</b>                                                                                                |             |                                                      |
| Arguments:                                                   | <table border="0"> <tr> <td>&lt;MacroName&gt;</td> <td>Name of the macro that is specified as startup macro</td> </tr> </table> | <MacroName> | Name of the macro that is specified as startup macro |
| <MacroName>                                                  | Name of the macro that is specified as startup macro                                                                            |             |                                                      |
| A startup macro is not used when no arguments are specified. |                                                                                                                                 |             |                                                      |

## MAC DEF? Call Macro Function: DEF?

*Used in: (87)*

|                                 |                                                                                                                                                                   |                                 |  |             |                    |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|--|-------------|--------------------|
| Description:                    | Queries the name of the startup macro.                                                                                                                            |                                 |  |             |                    |
| Format:                         | <b>MAC_DEF?</b>                                                                                                                                                   |                                 |  |             |                    |
| Response:                       | <table border="0"> <tr> <td>[&lt;MacroName&gt;] <small>LF</small></td> <td></td> </tr> <tr> <td>&lt;MacroName&gt;</td> <td>Startup macro name</td> </tr> </table> | [<MacroName>] <small>LF</small> |  | <MacroName> | Startup macro name |
| [<MacroName>] <small>LF</small> |                                                                                                                                                                   |                                 |  |             |                    |
| <MacroName>                     | Startup macro name                                                                                                                                                |                                 |  |             |                    |

## MAC DEL Call Macro Function: DEL

*Used in:* (87)

|              |                                           |
|--------------|-------------------------------------------|
| Description: | Deletes the specified macro.              |
| Format:      | <b>MAC_DEL_&lt;MacroName&gt;</b>          |
| Arguments:   | <MacroName>      Macro name to be deleted |

## MAC END Call Macro Function: END

*Used in:* (84)

|              |                       |
|--------------|-----------------------|
| Description: | Ends macro recording. |
| Format:      | <b>MAC_END</b>        |

## MAC ERR? Call Macro Function: ERR?

*Used in:* (87)

|              |                                                                                                                                                                                                                |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description: | Reports the last error that occurred while the macro was running.                                                                                                                                              |
| Format:      | <b>MAC_ERR?</b>                                                                                                                                                                                                |
| Response:    | <MacroName>_<uint1>=<uint2>"<"<CMD>>"<br><MacroName>      Name of the macro<br><uint1>            Line in the micro where the error occurred<br><uint2>            Error code<br><CMD>             Bad command |

## MAC NSTART Call Macro Function: NSTART

*Used in:* (85)

|                  |                                                                                                                                |
|------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Runs the specified macro several times.                                                                                        |
| Long description | The macro is restarted when the last macro recording has completed, until <uint> has been reached.                             |
| Format:          | <b>MAC_NSTART_&lt;Macro-<br/>Name&gt;_&lt;uint&gt;[_&lt;String1&gt;[_&lt;String2&gt;[_&lt;String3&gt;[_&lt;String4&gt;]]]]</b> |
| Arguments:       | <MacroName>      Macro name<br><uint>            Number of runs<br><String1...4>     Local variables 1 to 4                    |
| Troubleshooting: | No local variables specified although local variables are used in the macro                                                    |

## MAC START Call Macro Function: START

*Used in:* (85)

|                  |                                                                                                                                                    |             |            |               |                        |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------------|---------------|------------------------|
| Description:     | Runs the specified macro.                                                                                                                          |             |            |               |                        |
| Format:          | <b>MAC_START_&lt;Macro-Name&gt;[_&lt;String1&gt;[_&lt;String2&gt;[_&lt;String3&gt;[_&lt;String4&gt;]]]]</b>                                        |             |            |               |                        |
| Arguments:       | <table> <tr> <td>&lt;MacroName&gt;</td> <td>Macro name</td> </tr> <tr> <td>&lt;String1...4&gt;</td> <td>Local variables 1 to 4</td> </tr> </table> | <MacroName> | Macro name | <String1...4> | Local variables 1 to 4 |
| <MacroName>      | Macro name                                                                                                                                         |             |            |               |                        |
| <String1...4>    | Local variables 1 to 4                                                                                                                             |             |            |               |                        |
| Troubleshooting: | No local variables specified although local variables are used in the macro                                                                        |             |            |               |                        |

## MAC? List Macros

*Used in:* (84)

|                  |                                                                                                                                                                                        |             |                 |          |                                                                          |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------------|----------|--------------------------------------------------------------------------|
| Description:     | Lists macros or content of a specified macro.                                                                                                                                          |             |                 |          |                                                                          |
| Format:          | <b>MAC?[_&lt;MacroName&gt;]</b>                                                                                                                                                        |             |                 |          |                                                                          |
| Arguments:       | <table> <tr> <td>&lt;MacroName&gt;</td> <td>Name of a macro</td> </tr> <tr> <td></td> <td>If no arguments are specified, the names of all saved macros are listed.</td> </tr> </table> | <MacroName> | Name of a macro |          | If no arguments are specified, the names of all saved macros are listed. |
| <MacroName>      | Name of a macro                                                                                                                                                                        |             |                 |          |                                                                          |
|                  | If no arguments are specified, the names of all saved macros are listed.                                                                                                               |             |                 |          |                                                                          |
| Response:        | <table> <tr> <td>&lt;String&gt;</td> <td></td> </tr> <tr> <td>&lt;String&gt;</td> <td>Content of the macro or list of the names of all saved macros</td> </tr> </table>                | <String>    |                 | <String> | Content of the macro or list of the names of all saved macros            |
| <String>         |                                                                                                                                                                                        |             |                 |          |                                                                          |
| <String>         | Content of the macro or list of the names of all saved macros                                                                                                                          |             |                 |          |                                                                          |
| Troubleshooting: | Wrong macro name (<MacroName>)                                                                                                                                                         |             |                 |          |                                                                          |

## MAN? Get Help String For Command

|                  |                                                                                                                     |          |                                               |          |           |
|------------------|---------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------|----------|-----------|
| Description:     | Shows a detailed help text for a command.                                                                           |          |                                               |          |           |
| Format:          | <b>MAN?_&lt;CMD&gt;</b>                                                                                             |          |                                               |          |           |
| Arguments:       | <table> <tr> <td>&lt;CMD&gt;</td> <td>Command that the help text is to be shown for</td> </tr> </table>             | <CMD>    | Command that the help text is to be shown for |          |           |
| <CMD>            | Command that the help text is to be shown for                                                                       |          |                                               |          |           |
| Response:        | <table> <tr> <td>&lt;String&gt;</td> <td></td> </tr> <tr> <td>&lt;String&gt;</td> <td>Help text</td> </tr> </table> | <String> |                                               | <String> | Help text |
| <String>         |                                                                                                                     |          |                                               |          |           |
| <String>         | Help text                                                                                                           |          |                                               |          |           |
| Troubleshooting: | Help text is only available for certain commands.                                                                   |          |                                               |          |           |

## MEX Stop Macro Execution Due To Condition

*Used in: Analog Input Signals (75), Stopping the Macros (87)*

- Description: Stops the macro due to a specified condition.
- Long description If the parser encounters this command, the condition is checked. If the condition is fulfilled at a later time, it is ignored by the parser.  
Can only be used in macros.
- Possible relational operators:

| <OP> | Description           |
|------|-----------------------|
| =    | Equal                 |
| !=   | Not equal             |
| <=   | Smaller than or equal |
| <    | Smaller than          |
| >=   | Larger than or equal  |
| >    | Larger than           |

Format: **MEX\_<CMD?>\_<OP>\_<Value>**

- Arguments:
- |         |                                                 |
|---------|-------------------------------------------------|
| <CMD?>  | Query command that responds with a single value |
| <OP>    | Relational operator                             |
| <Value> | Relational value with <CMD?>                    |

## MOV Set Target Position

Used in: (30), Motion in closed-loop operation (28)

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Sets the absolute target position for the specified axis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Long description | MOV overwrites the last target position received by the electronics. Motion commands from macros and command lines can overwrite each other. The last target position received may then not be reached.<br><br>Servo mode must be switched on for the specified axis (axes) (closed-loop operation). HID control may not be activated for the corresponding axis.<br><br>The target position must be inside the soft limits.<br><br>The motion can be stopped by <a href="#">#24 (p. 109)</a> , <a href="#">STP (p. 155)</a> , and <a href="#">HLT (p. 134)</a> . |
| Format:          | <b>MOV{._&lt;AxisID&gt;._&lt;Position&gt;}</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Arguments:       | <AxisID>                    Axis ID<br><br><Position>                    Absolute target position in physical units                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Troubleshooting: | Illegal axis identifier<br>Servo mode not active ( <a href="#">SVO? (p. 156)</a> responds with the value "0")<br>Executing motion commands deactivated by parameter 0x130<br>Target position outside of the soft limits<br>HID control is enabled                                                                                                                                                                                                                                                                                                                 |

## MOV? Get Target Position

|                  |                                                                                                                                                                     |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Queries last valid commanded target position.                                                                                                                       |
| Format:          | <b>MOV?[._&lt;AxisID&gt;]</b>                                                                                                                                       |
| Arguments:       | <AxisID>                    Axis ID                                                                                                                                 |
| Response:        | {<AxisID>=<float> <sub>LF</sub> }<br><br><AxisID>                    Axis ID<br><br><float>                    Last valid target position in physical units (FLOAT) |
| Troubleshooting: | Illegal axis identifier                                                                                                                                             |

## MVR Set Target Relative To Current Position

*Used in: (30), Motion in closed-loop operation (28)*

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |         |            |                                                                     |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|------------|---------------------------------------------------------------------|
| Description:     | Moves the specified axis relative to the last commanded target position.                                                                                                                                                                                                                                                                                                                                                                                                     |          |         |            |                                                                     |
| Long description | <p>The new target position is calculated from the sum of the last commanded target position and &lt;Distance&gt;.</p> <p>Servo mode must be switched on for the specified axis (axes) (closed-loop operation). HID control may not be activated for the corresponding axis.</p> <p>The target position must be inside the soft limits.</p> <p>The motion can be stopped by <a href="#">#24 (p. 109)</a>, <a href="#">STP (p. 155)</a>, and <a href="#">HLT (p. 134)</a>.</p> |          |         |            |                                                                     |
| Format:          | <b>MVR{,_&lt;AxisID&gt;,_&lt;Distance&gt;}</b>                                                                                                                                                                                                                                                                                                                                                                                                                               |          |         |            |                                                                     |
| Arguments:       | <table border="0"> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;Distance&gt;</td> <td>Distance that the axis has to move, specification in physical units</td> </tr> </table>                                                                                                                                                                                                                                                                            | <AxisID> | Axis ID | <Distance> | Distance that the axis has to move, specification in physical units |
| <AxisID>         | Axis ID                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |         |            |                                                                     |
| <Distance>       | Distance that the axis has to move, specification in physical units                                                                                                                                                                                                                                                                                                                                                                                                          |          |         |            |                                                                     |
| Troubleshooting: | <p>Illegal axis identifier</p> <p>Servo mode not active (<a href="#">SVO? (p. 156)</a> responds with the value "0")</p> <p>Executing motion commands deactivated by parameter 0x130</p> <p>Target position outside of the soft limits</p> <p>HID control is enabled</p>                                                                                                                                                                                                      |          |         |            |                                                                     |

## ONT? Get On-Target State

*Used in: On-Target State (36)*

|                                                                       |                                                                                                                                                                                                                             |                                  |         |                                                                       |         |        |                         |
|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|---------|-----------------------------------------------------------------------|---------|--------|-------------------------|
| Description:                                                          | Queries the on-target status of the specified axis.                                                                                                                                                                         |                                  |         |                                                                       |         |        |                         |
| Long description                                                      | <p>The on-target state is influenced by the <a href="#">0x36 (p. 180)</a> and <a href="#">0x3F (p. 180)</a> settings.</p> <p>Servo mode must be switched on for the specified axis (axes) (closed-loop operation).</p>      |                                  |         |                                                                       |         |        |                         |
| Format:                                                               | <b>ONT?[{,_&lt;AxisID&gt;}]</b>                                                                                                                                                                                             |                                  |         |                                                                       |         |        |                         |
| Arguments:                                                            | <table border="0"> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td colspan="2">The value for all axes will be queried if no arguments are specified.</td> </tr> </table>                                       | <AxisID>                         | Axis ID | The value for all axes will be queried if no arguments are specified. |         |        |                         |
| <AxisID>                                                              | Axis ID                                                                                                                                                                                                                     |                                  |         |                                                                       |         |        |                         |
| The value for all axes will be queried if no arguments are specified. |                                                                                                                                                                                                                             |                                  |         |                                                                       |         |        |                         |
| Response:                                                             | <table border="0"> <tr> <td>{&lt;AxisID&gt;=&lt;uint&gt; <sub>LF</sub>}</td> <td></td> </tr> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;uint&gt;</td> <td>On-Target-Status (BOOL)</td> </tr> </table> | {<AxisID>=<uint> <sub>LF</sub> } |         | <AxisID>                                                              | Axis ID | <uint> | On-Target-Status (BOOL) |
| {<AxisID>=<uint> <sub>LF</sub> }                                      |                                                                                                                                                                                                                             |                                  |         |                                                                       |         |        |                         |
| <AxisID>                                                              | Axis ID                                                                                                                                                                                                                     |                                  |         |                                                                       |         |        |                         |
| <uint>                                                                | On-Target-Status (BOOL)                                                                                                                                                                                                     |                                  |         |                                                                       |         |        |                         |
| Troubleshooting:                                                      | <p>Illegal axis identifier</p> <p>Servo mode not active (<a href="#">SVO? (p. 156)</a> responds with the value "0")</p>                                                                                                     |                                  |         |                                                                       |         |        |                         |

## OSM Open-Loop Step Moving

*Used in: Motion in open-loop operation (29)*

|                                                                                |                                                                                                                                                                                                           |                         |                                                                                |                        |                            |
|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------------------------------------------------------------|------------------------|----------------------------|
| Description:                                                                   | Moves the specified axis by the specified number of steps.                                                                                                                                                |                         |                                                                                |                        |                            |
| Long description                                                               | The velocity in open-loop step mode is controlled via the step frequency (parameter 0x1F000400).<br>Servo mode must be switched off for the specified axis (axes) (open-loop operation).                  |                         |                                                                                |                        |                            |
| Format:                                                                        | <b>OSM{,_&lt;AxisID&gt;,_&lt;Value&gt;}</b>                                                                                                                                                               |                         |                                                                                |                        |                            |
| Arguments:                                                                     | <table> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;Value&gt;</td> <td>Number of steps to be made</td> </tr> </table>                                                                | <AxisID>                | Axis ID                                                                        | <Value>                | Number of steps to be made |
| <AxisID>                                                                       | Axis ID                                                                                                                                                                                                   |                         |                                                                                |                        |                            |
| <Value>                                                                        | Number of steps to be made                                                                                                                                                                                |                         |                                                                                |                        |                            |
| Troubleshooting:                                                               | <table> <tr> <td>Illegal axis identifier</td> </tr> <tr> <td>Servo mode active (<a href="#">SVO? (p. 156)</a> responds with the value "1")</td> </tr> <tr> <td>HID control is enabled</td> </tr> </table> | Illegal axis identifier | Servo mode active ( <a href="#">SVO? (p. 156)</a> responds with the value "1") | HID control is enabled |                            |
| Illegal axis identifier                                                        |                                                                                                                                                                                                           |                         |                                                                                |                        |                            |
| Servo mode active ( <a href="#">SVO? (p. 156)</a> responds with the value "1") |                                                                                                                                                                                                           |                         |                                                                                |                        |                            |
| HID control is enabled                                                         |                                                                                                                                                                                                           |                         |                                                                                |                        |                            |

## OSN? Read Number Steps

*Used in: Motion in open-loop operation (29)*

|                                  |                                                                                                                                                                                                                |                                  |          |         |                                                                       |                                  |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------|---------|-----------------------------------------------------------------------|----------------------------------|
| Description:                     | Queries the number of steps that still have to be performed by the specified axis.                                                                                                                             |                                  |          |         |                                                                       |                                  |
| Format:                          | <b>OSN?[_&lt;AxisID&gt;]</b>                                                                                                                                                                                   |                                  |          |         |                                                                       |                                  |
| Arguments:                       | <table> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td></td> <td>The value for all axes will be queried if no arguments are specified.</td> </tr> </table>                                       | <AxisID>                         | Axis ID  |         | The value for all axes will be queried if no arguments are specified. |                                  |
| <AxisID>                         | Axis ID                                                                                                                                                                                                        |                                  |          |         |                                                                       |                                  |
|                                  | The value for all axes will be queried if no arguments are specified.                                                                                                                                          |                                  |          |         |                                                                       |                                  |
| Response:                        | <table> <tr> <td>{&lt;AxisID&gt;=&lt;uint&gt;<sub>LF</sub>}</td> </tr> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;uint&gt;</td> <td>Number of steps still to be made</td> </tr> </table> | {<AxisID>=<uint> <sub>LF</sub> } | <AxisID> | Axis ID | <uint>                                                                | Number of steps still to be made |
| {<AxisID>=<uint> <sub>LF</sub> } |                                                                                                                                                                                                                |                                  |          |         |                                                                       |                                  |
| <AxisID>                         | Axis ID                                                                                                                                                                                                        |                                  |          |         |                                                                       |                                  |
| <uint>                           | Number of steps still to be made                                                                                                                                                                               |                                  |          |         |                                                                       |                                  |
| Troubleshooting:                 | Illegal axis identifier                                                                                                                                                                                        |                                  |          |         |                                                                       |                                  |

## POS Set Real Position

*Used in:* Reference point definition options (40)

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |         |            |                                   |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|------------|-----------------------------------|
| Description:     | Sets the current position of the axis (does not cause motion).                                                                                                                                                                                                                                                                                                                                                                                                   |          |         |            |                                   |
| Long description | POS can only be used when <a href="#">the reference point definition mode is set to "0"</a> (p. 148).<br>The minimum ( <a href="#">TMN? (p. 157)</a> ) and maximum ( <a href="#">TMX? (p. 157)</a> ) commandable positions are not influenced by POS. This means that target positions are possible that are permitted by the electronics but cannot be reached by the mechanics, or could be reached by the mechanics but are not permitted by the electronics. |          |         |            |                                   |
|                  | ■<br>■                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |         |            |                                   |
| Format:          | <b>POS{_.&lt;AxisID&gt;._&lt;Position&gt;}</b>                                                                                                                                                                                                                                                                                                                                                                                                                   |          |         |            |                                   |
| Arguments:       | <table border="0"> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;Position&gt;</td> <td>New current position [phys. unit]</td> </tr> </table>                                                                                                                                                                                                                                                                                                  | <AxisID> | Axis ID | <Position> | New current position [phys. unit] |
| <AxisID>         | Axis ID                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |         |            |                                   |
| <Position>       | New current position [phys. unit]                                                                                                                                                                                                                                                                                                                                                                                                                                |          |         |            |                                   |
| Troubleshooting: | Illegal axis identifier                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |         |            |                                   |

