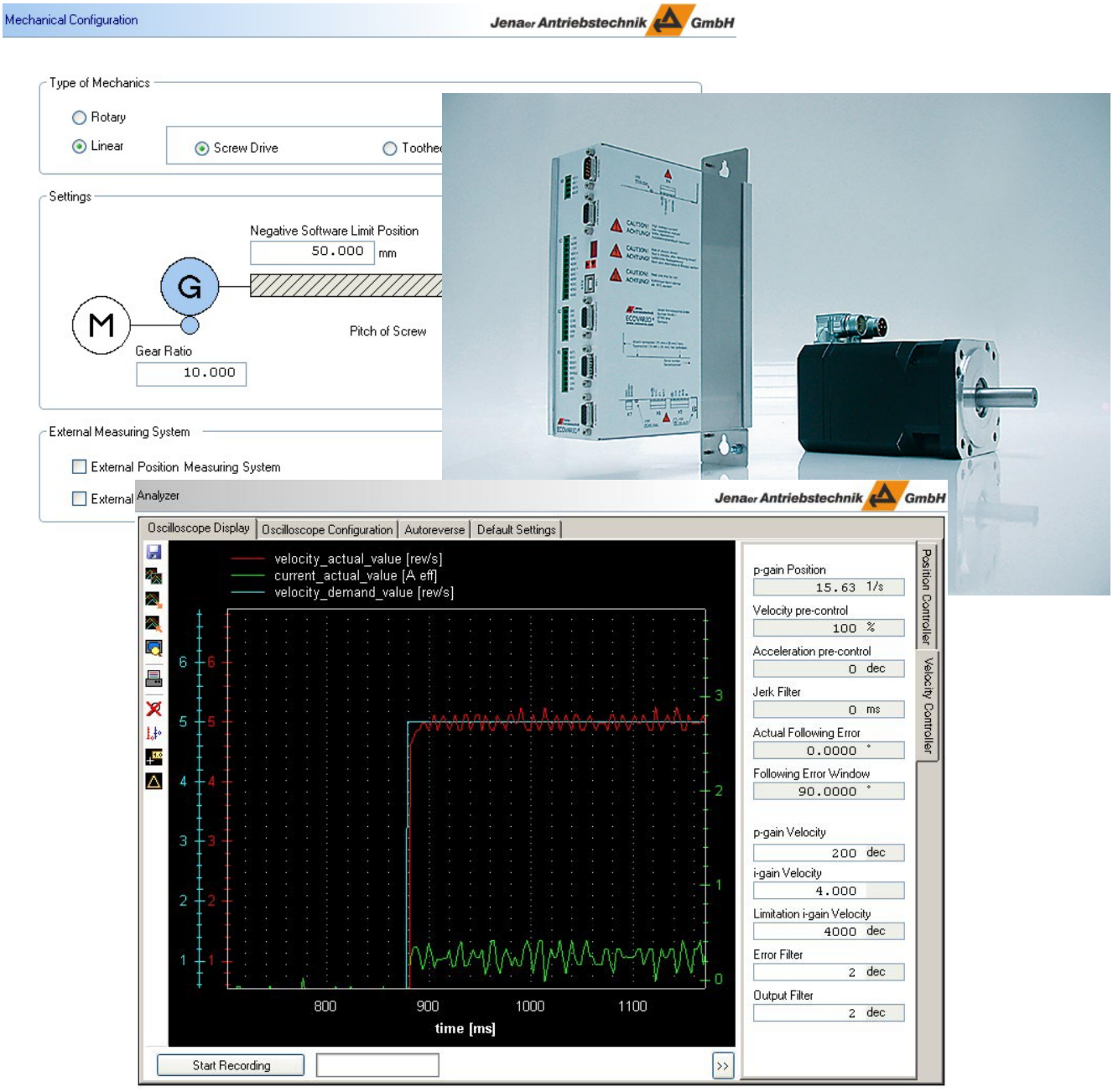
Jenaer Antriebstechnik GmbH



ECO Studio

Operation Manual

ECOVARIO®, ECOSTEP®, ECOMPACT®

Published editions:

Edition	Comment
Dec 2008	First english edition
Jan 2009	Revised english edition (english user interface)
April 2009	Revised english edition
June 2009	Revised english edition (new functions: firmware update, ECOSTEP54 support)
August 2009	Revised english edition (new functions: technology functions, ECOMiniDual support)
Nov 2009	Revised english edition for software version V1.9
Jan 2010	Revised english edition for software version V2.0
April 2010	Revised english edition for software version V2.1
August 2010	Revised english edition for software version V2.2
Feb 2011	Revised english edition for software version V2.3 (new functions: sequence editor, ECOVARIO 114 D support)
June 2011	Revised english edition for software version V2.4
August 2011	Revised english edition for software version V2.5
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1. First Steps

1.1 About this documentation

This documentation instructs you in the use of the operation software ECO Studio which is part of the sofware package ECO Suite. ECO Suite is used for commissioning, parameterization, operation and supervision of the servo drive families ECOVARIO® (incl. ECOMiniDual), ECOSTEP®, and ECOMPACT. The documentation consists of procedure parts which step by step describe commissioning, parameterization, operation and supervision tasks. Further there are reference tables which describe the function of the operation and display elements of the individual windows (see also *Context-sensitive F1 Help*).

During commissioning the installation manual of the respective servo amplifier and the contained safety precautions have to be observed!

Context-sensitive F1-Help

Topic-related help for the currently active window can be obtained by pressing the **F1 key**.

1.2 Features and Operation Modes

ECO Studio provides the following features:

- Parameterization of the servo amplifier families ECOSTEP®, ECOVARIO® (incl. ECOMiniDual) and ECOMPACT®
- Parameterization of the stepper motor amplifier ECOSTEP54
- Parameterization of the ETHERNET2CAN gateway
- Configuration of all parameters via PC
- Display of operation values
- Commissioning supported by wizards
- Explorer-like tree structure for easy menu guidance
- Oscilloscope function
- Loading and saving of parameter sets
- Offline parameterization
- Sequence programming
- Online help system

ECO Studio features two different modes:

- Basic mode
- Expert mode

In the basic mode, which is the default mode after installation, all functions required for commissioning and parameter setting are available.

The expert mode offers additional functions in communication setting, sequence programming, and in direct object editing.

	For an easy and fast commissioning it is recommended to use the available wizards which lead through all required steps.

1.3 Operating systems and hardware requirements

ECO Studio runs on all Windows® versions down to Windows®2000. The program can be easily deinstalled by using the Windows® function "Delete program".

To guarantee a perfect operation of ECO Studio your computer should fulfil the following requirements:

	Minimal requirements	**Recommended**
CPU	Intel® Pentium III, 800 MHz or compatible	Intel® Pentium IV, 2 GHz or compatible
RAM	256 MB	1 GB
Hard disk	min. 40 MB available	min. 100 MB available
Screen resolution	1024 x 768	1280 x 1024
Interfaces	1 x RS232 COM Port	USB 1.1 or 2.0 for ECOVARIO® CAN bus via PCAN Light dongle (PCAN-USB adapter and PCAN PCI card are supported as well)
Operating system	Windows®2000 SP2	Windows®XP SP3

As a prerequisite, .NET framework 2.0 has to be installed on the PC. If not yet available, you have the possibility to install .NET framework during the installation of ECO Studio. Please note that additional memory space is required on the hard disk in this case.

Communication between ECO Studio and the servo amplifier is possible via the fast CANopen interface as well as via the slower serial interfaces (COM1 to COM4, USB ports).

1.4 Software installation

ECO Studio is part of the program package ECO Suite. The software CD contains the complete program package. An installation wizard leads you through the installation procedure.

Note: If an ECO Studio version is already installed on the PC, this version has to be de-installed before a new installation of ECO Studio can be carried out. Therefore, in the Windows menu (**Start** on the bottom left) select **Settings** -> **System Control** and the **Software** icon.

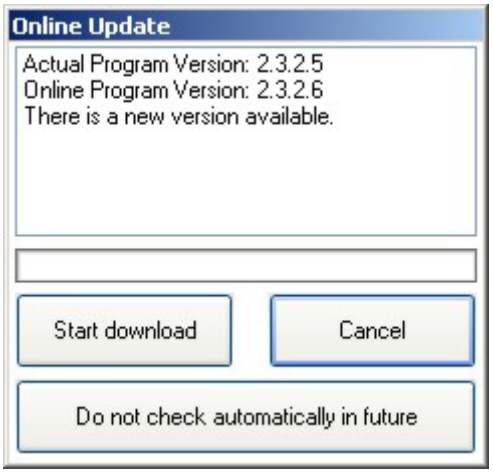
Note for Windows Vista and Windows 7: On PCs with the operating systems Windows Vista and Windows 7 the ECO Studio installation, the update function and the rollback function have to be carried out under full administrator rights.

If the autostart routine on the PC in use is switched off, the installation can be started by the file *setup.exe* contained in the root directory of the CD.

Online software update

After the initial installation has been completed, an online software update is possible via the internet.

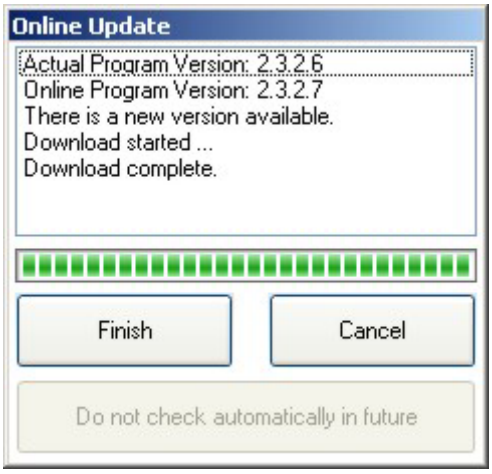
Establish a connection between the PC and the internet and start ECO Studio (cf. chapter 1.5). If the automatical check for updates is activated (default setting) ECO Studio displays the **Online Update** window if a new software version is available for download. If you do not wish an automatical check for updates in the future you can deactivate it by clicking **No automatic check in the future**.



If a new version is available you can update your installation by clicking **Start Download**.

When the message "Download finished" is displayed, click **Finish**.

Note for Windows Vista and Windows 7: When the message "Download aborted" is displayed, check whether you have full administrator rights. If not, no online software update is possible.



Confirm the upcoming window **ECoUpdate Completion** by clicking **Quit**.
Now you can start ECO Studio again.

Note: If the automatic check for updates is deactivated (setting via menu item **Settings\Automatical Check for Updates**) you can also check manually whether updates are available. Click the symbol displayed in the status bar of the computer with the right mouse button. Select the option **Check for Updates**.

The upcoming window **Online Update** displays whether a new software version is available for download. Further proceedings see above.

Roll back to former software version

If it should be necessary to roll back to a former software version of ECO-Studio, right-click the icon displayed in the status bar of the computer. Select the option **Rollback Old Version**. In the window **Rollback Version** the former ECO Studio versions available on the PC are displayed. Select the required version and confirm with **OK**. Confirm the upcoming window **ECoUpdate Completion** by clicking **Quit** after completion. The software is restarted in the selected former version. In the **Online Update** window click **Cancel**.

1.5 Starting ECO Studio

During ECO Suite standard installation the following symbol can be created on the desktop. The symbol can be used to start ECO Studio:

A further possibility to start the program is via the Windows® starting menu.

Therefore, click on the Windows® **Start** button on the left bottom corner of your desktop

And select **Programs** -> **JAT** -> **ECO Suite** -> 

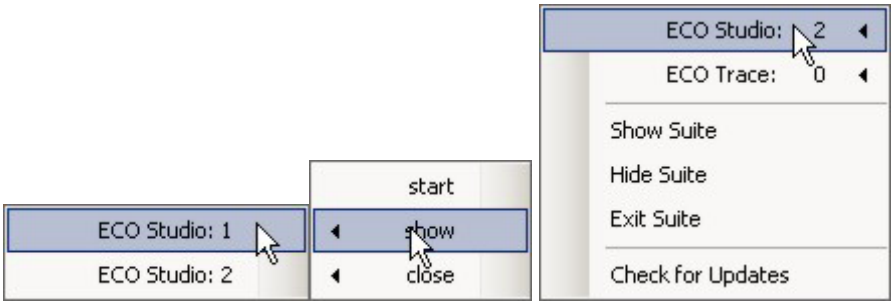
.

If ECO Suite is already running on your PC (symbol shown in the status line of your PC), you have the possibility to administrate several ECO Studio sessions via ECO Suite. This is useful e.g in case of multi-axis systems.

After right-clicking the symbol the following functions are available:

- Starting a new ECO Studio session
- Starting a new ECO Trace session (ECO Trace is a software tool which provides a user interface to easily display and read out the operational status and the parameter data of the servo drive. The collected data can be sent to the specialists of Jenaer Antriebstechnik and thus can give important hints for trouble shooting or for the optimization of your drive system. ECO Trace comes with a separate Online Help system which describes function and operation.)
- Displaying ECO Studio or ECO Trace sessions already running
- Closing ECO Studio or ECO Trace sessions
- Checking whether a new software version is available for update.

Furthermore, control elements are provided which allow either to show or to hide the ECO Suite user interface and to exit ECO Suite.



1.6 Operation philosophy

ECO Studio comes with a Windows user interface which is divided into the following areas:

- Title bar
- Menu bar
- Navigation area
- Main area
- Control buttons to switch on and off the drive
- Display area for current device status
- Message area
- Status bar

Furthermore, this section describes special features of the controls.

Title bar

The ECO Studio title bar displays the following values:

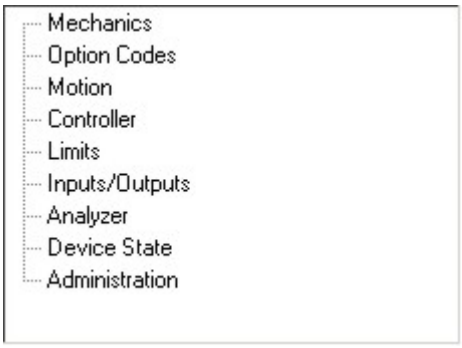
- ECO Studio software release
- Servo amplifier or stepper amplifier series
- Name of the axis (in parentheses, if a name has been assigned)

Menu bar

Load/Save	Full Screen	Communication	Documentation	Starting a new ECO Studio session
Controller Data				ECO Trace session
Load Project		Device Configuration	Information Overview	
Save Project	Edit	Mechanical Configuration		
Exit	Expert Mode			
	Language			

Note: If the connection to a 4-axis stepper motor amplifier ECOSTEP54 has been established, the menu bar additionally contains the item **ECOSTEP54**. With the help of this item the selection of the respective axis is done which is intended to be parameterized using ECO Studio.

Navigation area

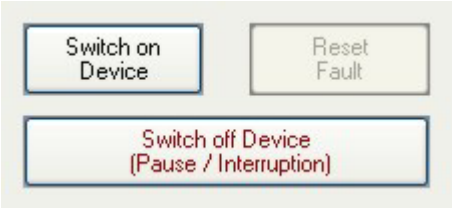


After the connection to the servo amplifier has been established the topic groups are displayed in the navigation area in the top left.
The navigation area is used to select the functions for configuration, control and diagnostics of the servo drives. The topic groups displayed in the navigation area depend on the chosen mode (basic mode, expert mode).

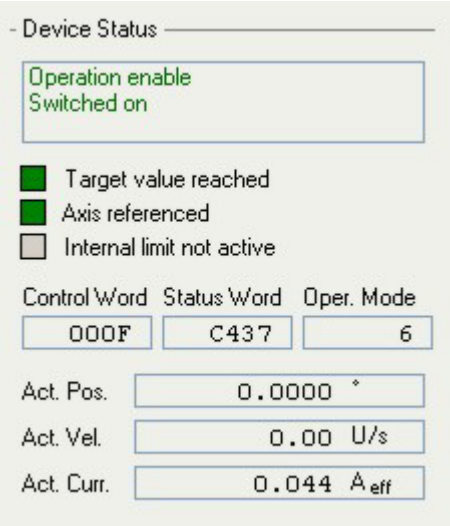
Main area

In the main area of the ECO Studio user interface the function windows related to the topics selected in the navigation area (or the menu bar) are displayed. After ECO Studio has been started the window **Communication: Connect/Disconnect** is displayed.

Control buttons to switch on and off the drive



Display area for current device status



The meaning of the coloured boxes is as follows:

Taget value	green = Setpoint reached yellow = Setpoint not reached
Referenced	green = Axis is referenced, i.e, homing procedure has been completed successfully red = Axis is not referenced
Limit	orange = Limit reached, i.e., axis has reached software limit position or hardware limit position grey = Limit not reached

Below the coloured boxes the status word (**Status Word**) and the control word (**Control Word**) are displayed as hexadecimal numbers. In the navigation area, the topic group **Device Status** leads to a bit by bit representation of the status word and of the control word. Furthermore, the control word can be edited there.

Another field in the display area for the current device status shows the **Operating Mode** of the servo amplifier. Normally, the operating mode is set automatically.

1	Position mode with profile generator (standard operating mode after initialization)
3	Velocity mode with position control and following error tracing
-3	Velocity mode without position control, no following error tracing
-4	Velocity mode with position control, no following error tracing
6	Homing mode
7	Interpolated mode with command (ECOVARIO® and ECOMPACT only)
	Additionally for ECOVARIO® only:
4	Customer specific mode for direct current setpoint setting
-1	If synchronous mode is activated: same as operating mode 7 otherwise direct position setting without internal interpolation
-10	Traversing mode
-21	Fine position mode

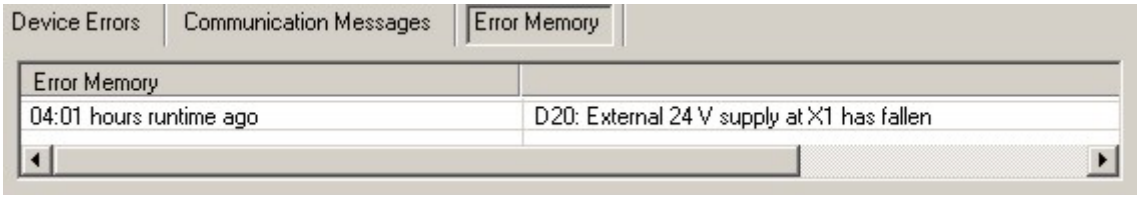
Furthermore, the following values are shown:

- Actual position
- Actual velocity
- Actual current.

Message area

In the bottom area of the basic window the messages concerning the operational status or the error status of the drive are displayed. The messages are divided into the following categories:

Device Errors (ECOVARIO®, ECOSTEP®, ECOSTEP54, ECOMPACT®, ECOMiniDual)	Error messages concerning the hardware or the software of the servo amplifier
Communication Messages	Error and status messages concerning the communication between PC and servo amplifier
Application Errors	Error messages concerning the ECO Studio software. This category is only shown if a respective error message comes up.
Error Memory (ECOVARIO only)	The last up to 8 error messages are stored in the non-volatile memory of the servo amplifier. The error messages can be displayed here for diagnosis purposes (see below) and are still available after switch-off of the servo amplifier.

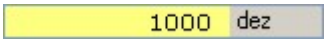


Status bar

In the status bar type and status of the connection between PC and drive system are shown.

Special features of the controls

The ECO Studio controls and display elements are implemented according to the Windows® standard. A speciality has to be noticed with the **edit boxes**. Values and parameters are entered using the number keys on the keyboard.

During the entry the edit box is highlighted in yellow: 

The entries get only valid after pressing **Enter** or **Return**.

The valid entry is then displayed on a white background: 

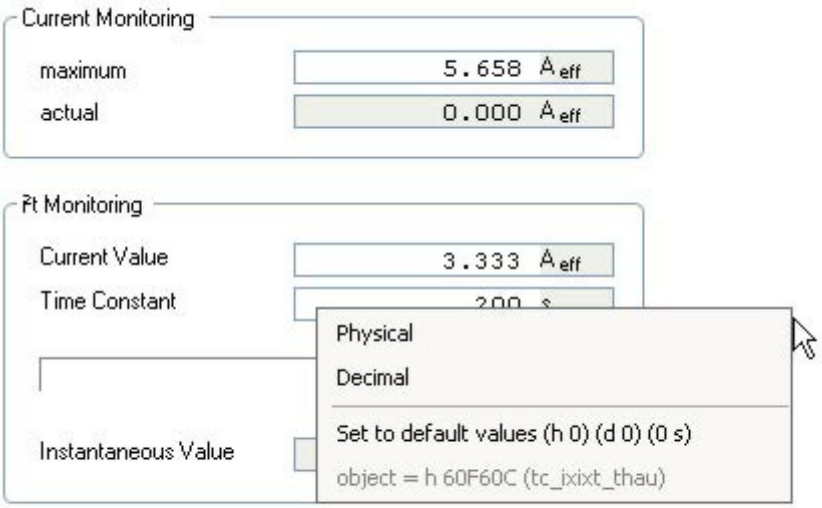
Entries to the edit boxes either can be done in the insert mode or in the overwrite mode. Switching between the two modes is via the **Ins** key on the keyboard or by means of the menu bar (**Settings/Edit** menu) respectively.

Pure display fields without an entry possibility are shown on a light grey background colour.

If you move the mouse pointer to a display field, the pointer changes the appearance: 

In some cases the same parameters appear in different windows because they can be assigned to multiple functions. If the parameter is changed in one window, this change is taken over to the other relevant windows automatically.

By right-clicking, the representation of the value can be changed in edit boxes and display fields. Depending on the parameter, the representation is switchable between physical representation in common units or decimal representation. Furthermore, the parameter can be reset to the default value and the object number behind the parameter can be retrieved.


Current Monitoring
maximum
5.658 A eff
actual
0.000 A eff
I²t Monitoring
Current Value
3.333 A eff
Time Constant
Physical
Decimal
Set to default values (h 0) (d 0) (0 s)
object = h 60F60C (tc_ixixt_thau)
Instantaneous Value

1.7 Keyboard Shortcuts

The following ECO Studio functions can be reached by keyboard shortcuts:

	Basic mode	Expert mode
Pause	STOP button (switch off device)	
F1	Context-sensitive Help	
F4	Administration	Control\Administration
F5	Motion\Positioning Mode	Control\Motion\Positioning Mode
F6	Motion\Velocity Mode	Control\Motion\Velocity Mode
F7	Motion\Torque Mode	Control\Motion\Torque Mode
F9		Control\Motion\Expert Mode
Alt+F	For oscilloscope function: View\Full Screen	
Ctrl +F4	File/Load/Save Controller Data	
Ctrl +F5	Controller\Position Controller	Configuration\Controller\Position Controller
Ctrl +F6	Controller\Velocity Controller	Configuration\Controller\Velocity Controller
Ctrl +F7	Controller\Current Monitoring	Configuration\Controller\Current Monitoring
Ctrl +C	Sequence Editor: Copy Sequence	Control\Sequence Programming\Sequences: Copy sequence Sequence Editor: Copy Sequence
Ctrl +V	Sequence Editor: Insert Sequence	Control\Sequence Programming\Sequences: Insert sequence Sequence Editor: Insert Sequence
Del	Sequence Editor: Delete Sequence	Control\Sequence Programming\Sequences: Delete sequence Sequence Editor: Delete Sequence
Ctrl +Z	Sequence Editor: Undo	
Ctrl +E		Configuration\Inputs/Outputs\Encoder (not ECOSTEP)
Ctrl +H	Motion\Homing	Control\Motion\Homing
Ctrl +K	Controller\Commutation	Configuration\Controller\Commutation
Ctrl +O	Analyzer\Oscilloscope Display	Analyzer\Oscilloscope\Oscilloscope Display
Ctrl +I	Administration: select INIT all Parameters	Control\Administration: select INIT all Parameters
Ctrl +Alt+I	Adminstration: execute INIT all Parameters	Control\Adminstration: execute INIT all Parameters
Ctrl +R	Administration: select RESET	Control\Administration: select RESET
Ctrl +Alt+R	Administration: execute RESET	Control\Administraton: execute RESET
Ctrl +S	Administration: select SAVE all Parameters	Control\Administation: select SAVE all Parameters
Ctrl +Alt+S	Administration: execute SAVE all Parameters	Control\Administation: execute SAVE all Parameters
Ctrl +1	Only for ECOSTEP54: switching to axis 1	
Ctrl +2	Only for ECOSTEP54: switching to axis 2	
Ctrl +3	Only for ECOSTEP54: switching to axis 3	
Ctrl +4	Only for ECOSTEP54: switching to axis 4	
Ctrl + 1...8		For all devices with the exception of ECOSTEP54: Analyzer\User-defined Variables masks 1...8
+	Analyzer\Oscilloscope Configuration: display object list	Analyzer\Oscilloscope\Oscilloscope Configuration: display object list
Ins	Switch on/off insertion mode for edit boxes	

1.8 Establishing the communication between the servo amplifier and the PC

After starting ECO Studio the window **Communication: Connect/Disconnect** is displayed. Here, you can configure the connection between the servo amplifier and the PC. The implementation of the interface hardware on the servo amplifier is described in the respective installation manual.

1. In the **Interface** selection list box select the desired interface:

RS232	In the **Parameters** group box, specify the serial interface of the PC (default: COM1) and the baud rate (default: 9600 Baud). If necessary, the type of RS232 transmission can be modified by switching off the **Echo**. Normally, however, the transmission is done with Echo (default setting). For a connection to an ECOSTEP in *bootloader mode* please observe the note below this table.
RS485	In the **Parameters** group box, specify the serial interface of the PC (default: COM1) and the baud rate (default: 9600 Baud).
CAN via USB Dongle	Set the CAN bus baud rate. ***Note:*** If in the menu item **Settings** the option **Automatic Baud Rate Search** is activated, the baud rate setting is done automatically. Make sure that the USB port is equipped with the appropriate dongle *and that the latest versions of the associated drivers are installed correctly*. More information is provided on the ECO software CD-ROM.
CAN via PEAK Parallelport-Dongle	Set the I/O address of the parallel port at the PC and the desired interrupt priority (IRQ). The values 16 ... 38 are virtual IRQs. Set the CAN bus baud rate. ***Note:*** If in the menu item **Settings** the option **Automatic Baud Rate Search** is activated, the baud rate setting is done automatically. Make sure that the parallel port is equipped with the appropriate dongle *and that the latest versions of the associated drivers are installed correctly*. More information is provided on the ECO software CD-ROM. Make sure that your PC permits the execution of interrupts at the parallel port. Check the settings of your PC under "Settings/Control Panel/Administration/Computer Administration". Here, in the left column select the entry "Device Manager" where the ports (COM and LPT) are listed. In the "Port Settings" tab select the parallel port used for CAN communication and select in the "Resource Method" group box the entry "Use each interrupt assigned to the port".
CAN via PEAK PCI	Set the CAN bus baud rate. ***Note:*** If in the menu item **Settings** the option **Automatic Baud Rate Search** is activated, the baud rate setting is done automatically. Also PCI Express cards are supported.
CAN via PEAK PCI2	Set the CAN bus baud rate. ***Note:*** If in the menu item **Settings** the option **Automatic Baud Rate Search** is activated, the baud rate setting is done automatically. Also PCI Express cards are supported.
USB direct	For ECOVARIO: By specifiying the respective USB port, select an ECOVARIO connected via USB. Please note that as a prerequisite for using the USB port the respective USB drivers for ECOVARIO have to be installed on the PC. Proceed according to the manual „USB driver installation ECOVARIO". Drivers and manual are provided on the ECO software CD-ROM or via www.jat-gmbh.de. For ECOSTEP: Because the ECOSTEP does not provide a USB interface, an adapter cable is available which transforms USB to RS232. Please note that as a prerequisite for using the adapter the respective driver „ECO2USB" has to be installed on the PC. The driver can be found on the ECO software CD ROM or via www.jat-gmbh.de. Activate the check box **ECO2USB**. Specify the baud rate of the RS232 interface (default: 9600 Baud).