## POS? Get Real Position

|                                                                       |                                                                                                                                                                                                                                               |                                   |         |                                                                       |         |         |                                         |
|-----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|---------|-----------------------------------------------------------------------|---------|---------|-----------------------------------------|
| Description:                                                          | Queries the current axis position.                                                                                                                                                                                                            |                                   |         |                                                                       |         |         |                                         |
| Format:                                                               | <b>POS?{_.&lt;AxisID&gt;}]</b>                                                                                                                                                                                                                |                                   |         |                                                                       |         |         |                                         |
| Arguments:                                                            | <table border="0"> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td colspan="2">The value for all axes will be queried if no arguments are specified.</td> </tr> </table>                                                         | <AxisID>                          | Axis ID | The value for all axes will be queried if no arguments are specified. |         |         |                                         |
| <AxisID>                                                              | Axis ID                                                                                                                                                                                                                                       |                                   |         |                                                                       |         |         |                                         |
| The value for all axes will be queried if no arguments are specified. |                                                                                                                                                                                                                                               |                                   |         |                                                                       |         |         |                                         |
| Response:                                                             | <table border="0"> <tr> <td>{&lt;AxisID&gt;=&lt;float&gt; <sub>LF</sub>}</td> <td></td> </tr> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;float&gt;</td> <td>Current axis position in physical units</td> </tr> </table> | {<AxisID>=<float> <sub>LF</sub> } |         | <AxisID>                                                              | Axis ID | <float> | Current axis position in physical units |
| {<AxisID>=<float> <sub>LF</sub> }                                     |                                                                                                                                                                                                                                               |                                   |         |                                                                       |         |         |                                         |
| <AxisID>                                                              | Axis ID                                                                                                                                                                                                                                       |                                   |         |                                                                       |         |         |                                         |
| <float>                                                               | Current axis position in physical units                                                                                                                                                                                                       |                                   |         |                                                                       |         |         |                                         |
| Troubleshooting:                                                      | Illegal axis identifier                                                                                                                                                                                                                       |                                   |         |                                                                       |         |         |                                         |

## RBT Reboot System

*Used in:* Controller Macros (83)

|                  |                                                                                                                         |
|------------------|-------------------------------------------------------------------------------------------------------------------------|
| Description:     | Restarts the electronics.                                                                                               |
| Long description | The electronics behave in the same way after restarting as they do after switching on.<br>RBT cannot be used in macros. |
| Format:          | <b>RBT</b>                                                                                                              |

## RMC? List Running Macros

*Used in:* (85)

|              |                                                          |
|--------------|----------------------------------------------------------|
| Description: | Queries all macros currently running.                    |
| Format:      | <b>RMC?</b>                                              |
| Response:    | {[<MacroName>] <sub>LF</sub> }<br><MacroName> Macro name |

## RON Set Reference Mode

*Used in:* Reference point definition options (40)

|                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                       |          |         |               |                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|---------------|---------------------------------|
| Description:                                                                                                                                                                                                                                                                                                                                                                      | Sets the reference point definition mode of the specified axis.                                                                                       |          |         |               |                                 |
| Format:                                                                                                                                                                                                                                                                                                                                                                           | <b>RON{,_&lt;AxisID&gt;,_&lt;ReferenceOn&gt;}</b>                                                                                                     |          |         |               |                                 |
| Arguments:                                                                                                                                                                                                                                                                                                                                                                        | <table> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;ReferenceOn&gt;</td> <td>Reference point definition mode</td> </tr> </table> | <AxisID> | Axis ID | <ReferenceOn> | Reference point definition mode |
| <AxisID>                                                                                                                                                                                                                                                                                                                                                                          | Axis ID                                                                                                                                               |          |         |               |                                 |
| <ReferenceOn>                                                                                                                                                                                                                                                                                                                                                                     | Reference point definition mode                                                                                                                       |          |         |               |                                 |
| Possible reference point definition modes:                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                       |          |         |               |                                 |
| 0    Absolute position value is assigned with <a href="#">POS (p. 147)</a> or a reference move is done with <a href="#">FRF (p. 125)</a> (also <a href="#">FNL (p. 124)</a> or <a href="#">FPL (p. 124)</a> if supported by the controller). Relative motion is possible with <a href="#">MVR (p. 145)</a> , even when the reference point for the axis has not been defined yet. |                                                                                                                                                       |          |         |               |                                 |
| 1    A reference move must be done with <a href="#">FRF (p. 125)</a> (also <a href="#">FNL (p. 124)</a> or <a href="#">FPL (p. 124)</a> if supported by the controller) for the reference point definition, <a href="#">POS (p. 147)</a> is not permitted. Motion in closed-loop operation is only possible when the reference point has been defined. (Default)                  |                                                                                                                                                       |          |         |               |                                 |
| Troubleshooting:                                                                                                                                                                                                                                                                                                                                                                  | Illegal axis identifier                                                                                                                               |          |         |               |                                 |

## RON? Get Reference Mode

*Used in:* Reference point definition options (40)

|                                        |                                                                                                                                                                                                                                               |                                        |  |          |                 |               |                                 |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|--|----------|-----------------|---------------|---------------------------------|
| Description:                           | Queries the reference point definition mode of the specified axis.                                                                                                                                                                            |                                        |  |          |                 |               |                                 |
| Format:                                | <b>RON?{,_&lt;AxisID&gt;}]</b>                                                                                                                                                                                                                |                                        |  |          |                 |               |                                 |
| Arguments:                             | <AxisID> Axis identifier                                                                                                                                                                                                                      |                                        |  |          |                 |               |                                 |
| Response:                              | <table> <tr> <td>{&lt;AxisID&gt;=&lt;ReferenceOn&gt;}<sub>LF</sub></td> <td></td> </tr> <tr> <td>&lt;AxisID&gt;</td> <td>Axis identifier</td> </tr> <tr> <td>&lt;ReferenceOn&gt;</td> <td>Reference point definition mode</td> </tr> </table> | {<AxisID>=<ReferenceOn>} <sub>LF</sub> |  | <AxisID> | Axis identifier | <ReferenceOn> | Reference point definition mode |
| {<AxisID>=<ReferenceOn>} <sub>LF</sub> |                                                                                                                                                                                                                                               |                                        |  |          |                 |               |                                 |
| <AxisID>                               | Axis identifier                                                                                                                                                                                                                               |                                        |  |          |                 |               |                                 |
| <ReferenceOn>                          | Reference point definition mode                                                                                                                                                                                                               |                                        |  |          |                 |               |                                 |
| Troubleshooting:                       | Illegal axis identifier                                                                                                                                                                                                                       |                                        |  |          |                 |               |                                 |

## RPA Reset Volatile Memory Parameters

*Used in:* Parameter Commands (95)

|                                  |                                                                                                                                                                                                                                                         |                                  |                                                                                                                |         |              |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------|---------|--------------|
| Description:                     | Resets the specified parameter.                                                                                                                                                                                                                         |                                  |                                                                                                                |         |              |
| Long description                 | The parameter value in the volatile memory is overwritten by the value in the nonvolatile memory.<br>RPA resets the parameter for the setting of hardware-specific parameters. Wrong values can lead to faulty operation or damage to the hardware.     |                                  |                                                                                                                |         |              |
| Format:                          | <b>RPA[ { &lt;ItemID&gt; &lt;PamID&gt; } ]</b>                                                                                                                                                                                                          |                                  |                                                                                                                |         |              |
| Arguments:                       | <table border="0"> <tr> <td>&lt;ItemID&gt;</td> <td>Element of the electronics<br/><br/>For example, axis identifier<br/>Parameter &lt;PamID&gt; is reset for this element.</td> </tr> <tr> <td>&lt;PamID&gt;</td> <td>Parameter ID</td> </tr> </table> | <ItemID>                         | Element of the electronics<br><br>For example, axis identifier<br>Parameter <PamID> is reset for this element. | <PamID> | Parameter ID |
| <ItemID>                         | Element of the electronics<br><br>For example, axis identifier<br>Parameter <PamID> is reset for this element.                                                                                                                                          |                                  |                                                                                                                |         |              |
| <PamID>                          | Parameter ID                                                                                                                                                                                                                                            |                                  |                                                                                                                |         |              |
| Troubleshooting:                 | <table border="0"> <tr> <td>Impermissible element identifier</td> </tr> <tr> <td>Wrong parameter ID</td> </tr> </table>                                                                                                                                 | Impermissible element identifier | Wrong parameter ID                                                                                             |         |              |
| Impermissible element identifier |                                                                                                                                                                                                                                                         |                                  |                                                                                                                |         |              |
| Wrong parameter ID               |                                                                                                                                                                                                                                                         |                                  |                                                                                                                |         |              |

## RTR Set Record Table Rate

*Used in:* Setting the record table rate (74)

|                  |                                                                                                                                                                                                 |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Sets the record table rate of the data recorder.                                                                                                                                                |
| Long description | The recording rate multiplied by the cycle time of the electronics results in the recording interval of the data recorder. Settings greater than 1 allow recording over longer periods of time. |
| Format:          | <b>RTR &lt;RecordTableRate&gt;</b>                                                                                                                                                              |
| Arguments:       | <RecordTableRate> Data recording rate of the data recorder in number of cycles (UINT >0)                                                                                                        |

## RTR? Get Record Table Rate

*Used in:* Setting the record table rate (74)

|                                                                                          |                                                                                                                                                                                                         |                             |                                                                                          |
|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------------------------------------------------------------------|
| Description:                                                                             | Queries the current recording rate of the date recorder.                                                                                                                                                |                             |                                                                                          |
| Long description                                                                         | The recording rate multiplied by the cycle time of the electronics results in the recording interval of the data recorder. Settings greater than 1 allow recording over longer periods of time.         |                             |                                                                                          |
| Format:                                                                                  | <b>RTR?</b>                                                                                                                                                                                             |                             |                                                                                          |
| Response:                                                                                | <table border="0"> <tr> <td>&lt;RecordTableRate&gt; <b>LF</b></td> </tr> <tr> <td>&lt;RecordTableRate&gt; Data recording rate of the data recorder in number of cycles (UINT &gt;0)</td> </tr> </table> | <RecordTableRate> <b>LF</b> | <RecordTableRate> Data recording rate of the data recorder in number of cycles (UINT >0) |
| <RecordTableRate> <b>LF</b>                                                              |                                                                                                                                                                                                         |                             |                                                                                          |
| <RecordTableRate> Data recording rate of the data recorder in number of cycles (UINT >0) |                                                                                                                                                                                                         |                             |                                                                                          |

## SAI Set Current Axis Identifiers

*Used in:* (23)

|                  |                                                                                                                                                                             |          |         |                 |             |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|-----------------|-------------|
| Description:     | Sets the axis identifier for the specified axis.                                                                                                                            |          |         |                 |             |
| Long description | The new axis identifier is stored in the nonvolatile memory of the electronics.<br>Use <a href="#">TVI? (p. 158)</a> to query the valid characters for the axis identifier. |          |         |                 |             |
| Format:          | <b>SAI{._&lt;AxisID&gt;._&lt;NewIdentifier&gt;}</b>                                                                                                                         |          |         |                 |             |
| Arguments:       | <table> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;NewIdentifier&gt;</td> <td>New axis ID</td> </tr> </table>                                         | <AxisID> | Axis ID | <NewIdentifier> | New axis ID |
| <AxisID>         | Axis ID                                                                                                                                                                     |          |         |                 |             |
| <NewIdentifier>  | New axis ID                                                                                                                                                                 |          |         |                 |             |

## SAI? Get List Of Current Axis Identifiers

*Used in:* (23)

|                           |                                                                                                                                                                                                                   |                           |                                                                                                                                                             |          |         |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|
| Description:              | Queries the axis identifiers.                                                                                                                                                                                     |                           |                                                                                                                                                             |          |         |
| Long description          | ALL ensures that the response also includes axes that are deactivated for electronics that permit axes to be deactivated.                                                                                         |                           |                                                                                                                                                             |          |         |
| Format:                   | <b>SAI?[._ALL]</b>                                                                                                                                                                                                |                           |                                                                                                                                                             |          |         |
| Arguments:                | <table> <tr> <td>[._ALL]</td> <td>Ensures that electronics that allow axes to be deactivated (parameter <a href="#">0x3C (p. 180)</a> = "NOSTAGE") also allow deactivated axes to be queried.</td> </tr> </table> | [._ALL]                   | Ensures that electronics that allow axes to be deactivated (parameter <a href="#">0x3C (p. 180)</a> = "NOSTAGE") also allow deactivated axes to be queried. |          |         |
| [._ALL]                   | Ensures that electronics that allow axes to be deactivated (parameter <a href="#">0x3C (p. 180)</a> = "NOSTAGE") also allow deactivated axes to be queried.                                                       |                           |                                                                                                                                                             |          |         |
| Response:                 | <table> <tr> <td>{&lt;AxisID&gt;<sub>LF</sub>}</td> <td></td> </tr> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> </table>                                                                                  | {<AxisID> <sub>LF</sub> } |                                                                                                                                                             | <AxisID> | Axis ID |
| {<AxisID> <sub>LF</sub> } |                                                                                                                                                                                                                   |                           |                                                                                                                                                             |          |         |
| <AxisID>                  | Axis ID                                                                                                                                                                                                           |                           |                                                                                                                                                             |          |         |

## SEP Set Non-Volatile Memory Parameters

*Used in:* (30), *Parameter Commands* (95)

|                                  |                                                                                                                                                                                                                                                                                                        |                                  |                                                |                    |                            |                |              |            |                 |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|------------------------------------------------|--------------------|----------------------------|----------------|--------------|------------|-----------------|
| Description:                     | Sets a parameter in the nonvolatile memory to a specific value.                                                                                                                                                                                                                                        |                                  |                                                |                    |                            |                |              |            |                 |
| Long description                 | Up to four parameters can be set per command.<br>Wrong values can lead to faulty operation or damage to the hardware.                                                                                                                                                                                  |                                  |                                                |                    |                            |                |              |            |                 |
| Format:                          | <b>SEP_&lt;Pswd&gt;{._&lt;ItemID&gt;._&lt;PamID&gt;._&lt;PamValue&gt;}</b>                                                                                                                                                                                                                             |                                  |                                                |                    |                            |                |              |            |                 |
| Arguments:                       | <table> <tr> <td>&lt;Pswd&gt;</td> <td>Password for writing to the nonvolatile memory</td> </tr> <tr> <td>&lt;ItemID&gt;</td> <td>Element of the electronics</td> </tr> <tr> <td>&lt;PamID&gt;</td> <td>Parameter ID</td> </tr> <tr> <td>&lt;PamValue&gt;</td> <td>Parameter value</td> </tr> </table> | <Pswd>                           | Password for writing to the nonvolatile memory | <ItemID>           | Element of the electronics | <PamID>        | Parameter ID | <PamValue> | Parameter value |
| <Pswd>                           | Password for writing to the nonvolatile memory                                                                                                                                                                                                                                                         |                                  |                                                |                    |                            |                |              |            |                 |
| <ItemID>                         | Element of the electronics                                                                                                                                                                                                                                                                             |                                  |                                                |                    |                            |                |              |            |                 |
| <PamID>                          | Parameter ID                                                                                                                                                                                                                                                                                           |                                  |                                                |                    |                            |                |              |            |                 |
| <PamValue>                       | Parameter value                                                                                                                                                                                                                                                                                        |                                  |                                                |                    |                            |                |              |            |                 |
| Troubleshooting:                 | <table> <tr> <td>Impermissible element identifier</td> <td></td> </tr> <tr> <td>Wrong parameter ID</td> <td></td> </tr> <tr> <td>Wrong password</td> <td></td> </tr> </table>                                                                                                                          | Impermissible element identifier |                                                | Wrong parameter ID |                            | Wrong password |              |            |                 |
| Impermissible element identifier |                                                                                                                                                                                                                                                                                                        |                                  |                                                |                    |                            |                |              |            |                 |
| Wrong parameter ID               |                                                                                                                                                                                                                                                                                                        |                                  |                                                |                    |                            |                |              |            |                 |
| Wrong password                   |                                                                                                                                                                                                                                                                                                        |                                  |                                                |                    |                            |                |              |            |                 |

## SEP? Get Non-Volatile Memory Parameters

*Used in: Parameter Commands (95), Saving Parameter Values in a Text File (96)*

|                                               |                                                                                                                                                                                                                                                                                                            |                                               |                            |                    |                            |         |              |            |                 |
|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|----------------------------|--------------------|----------------------------|---------|--------------|------------|-----------------|
| Description:                                  | Queries the value of a parameter in the nonvolatile memory.                                                                                                                                                                                                                                                |                                               |                            |                    |                            |         |              |            |                 |
| Long description                              | Up to four parameters can be queried per command.                                                                                                                                                                                                                                                          |                                               |                            |                    |                            |         |              |            |                 |
| Format:                                       | <b>SEP?[{_,&lt;ItemID&gt;_,&lt;PamID&gt;}]</b>                                                                                                                                                                                                                                                             |                                               |                            |                    |                            |         |              |            |                 |
| Arguments:                                    | <table> <tr> <td>&lt;ItemID&gt;</td> <td>Element of the electronics</td> </tr> <tr> <td>&lt;PamID&gt;</td> <td>Parameter ID</td> </tr> </table>                                                                                                                                                            | <ItemID>                                      | Element of the electronics | <PamID>            | Parameter ID               |         |              |            |                 |
| <ItemID>                                      | Element of the electronics                                                                                                                                                                                                                                                                                 |                                               |                            |                    |                            |         |              |            |                 |
| <PamID>                                       | Parameter ID                                                                                                                                                                                                                                                                                               |                                               |                            |                    |                            |         |              |            |                 |
| Response:                                     | <table> <tr> <td>{&lt;ItemID&gt;_,&lt;PamID&gt;=&lt;PamValue&gt; <sub>LF</sub>}</td> <td></td> </tr> <tr> <td>&lt;ItemID&gt;</td> <td>Element of the electronics</td> </tr> <tr> <td>&lt;PamID&gt;</td> <td>Parameter ID</td> </tr> <tr> <td>&lt;PamValue&gt;</td> <td>Parameter value</td> </tr> </table> | {<ItemID>_,<PamID>=<PamValue> <sub>LF</sub> } |                            | <ItemID>           | Element of the electronics | <PamID> | Parameter ID | <PamValue> | Parameter value |
| {<ItemID>_,<PamID>=<PamValue> <sub>LF</sub> } |                                                                                                                                                                                                                                                                                                            |                                               |                            |                    |                            |         |              |            |                 |
| <ItemID>                                      | Element of the electronics                                                                                                                                                                                                                                                                                 |                                               |                            |                    |                            |         |              |            |                 |
| <PamID>                                       | Parameter ID                                                                                                                                                                                                                                                                                               |                                               |                            |                    |                            |         |              |            |                 |
| <PamValue>                                    | Parameter value                                                                                                                                                                                                                                                                                            |                                               |                            |                    |                            |         |              |            |                 |
| Troubleshooting:                              | <table> <tr> <td>Impermissible element identifier</td> <td></td> </tr> <tr> <td>Wrong parameter ID</td> <td></td> </tr> </table>                                                                                                                                                                           | Impermissible element identifier              |                            | Wrong parameter ID |                            |         |              |            |                 |
| Impermissible element identifier              |                                                                                                                                                                                                                                                                                                            |                                               |                            |                    |                            |         |              |            |                 |
| Wrong parameter ID                            |                                                                                                                                                                                                                                                                                                            |                                               |                            |                    |                            |         |              |            |                 |