ETHERNET	The IP address either can be entered explicitly or by clicking **search** (c.f. step 2) all reachable servo amplifiers at the node are listed.
ETHERCAT	In the **Parameters** group box, select the **Network Adapter** to be used. All adapters available on your PC are listed. The detailed designation of the card is shown as a tooltip.
OFFLINE, Gen. Data Set	Generate a local data set, without connection to a servo amplifier, cf. Chap. 9

	***Specialty:* Connection to an ECOSTEP® in bootloader mode** A connection to an ECOSTEP® which is in bootloader mode can only be established via the RS232 interface. On the device the bootloader mode is displayed by means of the blinking red ERR LED on the front side. In this case the check box **ECOSTEP Bootloader mode** in the group box **Parameters** has to be set. In deviation to the procedure described in the following explicity specify the **ID** of the required ECOSTEP and click **connect**. The connection is established in the bootloader mode (which is displayed in the title bar) and the **Load Firmware** window is shown. As soon as the load procedure is finished successfully the bootloader mode is left and ECO Studio automatically connects to the servo amplifier in normal mode with the specified connection parameters. If the check box **ECOSTEP Bootloader mode** is set and you make an attempt to establish a connection to an ECOSTEP which is *not* in the bootloader mode, this is rejected.

2. Click on **search**. The servo amplifiers within reach via the selected interface are displayed. If the servo amplifier is equipped with an older firmware version, the displayed data might be incomplete. If the servo amplifier type is not displayed, it has to be specified explicitly in the dialog window.

3. Select the required servo amplifier in the list by clicking the respective entry. The connection is established by means of a double-click in the respective **ID** field in the list or by clicking **connect**.

	***Connection to multi-axes devices*** At the 2-axes servo amplifiers ECOMiniDual and ECOVARIO 114 D each axis is handled like a 1-axis servo amplifier, i.e. a separate **ID** is assigned to each axis. If you intend to parameterize both axes in parallel, start a separate ECO Studio session for each axis and establish the connection to the respective **ID**. The 4-axes stepper motor amplifier ECOSTEP®54 is addressed completely, i.e. all axes, via *one* ID. After establishing the connection the selection of the axis to be parameterized can be done via the separate menu item **ECOSTEP54**.

4. An application specific **Name** can be assigned to each servo amplifier. This gives you the possibility to specifiy e.g. in multi-axis systems which axis the servo amplifier is assigned to. In case that there has not yet been assigned a name to the servo amplifier (**Name** field in the list entry is empty) you now can enter a name in the field. Maximum length is 12 characters. Changes can be made to the name at any time.

	For a permanent storage of the name in the servo amplifier, an explicit action is necessary in the ECOSTEP®. The storage is initiated in the navigation area under **Administration**. In the ECOVARIO®, ECOMiniDual and ECOMPACT® the storage of the entered name is done automatically.

5. The option **Connection Guard** is activated by default for all interfaces. It is not activated in the offline mode. If the option is deactivated no messages about connection interruptions are displayed.

After the connection has been established successfully, ECO Studio displays the features and the technical data of the servo amplifier in the **Information Overview** window. This window can also be called up via the menu item **Info**.

Particularities concerning the Ethernet2CAN Gateway

The gateway serves as a coupler of CAN networks and Ethernet networks, e.g for connection of a PC or a controller to a servo amplifier series ECOVARIO®, ECOMPACT® or ECOSTEP® (without an own Ethernet interface) via Ethernet.

By default, the gateway parameters are set as follows:

Parameter	Value
CAN Node ID	2
Baud rate	1 Mbit/s
IP address	192.168.18.20
Ethernet gateway address	0.0.0.0
IP mask	255.255.255.0
Process data destination address	255.255.255.255
Process data destination port	50.000

For modifying the parameters of the *ETHERNET2CAN Gateway* connect the gateway via the Ethernet interface or the CAN interface (via an appropriate dongle), respectively (see below), to the PC. After the connection has been established, the window **Baudrate and ID** is displayed.

The Ethernet-specific settings can be made by means of the object *0x2FB2_dpo18_settings* with the respective sub indexes under **User Defined Variables**. The object is described in detail in the documentation of the Ethernet2CAN Gateway.

Under **Administration** the settings can be saved and the gateway can be restarted.

1.9 Parameterizing multi-axes systems

ECO Studio can be used for parameterization of multi-axes systems. In principle, it can be differentiated between the following proceedings:

- Calling several ECO Studio sessions by means of the ECO Suite
- Switching between all servo amplifiers which can be reached via the selected interface within one ECO Studio session
- Switching between the individual axes of the 4-axis stepper motor amplifier ECOSTEP54

Calling several ECO Studio sessions by means of ECO Suite

After right-clicking the ECO Suite icon in the status bar of the PC the following functions are available to administrate ECO Studio sessions:

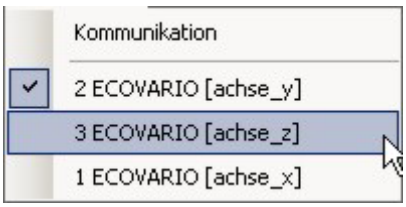
- Starting a new ECO-Studio session
- Displaying ECO-Studio sessions already running
- Closing ECO Studio sessions

The sessions are completely independent of each other, the connection between PC and servo amplifier can be established via different communication interfaces. The interface type is specified for each session individually.

Switching between all servo amplifiers which can be reached via one interface

If the PC can reach several servo amplifiers via one communication interface (e.g. Ethernet), the active connection can be switched from one servo amplifier to another within *one* ECO Studio session.

When in the **Connection/Communication** window the servo amplifiers are searched which can be reached via the selected interface, they are also listed with their type and name assigned in the pop-up menu under **Connection**:



The same goes for servo amplifiers at this interface where a connection already has been established to. The connection which is currently active is displayed by means of a checkmark in front of the entry. Switching to another servo amplifier is achieved by selecting an entry in the pop-up menu **Connection**.

During the switching procedure any function window can be active in the main area of the ECO Studio user interface. The window remains active after switching has been accomplished (provided that the servo amplifiers supports the function) and is filled with the data of the servo amplifier now active. Thus, e.g. the function **File/Load/Save Controller Data** can be applied to several servo amplifiers selected sequently via the pop-up menu **Connection**.

Switching between the individual axes of the stepper motor amplifier ECOSTEP54

The stepper motor amplifier ECOSTEP54 can control 4 axes. By means of the menu item **ECOSTEP54** the active connection can be switched from one axis to another within *one* ECO Studio session. In some windows the parameters for all 4 axes are displayed in parallel, e.g. in the window **Device Status**, in the window **Output Mode** as well as for the **Digital Inputs and Outputs**.

2. Commissioning

2.1 Commissioning Procedure

The following overview of the commissioning procedure of your servo drive system should serve as a „central theme" when working with ECO Studio. The references lead you directly to the respective topics.

1. After the connection between the servo drive (ECOVARIO® incl. ECOMiniDual or ECOSTEP®) and the PC has been established (c.f. Chapter 1.8), select the **Device Configuration** wizard in the menu bar under **Wizards** and work through it (Chapter 2.2).

   Note: With ECOMPACT this step is not required because the data is already preset by the manufacturer. Begin with step 2 in this case.

   Note: The wizard is not available for the 4-axis stepper motor amplifier ECOSTEP®54. Therefore, load the motor data set (.dat file) by using the **File/Load/Save Controller Data** menu item (Chapter 2.2.1).

2. In the menu bar under **Wizards** select the **Mechanical Configuration** wizard and work through it (Chapter 2.3). For ECOSTEP54 carry out the settings in the navigation area under **Mechanics**.

3. In addition to the settings made in the Device Configuration wizard (**OptionCodes**) there are some more parameters to specify the behaviour of the drive system in case of an error. In the navigation area select the topic group **Option Codes**. Check the default settings and, if necessary, change them (Chapter 2.4.1).

4. During commissioning of the drive system the maximum current that is available to the motor at the power stage output should be reduced (Chapter 2.4.3).

5. Before the first movements are carried out as a part of the commissioning procedure, it is necessary to put into operation the emergency stop function of the machine (Chapter. 2.4.4).

6. Now you can switch on the axis (Chapter 2.5).

7. In reversing operation (Chapter 2.6.1) monitor the behaviour of the drive with the help of the oscilloscope function (Chapter 2.6.2, Chapter 2.6.3). If necessary, optimize the controller parameters (Chapter 3). This step is not relevant for ECOSTEP54.

8. In most applications a zero reference point has to be established which serves as a reference for the position controller. This position is called the reference position and has to be determined after every switch-on of the servo amplifier. This happens in the so-called homing procedure (Chapter 2.7).

9. Save parameters (Chapter 2.8).

2.2 Initial Configuration of the Drive System

If you wish to initially configure your drive system (ECOVARIO®, ECOMiniDual or ECOSTEP®) the easy-to-handle device configuration wizard leads you through the necessary steps.

	During the device configuration, it is recommended to have the ordering key of the device at hand. The coding of the ordering key informs about the features and components of the motor. The ordering key is printed on the type label of the motor.

In the menu bar, select **Wizards\Device Configuration**.

1. **Servo Amplifier**: If a connection has been established to the servo amplifier, the data is retrieved from the servo amplifier and displyed here. In this case no entries are necessary here and you can proceed to the next step by clicking **>>**.

2. **Motor**: With the help of the selection list boxes specify the motor series in use. Your specifications are transfered to the field **Ordering Key**. Click **>>**.

3. **Parameters**: Specify the data of the **Brake**, if any. The type of brake is coded in the respective position of the ordering key. "0" means no brake. Specify the parameters of the built-in **Encoder**. You can either enter the code of the respective positions of the ordering key directly or you can specify the encoder with the help of the selection list boxes. Click **>>**.

4. **Application**: If you would like to use the switches in the group boxes **Limit Positions** and **OptionCodes**, confirm by clicking the respective check box. If you use an ECOVARIO®, in the selection list box **DC Link Voltage** the voltage which comes nearest to the measured DC link voltage is automatically selected. Normally, there is no need to change this. If you use an ECOSTEP®, select the value of the **DC Link Voltage** manually. Click **>>**.

5. **Settings**: Please observe that during transmission of the configured data the data formerly contained in the servo amplifier will be lost. If you want to preserve this data you should save them here before the new data specified in this wizard will be transmitted to the servo amplifier.

6. **Send**: Click  . The motor data set is transmitted to the servo amplifier. A progress bar shows the progress of the transmission. Subsequently, a restart of the device is carried out.

7. The wizard has been completed now. Click  .

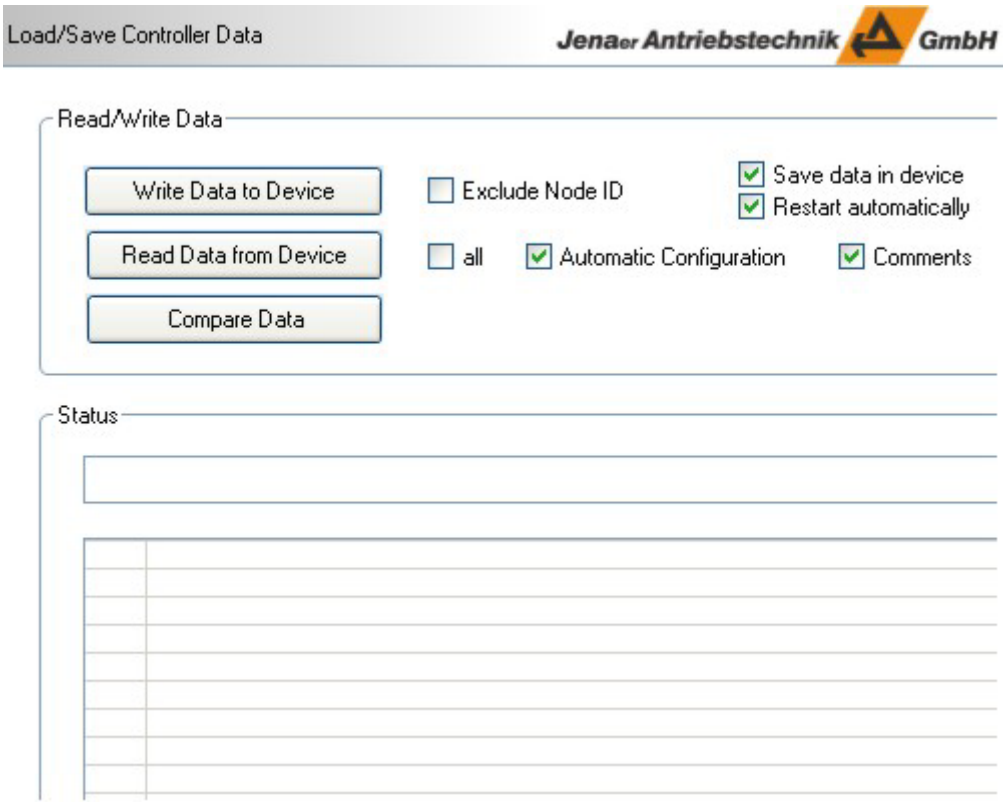
2.2.1 Option: Writing data into servo amplifier + reading data from servo amplifier

Writing motor data set (.DAT) into servo amplifier

For commissioning of the drive system it is necessary in a first step to load the appropriate motor data set into the servo amplifier. Thus, the relevant objects are preset with values appropriate for the motor. Normally, this is accomplished by the Device Configuration wizard (**Wizards/Device Configuration**). However, it is also possible to load the motor data set, the so-called „DAT file", directly.
You can either selectively load the data set into one servo amplifier or you can start loading the same data set to several servo amplifiers (multi-load). ***Multi-load is only possible for servo amplfiers of the same type which control motors of the same type.***

* for *one* servo amplifier:

For loading the motor data set an active connection to the servo amplifier has to be established. Then, select **File/Load/Save Controller Data** in the menu bar.



⚠	During writing of the data set into the device undefined states concerning motor control might occur. Therefore, it is highly recommended to carry this out only when power supply of the connected axes is switched off. Check the status of the axes and if necessary switch power off.

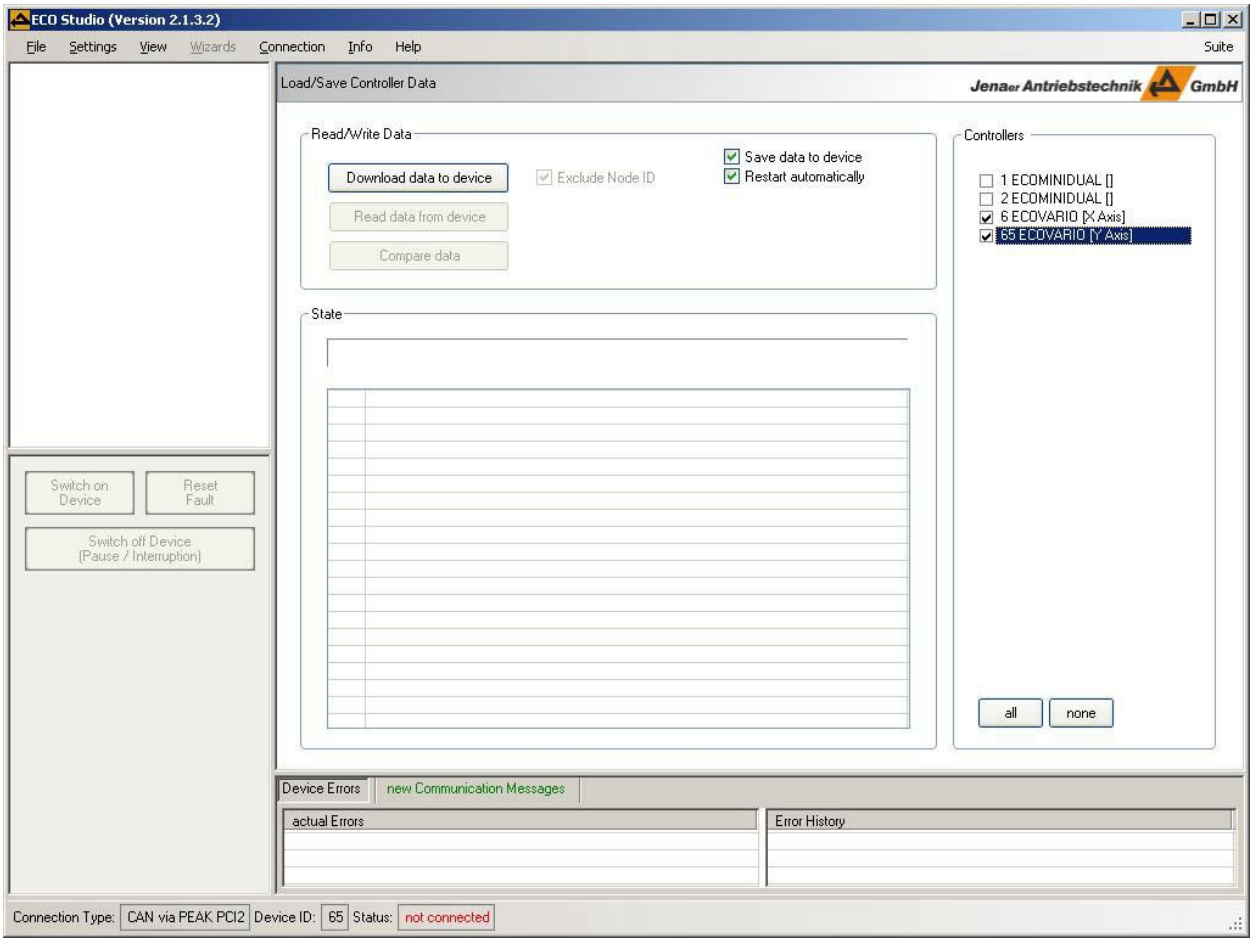
1. Click **Write Data into the Device**. Now, the motor data set appropriate for the servo amplifier, motor type and supply voltage used can be selected. The data sets for the individual motors are filed in a preselected folder of the ECO Studio installation. The latest .DAT files can also be downloaded from our homepage www.jat-gmbh.de. Normally, the checkboxes **Save Data in Device** and **Restart automatically** should be set.

   Notes:
   - The selection dialog for the .DAT files always offers the folder selected last.
   - Data sets for ECOVARIO 114 and 114 D can be found in the subdir. ECOVARIO100.

2. Now the data is transmitted to the servo amplifier. The progress can be seen in the **Status** field. If the respective checkboxes are checked the data is saved in the device afterwards and the servo amplifier **Restarts automatically**.

* for *several* servo amplifiers:

For loading the motor data set to several servo amplifiers of the same type which can be reached via the connection interface (when clicking **search** in the connection window), *no* active connection must be established. Select **File/Load/Save Controller Data** in the menu bar. On the right window area **Controllers** select the devices where the motor data set should be loaded to. The check boxes **Save data to device** and **Restart automatically** have to be set as well (default setting).

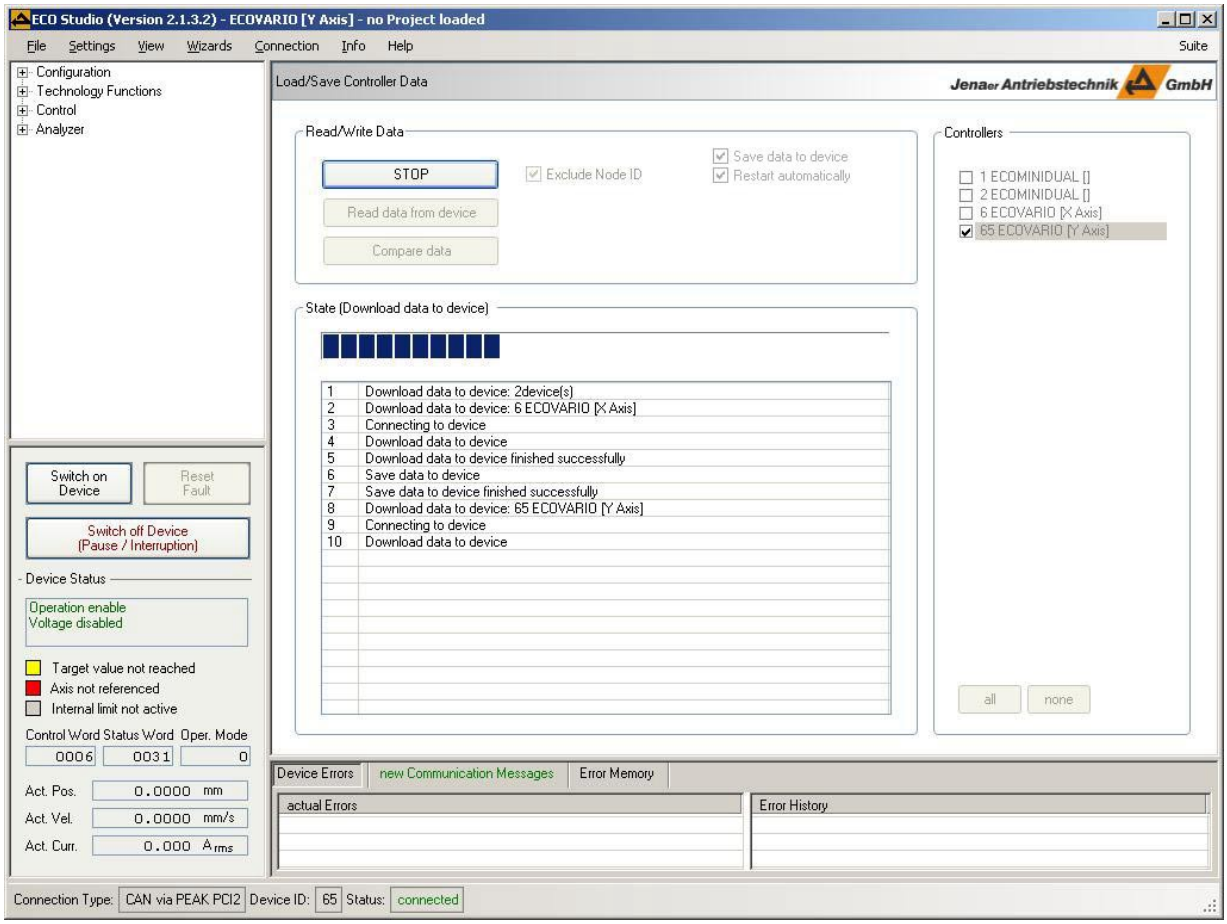


⚠	During writing of the data set into the device undefined states concerning motor control might occur. Therefore, it is highly recommended to carry this out only when power supply of the connected axes is switched off. Check the status of the axes and if necessary switch power off.

1. Click **Write Data into Device**. Now, the motor data set appropriate for the servo amplifier, motor type and supply voltage used can be selected. The data sets for the individual motors are filed in a preselected folder of the ECO Studio installation. The latest .DAT files can also be downloaded from our homepage www.jat-gmbh.de.

   Note: The selection dialog for the .DAT files always offers the folder selected last.

2. Now the data is transmitted sequentially to the servo amplifiers selected in the window area **Controllers**. Therefore, ECO Studio establishes the connection to the respective servo amplifier. The progress is displayed in the window area **Status**. If required, the loading procedure can be stopped at any time (**STOP** button). After the loading procedure is finished, the servo amplifiers are restarted automatically.



Read motor data set from servo amplifier

Reading the motor data set from the servo anplifier can e.g. make sense if several identical axes have to be parameterized. In this case, the parameterization can be done for one axis and the data set can be copied to the other axes.
For reading of the data set stored in the servo amplifier select **File/Load/Save Controller Data** in the menu bar.

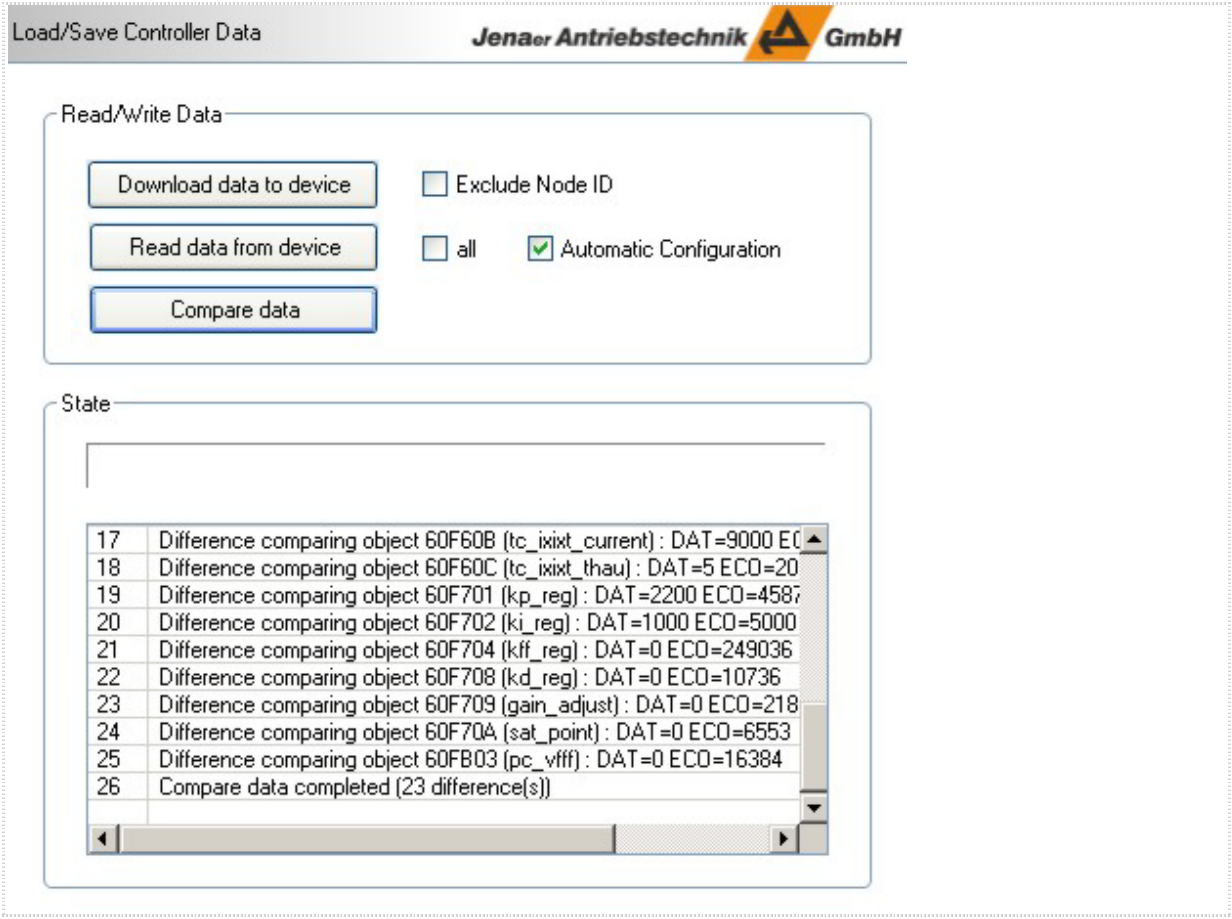
Note: If the data is copied to several axes you can check the check box **Exclude Node ID** in order to prevent identical node IDs within one network.

Note: In order to make the evaluation of the data which has been read out easier, the names/meanings of the objects can be automatically inserted into the file in addition to the object numbers. Activate the **Comments** checkbox.

Click **Read Data from the Device**. Specify a folder and a filename (".DAT") where the data should be written to. Confirm with **Save**. If **Automatic Configuration** has been deactivated or, in case of ECOSTEP® servo amplifiers, is not possible, enter the configuration file (.CFG) to be used now. Only the files relevant for the servo amplifier type in use are shown in the dialog. By activating the **all** checkbox you have the possibility to query all objects saved in the servo amplifier regardless of a selected configuration file. Normally, however, **Automatic Configuration** is recommended for standard devices.

Compare motor data sets

In the menu **File/Load/Save Controller Data** the function **Compare Data** offers the possibility to compare the data stored in the servo amplifier with an external data set ("DAT file"). After clicking **Compare Data** select the external data set (".DAT"), which is intended to be compared to the data stored in the servo amplifier.
The result of the comparison is shown in the **State** list. Detected differences and lacking definitions are listed objectwise. Double-clicking a specific entry in the list will show the complete text of this entry.



Log state list

If required, the state list can be logged to a file for further evaluation. With the right mouse button click into the displayed **State** list and select in the context menu **Log State List**. Enter a file name. A text file with the appendix .log is generated.

2.3 Adaptation to the mechanics

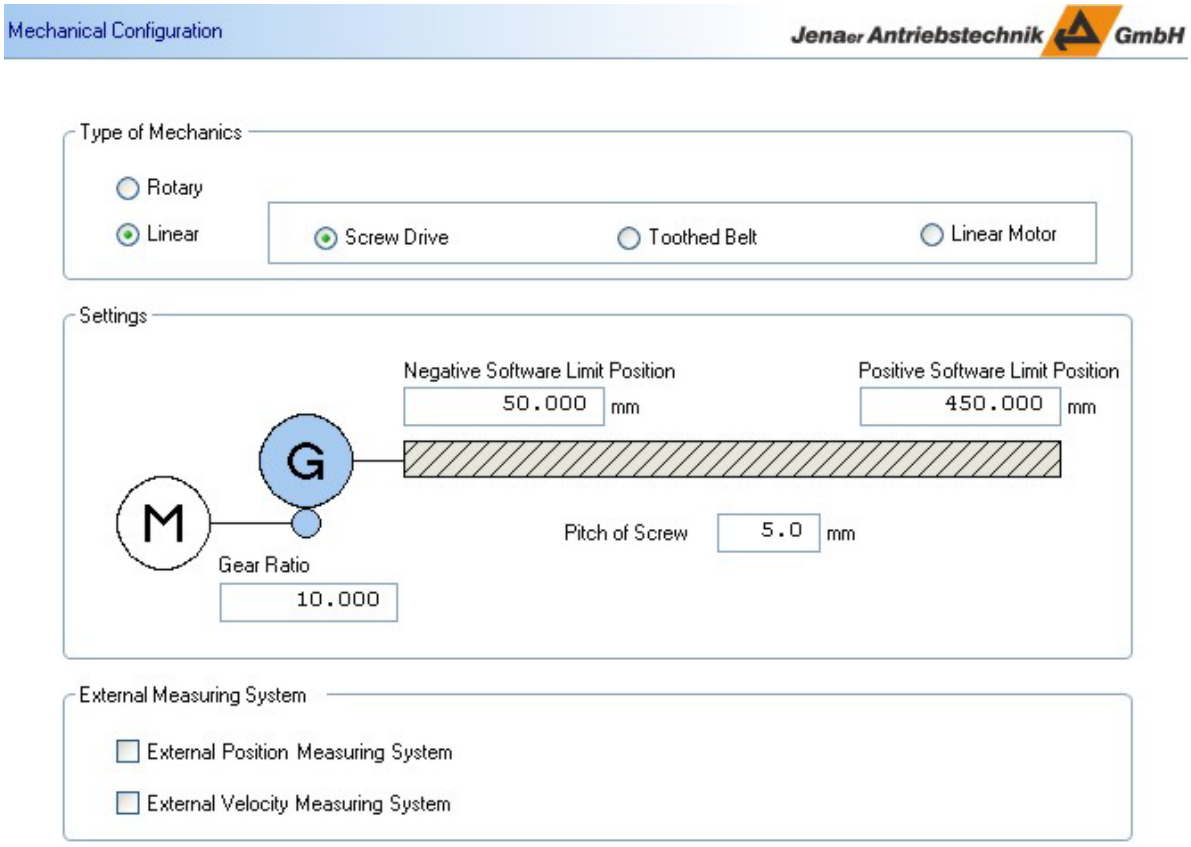
Subsequently to the device configuration now the mechanical components (e.g. gear, toothed belt, screw) are taken into consideration. The easy-to-handle **Mechanical Configuration** wizard leads you through the necessary steps. As an alternative, the mechanical parameters can also be entered via a dialog window, e.g for ECOSTEP54 (see below).

Mechanical configuration wizard

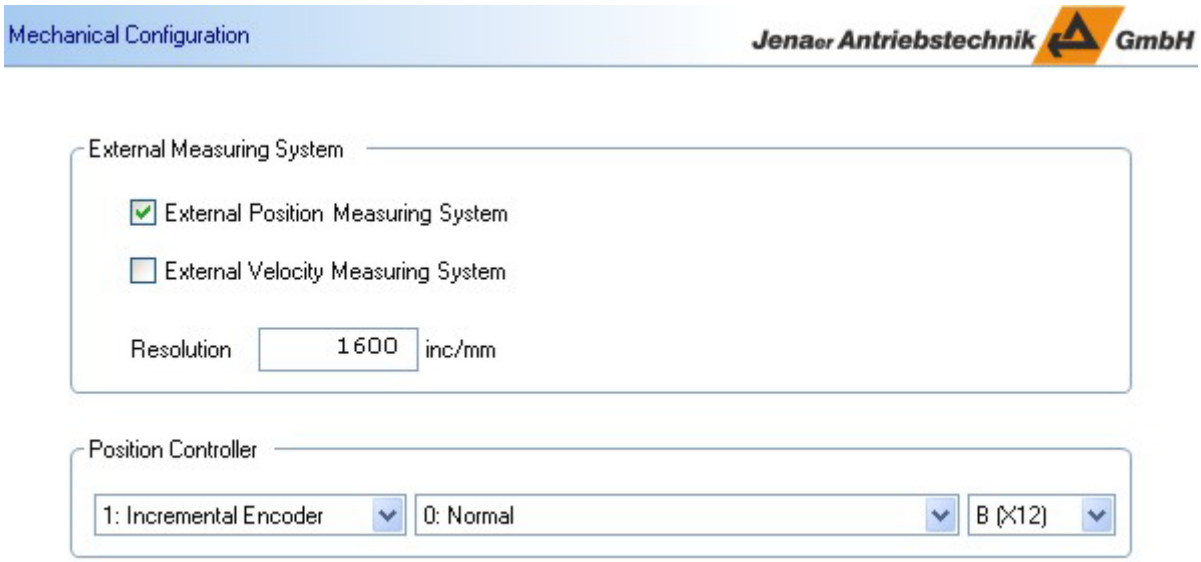
Select **Wizards\Mechanical Configuration** in the menu bar to use the wizard.

1. In the **Type of Mechanics** group box, first specify whether the mechanics is rotary or linear. For linear systems, additionally specify whether the linear movement is accomplished via **Screw Drive**, **Toothed Belt** or direct **Linear Motor**. Click **>>**.

2. In the schematic drawing of the selected type of mechanics in the **Settings** group box now enter the characteristic data of the mechanics. If no gear is used, click the gear symbol to switch it off (gear symbol is not shown with direct linear motor). If you work with software limit positions, enter the respective position values.



3. Where an external position or velocity measuring system is used which works to a second encoder input of the servo amplifier, activate the respective checkbox in the **External Measuring System** group box. Otherwise, proceed with step 4. Click **>>**. In the window which is now displayed, enter the **Resolution** of the applied measuring system. Specify the applied encoder type. The options offered in the selection list boxes might be limited due to the already configured internal measuring system (motor encoder). I.e., only the encoder interface is offered which is not already occupied by the motor encoder.



4. Confirm your entries made in the mechanical configuration wizard by clicking  . The relevant objects are transmitted to the servo amplifier where they are stored. A progress bar shows the progress of the transmission.

Alternative: Dialog window Mechanics

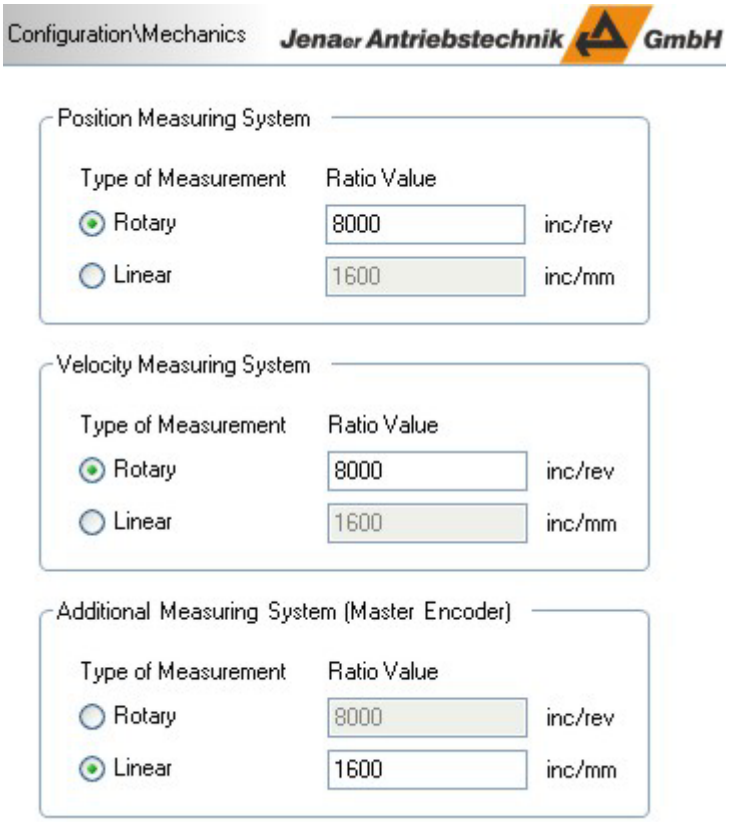
For entering or changing the mechanical data *without wizard* select the topic **Mechanics** in the navigation area. In opposite to the wizard, the values to be entered here have to be calculated first.

1. Under **Type of Measurement** first specify for the **Position Measuring System** as well as for the **Velocity Measuring System** and, if any, for an **Additional Measuring System (Master Encoder)** whether the measuring system is rotary or linear.

2. Calculate the **Ratio Value** as follows:

- rotary system: Value = encoder resolution [inc/rev] · gear ratio
- linear system (toothed belt axis): Value = $\frac{\text{encoder resolution [inc/rev]} \cdot \text{gear ratio}}{\text{pinion diameter [mm]} \cdot \text{Pi}}$
- linear system (screw axis): Value = $\frac{\text{encoder resolution [inc/rev]} \cdot \text{gear ratio}}{\text{pitch of screw [mm]}}$
- linear system (direct linear): Value = resolution of scale in [inc/mm] (e.g. 1 µm scale corresponds to 1000 inc/mm)

☞	For a permanent storage of the mechanical parameters in the servo amplifier, an explicit action is necessary in the ECOSTEP®. The storage is initiated in the navigation area under **Administration**. In the ECOVARIO® the storage of the entered mechanical parameters is done automatically.



2.4 Establishing safe operation

2.4.1 Setting the behaviour in case of an error

Before switch-on of the axis some settings are necessary concerning the safe operation. In the navigation area under **Option Codes** the **switch-off behaviour** of the servo amplifier in case of errors or in special operation situations is specified:

Quick Stop 	***Note:*** Default setting is the switching-off of the drive in case of quick stop. The axis coasts down without controlled braking. Especially with vertical axes (z axes) make sure that the quick stop ramp is configured with a sufficient deceleration (c.f. **Braking Effect**). If the quick stop ramp is configured too flat, movements could occur with high velocity towards the lower limit position in case of quick stop. Possible settings: • Drive is switched off and axis coasts down, no braking ramp • Slow down on slow down ramp (normal braking case) until standstill, drive is switched off and the motor is free to rotate • Slow down on quick stop ramp, drive is switched off and axis rotates freely • Slow down on slow down ramp, drive stays in quick stop • Slow down on quick stop ramp, drive stays in quick stop

Shutdown	Behaviour of the servo amplifier at the transition OPERATION ENABLE → READY TO SWITCH ON, i.e. Bit 0 of the control word is set to 0. Possible settings: • Drive is switched off and axis coasts down (default setting) • Slow down on slow down ramp, drive function is switched off and locked
Disable Operation	Behaviour of the servo amplifier at the transition OPERATION ENABLE → SWITCHED ON, i.e. Bit 3 of the control word is set to 0. Possible settings: • Drive is switched off and axis coasts down (default setting) • Slow down on slow down ramp, drive function is switched off and locked.
Stop (Halt)	Behaviour of the servo amplifier if bit 8 of the control word is set to 1. Possible settings: • reserved (no reaction) (default setting) • Slow down on quick stop ramp until standstill, drive function is switched off and locked • Slow down on slow down ramp until standstill, drive function is switched off and locked For ECOSTEP, the fixed setting is that the drive is switched off and the motor is free to rotate.
Fault 	Behaviour of the servo amplifier if a fault occurs in the drive. Guarantees a controlled stop of the drive in case of a fault. Especially with vertical axes (z axes) make sure that the quick stop ramp is configured with a sufficient deceleration (c.f. **Braking Effect**). If the quick stop ramp is configured too flat, movements could occur with high velocity towards the lower limit position in case of quick stop. Possible settings: • Drive is switched off and axis coasts down, no braking ramp (default setting) • Slow down on quick stop ramp until standstill, drive is switched off and the motor is free to rotate • Slow down on slow down ramp until standstill, drive is switched off and the motor is free to rotate
Abort CAN Connection	Behaviour of the servo amplifier if the CAN connection is aborted. Used with faults in the synchronous mode and in nodeguarding. Possible settings: • Sending out an emergency telegram only • Communication error is set and displayed, drive is switched off without slow down ramp and motor is free to rotate. • Drive is switched off immediately, motor is free to rotate, no error display, no emergency telegram • Behaviour as specified in the **Quick Stop** selection list box • Function disabled (no action)

	Braking Effect
Switch-off Delay of the Power Stage	Delay time between the activation of the holding brake and switching off the power stage
Slow Down Ramp	Setting the deceleration for the slow down ramp (normal braking case)
Quick Stop Ramp	Setting the deceleration for the quick stop ramp
	Behaviour when reaching the ...
Positive Limit Position	Behaviour of the servo amplifier when reaching the limit positions. Possible settings: • Slow down on quick stop ramp. Axis stops controlled. No fault condition. • Fault condition is set. Reaction according to „Switching off on Fault". • Drive is switched off immediately. No fault condition. • Reaction according to "Switching off on Quick Stop", no fault condition • Reaction according to "Switching off on Quick Stop", no fault condition, error code via CAN. • Slow down on quick stop ramp. Axis stops controlled. No error condition. Error code via CAN.
Negative Limit Position	

2.4.2 Current reduction

During commissioning of the drive system it is recommended that the maximum current available at the power stage is reduced.

Under **Limits** enter the **Maximum Current**. Limit the value to 1/3 to 1/2 of the maximum current specified in the motor data sheet. When commissioning a z axis, however, also take into consideration the load.

The values for the **Maximum i^2t Monitoring** normally are preset according to the loaded motor data set. If this is not the case, set the values according to the motor data sheet.

The values set here also have to be stored in the servo amplifier (c.f. **Administration**).

2.4.3 Limit position switches

ECOVARIO®, ECOMPACT, ECOMiniDual, ECOSTEP®

Especially during commissioning it is important that the limit position switches are activated. The state of the limit position switches can be read and evaluated by the servo amplifier. Normally, with ECOVARIO® and ECOMPACT® the digital inputs DIN3 (CWI, for positive limit position) and DIN4 (CCWI, for negative limit position) are used. With ECOMiniDual the digital inputs DIN13/DIN23 (positive limit position) and DIN14/DIN24 (for negative limit position) are used. With ECOSTEP® the digital inputs DIN6 (positive limit position) and DIN7 (negative limit position) are used. First, make sure that the cabling has been carried out properly. This means that if the drive movement is in positive direction, the limit position switch connected to DIN3 (ECOVARIO®, ECOMPACT®), DIN13/DIN23 (ECOMiniDual) or to DIN6 (ECOSTEP®) is actuated. The positive movement direction is defined by an increasing actual position value, shown in the window area **Device Status**. You can easily check this by monitoring the displayed actual position value while moving the axis manually.

Under **Inputs/Outputs** in the **Digital Inputs** tab you find the mask for setting the digital inputs. In order to use DIN3 and DIN4 (ECOVARIO®, ECOMPACT®), DIN13/DIN23 and DIN14/DIN24 (ECOMiniDual) or DIN6 and DIN7 (ECOSTEP®) for the evaluation of the limit position switches the check boxes **Use for positive Limit Position** and/or **Use for negative Limit Position** in the **Option** column have to be activated. Otherwise, the limit positions are not monitored.

ECOSTEP®54

ECOSTEP54 provides two options: either the inputs located directly at the motor connectors can be used, or the digital inputs DIN1 to DIN8 (galvanically isolated). First, make sure that the cabling has been carried out properly. This means that if the drive movement is in positive direction, the limit position switch connected to DIN1, DIN3, DIN5 and DIN7 is actuated. The positive movement direction is defined by an increasing actual position value, shown in the window area **Device Status**. You can easily check this by monitoring the displayed actual positon value while moving the axis manually.

Under **Inputs/Outputs** in the **Digital Inputs** tab you find the mask for setting the digital inputs. In order to use DIN1 to DIN8 for the evaluation of the limit position switches the check boxes **Use for Limit Position** in the window area **Limit Switch** have to be activated. Otherwise, the limit positions are not monitored.

Software position limits

The travel range can also be limited by software position limits which can be set in the navigation area under **Limits**. You should note, however, that homing has to be carried out first because the software position limits only can be specified in relation to a defined zero position.

2.4.4 Emergency-off of the machine

Before movements are carried out in the framwork of the initial commissioning of the drive system, it is necessary to activate the emergency-off function of the complete machine.

By taking the appropriate measures make sure that it is possible to switch off the power supply and the logic supply at any time!

The software ECO Studio is a user interface for ECOVARIO® and ECOSTEP® servo amplifiers, ECOSTEP54 stepper motor amplifiers and the ECOMPACT compact servo drive. All commands are saved to the drive system and are still valid if the user interface aborts. That means the drive system will still carry out movements even if ECO Studio or Windows does not run anymore.

2.5 Switching on the axis

2.5.1 Commutation

Before moving, ECOSTEP® and ECOSPEED servo motors and the ECOMPACT compact servo drive have to carry out a single commutation. This commutation gets invalid with certain errors or on putting off the logic supply.

The commutation settings depend on the motor in use and the application. In most cases they are preset because of the project data.

1. Switch on the axis by clicking **Switch on Device**. The device status „Device ready", „Axis switched on" is displayed (Control word 0x0F).

2. You can retrieve the detailed device status (control word and status word) from the **Device Status** topic in the navigation area. Here, it is also possible to enter the control word in hexadecimal or binary format.

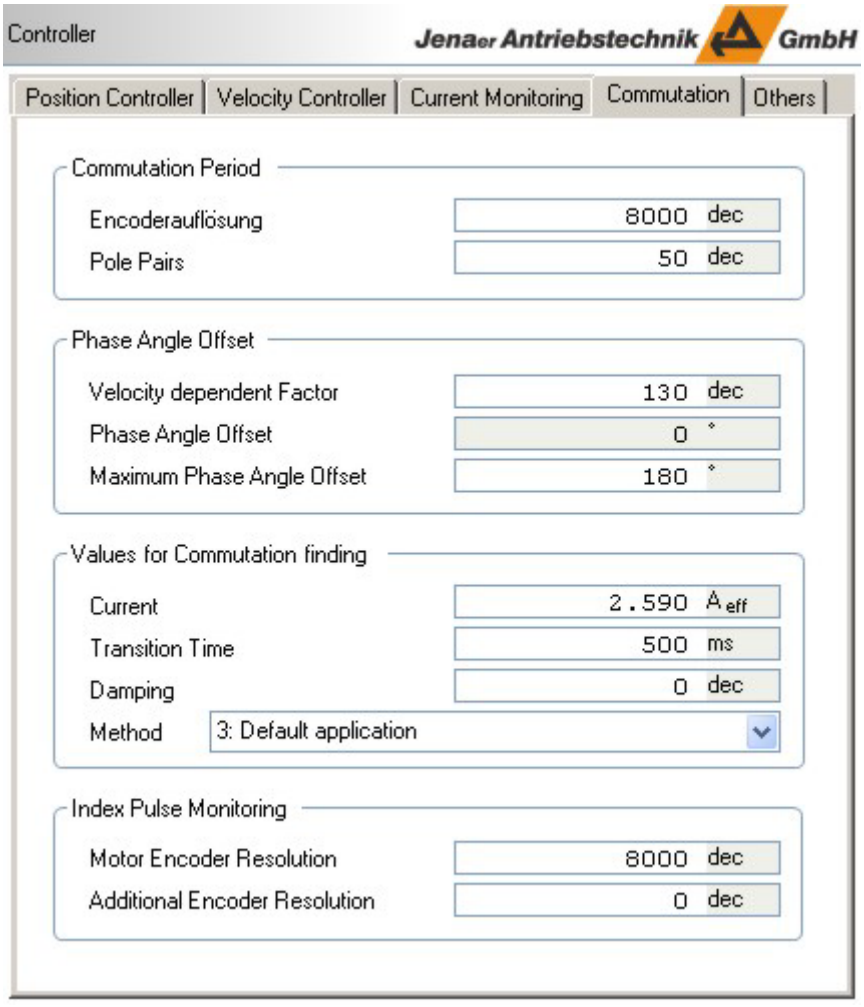
Now the first 4 bits are set and the motor is activated if no error occurs. After successful commutation, the status word 0x4437 is displayed.
The motor is in operating mode „positioning" and holds the current position. The characteristics of the positioning mode is that on moving the motor axis manually, it resists and springs back.

If the commutation finding process has not been successful, you will have to adapt the commutation parameters in **Controller\Commutation** (c.f. Chapter 2.5.2). Commutation finding can also fail in the event that the motor phases are switched in the wrong sense of rotation. The fault can be remedied by reversing the wires of one of the motor phases.

2.5.2 Setting the commutation period and commutation finding

Normally, the commutation settings are preset in the motor data set.

If in exceptional cases adjustments are necessary in the commutation settings, click the topic **Controller** in the navigation area and here select the **Commutation** tab.



Window area **Commutation Period**:
The values for **Encoder Resolution** and **Pole Pairs** result from the mechanical design and the measuring system used for the rotary or linear motor. ***Rotary Motor (Example 23S21-0560-805J7-AA):*** Encoder resolution: 8000 inc/rev Pole pairs = Pole pair number 2p: 50 ***Linear motor (Example SLM-040-192-200)*** Commutation period = $\frac{\text{magnet period 2p}}{\text{resolution [mm]}}$ Resolution of measuring system: 1 µm Magnet period 2p: 32 mm Commutation period (field **Encoder Resolution**) = $\frac{32\ \text{mm}}{0.001\ \text{mm}} = 32000$ The parameter **Pole Pairs** is 1 when using a linear motor.

Window area **Phase Angle Offset**	
Velocity dependent Factor	The velocity dependent factor is dependent on motor type and supply voltage. For all linear motors this value has to be set to 1, not regarding the supply voltage.
Phase Angle Offset	Phase angle offset of the current, is proportional to the velocity
Maximum Phase Angle Offset	Maximum phase angle offset of the current, should be less than ¼ of the period for ECOSTEP. Refers to 8000 inc/rev, is proportionally increased with higher encoder resolution.
Window area **Values for Commutation finding**	
Current	Amplitude of the current at commutation finding. The induction current normally is smaller than the rated motor current. With z axes the rated current should be adjusted.
Transition Time	• at small load (1 ... 5 times the motor inertia): 500 ms • at large load (20 ... 50 times the motor inertia): 1000 ms
Damping	Prevents from overshoot. Large values (0 ... 20) reduce the deflection during commutation finding
Method	See below
Window area **Index Pulse Monitoring**	
Motor Encoder Resolution	Resolution of the motor encoder in increments/revolution
Additional Encoder Resolution	Resolution of an optional additional encoder in increments/revolution. The value 0 means that no additional encoder is present.

Overview of the commutation methods (field **Method**):

Method	Application	Function
0	general	NO monitoring of the real commutation angle is done. With the other methods the angle is monitored. An error is generated if the angle done is > 1 pole.
-1	vertical axes (z axes)	The current is increased from 50% of the value specified in the **Current** field to 100%. Is used with large loads or with horizontal axes if the position limits are reached during commutation finding.
1	Default method for vertical axes (z axes)	The current is reduced from 70% of the value in the field **Current** to 50%. The number of increments the axis „sacks through" is measured in order to determine the position the axis would have taken at full current.
2	Linear motors	The damping parameter **(Damping)** takes effect travel shortening and damping with the factor (x+1)
3	Default application	The damping parameter **(Damping)** takes efffect only damping.
4	Enhanced default application	same as method 3, additionally for elastic/spring-like reaction of the axis

2.6. Analyzer tools: reversing mode and oscilloscope

Ideally the scalable oscilloscope window is used together with the reversing mode for adjusting and optimizing the controller. Assuming a certain trigger event, during the reversing mode contantly data streams are produced which are displayed continuously or manually triggered, respectively. Adjustable sample rate, number of samples, trigger event, trigger edge and automatic scaling guarantee convenient working.

The oscilloscope function is suitable among others also for analyzing the signals at the digital inputs and outputs and for analyzing positioning processes with respect to the load of the motor and of the servo amplifier by current peaks.

2.6.1 Reversing mode

By taking the appropriate measures make sure that it is possible to switch off the power supply and the logic supply at any time!

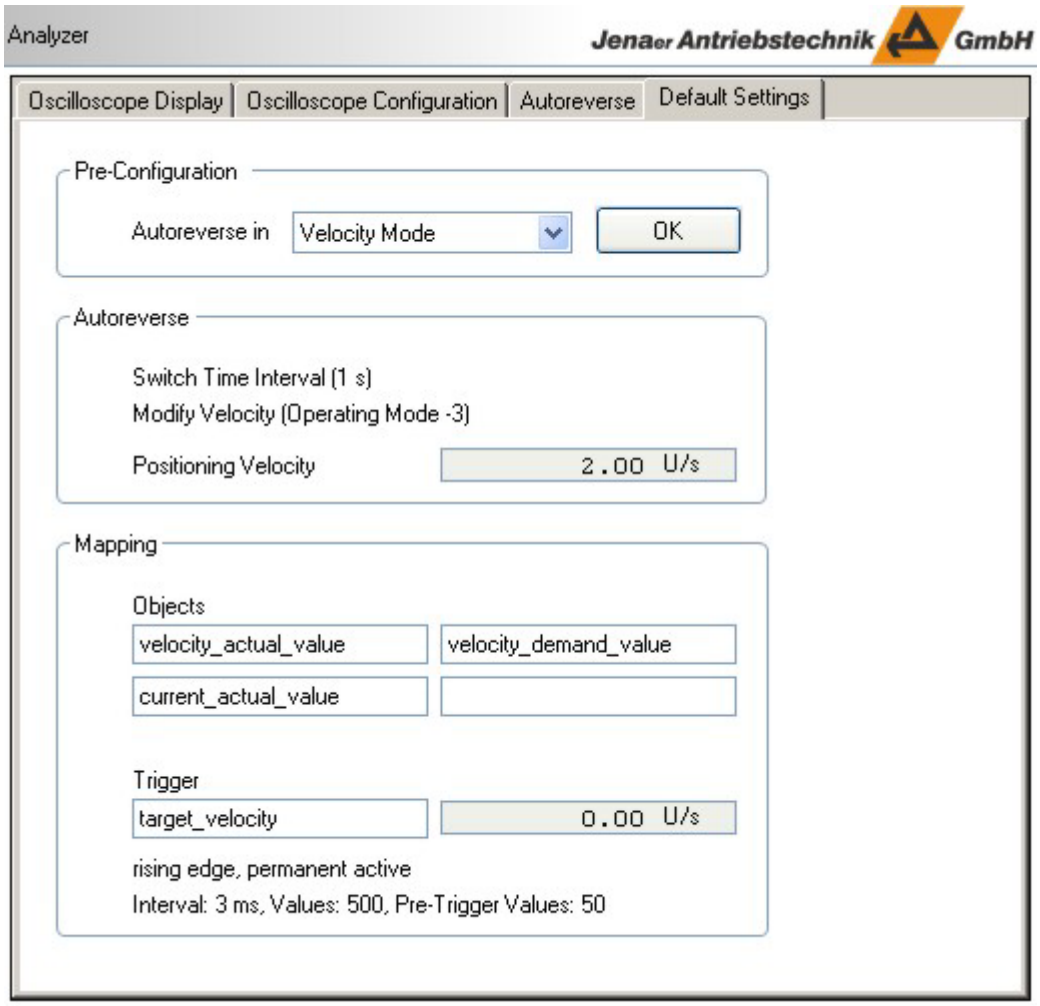
Preparations for reversing mode:

- Rotary motors with screw drive: Shift the screw manually approximately to the middle of the axis.
- Linear motors: Shift the primary part manually to the middle of the secondary part.