## SPA Set Volatile Memory Parameters

*Used in: (30), Parameter Commands (95)*

|                                  |                                                                                                                                                                                                               |                                  |                            |                    |              |            |                 |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------|--------------------|--------------|------------|-----------------|
| Description:                     | Sets a parameter in the volatile memory to a specific value.                                                                                                                                                  |                                  |                            |                    |              |            |                 |
| Long description                 | Up to four parameters can be set per command.<br>Wrong values can lead to faulty operation or damage to the hardware.                                                                                         |                                  |                            |                    |              |            |                 |
| Format:                          | <b>SPA{_,&lt;ItemID&gt;_,&lt;PamID&gt;_,&lt;PamValue&gt;}</b>                                                                                                                                                 |                                  |                            |                    |              |            |                 |
| Arguments:                       | <table> <tr> <td>&lt;ItemID&gt;</td> <td>Element of the electronics</td> </tr> <tr> <td>&lt;PamID&gt;</td> <td>Parameter ID</td> </tr> <tr> <td>&lt;PamValue&gt;</td> <td>Parameter value</td> </tr> </table> | <ItemID>                         | Element of the electronics | <PamID>            | Parameter ID | <PamValue> | Parameter value |
| <ItemID>                         | Element of the electronics                                                                                                                                                                                    |                                  |                            |                    |              |            |                 |
| <PamID>                          | Parameter ID                                                                                                                                                                                                  |                                  |                            |                    |              |            |                 |
| <PamValue>                       | Parameter value                                                                                                                                                                                               |                                  |                            |                    |              |            |                 |
| Troubleshooting:                 | <table> <tr> <td>Impermissible element identifier</td> <td></td> </tr> <tr> <td>Wrong parameter ID</td> <td></td> </tr> </table>                                                                              | Impermissible element identifier |                            | Wrong parameter ID |              |            |                 |
| Impermissible element identifier |                                                                                                                                                                                                               |                                  |                            |                    |              |            |                 |
| Wrong parameter ID               |                                                                                                                                                                                                               |                                  |                            |                    |              |            |                 |

## SPA? Get Volatile Memory Parameters

*Used in: Parameter Commands (95), Saving Parameter Values in a Text File (96)*

|                                               |                                                                                                                                                                                                                                                                                              |                                               |                            |                    |                            |         |              |            |                 |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|----------------------------|--------------------|----------------------------|---------|--------------|------------|-----------------|
| Description:                                  | Queries the value of a parameter in the volatile memory.                                                                                                                                                                                                                                     |                                               |                            |                    |                            |         |              |            |                 |
| Long description                              | Up to four parameters can be queried per command.                                                                                                                                                                                                                                            |                                               |                            |                    |                            |         |              |            |                 |
| Format:                                       | <b>SPA?[{_,&lt;ItemID&gt;_,&lt;PamID&gt;}]</b>                                                                                                                                                                                                                                               |                                               |                            |                    |                            |         |              |            |                 |
| Arguments:                                    | <br><table><tr><td>&lt;ItemID&gt;</td><td>Element of the electronics</td></tr><tr><td>&lt;PamID&gt;</td><td>Parameter ID</td></tr></table>                                                                                                                                                   | <ItemID>                                      | Element of the electronics | <PamID>            | Parameter ID               |         |              |            |                 |
| <ItemID>                                      | Element of the electronics                                                                                                                                                                                                                                                                   |                                               |                            |                    |                            |         |              |            |                 |
| <PamID>                                       | Parameter ID                                                                                                                                                                                                                                                                                 |                                               |                            |                    |                            |         |              |            |                 |
| Response:                                     | <br><table><tr><td>{&lt;ItemID&gt;_,&lt;PamID&gt;=&lt;PamValue&gt;<sub>LF</sub>}</td><td></td></tr><tr><td>&lt;ItemID&gt;</td><td>Element of the electronics</td></tr><tr><td>&lt;PamID&gt;</td><td>Parameter ID</td></tr><tr><td>&lt;PamValue&gt;</td><td>Parameter value</td></tr></table> | {<ItemID>_,<PamID>=<PamValue> <sub>LF</sub> } |                            | <ItemID>           | Element of the electronics | <PamID> | Parameter ID | <PamValue> | Parameter value |
| {<ItemID>_,<PamID>=<PamValue> <sub>LF</sub> } |                                                                                                                                                                                                                                                                                              |                                               |                            |                    |                            |         |              |            |                 |
| <ItemID>                                      | Element of the electronics                                                                                                                                                                                                                                                                   |                                               |                            |                    |                            |         |              |            |                 |
| <PamID>                                       | Parameter ID                                                                                                                                                                                                                                                                                 |                                               |                            |                    |                            |         |              |            |                 |
| <PamValue>                                    | Parameter value                                                                                                                                                                                                                                                                              |                                               |                            |                    |                            |         |              |            |                 |
| Troubleshooting:                              | <br><table><tr><td>Impermissible element identifier</td><td></td></tr><tr><td>Wrong parameter ID</td><td></td></tr></table>                                                                                                                                                                  | Impermissible element identifier              |                            | Wrong parameter ID |                            |         |              |            |                 |
| Impermissible element identifier              |                                                                                                                                                                                                                                                                                              |                                               |                            |                    |                            |         |              |            |                 |
| Wrong parameter ID                            |                                                                                                                                                                                                                                                                                              |                                               |                            |                    |                            |         |              |            |                 |

## SRG? Query Status Register Value

*Used in: (25), On-Target State (36)*

|              |                                                                                                                                                   |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Description: | Requests system status information.                                                                                                               |
| Format:      | <b>SRG?{_&lt;ItemID&gt;_&lt;RegisterID&gt;}</b>                                                                                                   |
| Arguments:   | <ItemID> Element of the electronics<br><RegisterID> Register ID                                                                                   |
| Response:    | {<ItemID>_<RegisterID>=<Value> <sub>LF</sub> }<br><ItemID> Element of the electronics<br><RegisterID> Register ID<br><Value> Register value (HEX) |

<StatusRegister> is bit-mapped. It comprises:

| Bit | Description                           |
|-----|---------------------------------------|
| 15  | On-target state                       |
| 14  | Reference point definition is running |
| 13  | In motion                             |
| 12  | Servo mode activated                  |
| 11  |                                       |
| 10  | Sensor signal valid                   |
| 9   | Reference edge found                  |
| 8   | Error                                 |
| 7   | Digital input 4 active                |
| 6   | Digital input 3 active                |
| 5   | Digital input 2 active                |
| 4   | Digital input 1 active                |
| 3   | Sensor is referenced                  |
| 2   | Positive limit switch active          |
| 1   | Reference switch active               |
| 0   | Negative limit switch active          |

## SST Set Step Size

|                         |                                                                                                                                                                                         |  |                         |               |            |                                                                               |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-------------------------|---------------|------------|-------------------------------------------------------------------------------|
| Description:            | Sets the distance to be travelled for relative motion that is triggered by an HID.                                                                                                      |  |                         |               |            |                                                                               |
| Long description        | Sets the distance (step size) for motion of the specified axis triggered by a manual control unit.                                                                                      |  |                         |               |            |                                                                               |
| Format:                 | <b>SST_{&lt;AxisID&gt;_&lt;StepSize&gt;}</b>                                                                                                                                            |  |                         |               |            |                                                                               |
| Arguments:              | <table><tr><td>&lt;AxisID&gt;</td><td>Axis ID</td></tr><tr><td>&lt;StepSize&gt;</td><td>Distance. Specified in the physical unit of the axis position (format: FLOAT)</td></tr></table> |  | <AxisID>                | Axis ID       | <StepSize> | Distance. Specified in the physical unit of the axis position (format: FLOAT) |
| <AxisID>                | Axis ID                                                                                                                                                                                 |  |                         |               |            |                                                                               |
| <StepSize>              | Distance. Specified in the physical unit of the axis position (format: FLOAT)                                                                                                           |  |                         |               |            |                                                                               |
| Troubleshooting:        | <table><tr><td>Illegal axis identifier</td></tr><tr><td>Illegal value</td></tr></table>                                                                                                 |  | Illegal axis identifier | Illegal value |            |                                                                               |
| Illegal axis identifier |                                                                                                                                                                                         |  |                         |               |            |                                                                               |
| Illegal value           |                                                                                                                                                                                         |  |                         |               |            |                                                                               |

## SST? Get Step Size

|                                      |                                                                                                                                                                                                                       |  |                                      |               |            |                                                                               |                                            |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--------------------------------------|---------------|------------|-------------------------------------------------------------------------------|--------------------------------------------|
| Description:                         | Queries the distance to be travelled for relative motion triggered by an HID.                                                                                                                                         |  |                                      |               |            |                                                                               |                                            |
| Long description                     | Queries the distance (step size) for motion of the specified axis triggered by a manual control unit.                                                                                                                 |  |                                      |               |            |                                                                               |                                            |
| Format:                              | <b>SST?_[{&lt;AxisID&gt;}]</b>                                                                                                                                                                                        |  |                                      |               |            |                                                                               |                                            |
| Arguments:                           | <table><tr><td>&lt;AxisID&gt;</td><td>Axis ID</td></tr><tr><td>&lt;StepSize&gt;</td><td>Distance. Specified in the physical unit of the axis position (format: FLOAT)</td></tr></table>                               |  | <AxisID>                             | Axis ID       | <StepSize> | Distance. Specified in the physical unit of the axis position (format: FLOAT) |                                            |
| <AxisID>                             | Axis ID                                                                                                                                                                                                               |  |                                      |               |            |                                                                               |                                            |
| <StepSize>                           | Distance. Specified in the physical unit of the axis position (format: FLOAT)                                                                                                                                         |  |                                      |               |            |                                                                               |                                            |
| Response:                            | <table><tr><td>{&lt;AxisID&gt;=&lt;StepSize&gt; <sub>LF</sub>}</td></tr><tr><td>&lt;AxisID&gt;</td><td>Axis ID</td></tr><tr><td>StepSize&lt;&gt;</td><td>Distance in physical units (format: FLOAT)</td></tr></table> |  | {<AxisID>=<StepSize> <sub>LF</sub> } | <AxisID>      | Axis ID    | StepSize<>                                                                    | Distance in physical units (format: FLOAT) |
| {<AxisID>=<StepSize> <sub>LF</sub> } |                                                                                                                                                                                                                       |  |                                      |               |            |                                                                               |                                            |
| <AxisID>                             | Axis ID                                                                                                                                                                                                               |  |                                      |               |            |                                                                               |                                            |
| StepSize<>                           | Distance in physical units (format: FLOAT)                                                                                                                                                                            |  |                                      |               |            |                                                                               |                                            |
| Troubleshooting:                     | <table><tr><td>Illegal axis identifier</td></tr><tr><td>Illegal value</td></tr></table>                                                                                                                               |  | Illegal axis identifier              | Illegal value |            |                                                                               |                                            |
| Illegal axis identifier              |                                                                                                                                                                                                                       |  |                                      |               |            |                                                                               |                                            |
| Illegal value                        |                                                                                                                                                                                                                       |  |                                      |               |            |                                                                               |                                            |

## STE Start Step And Response Measurement

*Used in:* (30), Motion in closed-loop operation (28), Motion in open-loop operation (29), Starting the Recording (74)

|                  |                                                                                                                                                                                                                                                                                                                            |          |         |             |                             |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|-------------|-----------------------------|
| Description:     | Starts a step for the specified axis and records the step response.                                                                                                                                                                                                                                                        |          |         |             |                             |
| Long description | Servo mode must be switched on for the specified axis (axes) (closed-loop operation). HID control may not be activated for the corresponding axis.<br>The target position must be inside the soft limits.                                                                                                                  |          |         |             |                             |
| Format:          | <b>STE_&lt;AxisID&gt;_&lt;Amplitude&gt;</b>                                                                                                                                                                                                                                                                                |          |         |             |                             |
| Arguments:       | <table> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;Amplitude&gt;</td> <td>Jump size in physical units</td> </tr> </table>                                                                                                                                                                            | <AxisID> | Axis ID | <Amplitude> | Jump size in physical units |
| <AxisID>         | Axis ID                                                                                                                                                                                                                                                                                                                    |          |         |             |                             |
| <Amplitude>      | Jump size in physical units                                                                                                                                                                                                                                                                                                |          |         |             |                             |
| Troubleshooting: | <ul style="list-style-type: none"> <li>Illegal axis identifier</li> <li>Servo mode not active (<a href="#">SVO? (p. 156)</a> responds with the value "0")</li> <li>Executing motion commands deactivated by parameter 0x130</li> <li>Target position outside of the soft limits</li> <li>HID control is enabled</li> </ul> |          |         |             |                             |

## STP Stop All Axes

*Used in:* (87), Triggering Motion (28)

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Stops all axes abruptly.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Long description | <ul style="list-style-type: none"> <li>Stops all motion started by motion commands (e.g., <a href="#">MOV (p. 144)</a>, <a href="#">MVR (p. 145)</a>, MVE, <a href="#">STE (p. 155)</a>, SMO), reference point definition commands (<a href="#">FNL (p. 124)</a>, <a href="#">FPL (p. 124)</a>, <a href="#">FRF (p. 125)</a>), and macros.</li> <li>Also stops the macro.</li> <li>Sets the error code to 10.</li> <li>After the axes are stopped, their target positions are set to their current positions.</li> </ul> |
| Format:          | <b>STP</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## SVO Set Servo Mode

*Used in:* (25), Restoring the E-873.1AT's Operational Readiness (73)

|                  |                                                                                                                                             |          |         |              |                   |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|--------------|-------------------|
| Description:     | Sets the servo mode for the specified axis.                                                                                                 |          |         |              |                   |
| Long description | The target position is set to the current position when switching to closed-loop operation. SVO deactivates the brake when it is activated. |          |         |              |                   |
| Format:          | <b>SVO{_&lt;AxisID&gt;_&lt;ServoState&gt;}</b>                                                                                              |          |         |              |                   |
| Arguments:       | <table> <tr> <td>&lt;AxisID&gt;</td> <td>Axis ID</td> </tr> <tr> <td>&lt;ServoState&gt;</td> <td>Servo mode (UINT)</td> </tr> </table>      | <AxisID> | Axis ID | <ServoState> | Servo mode (UINT) |
| <AxisID>         | Axis ID                                                                                                                                     |          |         |              |                   |
| <ServoState>     | Servo mode (UINT)                                                                                                                           |          |         |              |                   |

## SVO? Get Servo Mode

*Used in:* (25)

|                  |                                                                                           |
|------------------|-------------------------------------------------------------------------------------------|
| Description:     | Queries the servo mode for the specified axis.                                            |
| Format:          | <b>SVO?[{_.&lt;AxisID&gt;}]</b>                                                           |
| Arguments:       | <AxisID> Axis ID<br>The value for all axes will be queried if no arguments are specified. |
| Response:        | {<AxisID>=<ServoState> <sub>LF</sub> }                                                    |
|                  | <AxisID> Axis ID                                                                          |
|                  | <ServoState> Axis servo mode (UINT)                                                       |
| Troubleshooting: | Illegal axis identifier                                                                   |

## TAC? Tell Analog Channels

*Used in:* (23), Analog Input Signals (75)

|              |                                                              |
|--------------|--------------------------------------------------------------|
| Description: | Queries the number of available analog lines.                |
| Format:      | <b>TAC?</b>                                                  |
| Response:    | <uint><br><uint> Number of analog lines (inputs and outputs) |

## TAV? Get Analog Input Voltage

*Used in:* (23), Analog Input Signals (75)

|              |                                                                                                                                                                                                                                 |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description: | Queries the voltage at the analog input.                                                                                                                                                                                        |
| Format:      | <b>TAV?[{_.&lt;AnalogInputID&gt;}]</b>                                                                                                                                                                                          |
| Arguments:   | <AnalogInputID> is the identifier of an analog input channel                                                                                                                                                                    |
| Response:    | {<AnalogInputID>=<float> <sub>LF</sub> }<br><AnalogInputID> is the identifier of an analog input channel<br><float> Current voltage at the analog input (FLOAT)<br>All analog inputs are queried if no arguments are specified. |

## TIO? Tell Digital I/O Lines

|              |                                                                                                                                                     |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Description: | Queries the number of available digital I/O lines.                                                                                                  |
| Format:      | <b>TIO?</b>                                                                                                                                         |
| Response:    | I=<uint1> <sub>LF</sub><br>O=<uint2> <sub>LF</sub><br><uint1> Number of digital input lines (UINT)<br><uint2> Number of digital output lines (UINT) |

## **TMN? Get Minimum Commandable Position**

|                  |                                                                                             |
|------------------|---------------------------------------------------------------------------------------------|
| Description:     | Queries the minimum commandable position.                                                   |
| Long description | The minimum commandable position is determined by parameter <a href="#">0x30 (p. 178)</a> . |
| Format:          | <b>TMN?[{_,&lt;AxisID&gt;}]</b>                                                             |
| Arguments:       | <AxisID> Axis ID                                                                            |
| Response:        | {<AxisID>=<float> <sub>LF</sub> }                                                           |
|                  | <AxisID> Axis ID                                                                            |
|                  | <float> Minimum commandable position in physical units (FLOAT)                              |

## **TMX? Get Maximum Commandable Position**

|                  |                                                                                          |
|------------------|------------------------------------------------------------------------------------------|
| Description:     | Queries the maximum commandable position.                                                |
| Long description | The maximum commandable position is defined by parameter <a href="#">0x15 (p. 175)</a> . |
| Format:          | <b>TMX?[{_,&lt;AxisID&gt;}]</b>                                                          |
| Arguments:       | <AxisID> Axis ID                                                                         |
| Response:        | {<AxisID>=<float> <sub>LF</sub> }                                                        |
|                  | <AxisID> Axis ID                                                                         |
|                  | <float> Maximum commandable position in physical units (FLOAT)                           |

## **TNR? Get Number Of Record Tables**

*Used in: (23)*

|              |                                                                  |
|--------------|------------------------------------------------------------------|
| Description: | Queries the number of available data recorder tables.            |
| Format:      | <b>TNR?</b>                                                      |
| Response:    | <uint><br><uint> Number of available data recorder tables (UINT) |

## TRO Set Trigger Output State

Description: Activates or deactivates the trigger output for a digital output line.

Format: **TR0{.\_<TrigOutID>.\_<TrigMode>}**

Arguments:

|             |                                   |
|-------------|-----------------------------------|
| <TrigOutID> | Digital output of the electronics |
| <TrigMode>  | Trigger output state (UINT)       |

Troubleshooting: Impermissible element identifier

## TRO? Get Trigger Output State

Description: Queries the trigger output state for a digital output line.

Format: **TR0?[{.\_<TrigOutID>}]**

Arguments:

|             |                                   |
|-------------|-----------------------------------|
| <TrigOutID> | Digital output of the electronics |
|-------------|-----------------------------------|

If no arguments are specified, the state of all digital output lines is queried.

Response:

|                                         |                             |
|-----------------------------------------|-----------------------------|
| {<TrigOutID>=<TrigMode> <sub>LF</sub> } |                             |
| <TrigMode>                              | Trigger output state (UINT) |

Troubleshooting: Impermissible element identifier

## TRS? Indicate Reference Switch

*Used in: Reference Switch Detection (37)*

Description: Queries whether the specified axis has a reference switch with direction sensing.

Long description: TRS? queries the value of parameter [0x14 \(p. 174\)](#).

Format: **TRS?[{.\_<AxisID>}]**

Arguments:

|          |         |
|----------|---------|
| <AxisID> | Axis ID |
|----------|---------|

Response:

|                                  |                                                      |
|----------------------------------|------------------------------------------------------|
| {<AxisID>=<uint> <sub>LF</sub> } |                                                      |
| <AxisID>                         | Axis ID                                              |
| <uint>                           | Direction sensing reference switch available? (BOOL) |

Troubleshooting: Illegal axis identifier

## TVI? Tell Valid Character Set For Axis Identifiers

Description: Queries permissible characters for axis identifiers.

Format: **TVI?**

Response:

|                                                                    |  |
|--------------------------------------------------------------------|--|
| <String>                                                           |  |
| <String> Characters that are permitted for use in axis identifiers |  |

## VAR Set Variable Value

*Used in: Running the Macros (85)*

|                  |                                                                                                                                                                |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Sets a variable to a specific value.                                                                                                                           |
| Long description | Local variables can only be set in macros.<br>The variable is only in volatile memory (RAM).                                                                   |
| Format:          | <b>VAR_&lt;Variable&gt;_&lt;String&gt;</b>                                                                                                                     |
| Arguments:       | <Variable> Name of the variable whose value is set<br><String> Value, that the variable is set to<br>Can be specified directly or via the value of a variable. |

## VAR? Get Variable Values

*Used in: Running the Macros (85)*

|                  |                                                                                                           |
|------------------|-----------------------------------------------------------------------------------------------------------|
| Description:     | Queries the value of a variable.                                                                          |
| Long description | Local variables can only be queries when a macro is running that contains local variables.                |
| Format:          | <b>VAR?[_.&lt;Variable&gt;]</b>                                                                           |
| Arguments:       | <Variable> Name of the variable being queried<br>All variables are queried if no arguments are specified. |
| Response:        | {<Variable>=<String> <sub>LF</sub> }                                                                      |
|                  | <Variable> Name of the variable                                                                           |
|                  | <String> Value of the variable                                                                            |

## VEL Set Closed-Loop Velocity

*Used in: (30)*

|                  |                                                                                                                                                                                                                                                                                                     |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Sets the velocity for the specified axis.                                                                                                                                                                                                                                                           |
| Long description | Changes the value of the parameter <a href="#">0x49 (p. 181)</a> in the volatile memory. The maximum value that can be set with VEL, is specified by parameter <a href="#">0xA (p. 171)</a> .<br>The setting only takes effect when the specified axis is in closed-loop operation (servo mode ON). |
| Format:          | <b>VEL{_.&lt;AxisID&gt;_.&lt;Velocity&gt;}</b>                                                                                                                                                                                                                                                      |
| Arguments:       | <AxisID> Axis ID<br><br><Velocity> Velocity [physical units / s]]                                                                                                                                                                                                                                   |
| Troubleshooting: | Illegal axis identifier                                                                                                                                                                                                                                                                             |

*Used in:* (30)

|                  |                                                                                                         |
|------------------|---------------------------------------------------------------------------------------------------------|
| Description:     | Gets the commanded velocity.                                                                            |
| Format:          | <b>VEL?[{_,&lt;AxisID&gt;}]</b>                                                                         |
| Arguments:       | <AxisID> Axis ID<br>The value for all axes will be queried if no arguments are specified.               |
| Response:        | {<AxisID>=<float> <sub>LF</sub> }<br><AxisID> Axis ID<br><float> Velocity in physical units / s (FLOAT) |
| Troubleshooting: | Illegal axis identifier                                                                                 |

## **VER? Get Versions Of Firmware And Drivers**

*Used in:* Important Firmware Components (20)

|                  |                                                                                                                                      |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Description:     | Queries the version numbers of the firmware.                                                                                         |
| Long description | VER? also queries the version numbers of further components such as drivers and libraries.                                           |
| Format:          | <b>VER?</b>                                                                                                                          |
| Response:        | {<string1>:<string2> <sub>LF</sub> }<br><string1> Name of the component<br><string2> Version information and optional specifications |

## WAC Wait For Condition

*Used in: Analog Input Signals (75), Running the Macros (85)*

- Description: Waits until a condition is met.
- Long description WAC compares a specified value with a queried value according to a specified rule.  
Can only be used in macros.  
Possible relational operators:

| <OP> | Description           |
|------|-----------------------|
| =    | Equal                 |
| !=   | Not equal             |
| <=   | Smaller than or equal |
| <    | Smaller than          |
| >=   | Larger than or equal  |
| >    | Larger than           |

- Format: **WAC\_<CMD?>\_<OP>\_<Value>**
- Arguments:
- |         |                                                 |
|---------|-------------------------------------------------|
| <CMD?>  | Query command that responds with a single value |
| <OP>    | Relational operator                             |
| <Value> | Relational value with <CMD?>                    |

## WPA Save Parameters To Non-Volatile Memory

*Used in:* Parameter Commands (95)

**Description:** Writes the value of a parameter from the volatile memory (RAM) to the nonvolatile memory.

**Long description** WPA can also save parameter-independent settings. The used password determines what is saved with WPA:

| <Pswd> | Description                                                                                                                                                                      |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 100    | Saves current valid values of all parameters and the current valid settings for <a href="#">HDT (p. 127)</a> , <a href="#">HIA (p. 129)</a> , and <a href="#">HIT (p. 133)</a> . |
| 101    | Saves the currently valid values of all parameters.                                                                                                                              |
| HID    | Saves the current valid settings for <a href="#">HDT (p. 127)</a> , <a href="#">HIA (p. 129)</a> , and <a href="#">HIT (p. 133)</a> .                                            |

Wrong values can lead to faulty operation or damage to the hardware.

**Notice:** Note that the number of write cycles in the nonvolatile memory is limited. Therefore, save to the nonvolatile memory only when necessary.

**Format:** `WPA_<Pswd>[{_<ItemID>_<PamID>}]`

**Arguments:** `<Pswd>` Password for writing to the nonvolatile memory

`<ItemID>` Element of the electronics

`<PamID>` Parameter ID

The `<ItemID>` and `<PamID>` specifications are not supported by all electronics.

**Troubleshooting:** Impermissible element identifier

Wrong parameter ID

Wrong password

## 10 Parameter Reference

|            |                                                       |                                                                                                                                                                                                                                                                                                                                                                                     |
|------------|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>0x1</b> | P term                                                | Proportional constant of the PID servo algorithm. Is used for fast correction of the position error.<br>0 to 32767                                                                                                                                                                                                                                                                  |
| <b>0x2</b> | I term                                                | Integration constant of the PID servo algorithm. Used for reducing static position error.<br>0 to 32767                                                                                                                                                                                                                                                                             |
| <b>0x3</b> | D term                                                | Differential constant of the PID servo algorithm. Used for damping rapid control oscillation. The D term can be calculated as a floating average over several servo cycles. The parameter 0x71 (D-Term Delay) specifies how many values (i.e., servo cycles) are to be used for calculating the average.<br>0 to 32767<br>The preset value of this parameter should not be changed. |
| <b>0x4</b> | I limit                                               | Limit of the integration constant.<br>0 to 32767                                                                                                                                                                                                                                                                                                                                    |
| <b>0x5</b> | Kvff                                                  | Feed-forward control of the commanded velocity. Used for minimizing positioning error.<br>0 to 32767                                                                                                                                                                                                                                                                                |
| <b>0x8</b> | Maximum Position Error (Phys. Unit)                   | Maximum position error. Used by controllers that support a dynamic profile (parameter 0x1B < > 5) for detecting motion error.                                                                                                                                                                                                                                                       |
| <b>0xA</b> | Maximum Closed-Loop Velocity (Phys. Unit/s)           | Maximum velocity with dynamics profile in closed-loop operation. Specifies the maximum value for parameter 0x49.                                                                                                                                                                                                                                                                    |
| <b>0xB</b> | Closed-Loop Acceleration (Phys. Unit/s <sup>2</sup> ) | Acceleration with dynamics profile in closed-loop operation. Limited by parameter 0x4A.<br>0 to value of 0x4A [phys. units. / s <sup>2</sup> ]                                                                                                                                                                                                                                      |
| <b>0xC</b> | Closed-Loop Deceleration (Phys. Unit/s <sup>2</sup> ) | Deceleration with dynamics profile in closed-loop operation. Limited by parameter 0x4B.                                                                                                                                                                                                                                                                                             |

|             |                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>0xE</b>  | Numerator Of The Counts-Per-Physical-Unit Factor   | Numerator of the factor for converting impulses to physical units.<br>The factor for the counts per physical unit of length specifies the unit of length for position queries and motion commands in closed-loop operation. The values of every parameter, whose unit is either the physical unit of length itself or a unit of measurement based on it, are automatically adapted to the set factor. The factor for the counts per physical unit of length has no impact on the stability of the servo loop but is used for the input and output scaling of position values.<br>Decimal number   |
| <b>0xF</b>  | Denominator Of The Counts-Per-Physical-Unit Factor | Denominator of the factor for converting impulses to physical units.<br>The factor for the counts per physical unit of length specifies the unit of length for position queries and motion commands in closed-loop operation. The values of every parameter, whose unit is either the physical unit of length itself or a unit of measurement based on it, are automatically adapted to the set factor. The factor for the counts per physical unit of length has no impact on the stability of the servo loop but is used for the input and output scaling of position values.<br>Decimal number |
| <b>0x13</b> | Is Rotary Stage?                                   | Is this a rotation stage?<br>Is not evaluated by the electronics but instead by the PC software.<br>0 Not a rotation stage<br>1 Rotation stage                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>0x14</b> | Has Reference?                                     | Do the mechanics have a reference switch?<br>Activates respectively deactivates reference moves to the installed reference switch.<br>0 No reference switch<br>1 Reference switch available                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>0x15</b> | Maximum Travel In Positive Direction (Phys. Unit)  | Soft limit in positive direction, in relation to the zero position.<br>The positive travel range limit cannot be used for reference moves if this value is smaller than the position value for the positive travel range limit (that results from the sum of parameters 0x16 and 0x2F).<br>The value can be negative.                                                                                                                                                                                                                                                                             |
| <b>0x16</b> | Value At Reference Position (Phys. Unit)           | Position value at the reference switch.<br>The current position is set to this value if the axis has performed a reference move to the reference switch.<br>The parameter value is also used for calculating the position values set after reference moves to the limit switches; this also applies when the mechanics do not have a reference switch.                                                                                                                                                                                                                                            |

|             |                                                                 |                                                                                                                                                                                                                                                                                                                                     |
|-------------|-----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>0x17</b> | Distance From Negative Limit To Reference Position (Phys. Unit) | Gap between reference switch and negative travel range limit.<br>The current position is set to the difference between the values of parameters 0x16 and 0x17 if the axis has done a reference move to the negative travel range limit.                                                                                             |
| <b>0x18</b> | Limit Mode                                                      | Signal logic of the limit switches.<br>0 pos-HI, neg-HI<br>1 pos-LO, neg-HI<br>2 pos-HI, neg-LO<br>3 pos-LO, neg-LO                                                                                                                                                                                                                 |
| <b>0x1B</b> | Profile mode                                                    | Type of dynamics profile                                                                                                                                                                                                                                                                                                            |
| <b>0x2F</b> | Distance From Reference Position To Positive Limit (Phys. Unit) | Gap between the reference switch and the positive travel range limit.<br>If the axis has done a reference move to the positive travel range limit, the current position is set to the sum of the values of parameters 0x16 and 0x2F.                                                                                                |
| <b>0x30</b> | Maximum Travel In Negative Direction (Phys. Unit)               | Soft limit in a negative direction, in relation to the zero position.<br>The negative travel range limit cannot be used for reference moves if this value is greater than the position value for the negative travel range limit (that results from the difference between parameters 0x16 and 0x17).<br>The value can be negative. |
| <b>0x31</b> | Invert Reference?                                               | Should the reference signal be inverted?<br>Inverts the signal of the reference switch or a digital input that is used instead of the reference switch.<br>0 Reference signal not inverted<br>1 Reference signal inverted                                                                                                           |
| <b>0x32</b> | Has No Limit Switches?                                          | Do the mechanics not have limit switches?<br>Activates motion stop at the installed limit switches.<br>0 Mechanics have limit switches<br>1 Mechanics do not have limit switches                                                                                                                                                    |
| <b>0x33</b> | Motor Offset Positive                                           | Drive offset for the positive direction of motion.<br>0 to 32766                                                                                                                                                                                                                                                                    |
| <b>0x34</b> | Motor Offset Negative                                           | Drive offset for the negative direction of motion.<br>0 to 32766                                                                                                                                                                                                                                                                    |
| <b>0x36</b> | Settling Window (Encoder Counts)                                | Settling window around the target position.<br>Presets the window limits (half of the window width). If the current position exits the settling window, the target position is no longer considered as reached.<br>Can be changed only if the servo mode is switched off.<br>0 to 231 [encoder counts]                              |

|             |                                                               |                                                                                                                                                                       |
|-------------|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>0x3C</b> | Stage Name                                                    | Positioner name.<br>Default value: NOSTAGE<br>String up to 20 characters                                                                                              |
| <b>0x3F</b> | Settling Time (s)                                             | Delay time for setting the on-target state.<br>0.000 to 1.000 [s]                                                                                                     |
| <b>0x47</b> | Reference Travel Direction                                    | Default direction for the reference move.<br>0 Automatic detection<br>1 Negative direction<br>2 Positive direction                                                    |
| <b>0x48</b> | Motor Drive Offset                                            | Velocity-dependent drive offset.<br>Used if the commanded velocity does not equal zero (i.e., if the end of the dynamics profile has not been reached).<br>0 to 32766 |
| <b>0x49</b> | Closed-Loop Velocity (Phys. Unit/s)                           | Velocity in closed-loop operation with dynamics profile.<br>Limited by parameter 0xA.<br>0 to value of 0xA [phys. units / s]                                          |
| <b>0x4A</b> | Maximum Closed-Loop Acceleration (Phys. Unit/s <sup>2</sup> ) | Maximum acceleration in closed-loop operation with dynamics profile.<br>Specifies the maximum value for parameter 0xB.                                                |
| <b>0x4B</b> | Maximum Closed-Loop Deceleration (Phys. Unit/s <sup>2</sup> ) | Maximum deceleration in closed-loop operation with dynamics profile.<br>Specifies the maximum value for parameter 0xC.                                                |
| <b>0x50</b> | Velocity For Reference Moves (Phys. Unit/s)                   | Maximum velocity for reference moves.<br>0 to value of value 0x49 [phys. units / s]                                                                                   |
| <b>0x5A</b> | Numerator Of The Servo Loop Input Factor                      | Input factor numerator for the servo loop.<br>Decimal number                                                                                                          |
| <b>0x5B</b> | Denominator Of The Servo Loop Input Factor                    | Input factor denominator for the servo loop.<br>Decimal number                                                                                                        |
| <b>0x5C</b> | Source Of Reference Signal                                    | Reference signal source for reference moves.<br>Decimal number, digital input lines bit-mapped                                                                        |
| <b>0x5D</b> | Source Of Negative Limit Signal                               | Signal source for the negative limit switch.<br>Decimal number, digital input lines bit-mapped                                                                        |
| <b>0x5E</b> | Source Of Positive Limit Signal                               | Signal source for the positive limit switch.<br>Decimal number, digital input lines bit-mapped                                                                        |
| <b>0x5F</b> | Invert Digital Input Used For Negative Limit                  | Inverts the signal logic of the digital inputs that serve as sources of the negative limit switch signal.<br>Decimal number, digital input lines bit-mapped           |
| <b>0x60</b> | Invert Digital Input Used For Positive Limit                  | Inverts the signal logic of the digital inputs used as the source of the positive limit switch signal.<br>Decimal number, digital input lines bit-mapped              |
| <b>0x61</b> | Invert Direction Of Motion For Joystick-Controlled Axis?      | Inverts the direction of motion for HID-controlled axes.<br>0 Direction of motion not inverted (default)<br>1 Direction of motion inverted                            |

|                  |                                                         |                                                                                                                                                                                                                                                                           |
|------------------|---------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>0x63</b>      | Distance Between Limit And Hard Stop (Phys. Unit)       | Gap between internal limit switch and hard stop. Determines the maximum stopping distance during reference moves. The actual velocities during a reference move are calculated on the basis of this value, the set deceleration (0xC) and set velocities (0x49 and 0x50). |
| <b>0x70</b>      | Reference Signal Type                                   | Reference signal type.                                                                                                                                                                                                                                                    |
| <b>0x71</b>      | D Term Delay (No. Of Servo Cycles)                      | D term delay.<br>Determines how many values (i.e., servo cycles) are used for calculating the mean value of the D term.<br>The preset value of this parameter should not be changed.                                                                                      |
| <b>0x72</b>      | Ignore Macro Error?                                     | Ignore macro error?<br>0 Stop macro on error (default)<br>1 Ignore error                                                                                                                                                                                                  |
| <b>0x77</b>      | Use Limit Switches Only For Reference Moves?            | Should the limit switches only be used for reference moves?<br>Is intended for use with rotation stages.<br>Only evaluated when parameter 0x32 has the value 0.                                                                                                           |
| <b>0x78</b>      | Distance From Limit To Start Of Ref Search (Phys. Unit) | Gap between the limit switch and the starting position for the reference move to the index pulse.<br>Used for FRF when parameter 0x70 has the value 2.                                                                                                                    |
| <b>0x79</b>      | Distance For Reference Search (Phys. Unit)              | Maximum distance for motion to the index pulse.                                                                                                                                                                                                                           |
| <b>0x7A</b>      | Use Hard Stops For Referencing?                         | Should the hard stops be used for reference moves?                                                                                                                                                                                                                        |
| <b>0x94</b>      | Notch Filter Frequency 1 (Hz)                           | Frequency of the first notch filter.<br>The appropriate frequency component is reduced in the control value to compensate for undesired resonances in the mechanics.<br>40 to 20,000 [Hz]                                                                                 |
| <b>0x95</b>      | Notch Filter Edge 1                                     | Edge steepness of the first notch filter.<br>The greater the value of this parameter, the narrower the notch filter bandwidth.<br>0.1 to 10 (dimensionless)                                                                                                               |
| <b>0x3003300</b> | Sensor Interpolation                                    | Interpolation rate for the signals of the incremental sensor.                                                                                                                                                                                                             |
| <b>0x3003301</b> | Sensor Hysteresis (Deg)                                 | Correction of the hysteresis of the incremental sensor.                                                                                                                                                                                                                   |
| <b>0x3003302</b> | Sensor Board Gain                                       | Gain value for correcting the digitized signals of the incremental sensor.                                                                                                                                                                                                |
| <b>0x3003303</b> | Sensor Digital Offset 0 (V)                             | Offset 0 for correcting the digitized signals of the incremental sensor.                                                                                                                                                                                                  |

|                   |                                  |                                                                                                                                                                                                                                                                                                                            |
|-------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>0x3003304</b>  | Sensor Digital Offset 1 (V)      | Offset 1 for correcting the digitized signals of the incremental sensor.                                                                                                                                                                                                                                                   |
| <b>0x3003305</b>  | Sensor Digital Phase (Deg)       | Phase correction for the signals of the incremental sensor.                                                                                                                                                                                                                                                                |
| <b>0x3003306</b>  | Sensor Analog Gain (dB)          | Gain value for correcting the analog signals of the incremental sensor.                                                                                                                                                                                                                                                    |
| <b>0x3003307</b>  | Sensor Analog Offset 0 (V)       | Offset 0 for correcting the analog signals of the incremental sensor.                                                                                                                                                                                                                                                      |
| <b>0x3003308</b>  | Sensor Analog Offset 1 (V)       | Offset 1 for correcting the analog signals of the incremental sensor.                                                                                                                                                                                                                                                      |
| <b>0x7000601</b>  | Axis Unit                        | <p>Unit symbol.<br/>For example, the unit symbol is "mm" if the factor for the counts per physical unit of length is set with parameters 0xE and 0xF so that the encoder counts are converted into millimeters. The unit symbol for rotation stages is normally "deg".</p> <p>Examples:<br/>String up to 20 characters</p> |
| <b>0xD000000</b>  | Controller Device S/N            | Serial number of the electronics.                                                                                                                                                                                                                                                                                          |
| <b>0xE000200</b>  | Servo Update Time                | Servo cycle time.                                                                                                                                                                                                                                                                                                          |
| <b>0xF000100</b>  | Stage Type                       | Mechanics type.<br>x-xxx default positioners<br>x-xxxKxxx customized positioners                                                                                                                                                                                                                                           |
| <b>0xF000200</b>  | Stage Serial Number              | Serial number of the mechanics.<br>9-digit number                                                                                                                                                                                                                                                                          |
| <b>0xF000300</b>  | Stage Assembly Date              | Manufacturing date of the mechanics.<br>Date in TTMMJJ format                                                                                                                                                                                                                                                              |
| <b>0xF000400</b>  | Stage HW Version                 | Version number of the mechanics hardware.                                                                                                                                                                                                                                                                                  |
| <b>0x16000001</b> | Recorded Points Per Trigger      | Number of data points recorded per trigger impulse.<br>0 Unlimited (default)<br>n>0 n data points are recorded                                                                                                                                                                                                             |
| <b>0x1F000000</b> | PIShift Upper Supply Voltage (V) | Maximum output voltage for piezo inertia drives.<br>The value depends on the type of the drive.                                                                                                                                                                                                                            |
| <b>0x1F000100</b> | PIShift Lower Supply Voltage (V) | Minimum output voltage for piezo inertia drives.<br>The value depends on the type of the drive.                                                                                                                                                                                                                            |
| <b>0x1F000200</b> | PIShift Forward Current (A)      | Maximum output current for piezo inertia drives during forward motion.<br>The value depends on the type of the drive.                                                                                                                                                                                                      |
| <b>0x1F000300</b> | PIShift Backward Current (A)     | Maximum output current for piezo inertia drives during backward motion.<br>The value depends on the type of the drive.                                                                                                                                                                                                     |

|                   |                                |                                                                                                                                                                                                  |
|-------------------|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>0x1F000500</b> | PIShift Charge Cycle           | Duty cycle of the current source during output of a step.<br>Specified as part of a period which the current source is switched on for.<br>0 to 1<br>The value depends on the type of the drive. |
| <b>0x1F000700</b> | PIShift Step Size (Phys. Unit) | Size of the slow individual steps in closed-loop operation                                                                                                                                       |
| <b>0x1F000701</b> | PIShift Delay (ms)             | Delay time when switching between two operating modes (e.g., step mode and linear mode).<br>0 to 2000 [ms]                                                                                       |
| <b>0x1F000703</b> | PIShift Offset Current (A)     | Offset current in open-loop operation<br>- 0.05 to 0.05<br>The preset value should not be changed.                                                                                               |