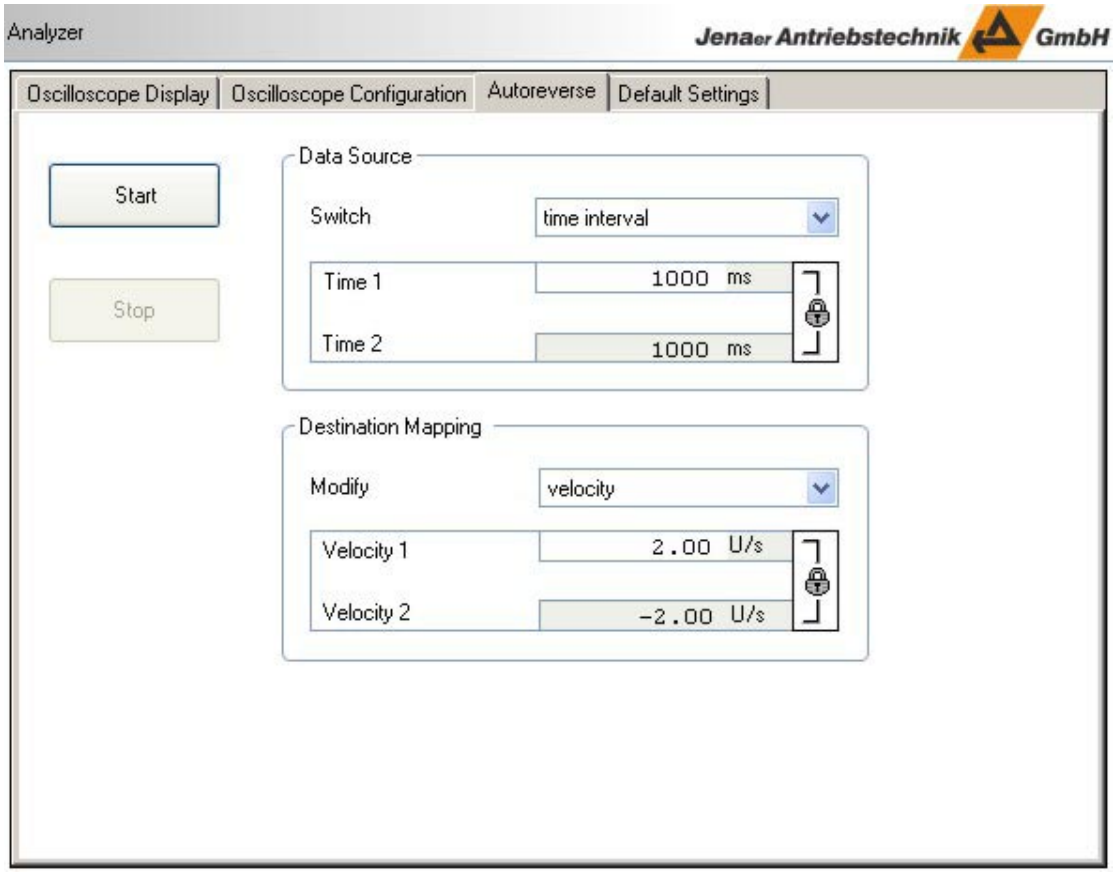
1. In the navigation area select the topic **Analyzer**.

2. For the first commissioning, it is recommended to carry out the reversing mode with the default settings. With these settings a symmetrical movement around the starting point can be reached in the positioning mode. In the velocity mode, a uniform movement in one direction and reverse beginning at the current position is carried out. Select the **Default Settings** tab.

Caution! Starting at the current position, the reversal points in both directions have to be located in the travel range. Check whether this is the case for the default settings with your mechanics used. If in doubt, choose a smaller travel range in the beginning. If you specify inadmissible times or velocity values, the motor might collide to the mechanical limit positions of the machine.



3. In the window area **Pre-Configuration** select the controller type you intend to parameterize. Click **OK**. The default settings are taken over to the **Autoreverse** tab and are displayed there.



4. If you would like to change the default settings or enter your own settings you can use the **Autoreverse** tab.

	Caution! Starting at the current position, the reversal points in both directions have to be located in the travel range. Check whether this is the case for the default settings with your mechanics used. If in doubt, choose a smaller travel range in the beginning. If you specify inadmissible times or velocity values, the motor might collide to the mechanical limit positions of the machine.

5. In order to guarantee a proper and safe reversing mode, determine the mechanical limit positions by moving the rotor manually. The precise limit positions can be read out in the basic window in the lower left area in the **Act. Pos.** field.

   Tip: By closing the lock symbols besides the edit boxes in the **Autoreverse** tab a symmetrical movement around the starting point can be reached in the positioning mode. In the velocity mode, a uniform movement in one direction and reverse beginning at the current position is carried out.

6. Make sure that the travel range of the axis is free and thus the reversing mode can be started. If not yet done, switch on the axis in the window area on the left. In the Autoreverse tab, click **Start**. The reversing mode starts immediately.

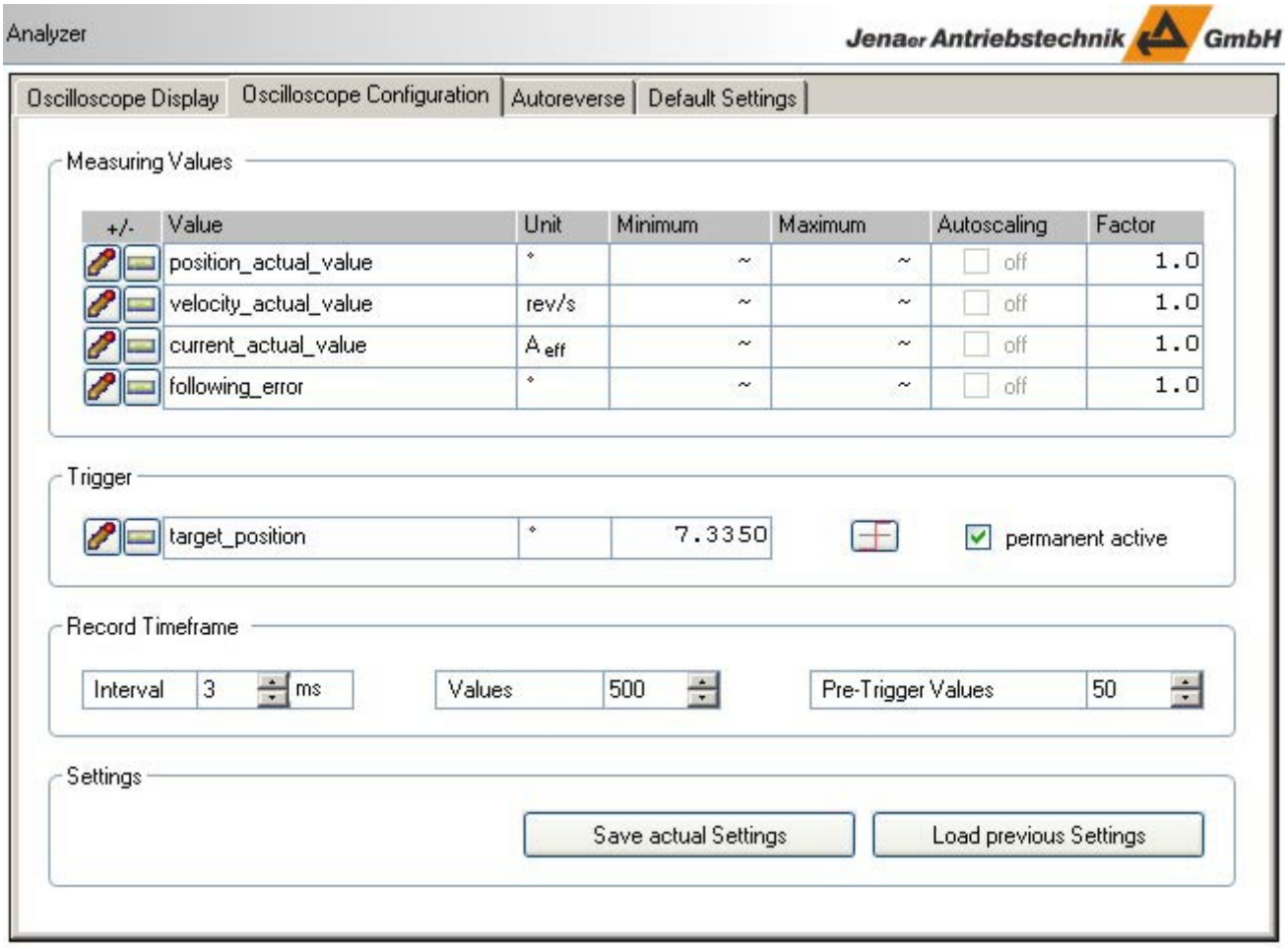
7. Now you can set and optimize the controller parameters (c.f. Chap. 3). Click **Stop** to finish the reversing mode.

   Note: The settings of the reversing mode can be modified without stopping the reversing mode.

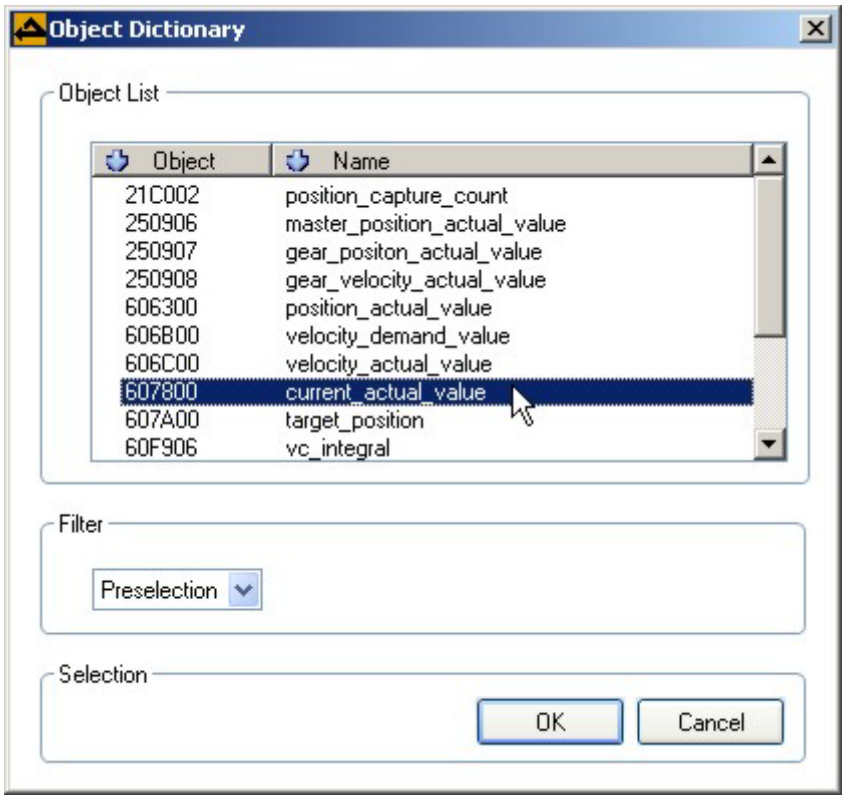
2.6.2 Configuration of the Oscilloscope

In the navigation area select the **Analyzer** topic. In the **Oscilloscope Configuration** tab specify the measuring values to be recorded, the trigger event, the scaling and the sampling rate.

Note: If you have started the reversing mode with the **Default Settings**, these settings are already preset in the **Oscilloscope Configuration** tab. Normally, no modifications are necessary here and you can select the **Oscilloscope Display** tab to view the resulting oscillogram (cf. Chapter. 2.6.3).



1. Specify the values to be recorded. Maximum 4 value rows can be recorded and displayed simultaneously. After clicking the „+" symbol in the table or on the keyboard a selection list box is displayed. This list box contains a **Preselection** of objects which are relevant in this context.



For an evaluation of the velocity control circuit the relevant measuring values are „current actual value", „velocity actual value", and „velocity demand value". For an evaluation of the position control circuit the relevant values are „velocity actual value", „position demand value","position actual value", and the following error. Select the desired values and click **OK**.

2. If you do not explicitly enter a value range in the **Minimum** and **Maximum** columns, an appropriate scaling is automatically selected for each curve (**Autoscaling**). The **Minimum** and **Maximum** values are only valid if the **Autoscaling** function is deactivated.

3. Specify the trigger event and the trigger threshold, if any.

4. By clicking the symbol **Trigger Edge** you can either trigger to the rising edge (default setting), to the falling edge or to a threshold without specified direction (triggering process starts as soon as the value passes the specified threshold, no matter in which direction) With activated check box **permanent active** recording is started continuously each time the trigger event comes true. If the check box is not activated, recording is only done once.

5. Enter the **Record Timeframe**. Please note that the recording time lasts the longer the higher the number of values is entered. Normally, 200 to 500 values are sufficient. If pre-trigger values are specified, also the respective part of the curve is shown *before* the trigger event comes true.

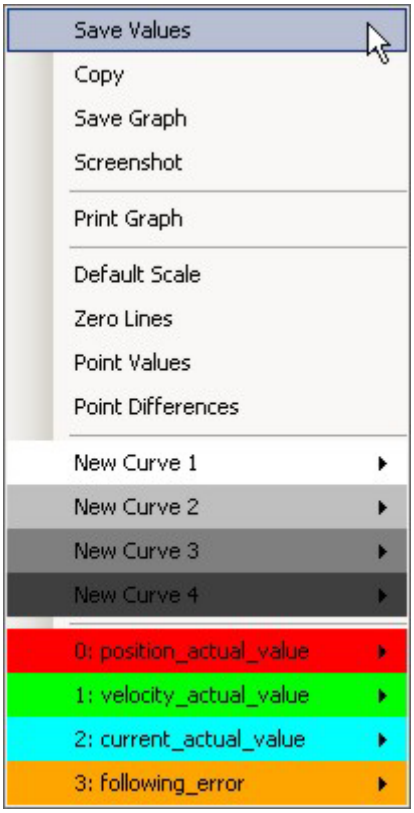
6. Change to the **Oscilloscope Display** tab.

2.6.3 Options in the displayed oscillogram

After the configuration of the oscilloscope has been finished, click **Start Recording** in the **Oscilloscope Display** tab. The progress of the data recording is displayed in a progress bar. If necessary, recording and reading out of the data can be stopped by clicking the respective pushbutton.

Note: By means of the **Read** button oscilloscope data already stored in the servo amplifier from the last recording can be read. This feature might be helpful in case of troubleshooting. The function is not available for some ECOSTEP types because the segmented transfer is not supported.

In the displayed oscillogram the options menu shown below can be called up by right-clicking.



In the menu, the following functions can be carried out. Functions with a symbol assigned to in the table also can be carried out via the symbol bar on the left side of the oscillogram.

Save Values		Saving the list of values, separated by commas, in a file (.CSV format)
Copy		Copying the oscillogram into the clipboard. From there, it can be inserted e.g. into documents.
Save Graph		All data of the oscillogram can be saved to a file. If saving is done in the .OGD format the data can be re-loaded to the oscilloscope display window by use of the **Load Graph** function. Data saved in the .JPG or .PNG format can be processed externally.
Load Graph		Load and display an oscillogram saved in the .OGD format with the **Save Graph** function before

Load Additional Graph		Comparison of two loaded oscillograms. When the function **Load Graph** has been executed an additional oscillogram saved in the .OGD format can be loaded here. The additional oscillogram is displayed dash-lined.
Screenshot		Generates a screenshot of the oscillogram including the display and entry area for the position and velocity controller parameters
Print Graph		Printing of the oscillogram
Default Scale		All scaling settings done manually by the user (e.g. shifting of the scales, zoom, etc.) are reset to the default values
Zero Lines		Zero lines are displayed for all curves
Point Values		The x-y-coordinates of the curve value where the mouse pointer is located are displayed. X and y value are separated by commas, maximum 3 decimal places are displayed. You can also permanently mark point values in a curve. To do so, position the mouse pointer on the required point. If the point value is displayed, double-click the left mouse button to get a permanent marking. By clicking the right mouse button on the label of a marked point a context menu is opened. You can use this e.g. for deleting one or all marked point values. Deleting one marked point is also possible by double-clicking the label with the left mouse button.
Point Differences		Displaying the difference between two points of a curve: 1. On a curve select a starting point by double-clicking. The point is highlighted by a small circle. 2. If the mouse pointer is positioned on the curve the distance between this point and the highlighted starting point in x-direction and y-direction is displayed (same format as in the **Point Values** display). By clicking to a target point the distance value is displayed below the oscillogram. The functions **Point Values** and **Point Differences** cannot be used simultaneously.
Delete all Curves		Deletes all displayed curves
		Alternative display Normal View <-> Fast Fourier Transformation (FFT) of the actual curves (not for freezed curves and new curves). If the symbol is not shown, we recommend an update to .NET Framework 3.5 SP1 which is available on the ECO2CD and in the download area of our homepage www.jat-gmbh.de.
New Curve 1 ...4		Different arithmetic operations can be applied to up to 4 of the displayed curves (see section „Mathematical functions in the displayed curve" below. The resulting curves are displayed as well.
Submenus of the menu items marked in different colours (related to the individual curves):		
Hide Curve		Selective masking of displayed curves
Freeze Curve		Selective freezing of displayed curves, useful e.g. for controller parameter optimization to directly monitor the impact of parameter modifications. After activation of the function the curve is displayed dash-lined and and remains in the display also after the recording has been started again, e.g. with modified parameters. Thus, both curves can be compared. The function can be switched off by selecting the menu item **Freeze Curve** again.
Hide Zero Line		Selective masking of the displayed zero lines
Scale As ...		If autoscaling is activated it might occur that the curves for actual values and the related target values (e.g. actual velocity and target velocity) are scaled differently. With this function the same scaling can be applied to selected curves. Thus, the curves can be better compared for deviations between actual values and target values.

Further functions provided in the oscillogram:

Zoom: Any areas of the oscillogram can be zoomed in or zooomed out. For zooming in keep the left mouse button pushed and draw a rectangle from the left to the right around the required area with the mouse. To cancel the latest zooming in action keep the left mouse button pushed and draw a rectangle from the bottom right to the top left around the required area with the mouse.

A **modification of the scale of the y axis** can be achieved by pushing the Ctrl key and the left mouse button simultaneoulsy, keep it pushed and draw the scale to the intended position.

Shifting a scale: A scale and the related curve can be moved up or down by shifting it with the mouse with pushed left mouse button.

Offline viewer for oscillogram data

ECO Studio provides a viewer function for a saved oscillogram (.OGD file) which can be used offline, i.e. an active connection to a servo amplifier is not necessary.

In the menu bar, select the menu item **View/OGD Viewer**. The menu item is only active if no connection to a servo amplifier exists.

Specify the servo amplifer type. The **Oscilloscope Display** window is shown. The .OGD file to be loaded can be selected by clicking  in the symbol bar on the left side of the oscillogram. The options available in the OGD viewer are identical to the options in the displayed oscillogram in the online operation.

If you load .OGD files which have been generated by ECO Studio version 2.2 and higher:
The velocity and position controller parameters and the user-defined variables are also saved in the .OGD file and can be displayed by clicking **<<** in the tabs on the right side. From ECO Studio Version 2.7 on additionally the time-relevant parameters (interval, number of values, pre-trigger values) are saved in the .OGD file and are displayed in the label of the x-axis after loading.

Note: If in addition to the .OGD file already loaded you load another .OGD file (Icon **Load additional graph**), e.g. for comparison purposes, the values displayed in the tabs on the right remain unchanged.

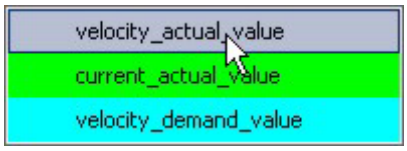
As soon as a connection is established, the window is closed automatically.

Mathematical functions in the displayed oscillogram

In the **Analyzer -> Oscilloscope Display** window different mathematic functions can be applied to up to 4 of the displayed oscillograms (curves).

1. In the option menu select **New Curve 1 ...4**. You can apply mathematic functions to one (**f(X1)**) or more (up to 4, **f(x1; x2; x3; x4)**).

2. Select the curve(s) the mathematic functions shall be applied to. To do so, double-click the variable (e.g. x1) and select the curve in the displayed pop-up list. x1 is then displayed in the respective curve colour.



3. Enter the required mathematic function.

   The following operations are possible:

   Note: The designation term represents an arithmetic concatenation out of numbers and mathematic functions. The term can also contain variables which represent the curve values. In a simple case the term is a constant value. Some examples are shown below the table.

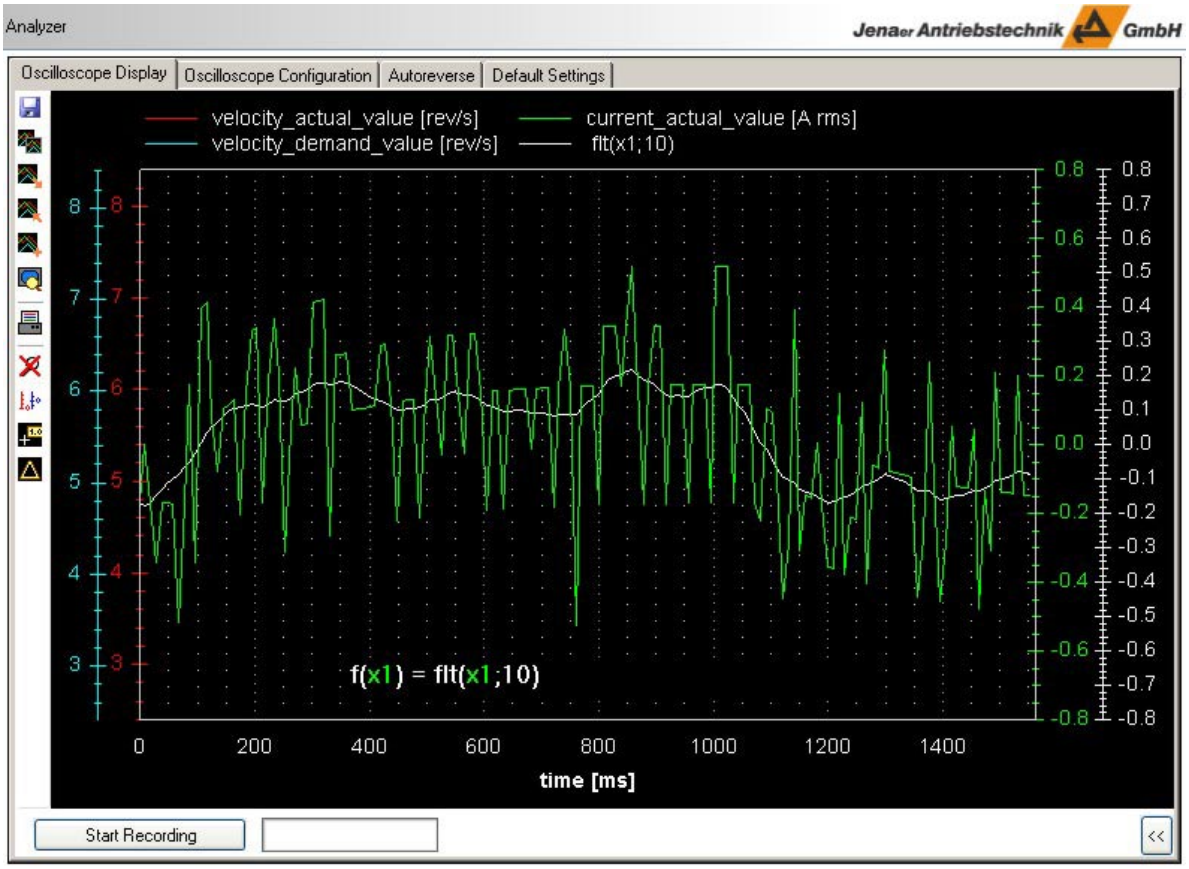
Operation	Description	Syntax (xn, n=1...4)
+	Addition	
-	Subtraction or sign	
*****	Multiplication	
/	Division	
sin	Sinus function	sin (*Term*)
cos	Cosinus function	cos (*Term*)
pot	Power of	pot (*Term; Exponent*)
sqrt	Square root	sqrt (*Term*)
abs	Absolute value	abs (*Term*)
lim	Limitation function. Limits the curve to a value range between the given limits.	lim (*xn; Limit1; Limit2*) wheras *Limit1* and *Limit2* are specified in the curve specific unit. Also terms can be entered for Limit1 and Limit2.
min	Minimum function. The lower value out of the two values is used.	min (*Term1*; *Term2*)
max	Maximum function. The higher value out of the two values is used.	max (*Term1*; *Term2*)
flt	Filter function. Forms the mean value over a given number of curve values. Can be used for smoothening the curves.	flt (*xn; Filter length*) whereas *Filter length* designates the number of curve values for which the mean value is generated. *Filter length* has to be a whole positive-signed number. A higher value results in a smoother new curve.
rot	"Rotation" function. If you want to compare two curves you can compensate a phase shift by means of this function.	rot (*xn; Number of values*) whereas *Number of values* designates the number of curve values by which the curve is shifted. *Number of values* has to be a whole number. Positive values: Shift to the left Negative values: Shift to the right
diff	Derivation function (d*xn*/dt)	diff (*xn*)
convert	Converting the data type	convert (*Term; destination data type*) whereas destination data type *U8*: unsigned, 8 bit data width *U16*: unsigned, 16 bit data width *U32*: unsigned, 32 bit data width *S8*: signed, 8 bit data width *S16*: signed, 16 bit data width *S32*: signed, 32 bit data width
pi	Constant number PI	
e	Constant number Eulersche Zahl	

Any number of arithmetic operations can be combined to a function. It is not necessary to enter blanks, however, they can be used for a better transparency. Please observe that the arithemtic operations are executed in the sequence in which they are entered. For other sequences of execution parentheses () have to be used. Any number of parenthesis levels are possible.

Some examples:

```
f(x1;x2)     =  (x1 * 5.5) + lim (x2; (x1/3); pi)
f(x1;x2;x3) =  sin (sqrt(x1-10)) + pot (abs(x2);3) - rot (x3;20)
f(x1)         =  flt (x1;10)
```

4. After you have entered the function press the **Enter** key. The resulting new curve is now displayed in a new colour. When the output curves are updated, the new curve is also adapted dynamically. The example below shows the application of the filter function.