## 0x1 P term

*Used in: Settings for the servo algorithm (34)*

|                 |                                                                                                         |
|-----------------|---------------------------------------------------------------------------------------------------------|
| Description:    | Proportional constant of the PID servo algorithm.<br>Is used for fast correction of the position error. |
| Data type       | INT                                                                                                     |
| Command level   | 0                                                                                                       |
| Item type       | Axis                                                                                                    |
| Source of data  | Positioner database                                                                                     |
| Possible values | 0 to 32767                                                                                              |

## 0x2 I term

*Used in: Settings for the servo algorithm (34)*

|                 |                                                                                              |
|-----------------|----------------------------------------------------------------------------------------------|
| Description:    | Integration constant of the PID servo algorithm.<br>Used for reducing static position error. |
| Data type       | INT                                                                                          |
| Command level   | 0                                                                                            |
| Item type       | Axis                                                                                         |
| Source of data  | Positioner database                                                                          |
| Possible values | 0 to 32767                                                                                   |

## Ox3 D term

*Used in: Settings for the servo algorithm (34)*

|                 |                                                                                                                                                                                                                                                                                                                                         |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Differential constant of the PID servo algorithm.<br>Used for damping rapid control oscillation.<br>The D term can be calculated as a floating average over several servo cycles. The parameter <a href="#">0x71 (p. 187)</a> (D-Term Delay) specifies how many values (i.e., servo cycles) are to be used for calculating the average. |
| Data type       | INT                                                                                                                                                                                                                                                                                                                                     |
| Command level   | 0                                                                                                                                                                                                                                                                                                                                       |
| Item type       | Axis                                                                                                                                                                                                                                                                                                                                    |
| Source of data  | Positioner database                                                                                                                                                                                                                                                                                                                     |
| Possible values | 0 to 32767<br>The preset value of this parameter should not be changed.                                                                                                                                                                                                                                                                 |

## Ox4 I limit

*Used in: Settings for the servo algorithm (34)*

|                 |                                    |
|-----------------|------------------------------------|
| Description:    | Limit of the integration constant. |
| Data type       | INT                                |
| Command level   | 0                                  |
| Item type       | Axis                               |
| Source of data  | Positioner database                |
| Possible values | 0 to 32767                         |

## 0x5 Kvff

|                 |                                                                                           |
|-----------------|-------------------------------------------------------------------------------------------|
| Description:    | Feed-forward control of the commanded velocity.<br>Used for minimizing positioning error. |
| Data type       | INT                                                                                       |
| Command level   | 0                                                                                         |
| Item type       | Axis                                                                                      |
| Source of data  | Positioner database                                                                       |
| Possible values | 0 to 32767                                                                                |

## 0x8 Maximum Position Error (Phys. Unit)

*Used in: Behavior with Motion Errors (72)*

|                |                                                                                                                                                           |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:   | Maximum position error.<br>Used by controllers that support a dynamic profile (parameter <a href="#">0x1B (p. 177)</a> < > 5) for detecting motion error. |
| Data type      | FLOAT                                                                                                                                                     |
| Command level  | 0                                                                                                                                                         |
| Item type      | Axis                                                                                                                                                      |
| Source of data | Positioner database                                                                                                                                       |

## 0xA Maximum Closed-Loop Velocity (Phys. Unit/s)

*Used in: (30)*

|                |                                                                                                                                               |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Description:   | Maximum velocity with dynamics profile in closed-loop operation.<br>Specifies the maximum value for parameter <a href="#">0x49 (p. 181)</a> . |
| Data type      | FLOAT                                                                                                                                         |
| Command level  | 0                                                                                                                                             |
| Item type      | Axis                                                                                                                                          |
| Source of data | Positioner database                                                                                                                           |

## OxB Closed-Loop Acceleration (Phys. Unit/s<sup>2</sup>)

*Used in:* (30)

|                 |                                                                                                                      |
|-----------------|----------------------------------------------------------------------------------------------------------------------|
| Description:    | Acceleration with dynamics profile in closed-loop operation.<br>Limited by parameter <a href="#">0x4A (p. 182)</a> . |
| Data type       | FLOAT                                                                                                                |
| Command level   | 0                                                                                                                    |
| Item type       | Axis                                                                                                                 |
| Source of data  | Positioner database                                                                                                  |
| Possible values | 0 to value of 0x4A [phys. units. / s <sup>2</sup> ]                                                                  |

## OxC Closed-Loop Deceleration (Phys. Unit/s<sup>2</sup>)

*Used in:* (30), *Reference Move Procedures* (40)

|                |                                                                                                                      |
|----------------|----------------------------------------------------------------------------------------------------------------------|
| Description:   | Deceleration with dynamics profile in closed-loop operation.<br>Limited by parameter <a href="#">0x4B (p. 182)</a> . |
| Data type      | FLOAT                                                                                                                |
| Command level  | 0                                                                                                                    |
| Item type      | Axis                                                                                                                 |
| Source of data | Positioner database                                                                                                  |

## OxE Numerator Of The Counts-Per-Physical-Unit Factor

|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Numerator of the factor for converting impulses to physical units. The factor for the counts per physical unit of length specifies the unit of length for position queries and motion commands in closed-loop operation. The values of every parameter, whose unit is either the physical unit of length itself or a unit of measurement based on it, are automatically adapted to the set factor. The factor for the counts per physical unit of length has no impact on the stability of the servo loop but is used for the input and output scaling of position values. |
| Data type       | INT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Command level   | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Item type       | Axis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Source of data  | Positioner database                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Possible values | Decimal number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

## OxF Denominator Of The Counts-Per-Physical-Unit Factor

|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Denominator of the factor for converting impulses to physical units. The factor for the counts per physical unit of length specifies the unit of length for position queries and motion commands in closed-loop operation. The values of every parameter, whose unit is either the physical unit of length itself or a unit of measurement based on it, are automatically adapted to the set factor. The factor for the counts per physical unit of length has no impact on the stability of the servo loop but is used for the input and output scaling of position values. |
| Data type       | INT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Command level   | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Item type       | Axis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Source of data  | Positioner database                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Possible values | Decimal number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Ox13 Is Rotary Stage?

|                 |                                                                                                  |
|-----------------|--------------------------------------------------------------------------------------------------|
| Description:    | Is this a rotation stage?<br>Is not evaluated by the electronics but instead by the PC software. |
| Data type       | INT                                                                                              |
| Command level   | 0                                                                                                |
| Item type       | Axis                                                                                             |
| Source of data  | Positioner database                                                                              |
| Possible values | 0 Not a rotation stage<br>1 Rotation stage                                                       |

## Ox14 Has Reference?

*Used in: Reference Switch Detection (37)*

|                 |                                                                                                                                    |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Do the mechanics have a reference switch?<br>Activates respectively deactivates reference moves to the installed reference switch. |
| Data type       | INT                                                                                                                                |
| Command level   | 0                                                                                                                                  |
| Item type       | Axis                                                                                                                               |
| Source of data  | Positioner database                                                                                                                |
| Possible values | 0 No reference switch<br>1 Reference switch available                                                                              |

## Ox15 Maximum Travel In Positive Direction (Phys. Unit)

*Used in: Settings for the soft limits (38)*

|                 |                                                                                                                                                                                                                                                                                                                                            |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Soft limit in positive direction, in relation to the zero position.<br>The positive travel range limit cannot be used for reference moves if this value is smaller than the position value for the positive travel range limit (that results from the sum of parameters <a href="#">0x16 (p. 175)</a> and <a href="#">0x2F (p. 177)</a> ). |
| Data type       | FLOAT                                                                                                                                                                                                                                                                                                                                      |
| Command level   | 0                                                                                                                                                                                                                                                                                                                                          |
| Item type       | Axis                                                                                                                                                                                                                                                                                                                                       |
| Source of data  | Positioner database                                                                                                                                                                                                                                                                                                                        |
| Possible values | The value can be negative.                                                                                                                                                                                                                                                                                                                 |

## Ox16 Value At Reference Position (Phys. Unit)

*Used in: Settings for the travel range (38)*

|                |                                                                                                                                                                                                                                                                                                                                                        |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:   | Position value at the reference switch.<br>The current position is set to this value if the axis has performed a reference move to the reference switch.<br>The parameter value is also used for calculating the position values set after reference moves to the limit switches; this also applies when the mechanics do not have a reference switch. |
| Data type      | FLOAT                                                                                                                                                                                                                                                                                                                                                  |
| Command level  | 0                                                                                                                                                                                                                                                                                                                                                      |
| Item type      | Axis                                                                                                                                                                                                                                                                                                                                                   |
| Source of data | Positioner database                                                                                                                                                                                                                                                                                                                                    |

## Ox17 Distance From Negative Limit To Reference Position (Phys. Unit)

*Used in: Settings for the travel range (38)*

|                |                                                                                                                                                                                                                                                                                           |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:   | Gap between reference switch and negative travel range limit.<br>The current position is set to the difference between the values of parameters <a href="#">0x16 (p. 175)</a> and <a href="#">0x17 (p. 176)</a> if the axis has done a reference move to the negative travel range limit. |
| Data type      | FLOAT                                                                                                                                                                                                                                                                                     |
| Command level  | 0                                                                                                                                                                                                                                                                                         |
| Item type      | Axis                                                                                                                                                                                                                                                                                      |
| Source of data | Positioner database                                                                                                                                                                                                                                                                       |

## Ox18 Limit Mode

*Used in: Limit Switch Detection (37)*

|                 |                                                                              |
|-----------------|------------------------------------------------------------------------------|
| Description:    | Signal logic of the limit switches.                                          |
| Data type       | INT                                                                          |
| Command level   | 0                                                                            |
| Item type       | Axis                                                                         |
| Source of data  | Positioner database                                                          |
| Possible values | 0 pos-HI, neg-HI<br>1 pos-LO, neg-HI<br>2 pos-HI, neg-LO<br>3 pos-LO, neg-LO |

## Ox1B Profile Mode

Description: Type of dynamics profile

Data type INT

Command level 0

Item type Axis

Source of data Positioner database

Possible values

0 Trapezoidal dynamics profile

5 Without dynamics profile

## Ox2F Distance From Reference Position To Positive Limit (Phys. Unit)

Used in: *Settings for the travel range (38)*

Description: Gap between the reference switch and the positive travel range limit.

If the axis has done a reference move to the positive travel range limit, the current position is set to the sum of the values of parameters [Ox16 \(p. 175\)](#) and [Ox2F \(p. 177\)](#).

Data type FLOAT

Command level 0

Item type Axis

Source of data Positioner database

## Ox30 Maximum Travel In Negative Direction (Phys. Unit)

*Used in: Settings for the soft limits (38)*

|                 |                                                                                                                                                                                                                                                                                                                                                          |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Soft limit in a negative direction, in relation to the zero position.<br>The negative travel range limit cannot be used for reference moves if this value is greater than the position value for the negative travel range limit (that results from the difference between parameters <a href="#">0x16 (p. 175)</a> and <a href="#">0x17 (p. 176)</a> ). |
| Data type       | FLOAT                                                                                                                                                                                                                                                                                                                                                    |
| Command level   | 0                                                                                                                                                                                                                                                                                                                                                        |
| Item type       | Axis                                                                                                                                                                                                                                                                                                                                                     |
| Source of data  | Positioner database                                                                                                                                                                                                                                                                                                                                      |
| Possible values | The value can be negative.                                                                                                                                                                                                                                                                                                                               |

## Ox31 Invert Reference?

*Used in: Reference Switch Detection (37)*

|                 |                                                                                                                                                         |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Should the reference signal be inverted?<br>Inverts the signal of the reference switch or a digital input that is used instead of the reference switch. |
| Data type       | INT                                                                                                                                                     |
| Command level   | 0                                                                                                                                                       |
| Item type       | Axis                                                                                                                                                    |
| Source of data  | Positioner database                                                                                                                                     |
| Possible values | 0 Reference signal not inverted<br>1 Reference signal inverted                                                                                          |

## Ox32 Has No Limit Switches?

*Used in: Limit Switch Detection (37)*

|                 |                                                                                                     |
|-----------------|-----------------------------------------------------------------------------------------------------|
| Description:    | Do the mechanics not have limit switches?<br>Activates motion stop at the installed limit switches. |
| Data type       | INT                                                                                                 |
| Command level   | 0                                                                                                   |
| Item type       | Axis                                                                                                |
| Source of data  | Positioner database                                                                                 |
| Possible values | 0 Mechanics have limit switches<br>1 Mechanics do not have limit switches                           |

## Ox33 Motor Offset Positive

|                 |                                                    |
|-----------------|----------------------------------------------------|
| Description:    | Drive offset for the positive direction of motion. |
| Data type       | INT                                                |
| Command level   | 0                                                  |
| Item type       | Axis                                               |
| Source of data  | Positioner database                                |
| Possible values | 0 to 32766                                         |

## Ox34 Motor Offset Negative

|                 |                                                    |
|-----------------|----------------------------------------------------|
| Description:    | Drive offset for the negative direction of motion. |
| Data type       | INT                                                |
| Command level   | 0                                                  |
| Item type       | Axis                                               |
| Source of data  | Positioner database                                |
| Possible values | 0 to 32766                                         |

## Ox36 Settling Window (Encoder Counts)

*Used in: On-Target State (36)*

|                 |                                                                                                                                                                                                                                                                           |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Settling window around the target position.<br>Presets the window limits (half of the window width). If the current position exits the settling window, the target position is no longer considered as reached.<br>Can be changed only if the servo mode is switched off. |
| Data type       | INT                                                                                                                                                                                                                                                                       |
| Command level   | 0                                                                                                                                                                                                                                                                         |
| Item type       | Axis                                                                                                                                                                                                                                                                      |
| Source of data  | Positioner database                                                                                                                                                                                                                                                       |
| Possible values | 0 to $2^{31}$ [encoder counts]                                                                                                                                                                                                                                            |

## Ox3C Stage Name

*Used in: (23)*

|                 |                                            |
|-----------------|--------------------------------------------|
| Description:    | Positioner name.<br>Default value: NOSTAGE |
| Data type       | CHAR                                       |
| Command level   | 0                                          |
| Item type       | Axis                                       |
| Source of data  | Positioner database                        |
| Possible values | String up to 20 characters                 |

## Ox3F Settling Time (s)

*Used in: On-Target State (36)*

|                 |                                             |
|-----------------|---------------------------------------------|
| Description:    | Delay time for setting the on-target state. |
| Data type       | FLOAT                                       |
| Command level   | 0                                           |
| Item type       | Axis                                        |
| Source of data  | Positioner database                         |
| Possible values | 0.000 to 1.000 [s]                          |

## Ox47 Reference Travel Direction

*Used in:* Reference Move Procedures (40)

|                 |                                                                       |
|-----------------|-----------------------------------------------------------------------|
| Description:    | Default direction for the reference move.                             |
| Data type       | INT                                                                   |
| Command level   | 0                                                                     |
| Item type       | Axis                                                                  |
| Source of data  | Positioner database                                                   |
| Possible values | 0 Automatic detection<br>1 Negative direction<br>2 Positive direction |

## Ox48 Motor Drive Offset

|                 |                                                                                                                                                         |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Velocity-dependent drive offset.<br>Used if the commanded velocity does not equal zero (i.e., if the end of the dynamics profile has not been reached). |
| Data type       | INT                                                                                                                                                     |
| Command level   | 0                                                                                                                                                       |
| Item type       | Axis                                                                                                                                                    |
| Source of data  | Positioner database                                                                                                                                     |
| Possible values | 0 to 32766                                                                                                                                              |

## Ox49 Closed-Loop Velocity (Phys. Unit/s)

*Used in:* (30), Reference Move Procedures (40)

|                 |                                                                                                                 |
|-----------------|-----------------------------------------------------------------------------------------------------------------|
| Description:    | Velocity in closed-loop operation with dynamics profile.<br>Limited by parameter <a href="#">OxA (p. 171)</a> . |
| Data type       | FLOAT                                                                                                           |
| Command level   | 0                                                                                                               |
| Item type       | Axis                                                                                                            |
| Source of data  | Positioner database                                                                                             |
| Possible values | 0 to value of <a href="#">OxA (p. 171)</a> [phys. units / s]                                                    |

## **Ox4A Maximum Closed-Loop Acceleration (Phys. Unit/s<sup>2</sup>)**

*Used in:* (30)

## **Ox4B Maximum Closed-Loop Deceleration (Phys. Unit/s<sup>2</sup>)**

*Used in:* (30)

## **Ox50 Velocity For Reference Moves (Phys. Unit/s)**

*Used in:* Reference Move Procedures (40)

|                 |                                                                     |
|-----------------|---------------------------------------------------------------------|
| Description:    | Maximum velocity for reference moves.                               |
| Data type       | FLOAT                                                               |
| Command level   | 0                                                                   |
| Item type       | Axis                                                                |
| Source of data  | Positioner database                                                 |
| Possible values | 0 to value of value <a href="#">Ox49 (p. 181)</a> [phys. units / s] |

## **Ox5A Numerator Of The Servo-Loop Input Factor**

*Used in:* Settings for the servo algorithm (34)

|                 |                                            |
|-----------------|--------------------------------------------|
| Description:    | Input factor numerator for the servo loop. |
| Data type       | INT                                        |
| Command level   | 0                                          |
| Item type       | Axis                                       |
| Source of data  | Positioner database                        |
| Possible values | Decimal number                             |

## 0x5B Denominator Of The Servo-Loop Input Factor

*Used in: Settings for the servo algorithm (34)*

|                 |                                              |
|-----------------|----------------------------------------------|
| Description:    | Input factor denominator for the servo loop. |
| Data type       | INT                                          |
| Command level   | 0                                            |
| Item type       | Axis                                         |
| Source of data  | Positioner database                          |
| Possible values | Decimal number                               |

## 0x5C Source Of Reference Signal

|                 |                                                |
|-----------------|------------------------------------------------|
| Description:    | Reference signal source for reference moves.   |
| Data type       | INT                                            |
| Command level   | 0                                              |
| Item type       | Axis                                           |
| Source of data  | Positioner database                            |
| Possible values | Decimal number, digital input lines bit-mapped |

## 0x5D Source Of Negative Limit Signal

|                 |                                                |
|-----------------|------------------------------------------------|
| Description:    | Signal source for the negative limit switch.   |
| Data type       | INT                                            |
| Command level   | 0                                              |
| Item type       | Axis                                           |
| Source of data  | Positioner database                            |
| Possible values | Decimal number, digital input lines bit-mapped |

## 0x5E Source Of Positive Limit Signal

|                 |                                                |
|-----------------|------------------------------------------------|
| Description:    | Signal source for the positive limit switch.   |
| Data type       | INT                                            |
| Command level   | 0                                              |
| Item type       | Axis                                           |
| Source of data  | Positioner database                            |
| Possible values | Decimal number, digital input lines bit-mapped |

## 0x5F Invert Digital Input Used For Negative Limit

|                 |                                                                                                           |
|-----------------|-----------------------------------------------------------------------------------------------------------|
| Description:    | Inverts the signal logic of the digital inputs that serve as sources of the negative limit switch signal. |
| Data type       | INT                                                                                                       |
| Command level   | 0                                                                                                         |
| Item type       | Axis                                                                                                      |
| Source of data  | Positioner database                                                                                       |
| Possible values | Decimal number, digital input lines bit-mapped                                                            |

## 0x60 Invert Digital Input Used For Positive Limit

|                 |                                                                                                        |
|-----------------|--------------------------------------------------------------------------------------------------------|
| Description:    | Inverts the signal logic of the digital inputs used as the source of the positive limit switch signal. |
| Data type       | INT                                                                                                    |
| Command level   | 0                                                                                                      |
| Item type       | Axis                                                                                                   |
| Source of data  | Positioner database                                                                                    |
| Possible values | Decimal number, digital input lines bit-mapped                                                         |

## 0x61 Invert Direction Of Motion For Joystick-Controlled Axis?

*Used in: HID Control Configuration (77)*

|                 |                                                                                |
|-----------------|--------------------------------------------------------------------------------|
| Description:    | Inverts the direction of motion for HID-controlled axes.                       |
| Data type       | INT                                                                            |
| Command level   | 0                                                                              |
| Item type       | Axis                                                                           |
| Source of data  | Positioner database                                                            |
| Possible values | 0 Direction of motion not inverted (default)<br>1 Direction of motion inverted |

## 0x63 Distance Between Limit And Hard Stop (Phys. Unit)

*Used in: Reference Move Procedures (40)*

|                |                                                                                                                                                                                                                                                                                                                                                             |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:   | Gap between internal limit switch and hard stop.<br>Determines the maximum stopping distance during reference moves. The actual velocities during a reference move are calculated on the basis of this value, the set deceleration ( <a href="#">0xC (p. 172)</a> ) and set velocities ( <a href="#">0x49 (p. 181)</a> and <a href="#">0x50 (p. 182)</a> ). |
| Data type      | FLOAT                                                                                                                                                                                                                                                                                                                                                       |
| Command level  | 0                                                                                                                                                                                                                                                                                                                                                           |
| Item type      | Axis                                                                                                                                                                                                                                                                                                                                                        |
| Source of data | Positioner database                                                                                                                                                                                                                                                                                                                                         |

## Ox70 Reference Signal Type

*Used in: Reference Move Procedures (40), Reference point definition options (40), Reference Switch Detection (37)*

Description: Reference signal type.

Data type INT

Command level 0

Item type Axis

Source of data Positioner database

|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                                                                                                   |   |                                                                                                                     |   |                                                                                        |   |                                                                                        |   |                                                                                                           |   |                                                                                                                                                                                                |   |                                                                                                                                                                                                |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---------------------------------------------------------------------------------------------------|---|---------------------------------------------------------------------------------------------------------------------|---|----------------------------------------------------------------------------------------|---|----------------------------------------------------------------------------------------|---|-----------------------------------------------------------------------------------------------------------|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Possible values | <table border="1"><tr><td>0</td><td>Direction-sensing reference switch<br/>The signal level changes when passing the reference switch.</td></tr><tr><td>1</td><td>Pulse signal (pulse width of several nanoseconds)<br/>Parameter <a href="#">0x47 (p. 181)</a> must be correctly set.</td></tr><tr><td>2</td><td>Index pulse<br/>The reference switch is approached via the negative travel range limit.</td></tr><tr><td>3</td><td>Index pulse<br/>The reference switch is approached via the positive travel range limit.</td></tr><tr><td>4</td><td>No reference signal<br/>Is only evaluated by the electronics that do not support the FNL and FPL commands.</td></tr><tr><td>5</td><td>The reference move is made to the negative limit switch or hard stop; this is set as reference position.<br/>Is only evaluated by the electronics that do not support the FNL and FPL commands.</td></tr><tr><td>6</td><td>The reference move is made to the positive limit switch or hard stop; this is set as reference position.<br/>Is only evaluated by the electronics that do not support the FNL and FPL commands.</td></tr></table> | 0 | Direction-sensing reference switch<br>The signal level changes when passing the reference switch. | 1 | Pulse signal (pulse width of several nanoseconds)<br>Parameter <a href="#">0x47 (p. 181)</a> must be correctly set. | 2 | Index pulse<br>The reference switch is approached via the negative travel range limit. | 3 | Index pulse<br>The reference switch is approached via the positive travel range limit. | 4 | No reference signal<br>Is only evaluated by the electronics that do not support the FNL and FPL commands. | 5 | The reference move is made to the negative limit switch or hard stop; this is set as reference position.<br>Is only evaluated by the electronics that do not support the FNL and FPL commands. | 6 | The reference move is made to the positive limit switch or hard stop; this is set as reference position.<br>Is only evaluated by the electronics that do not support the FNL and FPL commands. |
| 0               | Direction-sensing reference switch<br>The signal level changes when passing the reference switch.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |                                                                                                   |   |                                                                                                                     |   |                                                                                        |   |                                                                                        |   |                                                                                                           |   |                                                                                                                                                                                                |   |                                                                                                                                                                                                |
| 1               | Pulse signal (pulse width of several nanoseconds)<br>Parameter <a href="#">0x47 (p. 181)</a> must be correctly set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                                                                                                   |   |                                                                                                                     |   |                                                                                        |   |                                                                                        |   |                                                                                                           |   |                                                                                                                                                                                                |   |                                                                                                                                                                                                |
| 2               | Index pulse<br>The reference switch is approached via the negative travel range limit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                                                                                                   |   |                                                                                                                     |   |                                                                                        |   |                                                                                        |   |                                                                                                           |   |                                                                                                                                                                                                |   |                                                                                                                                                                                                |
| 3               | Index pulse<br>The reference switch is approached via the positive travel range limit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   |                                                                                                   |   |                                                                                                                     |   |                                                                                        |   |                                                                                        |   |                                                                                                           |   |                                                                                                                                                                                                |   |                                                                                                                                                                                                |
| 4               | No reference signal<br>Is only evaluated by the electronics that do not support the FNL and FPL commands.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                                                                                                   |   |                                                                                                                     |   |                                                                                        |   |                                                                                        |   |                                                                                                           |   |                                                                                                                                                                                                |   |                                                                                                                                                                                                |
| 5               | The reference move is made to the negative limit switch or hard stop; this is set as reference position.<br>Is only evaluated by the electronics that do not support the FNL and FPL commands.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                                                                                                   |   |                                                                                                                     |   |                                                                                        |   |                                                                                        |   |                                                                                                           |   |                                                                                                                                                                                                |   |                                                                                                                                                                                                |
| 6               | The reference move is made to the positive limit switch or hard stop; this is set as reference position.<br>Is only evaluated by the electronics that do not support the FNL and FPL commands.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                                                                                                   |   |                                                                                                                     |   |                                                                                        |   |                                                                                        |   |                                                                                                           |   |                                                                                                                                                                                                |   |                                                                                                                                                                                                |

## 0x71 D-Term Delay (No. Of Servo Cycles)

*Used in: Settings for the servo algorithm (34)*

|                 |                                                                                                                         |
|-----------------|-------------------------------------------------------------------------------------------------------------------------|
| Description:    | D term delay.<br>Determines how many values (i.e., servo cycles) are used for calculating the mean value of the D term. |
| Data type       | INT                                                                                                                     |
| Command level   | 0                                                                                                                       |
| Item type       | Axis                                                                                                                    |
| Source of data  | Positioner database                                                                                                     |
| Possible values | The preset value of this parameter should not be changed.                                                               |

## 0x72 Ignore Macro Error?

*Used in: (85)*

|                 |                                                                                                            |
|-----------------|------------------------------------------------------------------------------------------------------------|
| Description:    | Ignore macro error?                                                                                        |
| Data type       | INT                                                                                                        |
| Command level   | 0                                                                                                          |
| Item type       | System                                                                                                     |
| Source of data  | PC software commands ( <a href="#">SPA (p. 151)</a> , <a href="#">SEP (p. 150)</a> ) or operating elements |
| Possible values | 0 Stop macro on error (default)<br>1 Ignore error                                                          |

## Ox77 Use Limit Switches Only For Reference Moves?

*Used in: Limit Switch Detection (37)*

|                 |                                                                                                                                                                                                                    |   |                                                                                                  |   |                                             |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|--------------------------------------------------------------------------------------------------|---|---------------------------------------------|
| Description:    | Should the limit switches only be used for reference moves?<br>Is intended for use with rotation stages.<br>Only evaluated when parameter <a href="#">0x32 (p. 179)</a> has the value 0.                           |   |                                                                                                  |   |                                             |
| Data type       | INT                                                                                                                                                                                                                |   |                                                                                                  |   |                                             |
| Command level   | 0                                                                                                                                                                                                                  |   |                                                                                                  |   |                                             |
| Item type       | Axis                                                                                                                                                                                                               |   |                                                                                                  |   |                                             |
| Source of data  | Positioner database                                                                                                                                                                                                |   |                                                                                                  |   |                                             |
| Possible values | <table><tr><td>0</td><td>Use limit switches for stopping at the end of the travel range and for reference moves (default)</td></tr><tr><td>1</td><td>Use limit switches for reference moves only</td></tr></table> | 0 | Use limit switches for stopping at the end of the travel range and for reference moves (default) | 1 | Use limit switches for reference moves only |
| 0               | Use limit switches for stopping at the end of the travel range and for reference moves (default)                                                                                                                   |   |                                                                                                  |   |                                             |
| 1               | Use limit switches for reference moves only                                                                                                                                                                        |   |                                                                                                  |   |                                             |

## Ox78 Distance From Limit To Start Of Ref Search (Phys. Unit)

*Used in: Reference Move Procedures (40)*

|                |                                                                                                                                                                                                          |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:   | Gap between the limit switch and the starting position for the reference move to the index pulse.<br>Used for <a href="#">FRF (p. 125)</a> when parameter <a href="#">0x70 (p. 186)</a> has the value 2. |
| Data type      | FLOAT                                                                                                                                                                                                    |
| Command level  | 0                                                                                                                                                                                                        |
| Item type      | Axis                                                                                                                                                                                                     |
| Source of data | Positioner database                                                                                                                                                                                      |

## **Ox79 Distance For Reference Search (Phys. Unit)**

*Used in: Reference Move Procedures (40)*

|                |                                                 |
|----------------|-------------------------------------------------|
| Description:   | Maximum distance for motion to the index pulse. |
| Data type      | FLOAT                                           |
| Command level  | 0                                               |
| Item type      | Axis                                            |
| Source of data | Positioner database                             |

## **Ox7A Use Hard Stops For Referencing?**

*Used in: Reference point definition options (40)*

|                 |                                                                                                                                                                                                                                                                                                     |   |                                           |   |                                    |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-------------------------------------------|---|------------------------------------|
| Description:    | Should the hard stops be used for reference moves?                                                                                                                                                                                                                                                  |   |                                           |   |                                    |
| Data type       | INT                                                                                                                                                                                                                                                                                                 |   |                                           |   |                                    |
| Command level   | 0                                                                                                                                                                                                                                                                                                   |   |                                           |   |                                    |
| Item type       | Axis                                                                                                                                                                                                                                                                                                |   |                                           |   |                                    |
| Source of data  | Positioner database                                                                                                                                                                                                                                                                                 |   |                                           |   |                                    |
| Possible values | <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 5px;">0</td> <td style="padding: 5px;">Do not use hard stops for reference moves</td> </tr> <tr> <td style="padding: 5px;">1</td> <td style="padding: 5px;">Use hard stops for reference moves</td> </tr> </table> | 0 | Do not use hard stops for reference moves | 1 | Use hard stops for reference moves |
| 0               | Do not use hard stops for reference moves                                                                                                                                                                                                                                                           |   |                                           |   |                                    |
| 1               | Use hard stops for reference moves                                                                                                                                                                                                                                                                  |   |                                           |   |                                    |

## **Ox94 Notch Filter Frequency 1 (Hz)**

*Used in: Settings for the Notch Filter (35)*

|                 |                                                                                                                                                                      |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Frequency of the first notch filter.<br>The appropriate frequency component is reduced in the control value to compensate for undesired resonances in the mechanics. |
| Data type       | FLOAT                                                                                                                                                                |
| Command level   | 0                                                                                                                                                                    |
| Item type       | Axis                                                                                                                                                                 |
| Source of data  | Positioner database                                                                                                                                                  |
| Possible values | 40 to 20,000 [Hz]                                                                                                                                                    |

## Ox95 Notch Filter Edge 1

*Used in: Settings for the Notch Filter (35)*

|                 |                                                                                                                                |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Edge steepness of the first notch filter.<br>The greater the value of this parameter, the narrower the notch filter bandwidth. |
| Data type       | FLOAT                                                                                                                          |
| Command level   | 0                                                                                                                              |
| Item type       | Axis                                                                                                                           |
| Source of data  | Positioner database                                                                                                            |
| Possible values | 0.1 to 10 (dimensionless)                                                                                                      |

## Ox3003300 Sensor Interpolation

|                |                                                               |
|----------------|---------------------------------------------------------------|
| Description:   | Interpolation rate for the signals of the incremental sensor. |
| Data type      | FLOAT                                                         |
| Command level  | 2                                                             |
| Item type      | Axis                                                          |
| Source of data | ID chip of the mechanics                                      |

## Ox3003301 Sensor Hysteresis (Deg)

|                |                                                         |
|----------------|---------------------------------------------------------|
| Description:   | Correction of the hysteresis of the incremental sensor. |
| Data type      | FLOAT                                                   |
| Command level  | 2                                                       |
| Item type      | Axis                                                    |
| Source of data | ID chip of the mechanics                                |

## **0x3003302 Sensor Digital Gain**

|                |                                                                            |
|----------------|----------------------------------------------------------------------------|
| Description:   | Gain value for correcting the digitized signals of the incremental sensor. |
| Data type      | FLOAT                                                                      |
| Command level  | 2                                                                          |
| Item type      | Axis                                                                       |
| Source of data | ID chip of the mechanics                                                   |

## **0x3003303 Sensor Digital Offset 0 (V)**

|                |                                                                          |
|----------------|--------------------------------------------------------------------------|
| Description:   | Offset 0 for correcting the digitized signals of the incremental sensor. |
| Data type      | FLOAT                                                                    |
| Command level  | 2                                                                        |
| Item type      | Axis                                                                     |
| Source of data | ID chip of the mechanics                                                 |

## **0x3003304 Sensor Digital Offset 1 (V)**

|                |                                                                          |
|----------------|--------------------------------------------------------------------------|
| Description:   | Offset 1 for correcting the digitized signals of the incremental sensor. |
| Data type      | FLOAT                                                                    |
| Command level  | 2                                                                        |
| Item type      | Axis                                                                     |
| Source of data | ID chip of the mechanics                                                 |

## **Ox3003305 Sensor Digital Phase (Deg)**

|                |                                                             |
|----------------|-------------------------------------------------------------|
| Description:   | Phase correction for the signals of the incremental sensor. |
| Data type      | FLOAT                                                       |
| Command level  | 2                                                           |
| Item type      | Axis                                                        |
| Source of data | ID chip of the mechanics                                    |

## **Ox3003306 Sensor Analog Gain (dB)**

|                |                                                                         |
|----------------|-------------------------------------------------------------------------|
| Description:   | Gain value for correcting the analog signals of the incremental sensor. |
| Data type      | FLOAT                                                                   |
| Command level  | 2                                                                       |
| Item type      | Axis                                                                    |
| Source of data | ID chip of the mechanics                                                |

## **Ox3003307 Sensor Analog Offset 0 (V)**

|                |                                                                       |
|----------------|-----------------------------------------------------------------------|
| Description:   | Offset 0 for correcting the analog signals of the incremental sensor. |
| Data type      | FLOAT                                                                 |
| Command level  | 2                                                                     |
| Item type      | Axis                                                                  |
| Source of data | ID chip of the mechanics                                              |

## 0x3003308 Sensor Analog Offset 1 (V)

|                |                                                                       |
|----------------|-----------------------------------------------------------------------|
| Description:   | Offset 1 for correcting the analog signals of the incremental sensor. |
| Data type      | FLOAT                                                                 |
| Command level  | 2                                                                     |
| Item type      | Axis                                                                  |
| Source of data | ID chip of the mechanics                                              |

## 0x7000601 Axis Unit

|                              |                                                                                                                                                                                                                                                                    |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description:                 | Unit symbol.<br>For example, the unit symbol is "mm" if the factor for the counts per physical unit of length is set with parameters 0xE and 0xF so that the encoder counts are converted into millimeters. The unit symbol for rotation stages is normally "deg". |
| Examples:                    |                                                                                                                                                                                                                                                                    |
| ■ 1 Encoder count = 100 nm   | Counts per physical unit of length: 10000:1<br>→ unit symbol: mm                                                                                                                                                                                                   |
| ■ 1 Encoder count = 0.254 mm | Counts per physical unit of length: 100:1<br>→ unit symbol: inch                                                                                                                                                                                                   |
| Data type                    | CHAR                                                                                                                                                                                                                                                               |
| Command level                | 0                                                                                                                                                                                                                                                                  |
| Item type                    | Axis                                                                                                                                                                                                                                                               |
| Source of data               | Positioner database                                                                                                                                                                                                                                                |
| Possible values              | String up to 20 characters                                                                                                                                                                                                                                         |