5. For the new curves in principle the same options are available as for the other curves. In the options menu (right mouse button) the following options are provided for the **New Curve**:

Modify Curve	The arithmetic function for the curve can be modified. The formula is re-displayed.
Delete Curve	The new curve is deleted including its definition
Hide Zero Line	Selective masking of the displayed zero lines
Scale as ...	If autoscaling is activated it might occur that the curves for actual values and the related target values (e.g. actual velocity and target velocity) are scaled differently. With this function the same scaling can be applied to selected curves. Thus, the curves can be better compared for deviations between actual values and target values.

Further functions provided in the new curve:

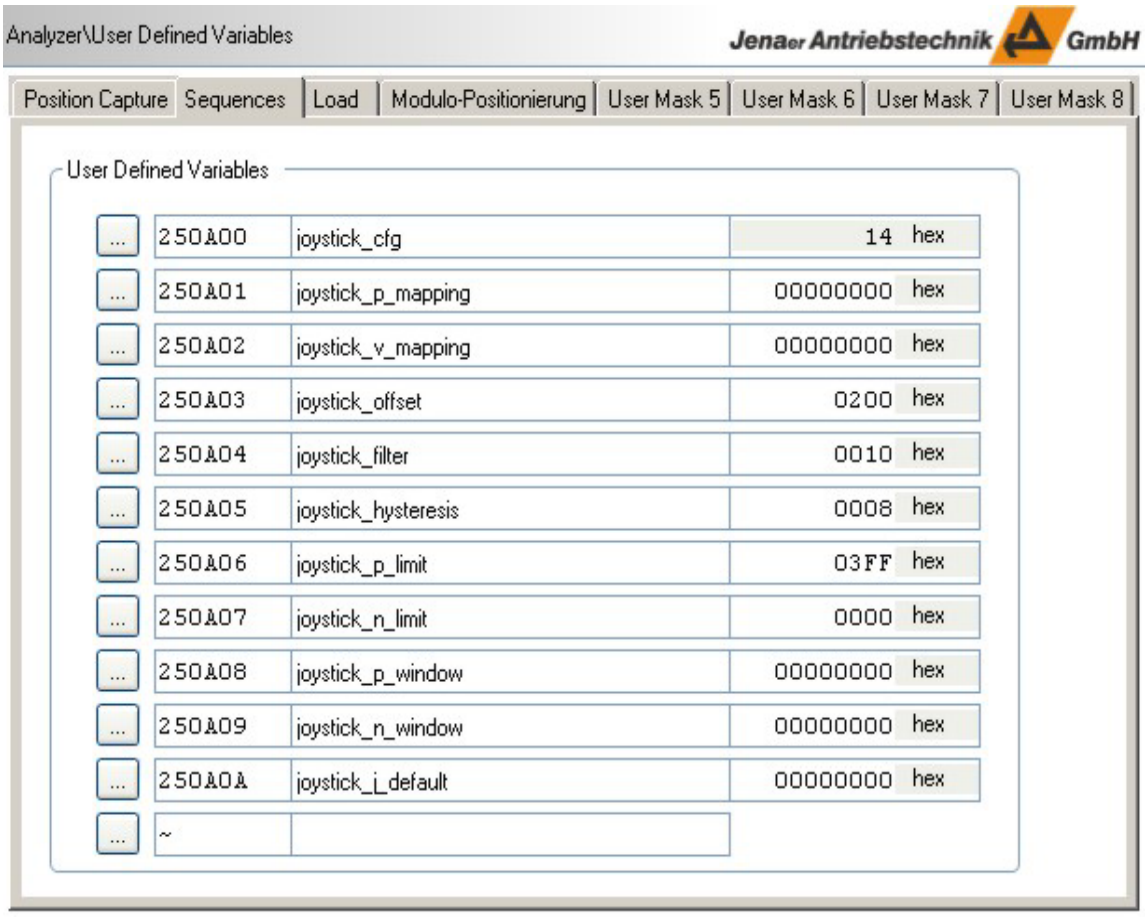
Zoom: Any areas of the oscillogram can be zoomed in or zooomed out. For zooming in keep the left mouse button pushed and draw a rectangle from the left to the right around the required area with the mouse. To cancel the latest zooming in action keep the left mouse button pushed and draw a rectangle from the bottom right to the top left around the required area with the mouse.

A **modification of the scale of the y axis** can be achieved by pushing the Ctrl key and the left mouse button simultaneoulsy, keep it pushed and draw the scale to the intended position.

Shifting a scale: A scale and the related curve can be moved up or down by shifting it with the mouse with pushed left mouse button.

2.6.4 User-defined variables

In the path **Analyzer\User Defined Variables** ECO Studio provides in the Expert Mode the option to directly assign values to any objects. Therefore, 8 user masks are available by default where the objects to be set can be selected. E.g. this can be objects for special functions where no window is implemented in ECO Studio. If required, additional user masks can be generated (click the right mouse in any user mask: select **new page**). Only additionally generated user masks can be deleted (in the respective user mask right mouse key: **delete**). The storage of the user defined variables is non-volatile. In the example user mask 2 is used for parameterization of the joystick function. In the tab a name can be assigned to each user mask.



Notes: If segmented transfer is configured the contents of the variable is displayed as string. Only a part of the string might be visible in the window, a complete representation of the string is implemented as a tooltip.

Working with user-defined variables is also possible directly in the oscilloscope window. Thus, 10 additional user-defined variables can be defined. This is helpful e.g. for the optimization procedure or for problem analysis if additional parameters have to be monitored. The storage is non-volatile as well.

In the path **Analyzer\Oscilloscope** select the **Oscilloscope Display** tab. On the bottom right side of the window click on the **>>** button to open the tab panel. Here, select the **User Defined Variables** tab. Choose the variables to be displayed by clicking **...**, the **Object Dictionary** window is displayed. The object number (with sub index) can also be entered directly.

2.7 Homing

In the most applications an agreement has to be made about the neutral position the position controller can refer to. This position is called the home position. It has to be determined after each power-on of the servo amplifier. This is achieved in the so-called homing procedure. Several homing methods are available. Homing is started by setting the enable signal of the power stage via the field bus or via a digital input. If the homing procedure is finished successfully, a status bit is set in the device. This status can be evaluated via field bus or via a digital output.

Limit position switches and homing switch

To set a reference point of a linear or rotative axis at least one electric switch is necessary. Alternatively, homing is also possible by exclusively using the index pulse or by using the mechanical limit positions. „Switch" means mechanic switches as well as electronic sensors. The following table shows the default setting of the digital inputs for connecting the limit position switches or the homing switches to ECOSTEP®, ECOVARIO®, or ECOMPACT.

Input	ECOSTEP® *)		ECOVARIO® **)		ECOMPACT	
	default setting	*free use*	*default setting*	*free use*	*default setting*	*free use*
DIN1	-	✓	Reset	✓	Reset / Enable 2	✓
DIN2	-	✓	Enable	-	Enable 1	-
DIN3	-	✓	positive limit pos.	✓	positive limit pos.	✓
DIN4	-	✓	negative limit position	✓	negative limit position	✓
DIN5	-	✓	homing position	✓	homing position	✓
DIN6	positive limit position	✓	-	✓	-	-
DIN7	negative limit position	✓	Capture input	✓	-	-
DIN8	homing position	✓	Capture input	✓	-	-

*) At **ECOSTEP54** limit position switches can be connected to DIN1 to DIN8 (DIN1, DIN3, DIN5, DIN7: positive limit position axis 1 to 4; DIN2, DIN4, DIN6, DIN8: negative limit position axis 1 to 4). Optionally, the digital inputs can be used freely.

) At the 2-axis servo amplifiers **ECOVARIO 114 D and **ECOMiniDual** the default assignment of the digital inputs 1 to 5 for one axis is the same as for ECOVARIO. However, the naming on hardware side deviates in order to differentiate between the two axes. Axis 1: DIN11 to DIN15, axis 2: DIN21 to DIN25.

The configuration of the digital inputs is done via **Inputs/Outputs\Digital Inputs**.

Note: All switches must produce a +24 V level at the digital inputs of the servo amplifiers (active HIGH). The HIGH level has to be fed until standstill of the axis. Appropriate switching blocks should be used. If reversed logic levels are used the settings under **Inputs/Outputs\Digital Inputs** have to be adapted accordingly.

Limit position switches and homing switch can be configured differently:

- Using 1 switch, the switch is homing switch as well as limit position switch for one limit position.
- Using 2 switches, each switch monitors one limit position. One of the limit positions is identical to the homing position.
- Using 3 switches, 2 switches monitor the limit positions and the third between the two others is the homing switch.

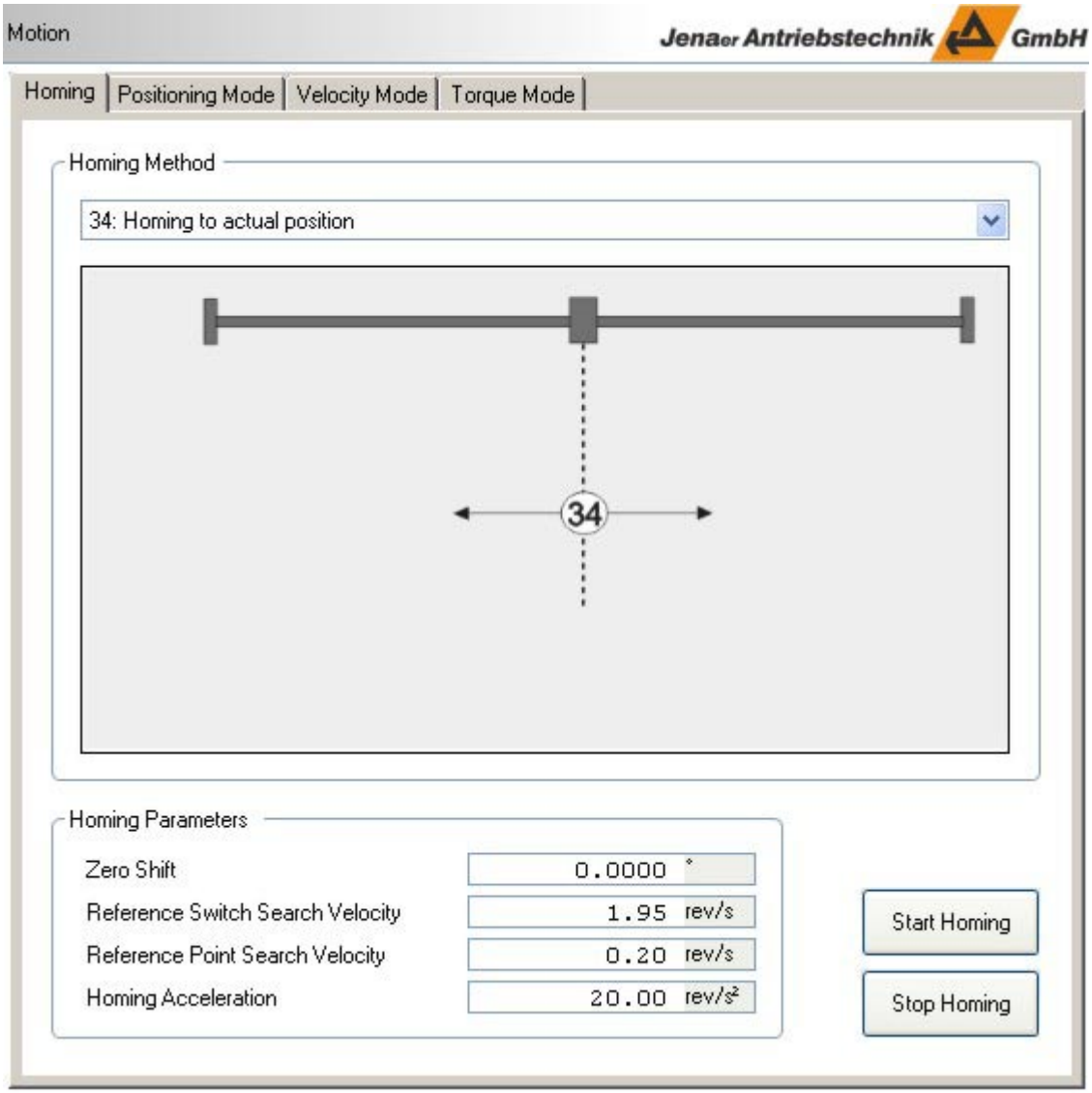
The homing process is according to CAN specification DS402. The home position is set off against a freely definable offset. The position counter is set to the resulting value. The actual stop position after homing is not zero because after identifying the reference mark the axis decelerates according to the set homing acceleration till standstill.

Search principle

For reference search CAN operation mode 6 is implemented in the servo amplifiers. Mode 6 is set automatically as soon as homing is selected.

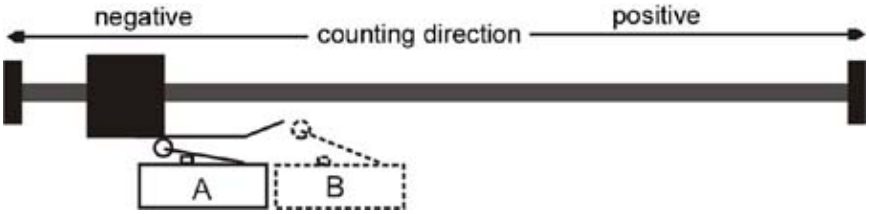
In the ECO Studio navigation area under **Motion** in the **Homing** tab

- Adjust the velocity for searching for limit position switch / homing switch
- Define the velocity for searching for the reference point
- Adjust the acceleration/deceleration for homing
- Limit the time for dearching the reference
- Select the homing method (Explanations to the individual methods can be found in the *Tooltips*)



Zero Shift	After homing has been finished the home position can be shifted with this parameter
Two velocity values can be set:	
Reference Switch Search Velocity	Velocity of the search travel for the reference switch
Reference Point Search Velocity	Velocity of the search travel for the home position
Homing Acceleration	Acceleration and deceleration during the homing process
The following two parameters can only be set if homing methods –1, -2, -17, or –18 are selected. These methods evaluate the increased current consumption in case of mechanical blocking as switching criteria.	
Max. End Stop Current	Upper limit of the increased current in case of mechanical blocking
Hold Time for End Stop Current	Time period for which the end stop current is provided
Buttons:	
Set Absolute Encoder to Zero	Only available if a motor with absolute value encoder is used: sets the counter of the absolute value encoder to zero
Start Homing	Starts homing with the specified parameters. As soon as the reference has been found, „Reference found" is displayed in the message area. In the window area **Device Status** the **Referenced** box is displayed in green colour.
Stop Homing	Stops homing, e.g. if it is not ended automatically because no reference has been found or if the homing process should be interrupted.

For the explanations of the individual homing methods the following count and travel directions are defined:



You can look up the count direction of the used system in the display area of the actual device status (in the lower left area of the user interface) in the **Act. Pos.** field.

2.8 Save parameters

The *device specific settings* made in ECO Studio have to be saved permanently in the servo amplifier in order to maintain them after disconnection and switch-off of the servo amplifier. Select the topic **Administration** in the navigation area. Select **All Parameters** and click **SAVE Parameters**.

Note: For saving the *user specific settings*, e.g. communication settings, oscilloscope configuration, etc. select the function **File/Save Project** in the menu bar (cf. Chapter 2.9)

2.9 Working with projects

User specific settings of ECO Studio can be saved in so-called projects.

Note: All *device specific* settings of the drive system are stored *in the servo amplifier* with the help of the function **SAVE Parameters**, which can be called up in the navigation area under **Administration**.

The following user specific settings are stored in an ECO Studio project file (ending .epr):

- Connection settings, i.e. used communication interface, baud rate, etc.
- Settings with repsect to the used mechanics, made in the wizard „mechanical configuration"
- Configuration of the oscilloscope, i.e., selected measuring values, recording time, etc.
- User defined variables, i.e., selection, assigned names, etc.

Saving to a project file

For saving the above mentioned user specific settings of an ECO Studio session select **File/Save Project** in the menu bar. When initially saving a project file, select the path and enter a file name (appendix .epr) where the user specific settings are to be stored. Default directory is the „data" directory. Default file name is the axis name specified in the **Communication: Connect/Disconnect** window.

If you want to save an already existing project to another directory and/or file name, select **File/Save Project As...** in the menu bar.

Loading a project file

For loading a project file select **File/Load Project** in the menu bar. In the displayed dialog window select the desired project file (appendix .epr).

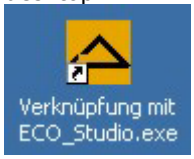
Autosave of the project file when quitting ECO Studio

The project file can be saved automatically when ECO Studio is quit. This option is activated in the menu bar under **File/Project Options/Autosave**. Default setting after the installation of ECO Studio is the option "**Query when Quitting**", i.e., when quitting ECO Studio there is a query whether the user specific settings made in the session should be saved to a project file.

Invoking ECO Studio with settings from a project file

There is the possibility to invoke ECO Studio directly with settings from a specified project file. In this case also the connection to the servo amplifier is accomplished automatically via the communication interface specified in the project file. Proceed as follows:

1. In the Windows explorer, establish a link to the file ECO_Studio.exe which is located in the ECO Studio installation directory (... Programs\JAT\ECO Suite\App). Drag the link icon onto the desktop.



2. Right-click to the ECO Studio link icon on your desktop. In the selection list box displayed select the entry **Properties**.

3. Select the **Link** tab.

4. As shown in the example, add the name and the complete path of the project file to the ECO Studio invokation path (separated by a blank) in the field **Target:**

   Example:
   "D:\Programs\JAT\ECO Suite\App\ECO_Studio.exe" "D:\Programs\JAT\ECO Suite\App\data\Achse_x.epr"

5. Confirm your settings by clicking **OK**.

6. At the next start of ECO Studio via the icon on the desktop the connection to the servo amplifier is set up automatically via the communication interface stored in the project file.

2.10 Disconnecting servo amplifier from PC

	Note that parameter modifications, if any, will have to be saved in the servo amplifier before disconnecting. Select **Administration** in the navigation area. Select **All Parameters** and click **SAVE Parameters**.

The connection between PC and servo amplifier can be disconnected via the **Connection** menu in the menu bar. In the window **Communication: Connect/Disconnect** click **disconnect**.

Note: Before disconnecting, ECO Studio checks whether the autoreverse mode is still active. For safety reasons, a message is displayed where the autoreverse mode can be stopped, if required

3. Optimizing the controller parameters

An optimum operation of the drive system highly depends on the parameter settings of the velocity controller and of the position controller.

The servo amplifier families ECOVARIO® and ECOSTEP® are cascade controllers.

The following controller blocks are available:

- Position controller: P controller
- Velocity controller: PI controller with additional filters
- Current controller

A prerequisite for the optimization of the controller parameters is that the servo amplifier is completely commissioned.

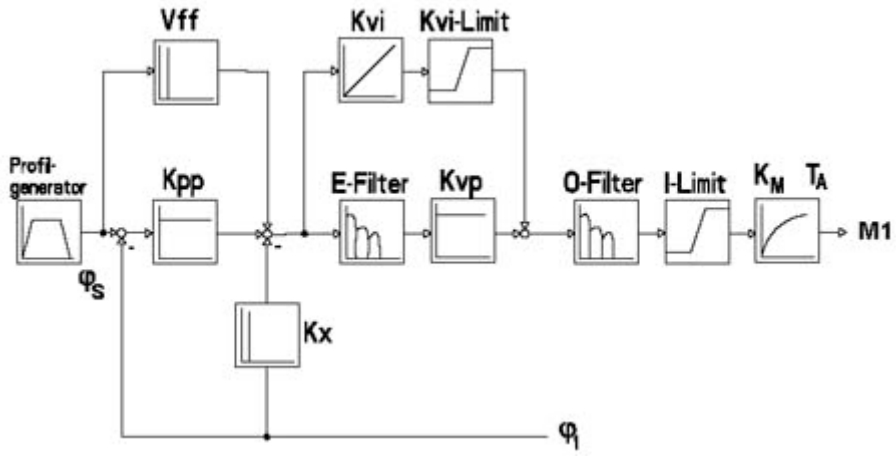
The controller parameters are optimized in the following steps:

- Autoreverse mode with low velocity, setting the velocity controller parameters
- Autoreverse mode with optimization of the position controller parameters
- Homing
- Save parameters.

For parameter optimization the ECO Studio oscilloscope function is used. The parameters can be modified directly in the oscilloscope window and the impact of the modifications can be viewed immediately.

3.1 Background: Controller Structure

The diagram shows the principle controller structure of ECOSTEP®, ECOVARIO® (incl. ECOMiniDual), and ECOMPACT.



The **position controller** is implemented as a P (proportional) controller. The P gain is called Kpp, the unit is 1/s. The difference between the position demand value and the actual position value (called the following error) multiplied with Kpp equals the new position demand value. The velocity pre-control is the factor vff, which is multiplied with the position demand value and directly pre-controlled as velocity demand value. The diagram doesn't show the acceleration pre-control. This functional block has the effect that the profile acceleration multiplied with the value of the acceleration pre-control is directly pre-controlled as current demand value.

The most important function is the **velocity controller**, a PI controller with additional filters. The diagram shows the P gain as Kvp, the I gain as Kvi and their parameterizable limit as Kvi-Limit. The P gain has a proportional effect on the *actual* difference between the velocity demand value and the actual velocity value (difference = velocity error). The I gain has a proportional effect on the *addition of all* differences between the velocity demand value and the actual velocity. Before the multiplication of the velocity error with Kvp, the error can be filtered by averaging over n periods (time constant error filter) of the velocity controller. The result is an additional P gain of factor n.

At the output of the velocity controller there is an output filter (O-filter) which is scaled with its time constant n and so works as a pure low-pass. The current demand value behind the O-filter can be limited by the maximum current value. The motor torque results from the torque constant Km of which the temporal stamp depends on the winding time constant Ta (=LPh/RPh). The counts of the motor encoder are differentiated and by the factor Kx sent to the velocity controller as actual value. The pure counts are additionally sent as 1-ms clock to the position controller as actual position value.

At the **current controller** the maximum current and the i^2t-fuse can be parameterized. All other parameters are set by the manufacturer and must not modified in regular cases.

3.2 Setting the velocity controller parameters

Prerequisite: Initial commissioning of the drive system has been completed. The drive is in quick stop and the voltage is disabled (Control word: 6h).

Note: The velocity controller comes up with the appropriate default settings from the motor data set. Depending on the mechanics of your application, however, modifications of the settings might be necessary.

For setting and optimizing the velocity controller parameters first switch on the autoreverse mode in the **Velocity Mode**, cf. Chapter 2.6.1.

After this, in the **Analyzer** window select the **Oscilloscope Display** tab and click **<<** in the lower right of the window. An area is opened where position controller parameters and velocity controller parameters are displayed and can be modified. Here select the **Velocity Controller** tab.

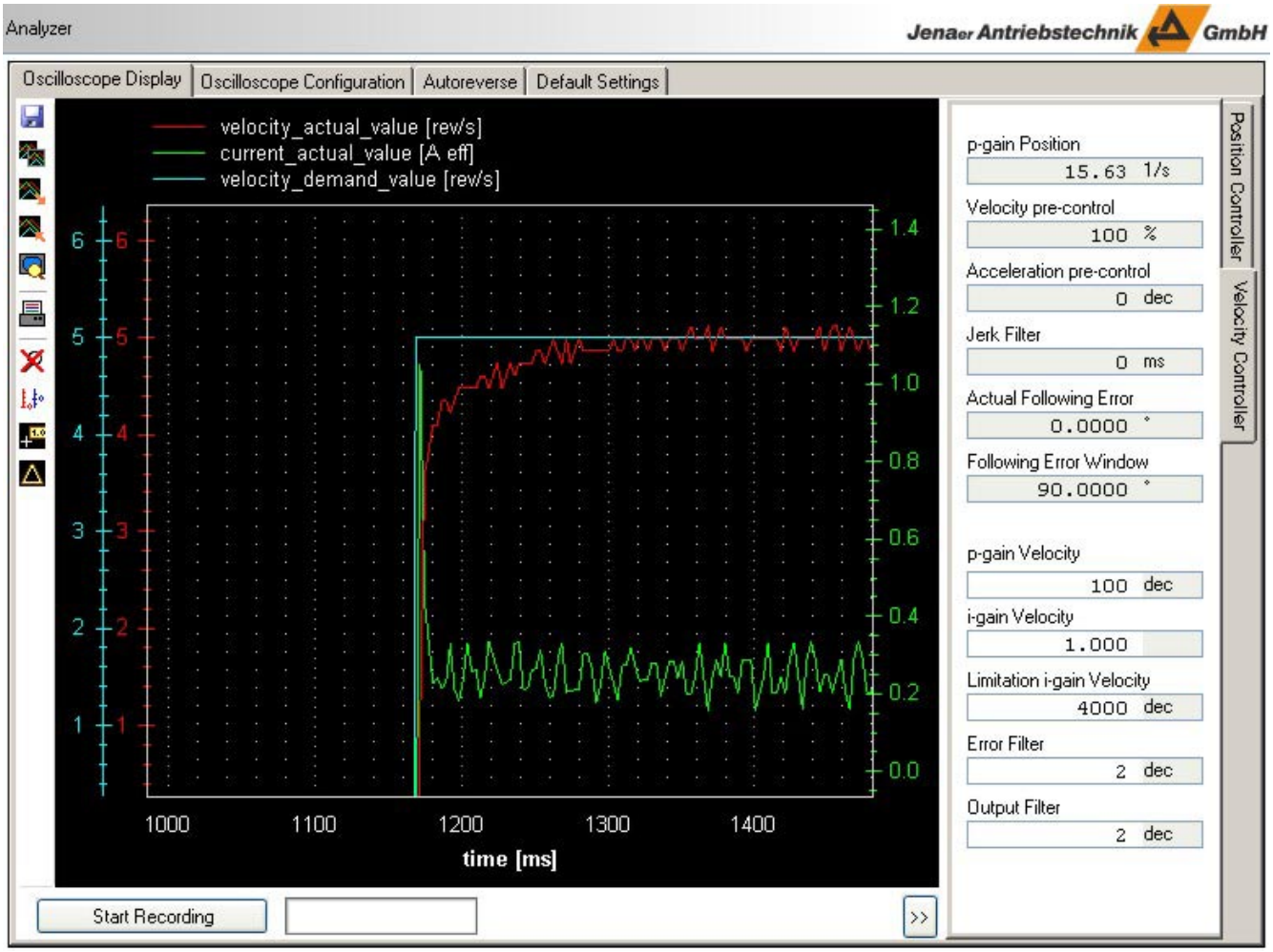
1. The time constant of the **Error Filter** should be set to 1. The **i-gain Velocity** of the velocity controller should be set to 0.

   Exception: In case of a z axis an i-gain of 0 might not be sufficient to move the axis up. In this case set the i gain to 1.

2. In the **Velocity Controller** tab increase the **p-gain Velocity** until the motor begins to vibrate. Start with a value of approximately 100. At high encoder resolutions (> 50.000 inc/rev) start with approx. 50. If the vibration is of low frequency, normally a natural frequency of the system has been met. In this case, step by step increase the time constant of the **Output Filter** until the disturbances are eliminated. You can use positive as well as negative values, by experience they should be higher than ±10...30 with toothed belt axes, otherwise ±2...7 (Note: with firmware versions < 0044 there exist no negative values). After the filter values have been increased, the **p-gain Velocity** may be increased as well until the motor begins to vibrate again. If the vibrations are of high frequency, they are caused mostly in the control circuit. Decrease the p-gain by approx. 30% in this case.