## 0xD000000 Controller Device S/N

|                |                                   |
|----------------|-----------------------------------|
| Description:   | Serial number of the electronics. |
| Data type      | CHAR                              |
| Command level  | 0                                 |
| Item type      | Axis                              |
| Source of data | Positioner database               |

## OxE000200 Servo Update Time

|                |                                                                                                            |
|----------------|------------------------------------------------------------------------------------------------------------|
| Description:   | Servo cycle time.                                                                                          |
| Data type      | FLOAT                                                                                                      |
| Command level  | 2                                                                                                          |
| Item type      | System                                                                                                     |
| Source of data | PC software commands ( <a href="#">SPA (p. 151)</a> , <a href="#">SEP (p. 150)</a> ) or operating elements |

## OxF000100 Stage Type

|                 |                                                               |
|-----------------|---------------------------------------------------------------|
| Description:    | Mechanics type.                                               |
| Data type       | CHAR                                                          |
| Command level   | 2                                                             |
| Item type       | Axis                                                          |
| Source of data  | ID chip of the mechanics                                      |
| Possible values | x-xxx default positioners<br>x-xxxKxxx customized positioners |

## OxF000200 Stage Serial Number

|                 |                                 |
|-----------------|---------------------------------|
| Description:    | Serial number of the mechanics. |
| Data type       | CHAR                            |
| Command level   | 2                               |
| Item type       | Axis                            |
| Source of data  | ID chip of the mechanics        |
| Possible values | 9-digit number                  |

## OxF000300 Stage Assembly Date

|                 |                                      |
|-----------------|--------------------------------------|
| Description:    | Manufacturing date of the mechanics. |
| Data type       | CHAR                                 |
| Command level   | 2                                    |
| Item type       | Axis                                 |
| Source of data  | ID chip of the mechanics             |
| Possible values | Date in TTMMJJ format                |

## OxF000400 Stage HW Version

|                |                                           |
|----------------|-------------------------------------------|
| Description:   | Version number of the mechanics hardware. |
| Data type      | INT                                       |
| Command level  | 2                                         |
| Item type      | Axis                                      |
| Source of data | ID chip of the mechanics                  |

## Ox16000001 Recorded Points Per Trigger

*Used in: Configuring data processing (74)*

|                 |                                                                                                            |
|-----------------|------------------------------------------------------------------------------------------------------------|
| Description:    | Number of data points recorded per trigger impulse.                                                        |
| Data type       | INT                                                                                                        |
| Command level   | 0                                                                                                          |
| Item type       | System                                                                                                     |
| Source of data  | PC software commands ( <a href="#">SPA (p. 151)</a> , <a href="#">SEP (p. 150)</a> ) or operating elements |
| Possible values | 0 Unlimited (default)<br>n>0 n data points are recorded                                                    |

## 0x1F000000 PIShift Upper Supply Voltage (V)

*Used in:* (27)

|                 |                                                  |
|-----------------|--------------------------------------------------|
| Description:    | Maximum output voltage for piezo inertia drives. |
| Data type       | FLOAT                                            |
| Command level   | 1                                                |
| Item type       | Axis                                             |
| Source of data  | Positioner database                              |
| Possible values | The value depends on the type of the drive.      |

## 0x1F000100 PIShift Lower Supply Voltage (V)

*Used in:* (27)

|                 |                                                  |
|-----------------|--------------------------------------------------|
| Description:    | Minimum output voltage for piezo inertia drives. |
| Data type       | FLOAT                                            |
| Command level   | 1                                                |
| Item type       | Axis                                             |
| Source of data  | Positioner database                              |
| Possible values | The value depends on the type of the drive.      |

## 0x1F000200 PIShift Forward Current (A)

*Used in:* (27)

|                 |                                                                        |
|-----------------|------------------------------------------------------------------------|
| Description:    | Maximum output current for piezo inertia drives during forward motion. |
| Data type       | FLOAT                                                                  |
| Command level   | 1                                                                      |
| Item type       | Axis                                                                   |
| Source of data  | Positioner database                                                    |
| Possible values | The value depends on the type of the drive.                            |

## **Ox1F000300 PIShift Backward Current (A)**

*Used in:* (27)

|                 |                                                                         |
|-----------------|-------------------------------------------------------------------------|
| Description:    | Maximum output current for piezo inertia drives during backward motion. |
| Data type       | FLOAT                                                                   |
| Command level   | 1                                                                       |
| Item type       | Axis                                                                    |
| Source of data  | Positioner database                                                     |
| Possible values | The value depends on the type of the drive.                             |

## **Ox1F000500 PIShift Charge Cycle**

*Used in:* (27)

|                 |                                                                                                                                         |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Description:    | Duty cycle of the current source during output of a step.<br>Specified as part of a period which the current source is switched on for. |
| Data type       | FLOAT                                                                                                                                   |
| Command level   | 1                                                                                                                                       |
| Item type       | Axis                                                                                                                                    |
| Source of data  | Positioner database                                                                                                                     |
| Possible values | 0 to 1<br>The value depends on the type of the drive.                                                                                   |

## **Ox1F000700 PIShift Step Size (Phys. Unit)**

*Used in:* Motion in closed-loop operation (26)

|                |                                                            |
|----------------|------------------------------------------------------------|
| Description:   | Size of the slow individual steps in closed-loop operation |
| Data type      | FLOAT                                                      |
| Command level  | 1                                                          |
| Item type      | Axis                                                       |
| Source of data | Positioner database                                        |

## 0x1F000701 PIShift Delay (ms)

*Used in:* Motion in closed-loop operation (26)

|                 |                                                                                          |
|-----------------|------------------------------------------------------------------------------------------|
| Description:    | Delay time when switching between two operating modes (e.g., step mode and linear mode). |
| Data type       | FLOAT                                                                                    |
| Command level   | 1                                                                                        |
| Item type       | Axis                                                                                     |
| Source of data  | Positioner database                                                                      |
| Possible values | 0 to 2000 [ms]                                                                           |

## 0x1F000703 PIShift Offset Current (A)

*Used in:* (27)

|                 |                                                           |
|-----------------|-----------------------------------------------------------|
| Description:    | Offset current in open-loop operation                     |
| Data type       | FLOAT                                                     |
| Command level   | 1                                                         |
| Item type       | Axis                                                      |
| Source of data  | Positioner database                                       |
| Possible values | - 0.05 to 0.05<br>The preset value should not be changed. |

# 11 Maintenance

## 11.1 Cleaning

### Requirements

- ✓ You have disconnected the E-873.1AT from the power supply.

### Other Materials Required

- Soft, lint-free cloth
- Mild cleaning agent or disinfectant

If you have any questions on the auxiliary materials recommended for the E-873.1AT, contact our [customer service department \(p. 207\)](#).

### NOTICE

#### Short circuits or flashovers!

The E-873.1AT contains electrostatically sensitive devices that can be damaged by short circuits or flashovers when cleaning fluids penetrate the housing.

- Before cleaning, disconnect the E-873.1AT from the power supply.
- Prevent cleaning fluid from penetrating the case.

### Cleaning the E-873.1AT

1. Dampen the cloth with the cleaning agent or disinfectant.
2. Carefully wipe the surfaces of the E-873.1AT.

## 11.2 Updating the Firmware

The following describes the procedure for updating the E-873.1AT's firmware.

The figures show the procedure for any electronics; the procedure for the E-873.1AT corresponds.

### Requirements

- ✓ You have connected the E-873.1AT to the PC [via the RS-232 interface \(p. 51\)](#).
- ✓ "PI Firmware Updater" is [installed on the PC \(p. 46\)](#).
- ✓ You have copied the new firmware file, which you have received from our customer service department, to a directory on the PC.
- ✓ You have read and understood the documentation that you received from our customer service department together with the new firmware. You have learned from the documentation whether new parameters are introduced with the firmware update or the memory management of the E-873.1AT changes.
- ✓ You have saved the parameter values of the E-873.1AT [in a text file on the PC \(p. 70\)](#).
- ✓ You have saved the controller macros of the E-873.1AT [in files on the PC \(p. 71\)](#).
- ✓ You have [established \(p. 53\)](#) communication between the E-873.1AT and the PC with PIMikroMove or PITerminal.

## Information

The status LED of the E-873.1AT flashes as long as the E-873.1AT is in firmware update mode. The E-873.1AT exits the firmware update mode only when it **reboots** after the firmware was **successfully** updated. If the firmware update was unsuccessful or aborted, the E-873.1AT remains in the firmware update mode after a reboot.

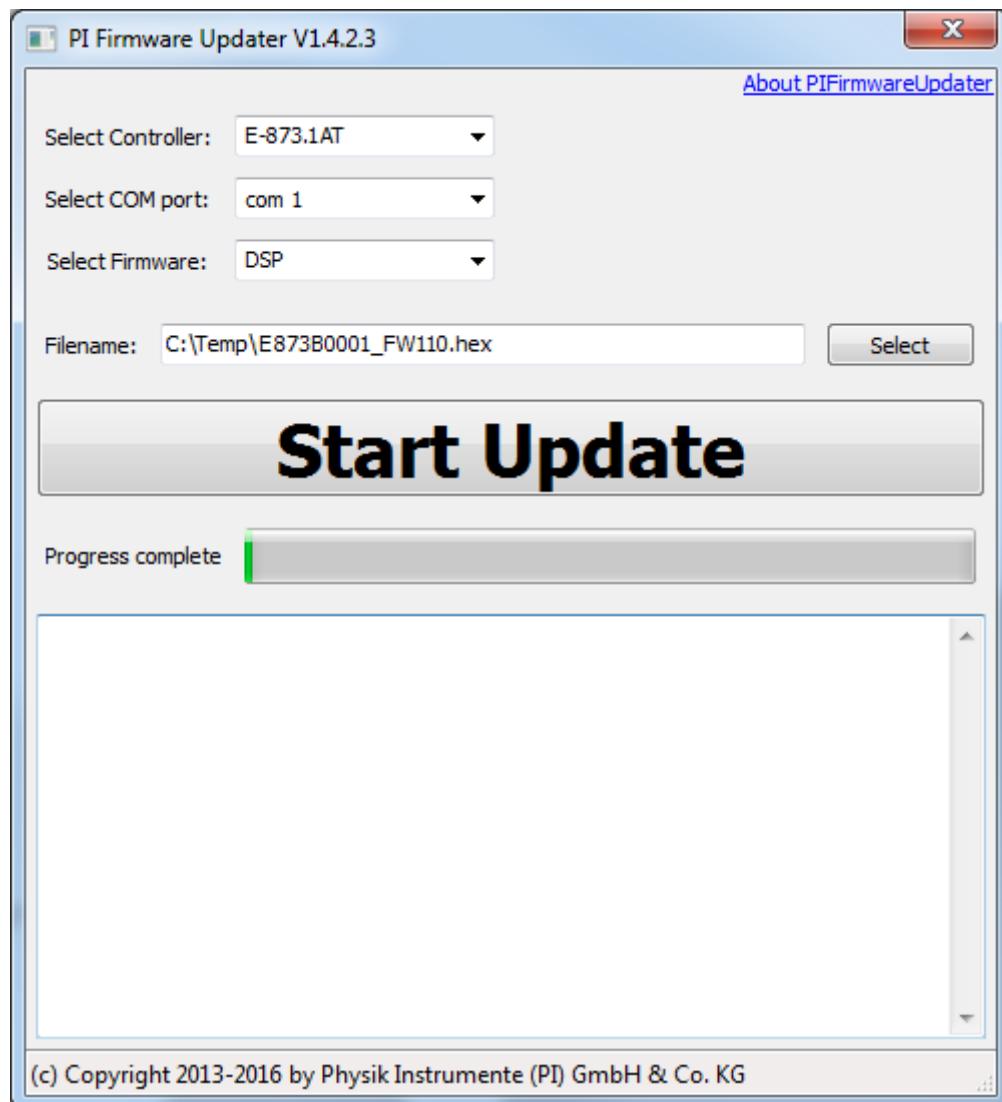
If the status LED lights up continuously although the E-873.1AT was restarted after updating the firmware:

- ▶ Repeat the firmware update.
- ▶ If the update of the firmware fails, contact our [customer service department \(p. 207\)](#).

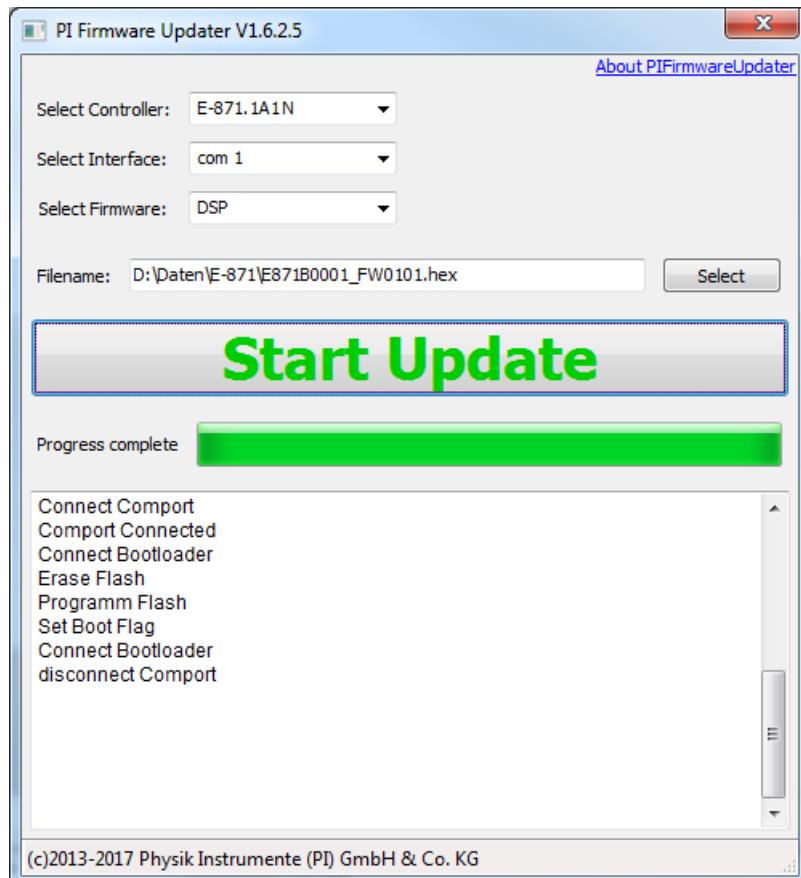
## Updating the Firmware of the E-873.1AT

1. Activate the firmware update mode in PI MikroMove or PI Terminal:
  - a) Select **Tools > Command entry** in the PI MikroMove's main window or press **F4** on the keyboard.
  - b) Send the following commands successively:  
ZZZ 100 Flash  
rbt

→ *The E-873.1AT reboots and restarts in firmware update mode. The status LED of the E-873.1AT flashes as long as the E-873.1AT is in firmware update mode.*
2. Close PI MikroMove respectively PI Terminal.
3. Run "PI Firmware Updater" on the PC.  
→ *The PI Firmware Updater window opens.*
4. Set the following in the selection fields:
  - Select the entry for your controller model in the **Select Controller** field: E-873.1AT.
  - Select the COM port of the PC that is connected to the E-873.1AT in the **Select COM port** field.
  - If necessary: Select "DSP" (= Digital Signal Processor) in the **Select Firmware** field.
5. Select the new firmware file:
  - a) Click the **Select** button.
  - b) Go to the directory in the file selection window where you stored the firmware file.
  - c) Double-click the new firmware file (.hex extension) to enter the file path in the **Filename** field.



6. Start the firmware update by clicking on the **Start Update** button.
  - The firmware of the E-873.1AT is updated. The update progress is displayed in the message list and by the progress bar.
  - The update was successful when the disconnect Comport message appears as the last entry in the message list.



7. Close the "PI Firmware Updater" by clicking the cross in the top right corner of the window.
8. Switch the E-873.1AT off and on again via its toggle switch.  
→ If the firmware update was successful, the E-873.1AT exits the firmware update mode and the STA LED lights up green.
9. If new parameters were added during updating of the firmware or the memory management of the E-873.1AT was changed: [Initialize the E-873.1AT \(p. 202\)](#).

#### Initializing the E-873.1AT after a Firmware Update

1. Make sure that the current parameter values and controller macros of the E-873.1AT have been saved on the PC.  
The initialization of the E-873.1AT resets all parameters to their factory settings and deletes all controller macros. Consequently, parameter values and controller macros that are not saved are lost during the initialization process.
2. On the PC, start PITerminal or PIMikroMove, connect to the E-873.1AT, and, if necessary, open the window to send commands.  
Initialize the E-873.1AT by sending the following commands successively:  
ZZZ 100 parameter  
ZZZ 100 macros  
→ After successful initialization, the controller issues a corresponding message.
3. Adapt the parameter values of the E-873.1AT:
  - Reset the parameters that were already present prior to the firmware update to the saved values from the text file.
  - Set the parameters that were introduced with the firmware update to the appropriate values.

4. If you have saved controller macros on the PC: Load the controller macros into the E-873.1AT, see "[Loading Controller Macros from the PC into the E-873.1AT \(p. 71\)](#)".

## 12 Troubleshooting

### The positioner does not move

|                                                                                                                                                                                               |                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cable not connected correctly                                                                                                                                                                 | ► Check the cable connections.                                                                                                                                                       |
| Unsuitable positioner cable used.<br>Interference with the signal transmission between the positioner and E-873.1AT can occur when an unsuitable cable is used.                               | ► Only use genuine PI parts when connecting the positioner to the E-873.1AT.<br>► If you need extension cables, contact our <a href="#">customer service department (p. 207)</a> .   |
| Positioner was connected to the switched-on E-873.1AT<br><br>The sensor electronics in the positioner was not initialized and the sensor's ID chip was not read out.                          | ► Switch the E-873.1AT off and on again, or reboot the E-873.1AT with the <code>RBT</code> command or with the corresponding functions of the PC software.                           |
| Limit switch signal logic wrongly set<br><br>In order for the positioner to be able to move, the settings of the E-873.1AT must correspond to the limit switch logic level of the positioner. | ► Adjust the <b>Limit Mode</b> parameter (0x18) accordingly.                                                                                                                         |
| Limit switch signals not compatible with the E-873.1AT<br><br>It is possible that positioners from third-party suppliers use unsuitable limit switch signals.                                 | ► Contact the customer service department or the manufacturer of the positioner.                                                                                                     |
| Motion platform has triggered the limit switch                                                                                                                                                | ► Switch the servo mode on for the affected axis again.<br>► Command the axis to move away from the limit switch.                                                                    |
| Incorrect axis or channel commanded                                                                                                                                                           | ► Make sure that the correct axis or channel identifier is used and that the positioner is connected correctly.                                                                      |
| Incorrect configuration                                                                                                                                                                       | ► Check the parameter settings of the E-873.1AT with the <code>SPA?</code> (volatile memory) and <code>SEP?</code> (nonvolatile memory) commands and make the necessary corrections. |
| Incorrect command or incorrect syntax                                                                                                                                                         | ► Send the <code>ERR?</code> command and check the error code that is returned.                                                                                                      |
| HID control active<br><br>motion commands are not permitted when HID control is activated for the axis or the channel.                                                                        | ► Deactivate HID control.                                                                                                                                                            |

### Positioner performs unintentional motion

|                                                                                |                                                                                                                       |
|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Control device is not connected, but HID control is activated in the E-873.1AT | ► Activate HID control only when a control device is actually connected to the E-873.1AT.                             |
| HID axis is not calibrated                                                     | ► Calibrate the axis of the control device.                                                                           |
| Startup macro is run                                                           | ► Check whether a macro is specified as the startup macro and cancel the selection of the startup macro if necessary. |

### Stage is oscillating or positions inaccurately

|                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The load was changed                                                                  | ► Reset the <a href="#">notch filter (p. 62)</a> and the <a href="#">servo control parameters (p. 67)</a> according to the change of load.                                                                                                                                                                                                                                                                                                                                      |
| <b>Stage is oscillating already during the reference move</b>                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Very high load on the positioner                                                      | <ul style="list-style-type: none"> <li>► Stop the reference move immediately.</li> <li>► Switch servo mode off.</li> <li>► Enter suitable values for setting the <a href="#">notch filter (p. 62)</a>.</li> <li>► Restart the reference move.</li> <li>► If the positioner continues to oscillate, repeat the specified steps until the reference move has completed successfully without oscillation.</li> </ul>                                                               |
| <b>Communication between the E-873.1AT and the PC not functioning</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Wrong communication cable used                                                        | <ul style="list-style-type: none"> <li>► Use a straight-through cable for TCP/IP connections to a network.</li> <li>► Use a crossover network cable for TCP/IP connections direct to the PC.</li> <li>► Use a null-modem cable for RS-232 connections.</li> <li>► Use a standard-compliant USB cable (type A to type B or type A to type Mini-B) for USB connections</li> </ul>                                                                                                 |
| Communication cable defective                                                         | ► Replace the communication cable.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| RS-232 interface not configured correctly                                             | <ul style="list-style-type: none"> <li>► Check the port settings, the baud rate and the handshake setting of the PC.</li> </ul>                                                                                                                                                                                                                                                                                                                                                 |
| TCP/IP interface not configured correctly                                             | <ul style="list-style-type: none"> <li>► Connect the controller to the network <b>before</b> you switch it on. Restart the E-873.1AT if necessary.</li> <li>► Check the network settings.</li> <li>► Make sure that the network is not blocked for unknown devices.</li> <li>► Make sure that you have selected the correct E-873.1AT when establishing communication.</li> <li>► If you cannot solve the problems, consult your network administrator if necessary.</li> </ul> |
| Another program is accessing the interface                                            | ► Close the other program.                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| The start procedure of the E-873.1AT's firmware has not finished yet                  | <ul style="list-style-type: none"> <li>► Wait until the <b>STA</b> LED lights up continuously after switching on or rebooting the E-873.1AT.</li> <li>► Try to establish communication.</li> </ul>                                                                                                                                                                                                                                                                              |
| Problems with special software                                                        | <ul style="list-style-type: none"> <li>► Check whether the system works with other software, e.g., a terminal program, or a development environment; for this purpose, enter the <b>*IDN?</b> or <b>HLP?</b> command using that software. Make sure that you end commands with an LF (line feed); a command is only executed when an LF is received.</li> </ul>                                                                                                                 |
| <b>E-873.1AT does not send an error code in the case of incorrect system behavior</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| The error code was already queried by a different instance                            | <ul style="list-style-type: none"> <li>► If possible, access the E-873.1AT with one instance only.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                   |

In the case of simultaneous access to the E-873.1AT by several instances, the error code is only returned to the first instance that sent the `ERR?` command. The error code is reset to 0 during the query.

- ▶ Check whether the error code is queried regularly in the background by a macro or script or PC software (e.g., PI MikroMove).

#### LEDs do not light up even though the E-873.1AT is switched on

E-873.1AT not connected to the power supply or the power cord is defective.

- ▶ Switch off the E-873.1AT.
- ▶ Make sure that the E-873.1AT is connected to the power supply and the power cord is not defective.
- ▶ Switch on the E-873.1AT.

If the problem is not listed in the table or cannot be solved as described, contact our [customer service department \(p. 207\)](#).

## 13 Customer Service Department

For enquiries and orders, contact your PI representative or send us an [email](#).

If you have any questions concerning your system, provide the following information:

- Product and serial numbers of all products in the system
- Firmware version of the controller (if applicable)
- Version of the driver or the software (if applicable)
- Operating system on the PC (if applicable)

If possible: Take photographs or make videos of your system that can be sent to our customer service department if requested.

### **Customer service address:**

Physik Instrumente (PI) GmbH & Co. KG  
Auf der Roemerstrasse 1  
76228 Karlsruhe  
Germany  
[service@pi.de](mailto:service@pi.de)  
[www.pi.de](http://www.pi.de)

## 14 Technical Data

### 14.1 Specifications

| <b>E-873.1AT</b>                                    |                                                                                                                                                                                                                         |
|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Function                                            | Q-Motion® controller for positioning systems with piezo inertia drives, benchtop device with option for control cabinet mounting                                                                                        |
| Axes                                                | 1                                                                                                                                                                                                                       |
| Supported functions                                 | Startup macro. Data recorder for recording operating data such as motor voltage, velocity, position or position error. Internal safety circuitry: Watchdog timer. ID chip detection.                                    |
| <b>Motion and servo controller</b> <b>E-873.1AT</b> |                                                                                                                                                                                                                         |
| Controller type                                     | PID controller, parameters modifiable during operation                                                                                                                                                                  |
| Servo cycle time                                    | 50 µs                                                                                                                                                                                                                   |
| Dynamics profile                                    | Trapezoid velocity profile. Point-to-point motion.                                                                                                                                                                      |
| Encoder Input                                       | Analog encoder inputs sine-cosine, interpolation selectable to 20000.<br>Interpolation electronics preset for differential transmission, 1 Vpp and 2.5 V encoder signal offset.<br>BiSS interface for absolute encoders |
| Stall detection                                     | Automatic motor stop                                                                                                                                                                                                    |
| Input limit switch                                  | 2 × TTL (pull-up / pull-down, programmable)                                                                                                                                                                             |
| Input reference switch                              | 1 × TTL for integrated reference in the encoder                                                                                                                                                                         |
| <b>Electrical properties</b> <b>E-873.1AT</b>       |                                                                                                                                                                                                                         |
| Max. output power                                   | 30 W                                                                                                                                                                                                                    |
| Output voltage                                      | 0 to 100 V, drive-dependent selection                                                                                                                                                                                   |
| <b>Interfaces and operation</b> <b>E-873.1AT</b>    |                                                                                                                                                                                                                         |
| Communication interfaces                            | USB, RS-232, TCP/IP, SPI                                                                                                                                                                                                |
| Motor / sensor connector                            | D-sub 15 (f)                                                                                                                                                                                                            |
| I/O lines                                           | 4 analog / digital inputs, 4 digital outputs                                                                                                                                                                            |
| Command set                                         | PI General Command Set (GCS)                                                                                                                                                                                            |
| User software                                       | PI MikroMove                                                                                                                                                                                                            |
| Application programming interfaces                  | API for C / C++ / C# / VB.NET / MATLAB / Python, drivers for NI LabVIEW                                                                                                                                                 |
| Manual control (optional)                           | Joystick                                                                                                                                                                                                                |

| Miscellaneous               | E-873.1AT                                                               |
|-----------------------------|-------------------------------------------------------------------------|
| Operating Voltage           | 24 V DC from external power adapter (included in the scope of delivery) |
| Max. current consumption    | 1.5 A                                                                   |
| Operating temperature range | 0 to 50 °C                                                              |
| Mass                        | 0.335 kg                                                                |
| Dimensions                  | 147 mm × 105 mm × 44 mm (incl. mounting rails)                          |

## 14.2 Maximum Ratings

The E-873.1AT is designed for the following operating data:

| Maximum operating voltage                                                              | Operating frequency                                                                  | Maximum current consumption                                                               |
|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
|  24 V |  DC |  2.5 A |

## 14.3 Ambient Conditions and Classifications

The following ambient conditions and classifications for the E-873.1AT must be observed:

|                                             |                                                                           |
|---------------------------------------------|---------------------------------------------------------------------------|
| Area of application                         | For indoor use only                                                       |
| Maximum altitude                            | 2000 m above msl                                                          |
| Air pressure                                | 1100 hPa to 0.1 hPa                                                       |
| Relative humidity                           | Max. 80 % for temperatures to 31 °C, decreasing linearly to 50 % at 40 °C |
| Storage temperature                         | 0 °C to 70 °C                                                             |
| Transport temperature                       | -25 °C to +85 °C                                                          |
| Overvoltage category                        | II                                                                        |
| Protection class                            | I                                                                         |
| Degree of pollution                         | 2                                                                         |
| Degree of protection according to IEC 60529 | IP20                                                                      |

## 14.4 Dimensions

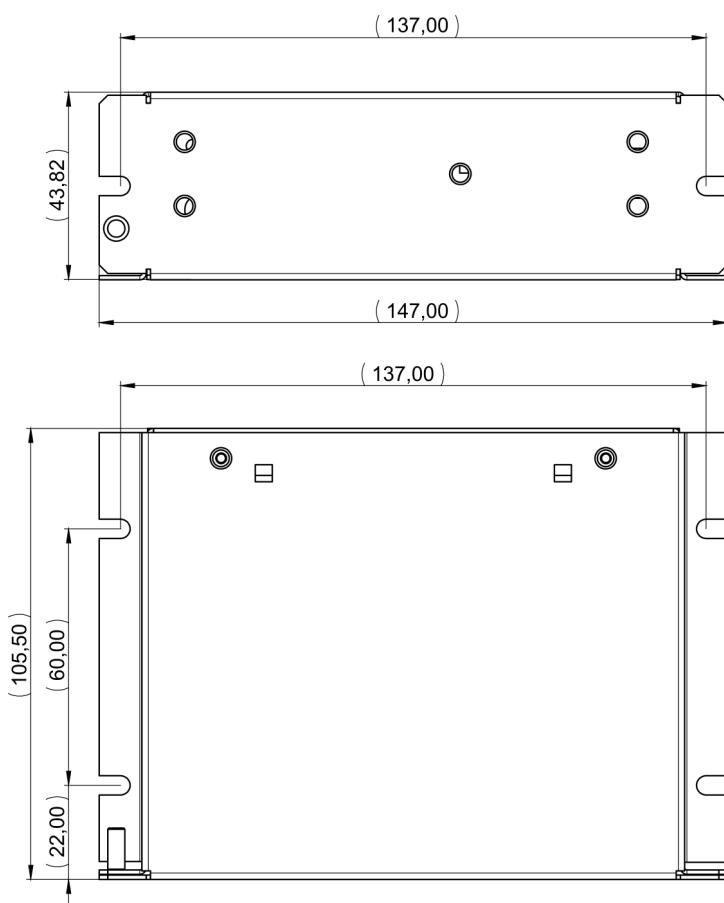


Figure 16: Dimensions of the E-873.1AT

Dimensions in mm. Note that the decimal places are separated by a comma in the drawings.

## 15 Old Equipment Disposal

In accordance with EU law, electrical and electronic equipment may not be disposed of in EU member states via the municipal residual waste.

Dispose of your old equipment according to international, national, and local rules and regulations.

In order to fulfil the responsibility as the product manufacturer, PI undertakes environmentally correct disposal of all PI equipment free of charge, if it was made available to the market after August 13, 2005.

Any old PI equipment can be sent free of charge to the following address:

Physik Instrumente (PI) GmbH & Co. KG

Auf der Roemerstrasse 1

76228 Karlsruhe

Germany

[info@pi.de](mailto:info@pi.de)

[www.pi.de](http://www.pi.de)



# 16 Appendix

## 16.1 Pin Assignment

### 16.1.1 Axis Connector

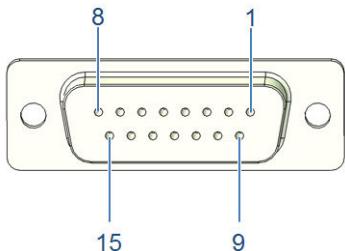


Figure 17: D-sub 15 (f)

| Pin | Signal  | Function                             |
|-----|---------|--------------------------------------|
| 1   | REF-    | Reference switches, differential (-) |
| 2   | PIEZO-  | Motor signal (-)                     |
| 3   | PIEZO+  | Motor signal (+)                     |
| 4   | 5 V     | Supply voltage, +5 V                 |
| 5   | PLIM    | Positive limit switch                |
| 6   | ID_CHIP | Bidirectional: Data line for ID chip |
| 7   | ENCA-   | Encoder channel A, differential (-)  |
| 8   | ENCB-   | Encoder channel B, differential (-)  |
| 9   | PIEZO-  | Motor signal (-)                     |
| 10  | GND     | Ground                               |
| 11  | PIEZO+  | Motor signal (+)                     |
| 12  | NLIM    | Negative limit switch                |
| 13  | REF+    | Reference switches, differential (+) |
| 14  | ENCA+   | Encoder channel A, differential (+)  |
| 15  | ENCB+   | Encoder channel B, differential (+)  |

### 16.1.2 I/O connector

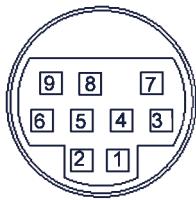


Figure 18: I/O connector: Mini DIN 9 (f)

| Pin    | Function                                   |
|--------|--------------------------------------------|
| 1      | Input 1 (analog: 0 to +5 V / digital: TTL) |
| 2      | Input 2 (analog: 0 to +5 V / digital: TTL) |
| 3      | Input 3 (analog: 0 to +5 V / digital: TTL) |
| 4      | Input 4 (analog: 0 to +5 V / digital: TTL) |
| 5      | Output 1 (digital: TTL)                    |
| 6      | Output 2 (digital: TTL)                    |
| 7      | Output 3 (digital: TTL)                    |
| 8      | Output 4 (digital: TTL)                    |
| 9      | Vcc (+5 V)                                 |
| Shield | Ground                                     |

### 16.1.3 C-170.IO Cable for Connecting to the I/O Socket

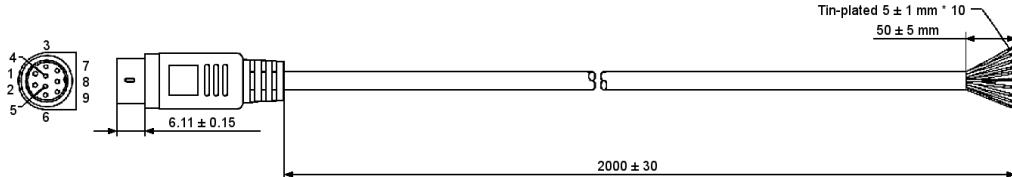


Figure 19: C-170.IO cable

| Pin    | Wire Color                                                      | Function on the I/O socket of the E-873.1AT |
|--------|-----------------------------------------------------------------|---------------------------------------------|
| 1      | Black                                                           | Input 1 (analog: 0 to +5V / digital: TTL)   |
| 2      | white                                                           | Input 2 (analog: 0 to +5V / digital: TTL)   |
| 3      | Red                                                             | Input 3 (analog: 0 to +5V / digital: TTL)   |
| 4      | Yellow                                                          | Input 4 (analog: 0 to +5V / digital: TTL)   |
| 5      | Purple                                                          | Output 1 (digital, TTL)                     |
| 6      | Blue                                                            | Output 2 (digital, TTL)                     |
| 7      | Green                                                           | Output 3 (digital, TTL)                     |
| 8      | Brown                                                           | Output 4 (digital, TTL)                     |
| 9      | Gray                                                            | Vcc (+5V)                                   |
| Sheath | Shield, coated black (thicker than the wire connected to pin 1) | GND                                         |

### 16.1.4 RS-232 Connector

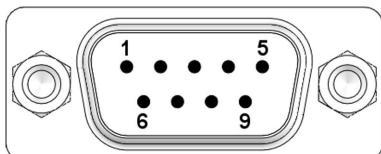


Figure 20: RS-232 connector: D-sub 9 (m)

| Pin | Function               |
|-----|------------------------|
| 1   | Not connected          |
| 2   | RxD (PC to controller) |
| 3   | TxD (controller to PC) |
| 4   | Not connected          |
| 5   | GND                    |
| 6   | Not connected          |
| 7   | Not connected          |
| 8   | Not connected          |
| 9   | Not connected          |

### 16.1.5 Power Adapter Connector



Figure 21: Power adapter connector: barrel connector socket

| Pin            | Signal | Function                   |
|----------------|--------|----------------------------|
| Center pin     | V+     | Input: Power supply, +24 V |
| Line connector | GND    | Ground                     |

## 17 EU Declaration of Conformity

An EU Declaration of Conformity was issued for the E-873.1AT in accordance with the following European directives:

- Low Voltage Directive
- EMC Directive
- RoHS Directive

The standards applied for certifying conformity are listed below.

- Safety (Low Voltage Directive): EN 61010-1
- EMC: EN 61326-1
- RoHS: EN 50581

# Glossary

## **Daisy chain**

Wiring diagram by which one controller is connected to the next in sequence (series connection principle). The first controller is connected directly to the PC. The additional controllers are always connected to the ones that precede them so that a chain is formed. The signal to and from a controller goes to the PC via the previous controllers.

## **Design Resolution**

The theoretical minimum movement that can be made. Design resolution must not be confused with minimum incremental motion. In indirect position measurement methods, values for drive screw pitch, gear ratio, motor or sensor/encoder resolution, for example, are included in the calculation of the resolution. Normally, the design resolution is considerably below the minimum incremental motion of the mechanics. In direct measurement methods, the resolution of the sensor system is specified.

## **Dynamics profile**

The dynamic profile includes the target position, speed, and acceleration of the axis calculated by the profile generator of the electronics for each point in time of motion. The calculated values are called "commanded values".

## **GCS**

Abbreviation for "General Command Set", the command set for electronics from PI. Piezo and servo controllers can be operated together with minimal programming effort thanks to GCS.

## **HID**

Abbreviation for "Human Interface Device". HID refers to an input or output device that is connected to the electronics and intended for manual operation. Depending on the electronics, the connection can be made via USB, analog or digital interfaces. Joysticks and gamepads are typical HIDs.

## **Limit Switch**

Each limit switch sends its signal to the controller on a dedicated line. The controller then interrupts the motion avoiding that the positioner moves until the hard stop and gets damaged. PI positioners have mechanical, noncontact optical or Hall-effect limit switches.

## **Linear Encoder**

The linear encoder is an incremental sensor for capturing changes in position. Signals from the sensor are used for axis position feedback. After the controller is switched on, a reference point definition must be performed before absolute target positions can be commanded and reached.

**Nonvolatile memory**

Electronics read-only memory. The default values for the parameters are loaded from the nonvolatile memory into the volatile memory when the electronics are started. The parameter values in the nonvolatile memory are also referred to as "Startup Values" in the PC software from PI.

**Reference Switch**

Many of the positioners are equipped with a direction sensing reference switch positioned approx. in the middle of the travel range. It is recommended to approach the reference switch always from the same direction to obtain best position repeatability.

Function: Optical, magnetic

**Sensor resolution**

The sensor can be the critical element of position resolution so it may be necessary to specify the sensor resolution separately. Rotary encoder: Impulses per screw rotation. Linear encoder: Smallest motion still detected by the sensor system.

**Travel range**

The maximum possible travel range is limited by the length of the drive screw. A possible gap between the limit switches determines the travel range.

**Volatile memory**

Electronics main memory. Parameters are stored in the volatile memory when the device is switched on. The parameter values in the volatile memory determine the current behavior of the system. The parameter values in the volatile memory are also referred to as "Active Values" in the PC software from PI.