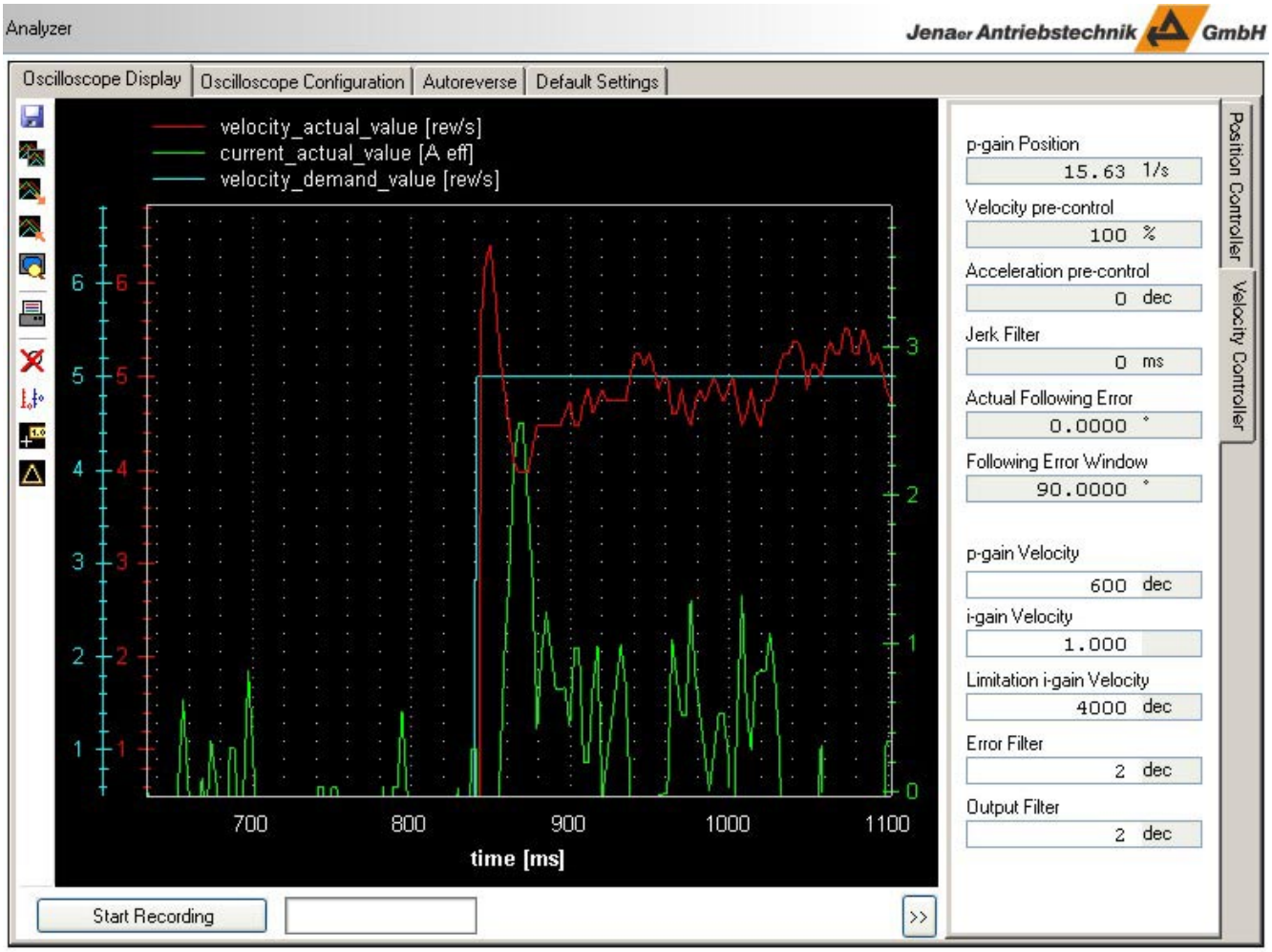
3. In standstill the motor should neither vibrate nor cause large noise. On moving the motor axis manually, it resists and springs back.

The better the controller settings are the better the actual velocity value follows the velocity demand value. The following diagrams show the effects of a step by step increase of the p-gain.



ECOVARIO with 23S21: p-gain = 100, Actual velocity slowly follows the velocity demand value

ECOVARIO with 23S21: p-gain = 400, Actual velocity follows the velocity demand value pretty good



ECOVARIO with 23S21: p-gain =600, Overshoot of the actual velocity

For parameterization of the **i-gain** first the friction current of the axis has to be determined. With the help of the ECO Studio oscilloscope function you can read this value easily during autoreverse mode. The friction current is the actual current displayed at a constant velocity.
As parameters you use the actual velocity value (e.g. on channel 2) and the actual current value (e.g. on cannel 3).

Definitions:
i_limit: limitation of the i component [inc]
kvi: i-gain
Imax: Maximum controller current [inc]
imin: minimum i component of the velocity control circuit [inc]

1. Measuring the friction current [A]

2. Convert friction current [A] into increments [inc]:

   for ECOVARIO: friction current [inc] = $\frac{\text{friction current [A]}}{20\ \text{A}} \cdot 16383\ [\text{inc}]$

   for ECOSTEP100: friction current [inc] = $\frac{\text{friction current [A]}}{8\ \text{A}} \cdot 2047\ [\text{inc}]$

   for ECOSTEP200: friction current [inc] = $\frac{\text{friction current [A]}}{12\ \text{A}} \cdot 2047\ [\text{inc}]$

   for ECOSTEP216: friction current [Ink] = $\frac{\text{friction current [A]}}{24\ \text{A}} \cdot 2047\ [\text{inc}]$

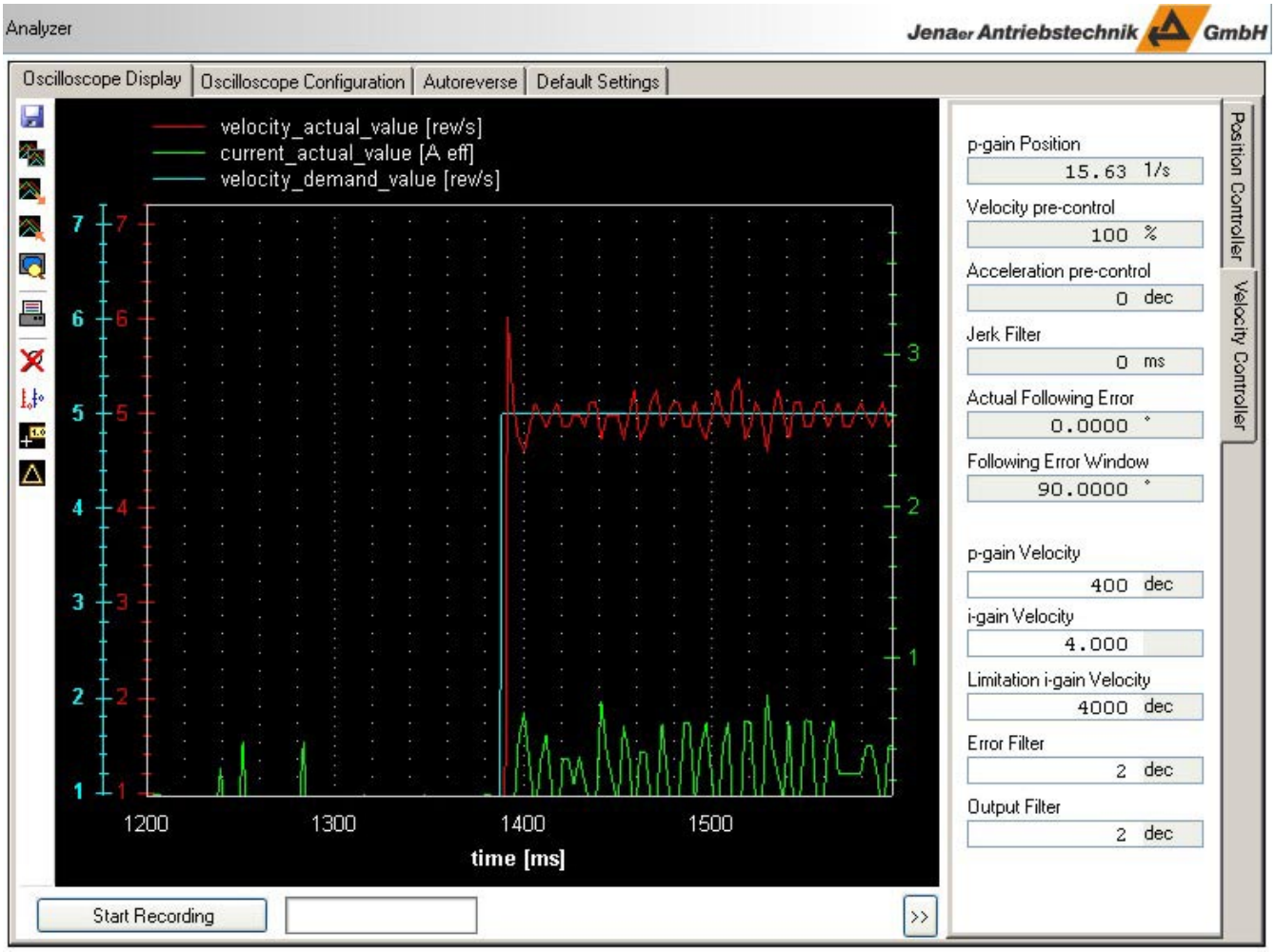
3. Calculate imin

   imin [inc] approximately corresponds to friction current [inc] · 1.3

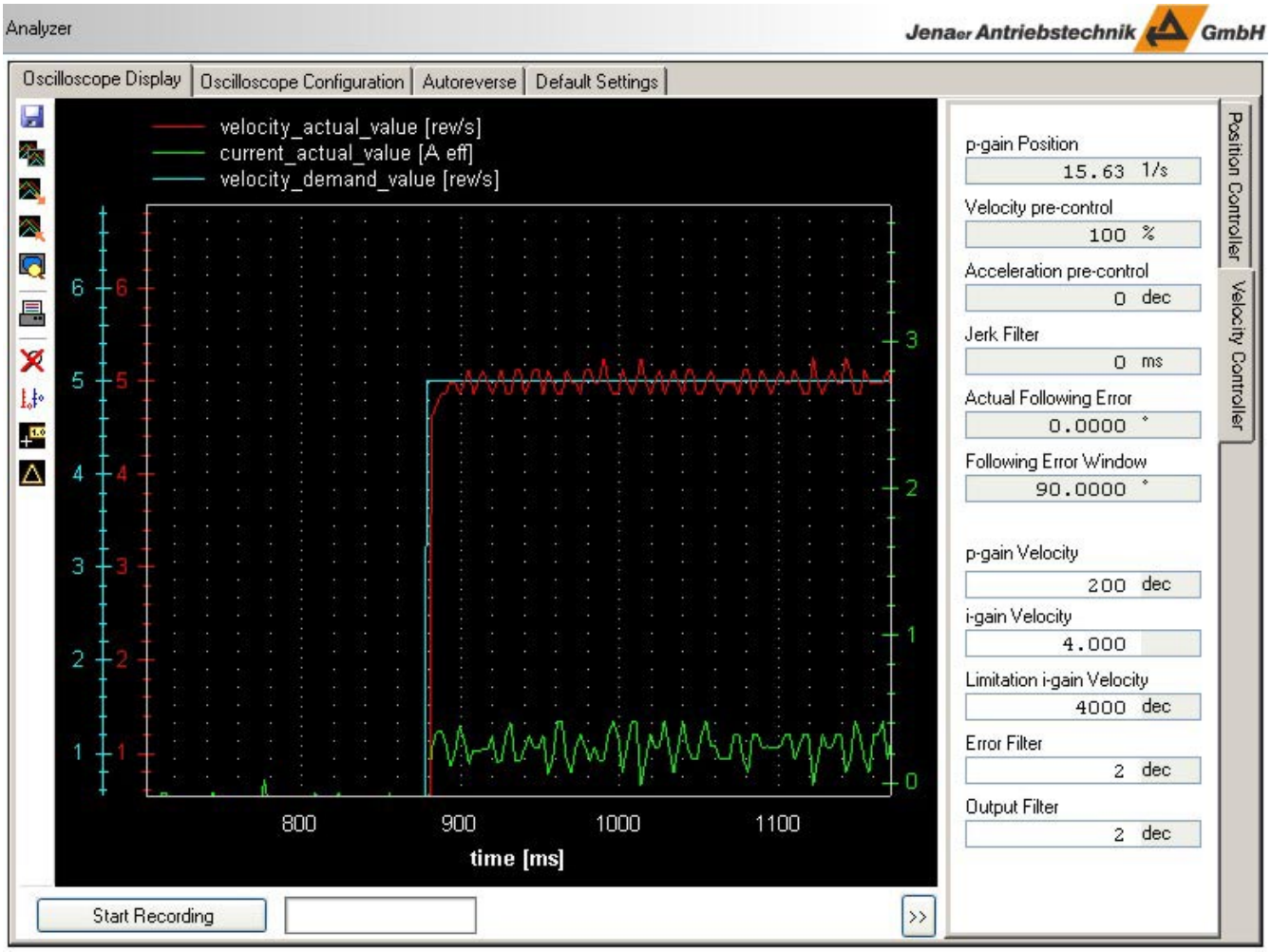
   wheras: imin < kvi · i_limit < 3/4 imax

A common value is kvi = 1, i.e., often i_limit corresponds to the i component.
The i component should not exceed ¾ of the maximum controller current. If a higher rigidity is necessary, kvi has to be increased correspondingly.

The following example shows the impact of increasing the i-gain.



The overshoot of the actual velocity value and the unsmooth current curve can be smoothed by reducing the p-gain, as shown in the following diagram.



The actual velocity now follows the demand value very good. Thus, the velocity controller parameters are adapted to the mechanics.

Select the **Autoreverse** tab and click **Stop**.

3.3 Setting the position controller parameters

Prerequisite: The optimization of the velocity controller parameters has been finished. The drive is ready for operation and the axis is switched on. (Control word: 0Fh).

Note: The position controller comes up with the appropriate default settings from the motor data set. Depending on the mechanics of your application, however, modifications of the settings might be necessary.

For setting and optimizing the position controller parameters first switch on the **Autoreverse** mode in the **Position Mode**, cf. Chapter 2.6.1.

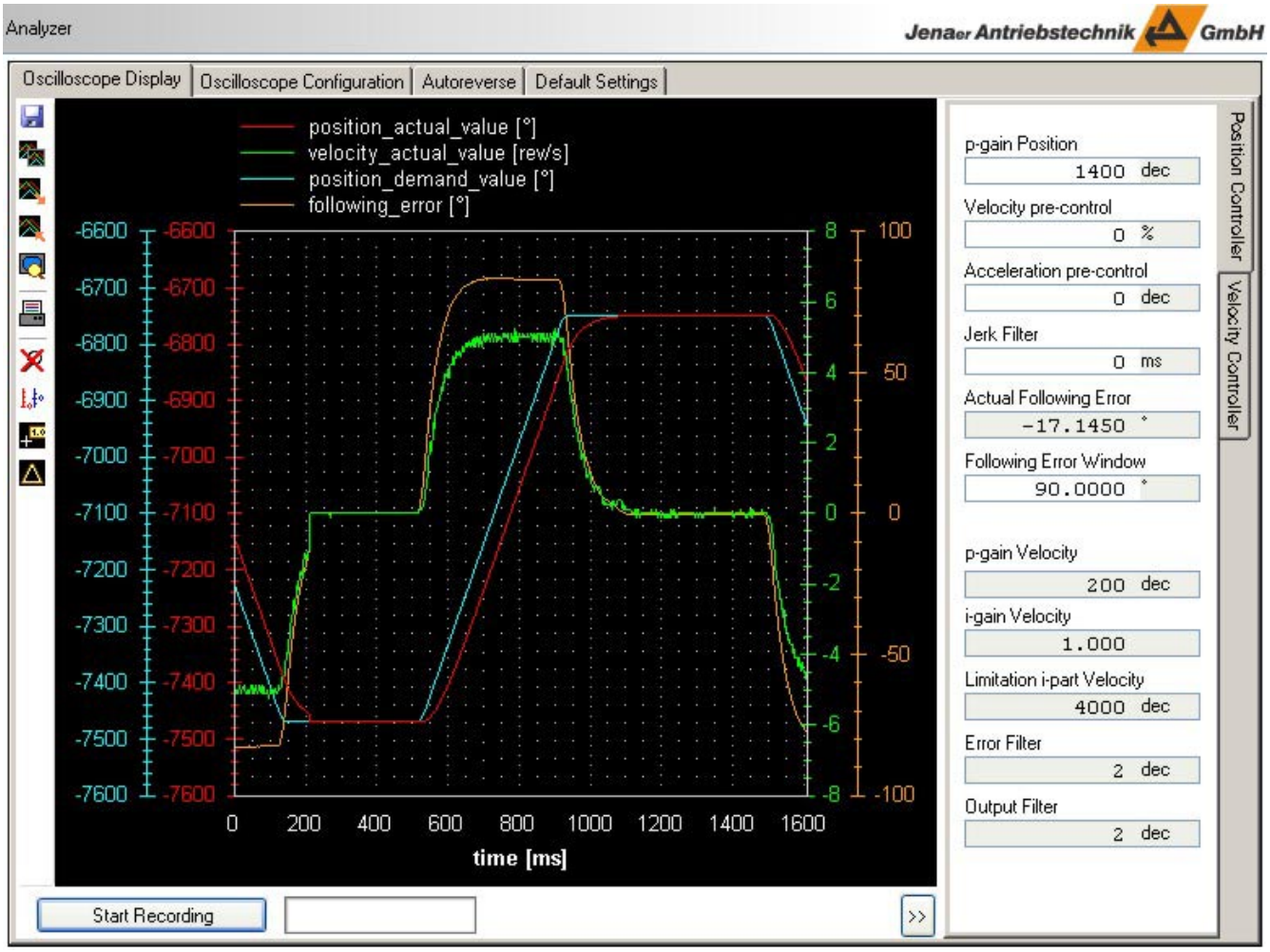
1. After this, in the **Analyzer** window select the **Oscilloscope Display** tab and click **<<** in the lower right of the window. An area is opened where position controller parameters and velocity controller parameters are displayed and can be modified. Here select the **Position Controller** tab.

2. Now, it has to be differentiated between normal positioning tasks (point-to-point) and trajectory driving.

   For normal positioning tasks (point-to-point), an oscillation free reaching of the position is important (without overshoot, fast reaching of the position window). The behaviour is determined mainly by the p-gain parameter in the position controller.

   For trajectory driving additionally the deviation of the actual position value from the position demand value is important, called the following error. By means of the parameter velocity pre-control (vfff) it is therefore possible to reduce the following error.

In the following, the procedure for optimizing the position controller is shown. The following error and the position reaching behaviour can be displayed with the help of the oscilloscope function (Chapter 2.6.3).



At a constant velocity, the following error is calculated according to the following formula:
ep: following error [°]
vsoll: velocity demand value [360°/s]
kp: p-gain of the position controller [1/s]
vfff: velocity pre-control [%]

$$ep = (1-vfff/100) \cdot vsoll/kp$$

In order to eliminate the influence of the parameter velocity pre-control (vfff), it is set to 0.
Thus the following error is

$$ep = vsoll/kp$$

in the example (vsoll = 5 rev/s):

$$ep = \frac{5 \cdot 360° \cdot 64}{1400} = 82.3°$$

At least this value has to set in the parameter **Following Error Window** in the beginning, otherwise the error message „following error" is raised immediately after the initial movements. In the example the default setting of 90° has been maintained.

Normally, the following error should be as low as possible. Now, increase the **p-gain Position** until the following error is in the desired range.

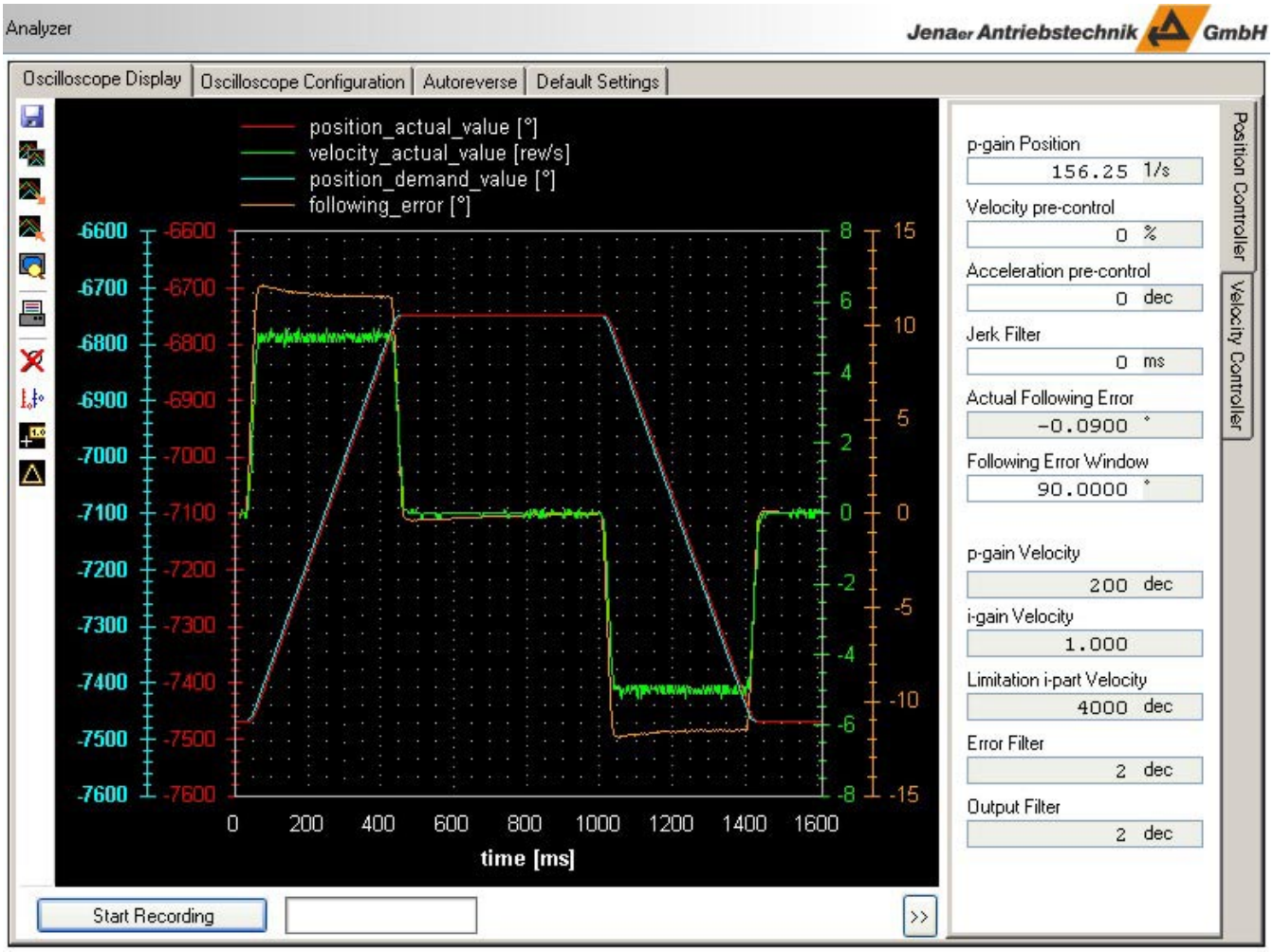


Fig.: Increasing the p-gain in order to reduce the following error

If the **p-gain Position** is too high, there is an overshoot during the position reaching process. In the following, increase the demand values for acceleration and velocity step by step until they reach the values required for the application.

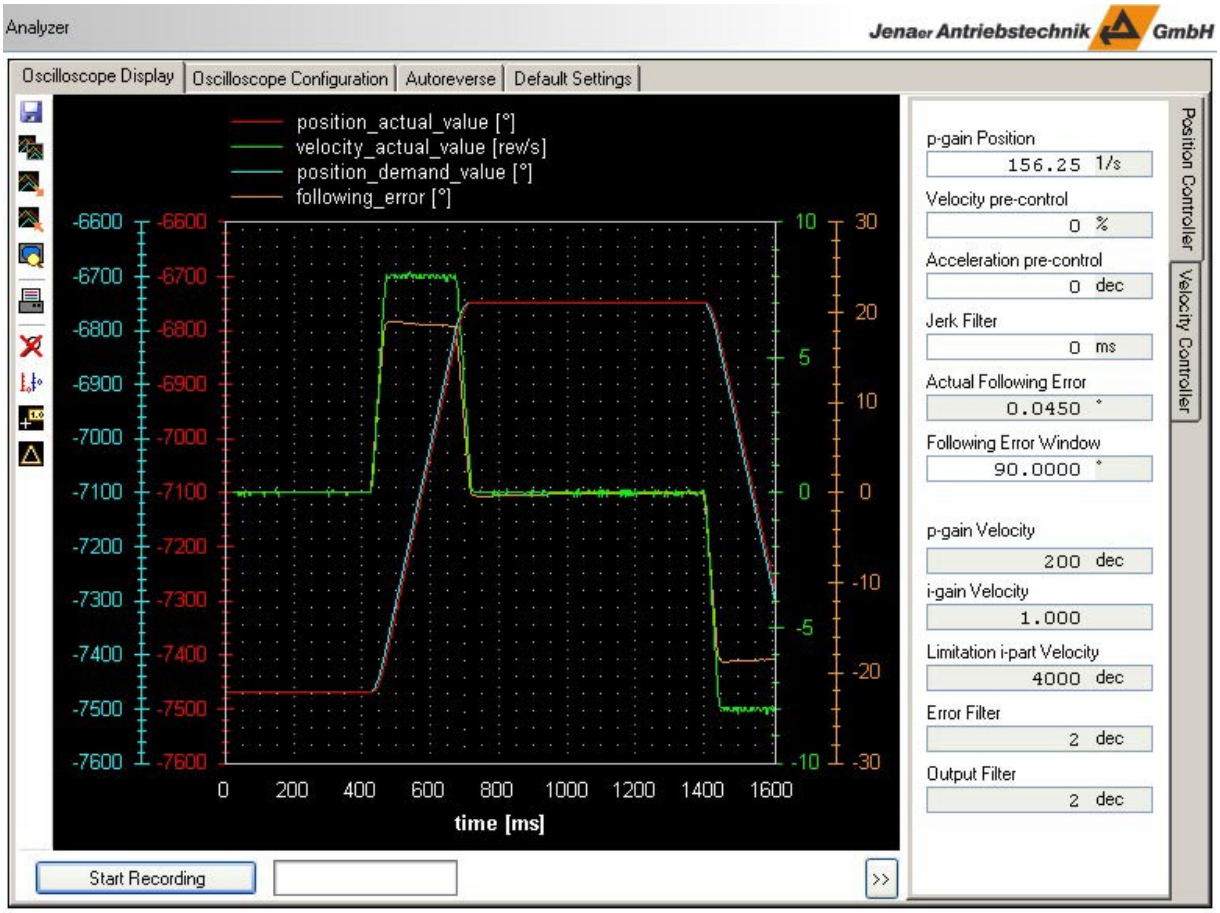


Fig.: Adapting the velocity to the application specific requirements

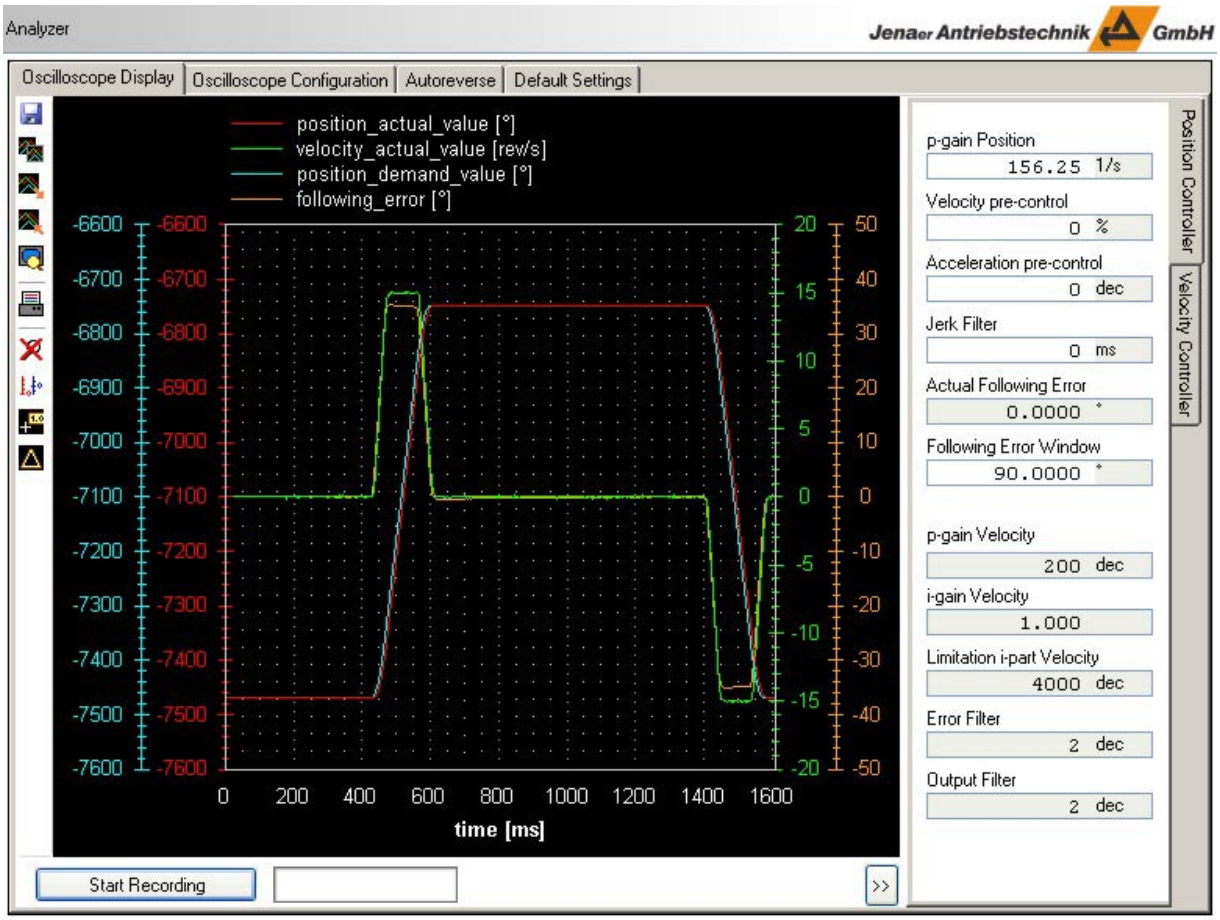


Fig.: Adapting the acceleration values and further increase of the velocity

The **Following Error** which occurs can be set depending on the **Velocity pre-control**. If the **Velocity pre-control** is increased, the following error is reduced. Vice versa, if the **Velocity pre-control** is reduced, the following error is increased.

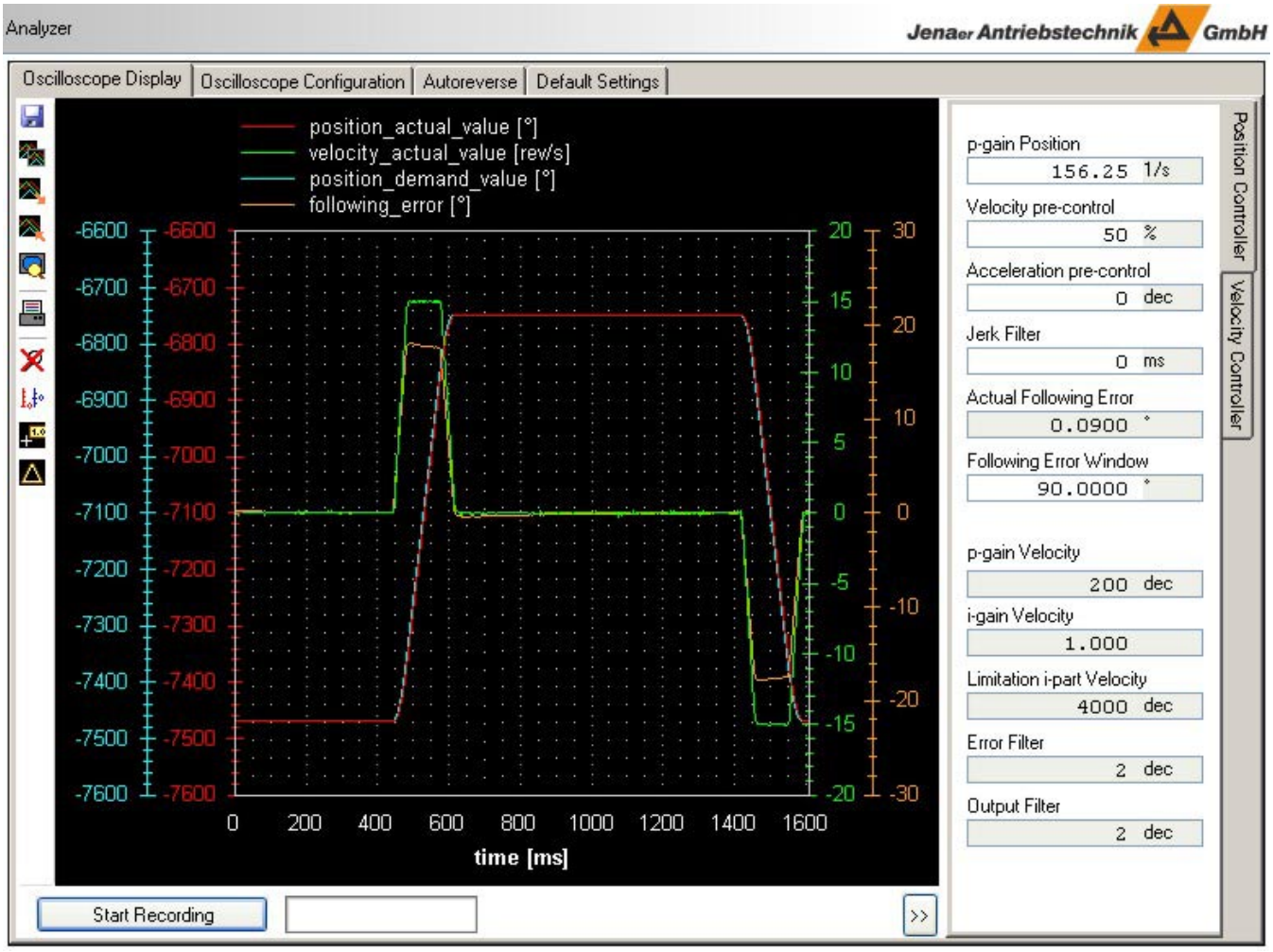


Fig.: Increasing the velocity pre-control in order to reduce the following error

If the values for **Velocity pre-control** and **p-gain Position** of the position controller are too high, there is an overshoot when the target position is reached.

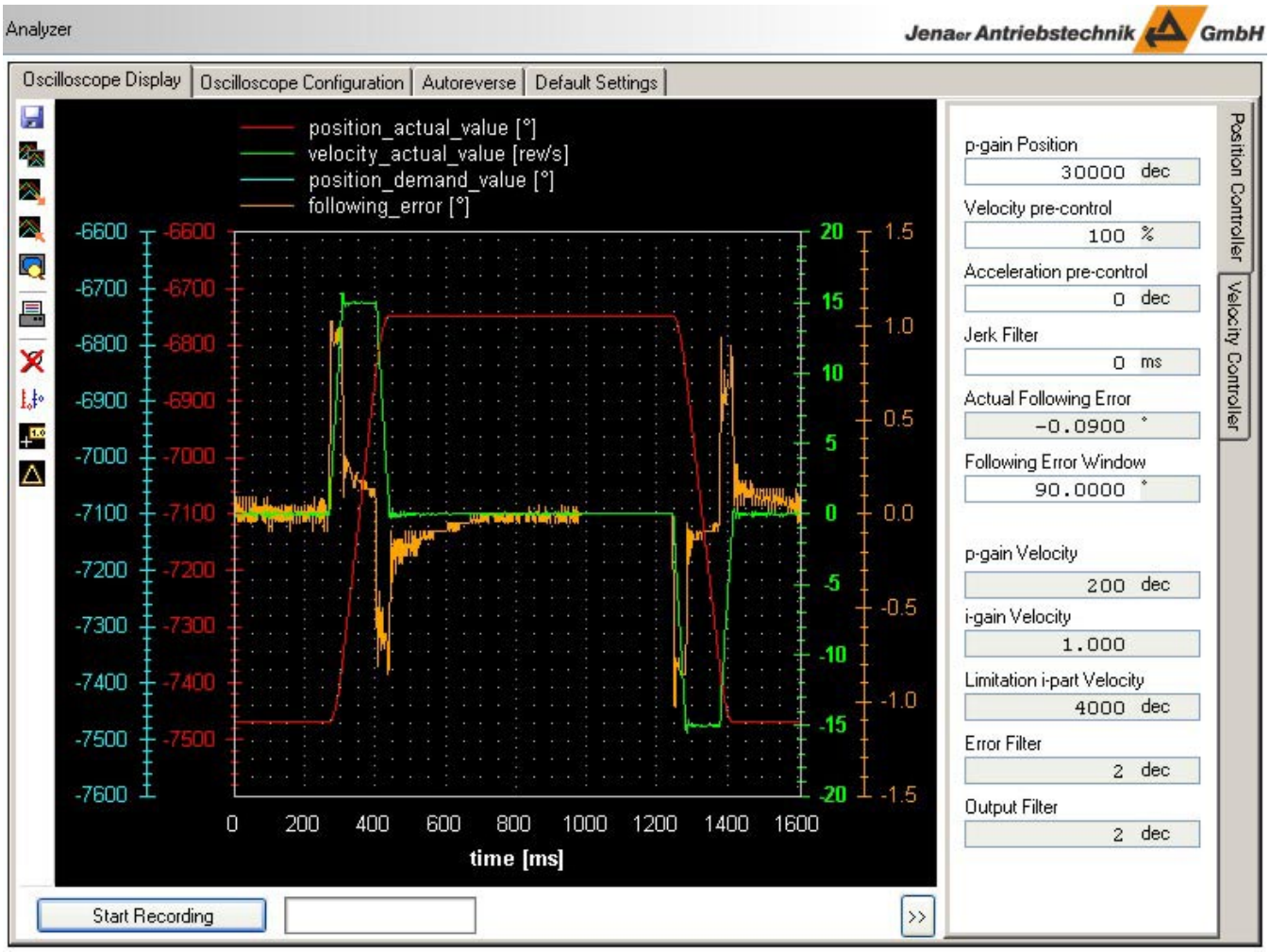


Fig.: Velocity pre-control too high: Overshoot of the drive when target position is reached

If the drive is not able to reach the demanded accelerations, the controller will increase the actual current until the current limit is reached and there is an overshoot when the target position is reached.

On trajectory driving of more than one drive the parameters of the position controller have to be set to the same values for all drives. The worst drive determines the performance of the system.

The velocity profile is „smoothed" with the help of the parameter **Jerk Filter**. Thus, a smooth sequence of movement is achieved. The unit of the parameter is ms. Positioning time is increased by the time specified for the jerk filter parameter. On trajectory driving the higher-level controller takes this job. In this case the parameter has to be set to 0.

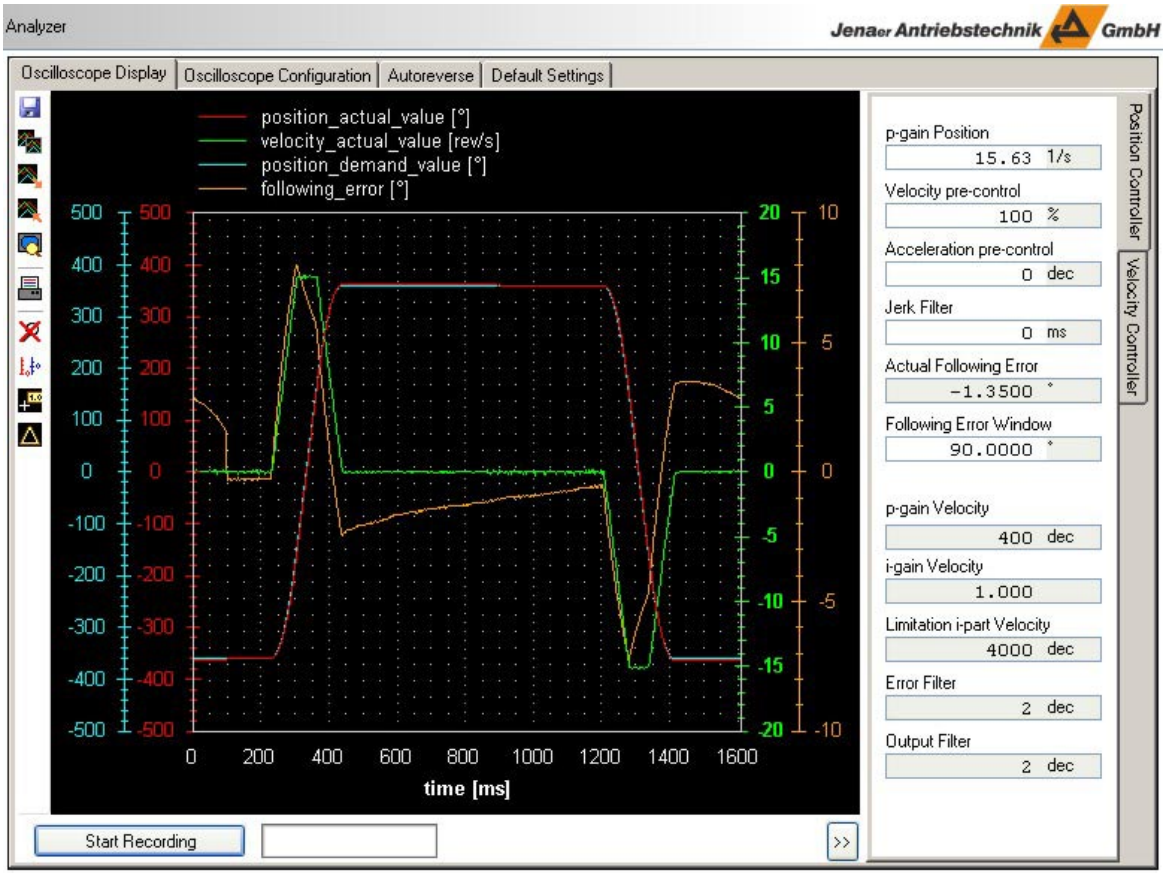


Fig.: Initial situation before setting the jerk filter

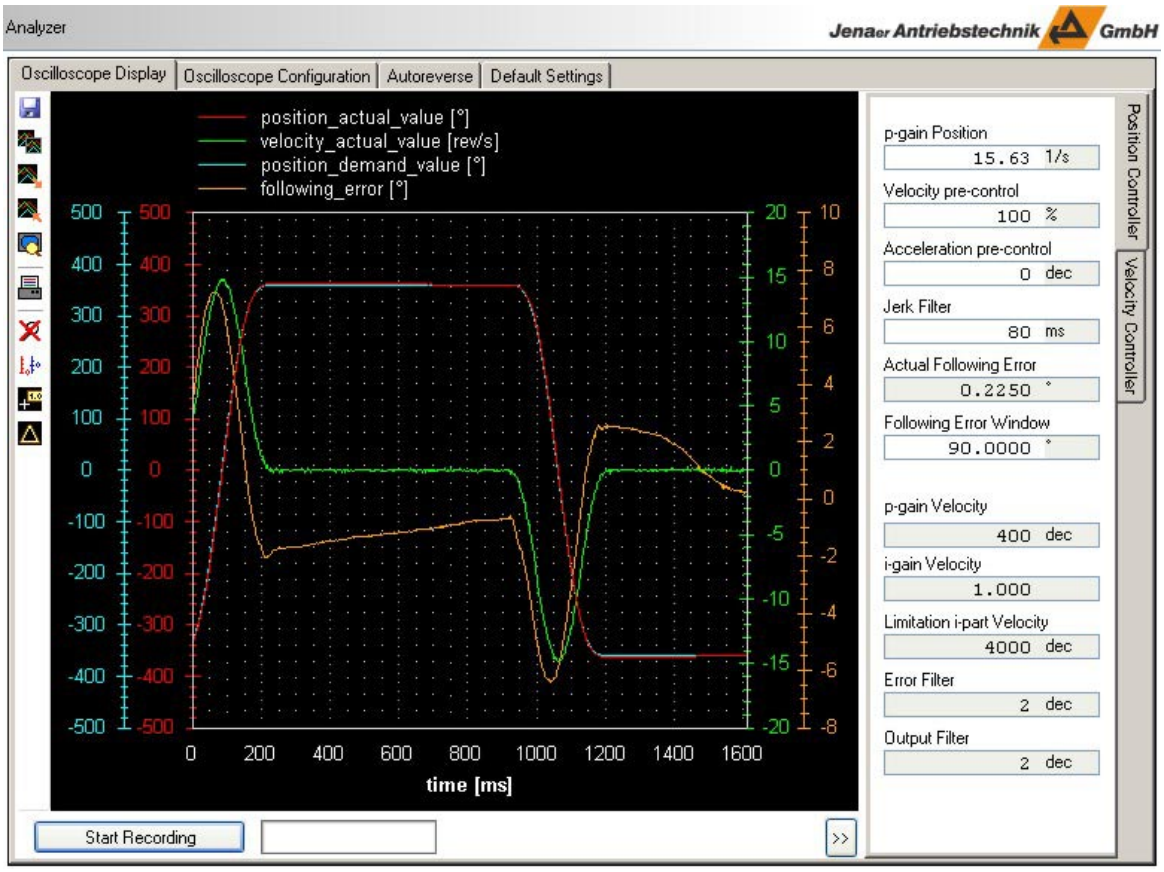
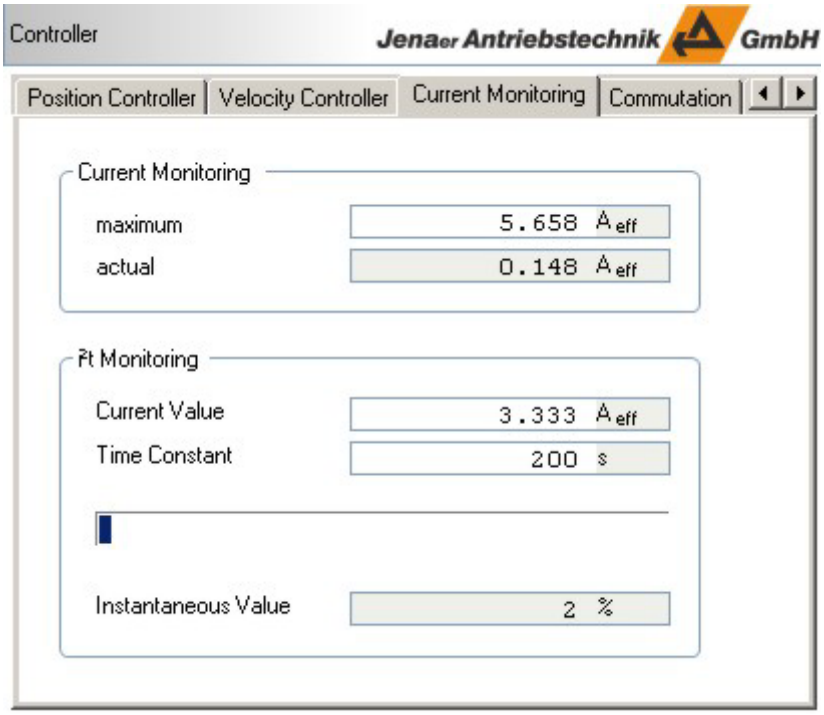


Fig.: Increasing the jerk filter parameter

After the optimization of the position controller is finished, select the **Autoreverse** tab and click **Stop**.

3.4 Current monitoring

In the basic mode, only the maximum current and the i^2t monitoring can be parameterized in the current controller. All other parameters are set by the manufacturer and can only be modified in the expert mode.

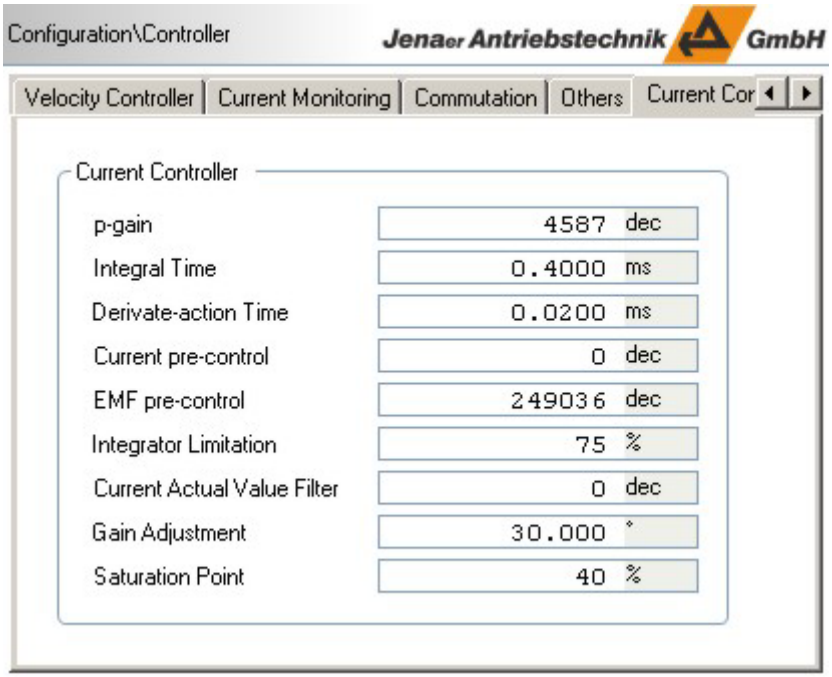


Window area **Current Monitoring**	
maximum	Maximum admissible motor current. The upper limit of the value range is given by the maximum controller current which depends on the servo amplifer: ECOSTEP100: 8 A_{DC} or 5,6 A_{RMS} ECOSTEP200: 12 A_{DC} or 8 A_{RMS} ECOSTEP216: 24 A_{DC} or 17 A_{RMS} ECOVARIO: 20 A_{DC} or 14 A_{RMS} ECOMiniDual: 10.5 A_{DC} or 7.5 A_{RMS} ECOMPACT: 20 A_{DC} or 14 A_{RMS}
actual	Actual motor current
Window area **i^2t Monitoring**	
Current Value	Power stage current value for i^2t monitoring. Can also be used for a temporary (short-term) overcurrent monitoring
Time Constant	i^2t monitoring of the powerstage, tau value (63%)
Instantaneous Value	i^2t output value
For ECOSTEP only in stepper mode:	
Holding Current	Current that has to be configured in order to reliably hold the position under load
Additional Travel Current	Current that is required in addition to the holding current to move the axis.

3.5 Current controller (Expert mode only)

The current controller parameters are preset appropriately for the motor in use by means of the motor data set. Modifications are necessary only in exceptional cases and may only be carried out by authorized personnel.

⚠	Wrong settings of the current controller and of the current limitation might destroy the motor and the servo amplifier! Modifications of the current controller parameters may only be carried out by experts of Jenaer Antriebstechnik GmbH or by authorized personnel.



Meaning and calculation of the **Current Controller** parameters:

p-gain	$Kp = 2 \cdot \Pi \cdot f \cdot L[H] \cdot \frac{20A}{400V} \quad \{f = 636Hz\}$ $Kp \approx 200 \cdot L[H]$ $Kp(Reg) = Kp \cdot 2^{15}$
Integral Time	The integral time Tn finds its way into the integral gain Ki of the current controller: $Tn = 0.5 \cdot \frac{L[H]}{R[\Omega]}$

	$$Ki(Reg) = \frac{T}{Tn} \cdot 2^{15} \quad \{T = 61\mu s\}$$
Derivate-action time	The derivate-action time Tv finds its way into the derivate-action Kd of the current controller: $$K_d(Reg) = \frac{T_v}{T} \cdot 2^{15} \quad \{T = 61\mu s\}$$
Current pre-control	also I*R pre-control $$IR(Reg) = R[\Omega] \cdot \frac{20A}{400V} \cdot 2^{15}$$
EMF pre-control	For rotary encoders: $$k_{ff}(Reg) = K_v[Vrms/1000rpm] \cdot \frac{0{,}885 \cdot 2^{29}}{EncoderRes[inc/rev]} * 50\%$$ For linear axes: $$k_{ff}(Reg) = K_v[Vs/m] \cdot \frac{0{,}885 \cdot 2^{29} \cdot 16{,}66}{EncoderRes[inc/m]} * 50\%$$ each with the respective motor constant Kv
Integrator Limitation	Limitation of the integral part of the current controller
Current Actual Value Filter	Error filter
Gain Adjustment	End value of the gain reduction. Is e.g. as end value only ¼ of the beginning Kp value possible, the kink angle in the diagram has to be selected in such a way that the axis on the right is cut at 0.25.
Saturation Point	Saturation starting point in %. If the saturation range begins e.g. at 5A of 20A max. current, 25% have to be entered here.

Note: The value for the integrator limitation should also be set with IR compensation!

For 3-phase motors a different motor constant is valid. The specification of the phase inductance can vary (terminal – terminal or terminal – neutral point). Please only measure the current of phase A (under **Configuration\Output Mode**) set the **Mode** to "DC mode, current output phase A"), because otherwise measuring is erroneous with 3-phase motors. With 3-phase motors, measuring is mostly done between two windings. As a result, two times the phase resistance and the 2.7 fold of the phase inductance are measured. The time constant (L/R) is 75% of the „2-phase value". For motors with a very low armature resistance the influence of the motor cable has to be taken into account for the calculation of the integral time.

4. Configuration of the inputs and outputs

4.1 Digital inputs

1-axis servo amplifier ECOVARIO®114/214/414, ECOMPACT, ECOSTEP®

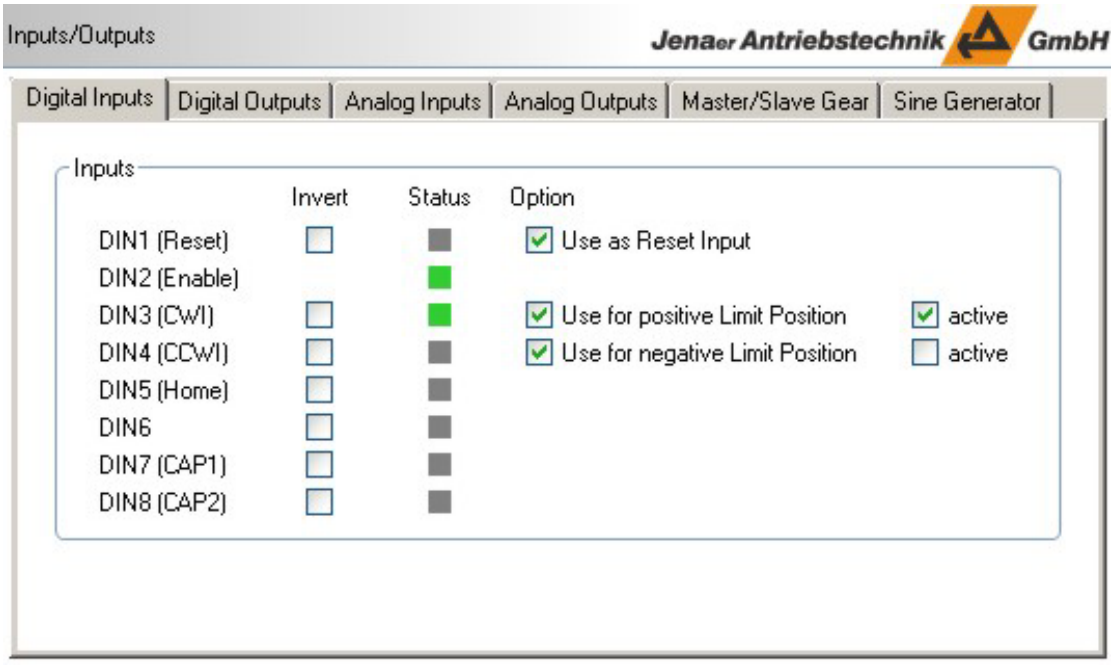
The digital inputs of ECOSTEP®, ECOVARIO® and ECOMPACT are edge-controlled, so only changes of level are evaluated. In the navigation area under **Inputs/Outputs** in the **Digital Inputs** tab the levels are displayed, inputs can be inverted and limit position switch functions can be activated.

⚠	In order to use DIN3 and DIN4 (ECOVARIO®, ECOMPACT) or DIN6 and DIN7 (ECOSTEP®) for the evaluation of the limit position switches the check boxes **Use for positive Limit Position** and/or **Use for negative Limit Position** have to be set as shown in the following. Otherwise the limit positions are not monitored!

The limit position switches are pre-configured as openers by means of the loaded motor data set:

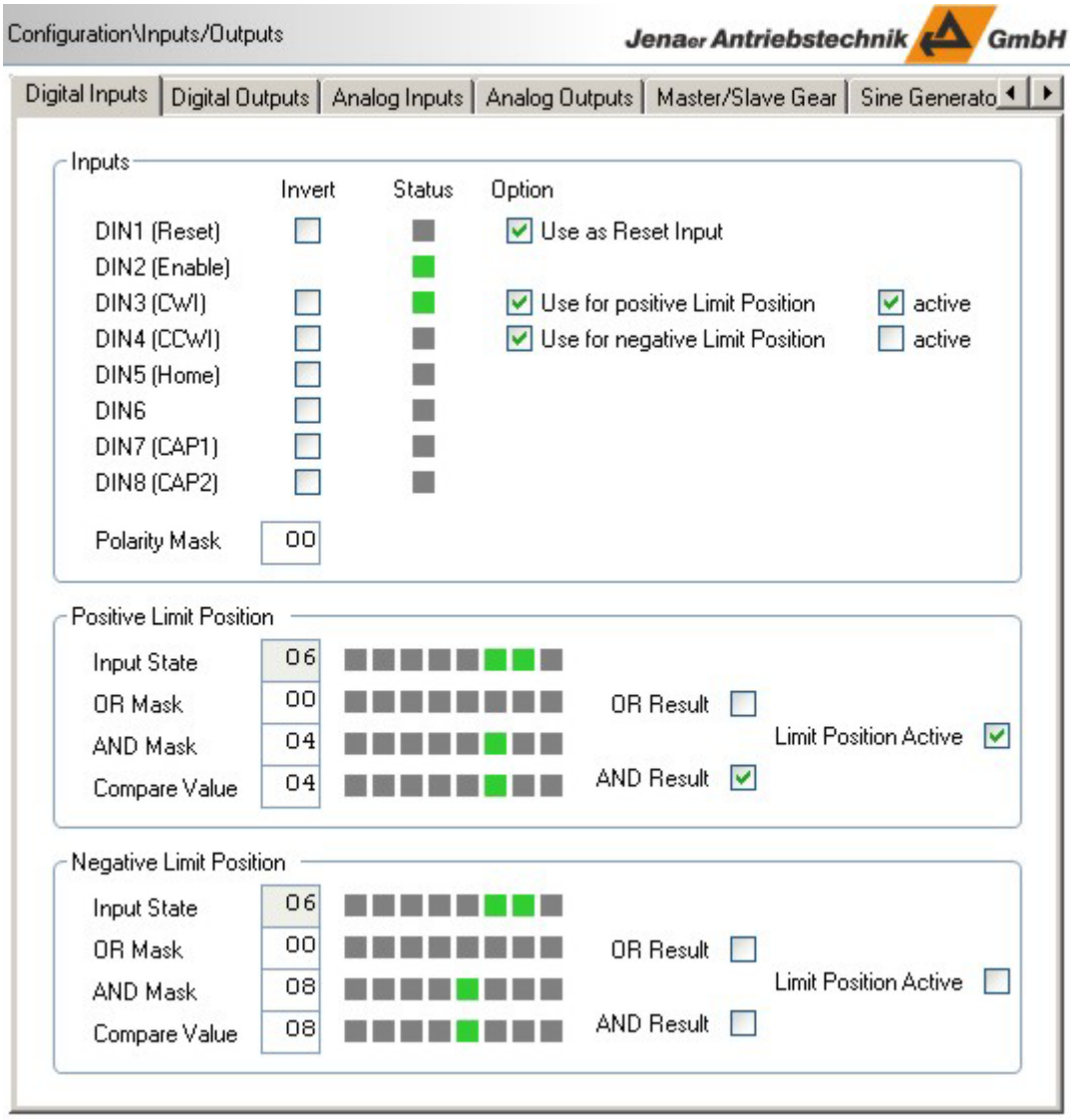
- DIN3 (ECOVARIO®, ECOMPACT) or DIN6 (ECOSTEP®) for positive limit switch, i.e. limit in positive count direction of the motor
- DIN4 (ECOVARIO®, ECOMPACT) or DIN7 (ECOSTEP®) for negative limit switch, i.e. limit in negative count direction of the motor.

The following screenshot shows the correct settings in the *basic mode* for the evaluation of the limit position switches at ECOVARIO®. DIN3 for the positive limit switch is active here (limit switch event), which can be seen from the green box in the **Status** column and the checked **active** check box.



Window area **Inputs**	
Invert	If the check box is checked, the applied digital input signal is inverted. I.e., the input is set to „active" by a LOW-level signal (without inverting the signal a HIGH level sets the input).
Status	Level indicator Grey: Input is not set to „active" Green: Input is set to „active"
Option	Mapping of the digital inputs in ECOVARIO®: • **DIN1:** If the check box is checked, DIN1 is used as reset input. • **DIN3:** If the check box is checked, DIN3 is used for monitoring of the positive limit position • **DIN4:** If the check box is checked, DIN4 is used for monitoring of the negative limit position. Alternatively, the inputs can be used for other general control purposes. In this case, the respective check box must not be set.

In the *expert mode*, ECO Studio provides enhanced configuration possibilities. The following screenshot shows the correct settings for the evaluation of the limit switches at ECOVARIO®. DIN3 for the positive limit switch is active here (limit switch event), which can be seen from checked **active** check box and the green box in the **Status** column.



Windows area **Inputs**	
Invert	If the check box is checked, the applied digital input signal is inverted. I.e., the input is set to „active" by a LOW-level signal (without inverting the signal a HIGH level sets the input).
Status	Level indicator Grey: Input is not set to „active" Green: Input is set to „active"
Option	Mapping of the digital input DIN1 in the ECOVARIO®: If the check box is checked, DIN1 is used as reset input. Alternatively, the input can be used for other general control purposes. In this case, the check box must not be set.
Window area **Positive Limit Position** or **Negative Limit Position**	
Input State	Level indicator (corresponds to the column **Status**): Grey: Input is not set to „active" Green: Input is set to „active"
OR Mask	Bit by bit activation of the OR operation between input status and compare value
AND Mask	Bit by bit activation of the AND operation between input status and compare value
Compare value	Compare value of the AND or the OR operation, respectively. Depending on the bit pattern in the rows **OR** and **AD** this value is operated with the input state.
Status	A limit position event occured: Limit position switch has been triggered and limit position detection is activated in the servo amplifier

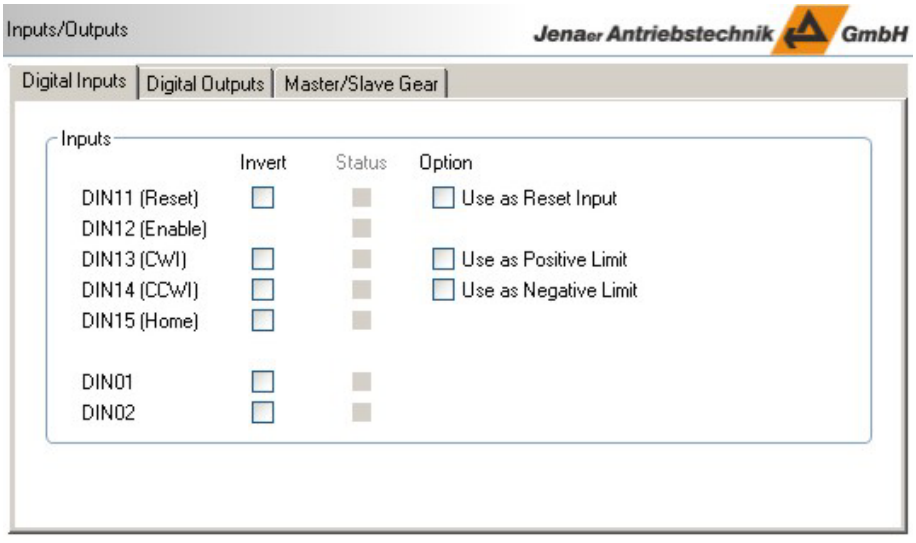
If, e.g. for test purposes, limit position switches are not used, enter the value 0 in the fields **AND Mask** in the window areas **Positive Limit Position** and **Negative Limit Position** to allow motor movements.

2-axis servo amplifiers ECOVARIO®114 D, ECOMiniDual

The 2-axis servo amplifiers ECOVARIO®114 D and ECOMiniDual provide 5 digital inputs for each axis (DIN11 to DIN15 for axis 1 and DIN21 to DIN25 for axis 2). Additionally, the ECOMiniDual supports two axis-independent digital inputs (DIN01, DIN02).

The digital inputs are edge-controlled, so only changes of level are evaluated. In the navigation area under **Inputs/Outputs** in the **Digital Inputs** tab the levels are displayed, inputs can be inverted and limit position switch functions can be activated. The digital inputs are partly pre-assigned to fixed functions (e.g. DIN12 or DIN22, resp. are always used as Enable inputs), partly they can be used customer-specific, e.g. as trigger for the processing of a sequence programmed before.

	In order to use DIN13 and DIN14 (axis 1) or DIN23 and DIN24 (axis 2) for the evaluation of the limit position switches the check boxes **Use for positive Limit Position** and/or **Use for negative Limit Position** have to be set. Otherwise the limit positions are not monitored!



Window area **Inputs**	
Invert	If the check box is checked, the applied digital input signal is inverted. I.e., the input is set to „active" by a LOW-level signal (without inverting the signal a HIGH level sets the input).
Status	Level indicator Grey: Input is not set to „active" Green: Input is set to „active"
Option	Mapping of the digital inputs: • **DIN11** or **DIN21:** If the check box is checked, DIN11 or DIN21 is used as reset input. • **DIN13** or **DIN23:** If the check box is checked, DIN13 or DIN23 is used for monitoring of the positive limit position. • **DIN14** or **DIN24:** If the check box is checked, DIN14 or DIN24 is used for monitoring of the negative limit position. Alternatively, the inputs can be used for other general control purposes. In this case, the respective check box must not be set.

ECOSTEP®54

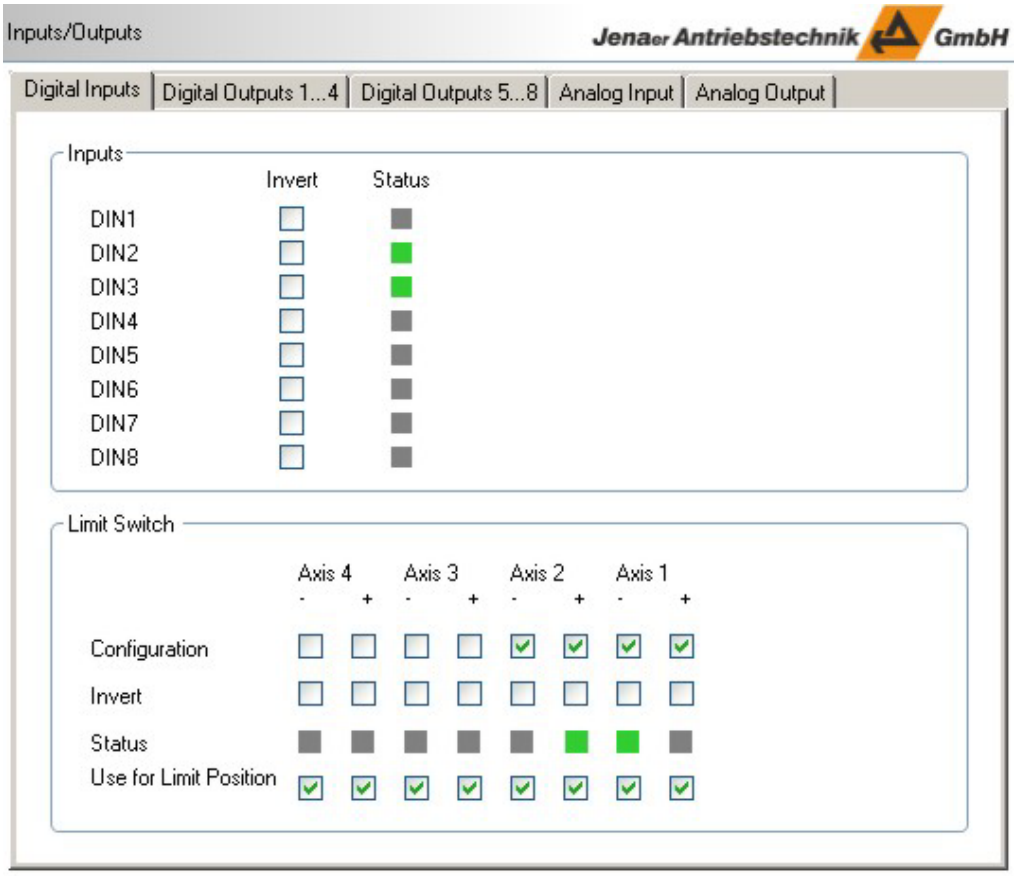
The digital inputs DIN1 to DIN8 of the ECOSTEP®54 are edge-controlled, so only changes of level are evaluated. The inputs are implemented galvanically isolated. In the navigation area under **Configuration\Inputs/Outputs** in the **Digital Inputs** tab the levels are displayed, inputs can be inverted and limit position switch functions can be activated.

	In order to use DIN1 to DIN8 for the evaluation of the limit position switches in the window area **Limit Positions** the check boxes **Configuration** and **Use for Limit Positions** have to be set for the respective selection. Alternatively, the limit switch inputs at the motor connectors of the ECOSTEP54 can be used (not galvanically isolated), in this case the check box **Configuration** has not to be set.

The limit position switches are assigned as follows:

- DIN1, DIN3, DIN5, and DIN7 for positive limit switch axis 1 to 4, i.e. limit in positive count direction of the motor
- DIN2, DIN4, DIN6, and DIN8 for negative limit switch axis 1 to 4, i.e. limit in negative count direction of the motor.

In the following example the digital inputs DIN1 to DIN4 are used for the limit position switches at the axes 1 and 2 (check box in the row **Configuration** checked), for the axes 3 and 4 the inputs at the motor connectors are used (respective check boxes in row **Configuration** not set). The limit position switches connected to DIN2 and DIN3 are active here, i.e. limit position events for negative limit position at axis 1 and for positive limit position at axis 2, which can be seen from the green box in the **Status** row.



Window area **Inputs**	
Invert	If the check box is checked, the applied digital input signal is inverted. I.e., the input is set to „active" by a LOW-level signal (without inverting the signal a HIGH level sets the input).
Status	Level indicator Grey: Input is not set to „active" Green: Input is set to „active"
Window area **Limit Positions**	
Configuration	It can be specified whether the digital inputs DIN1 to DIN8 or the inputs at the motor connectors should be used as limit position inputs. If DIN1 to DIN8 should be used, the respective check boxes have to be checked. The inputs at the motor connectors are galvanically not isolated. DIN1 corresponds to positive limit position axis 1 DIN2 corresponds to negative limit position axis 1 DIN3 corresponds to positive limit position axis 2 DIN4 corresponds to negative limit position axis 2 DIN5 corresponds to positive limit position axis 3 DIN6 corresponds to negative limit position axis 3 DIN7 corresponds to positive limit position axis 4 DIN8 corresponds to negative limit position axis 4
Invert	- If the connected limit position switch works as a normally open contact: do *not* set check box - If the connected limit position switch works as a normally closed contact: set check box
Status	Green: A limit position event occured: Limit position switch has been triggered and limit position detection is activated in the stepper motor amplifier.
Use for Limit Position	It can be specified whether for the detection of the respective limit position a limit position switch us used.

If, e.g. for test purposes, limit position switches are not used leave the respective check boxes in the **Use for Limit Position** row unset to allow motor movements.

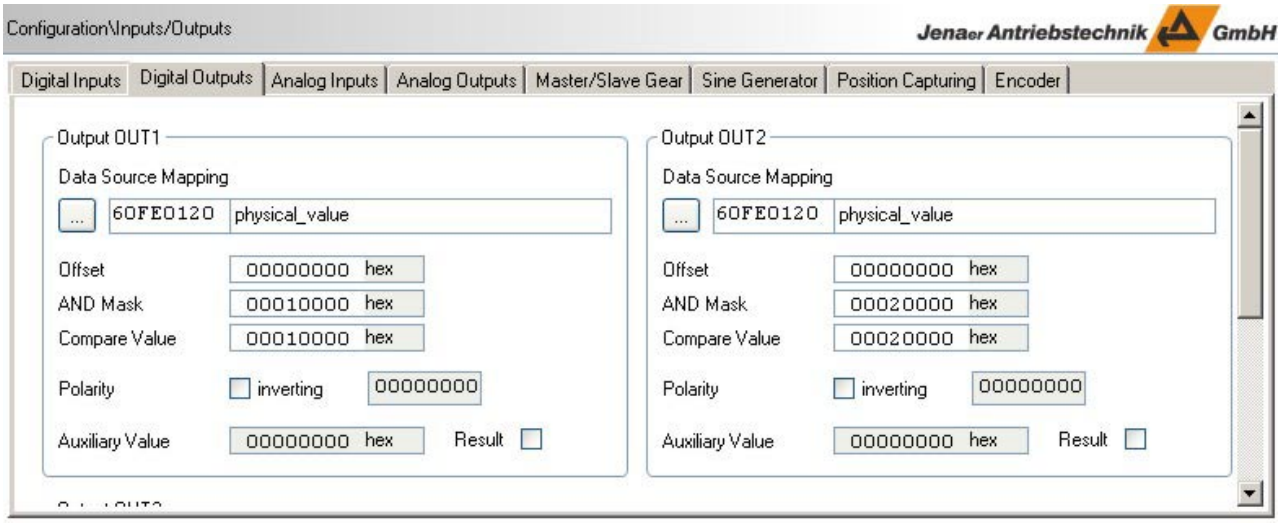
4.2 Digital outputs

The servo amplifiers ECOVARIO®, ECOMiniDual, and ECOSTEP®, the stepper motor amplifier ECOSTEP54, as well as the ECOMPACT are equipped with digital outputs which allow for the output of logic signals, e.g. operating displays (commutation found, reference found, etc.) error displays, or the result of a sequence program.

The configuration of the digital outputs is done via the navigation area, topic **Inputs/Outputs** in the **Digital Outputs** tab. Additionally, in the expert mode the third digital output of ECOVARIO® x14 (OUT3) is configurable.

The ECOMiniDual provides 4 digital outputs which can be used axis-independent.

The ECOSTEP54 provides 8 digital outputs. The upper 4 outputs (OUT5...OUT8) can optionally be used to control the holding brakes of the 4 axes. If the holding brake shall be connected to connector X5 OUT5 ... 8, the mapping of the respective output has to be set to object 0x21240020. AndMask and CmpMask specify the respective output.



Window areas **Output x**	
Data Source Mapping	Selection of the object which is mapped to the output. Default settings are e.g. for ECOVARIO®: • **Output OUT1**: 60FE 01 20 Digital output physical value • **Output OUT2**: 60FE 01 20 Digital output physical value • **Output OUT3**: 6041 00 10 Status word for device status
Offset	Offset which is added to the value of the object specified in the **Mapping Data Source** field.
AND Mask	At the positions where a 1 is entered the AND operation is done between the value of the object specified in the **Data Source Mapping** field (and additionally the **Offset**, if any) and the **Compare Value**. At the output OUT3 the bits „Ready to switch on", „Voltage disabled" and „Fault" are masked.

Compare Value	Value which is AND-operated to the value of the object specified in the **Data Source Mapping** field (including an **Offset** value, if any) if the respective digit shows a „1" in the **AND Mask** box
Polarity	Possibility to invert the output signal. Without inversion „high" level is available at a set output. With inversion „low" level is available at a set ouptut.
Intermediate Result	Output value after AND mask evaluation
Result	Resulting status that is available at the output. An activated check box means that the output is set.

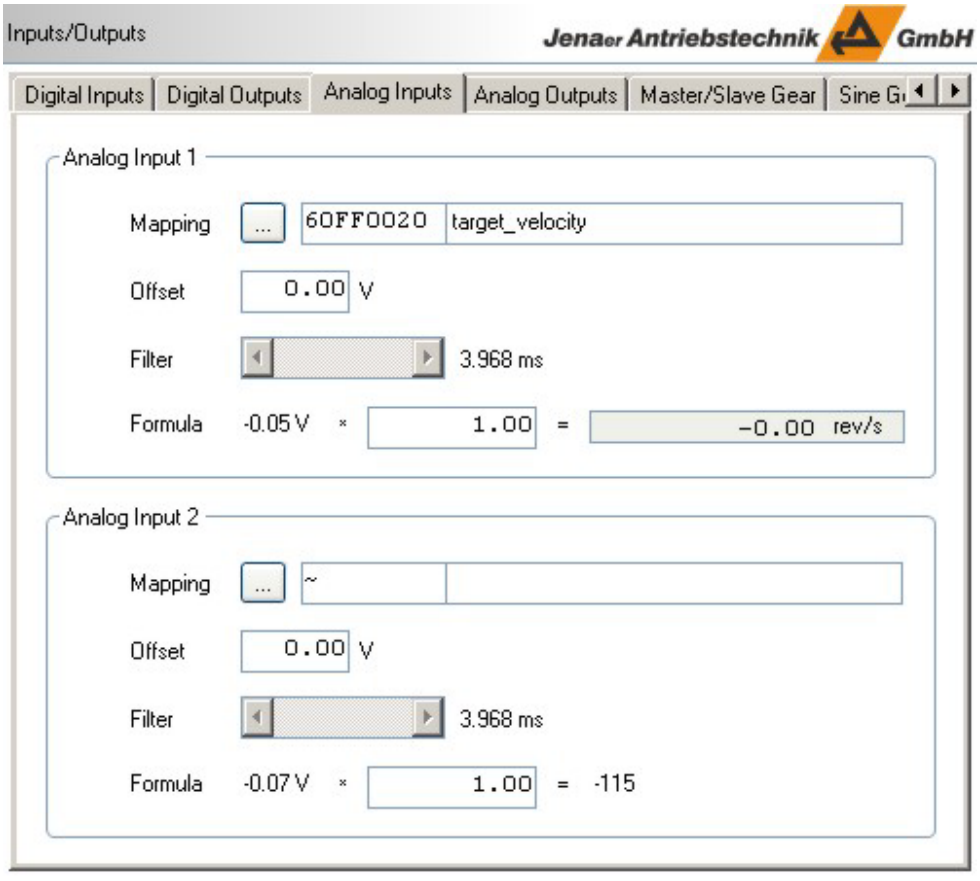
4.3 Analog Inputs ECOVARIO

The ECOVARIO®214/414 provides two differential analog inputs for voltage measurement. The voltage range between -10 V...+10 V is assigned to a value range of +/- 16383.

The ECOVARIO®114 provides one differential analog input for voltage measurement. The voltage range 0 ...+10 V is assigned to a value range of 0 ... 16383.

The values are filtered at least 4-fold (1 ms) and a mean value can be calculated within a timeframe of up to 65 s.

The configuration of the analog inputs is done via **Inputs/Outputs** in the **Analog Inputs** tab.



Mapping	Object where the value of the respective anlog input is written to (after filtering and taking into acount the **Offset**, if any, and the scaling factor)
Offset	Input voltage offset [in V]. Can be used to compensate a superimposed voltage if the external setting voltage is intended to be 0V. Without offset compensation the setpoint setting would not be 0.
Filter	Time constant the input value is filtered with, values between 1 ms and 65 ms are possible.
Formula	Here, the digital output value is calculated from the measured analog input voltage. The digital output value is written to the object specified in the **Mapping** box. You can enter a scaling factor. Default value of the scaling factor is 1.00.

Example

A motor with an encoder resolution of 80,000 inc/rev is intended to be driven 10 revolutions per second by a motor voltage (max. +/-10V) at the analog input 1 of the ECOVARIO®:

- The data source **Mapping** is done to the object 60FF (target velocity).
- The scaling factor for the formula **Formula** is determined as follows:

  Target velocity = 10 U/s -> 10 · 80,000 inc/rev · 64 = 51200000 dec
  Input voltage max. = + 10 V -> 16383
  Input voltage min. = - 10 V -> - 16383
  Input voltage offset = 0

  Scaling factor = 51200000 dec / (input voltage + input voltage offset)
  = 51200000 / (16383 + 0)
  = 3125.19

4.4 Analog Input ECOSTEP

The ECOSTEP® provides one differential analog input for voltage measurement (pin AIN+ and pin AIN-). The voltage range -10 V ... +10 V (resp. 0 ... +5V at ECOSTEP54) is assigned to a value range of -512 ... +511 A/D converter increments.

In principle, the analog input can be mapped to each mappable object. In most cases, these objects are the target velocity or the current limitation. The setting of the scaling factors depends on the application by taking into consideration the internal resolution and the dimension of the mapped object.

The configuration of the analog input is done via **Inputs/Outputs** in the **Analog Input** tab.

Mapping	Object where the value of the respective anlog input is written to (after filtering and taking into acount the scaling factor)
1. Scaling Factor	Scaling factor according to the formula $\frac{\text{maximum value}}{2^{\text{2. scaling factor}} \cdot 512}$ The determination of the scaling factor is shown by means of an example below this table.
2. Scaling Factor	Exponent used for the calculation of the first scaling factor
Output Value	Calculated value which is written to the object specified in the **Mapping** field. The unit is displayed appropriately depending on the chosen object. The method of representation of the object can be switched between **physical** and **decimal** by right-clicking the mouse.
High Resolution Mode	The input voltage range in the high resolution mode is +/- 1 V. The resolution is factor 10 better than in the standard mode of the analog input.

Example

The analog input of the ECOSTEP® is used for the velocity controller. Maximum velocity is 2000 rpm, the encoder resolution is 8000 increments.

- The data source **Mapping** is done to the object 60FF (target_velocity).
- +/- 10 V correspond to +/-2000 rpm
- +/- 10 V at the analog input (AIN+, AIN-) correspond to +/- 512 A/D converter increments
- +/- 2000 U/min correspond to +/- 266667 Ink/s (at an encoder resolution of 8000 inc/rev)
- Object 0x60FF (target_velocity, unit: inc/64s) has to reach +/- 17066667 (maximum value) in order to generate a speed of +/- 2000 rpm at the motor.
- The exponent of the second scaling factor (**2. Scaling Factor**) is set to 3, thus for the second scaling factor the resulting value is 8 (2^3). The **1. Scaling Factor** is calculated:

$$\frac{\text{maximum value}}{\text{2. scaling factor} \cdot 512}$$

$$= \frac{17066667}{8 \cdot 512}$$

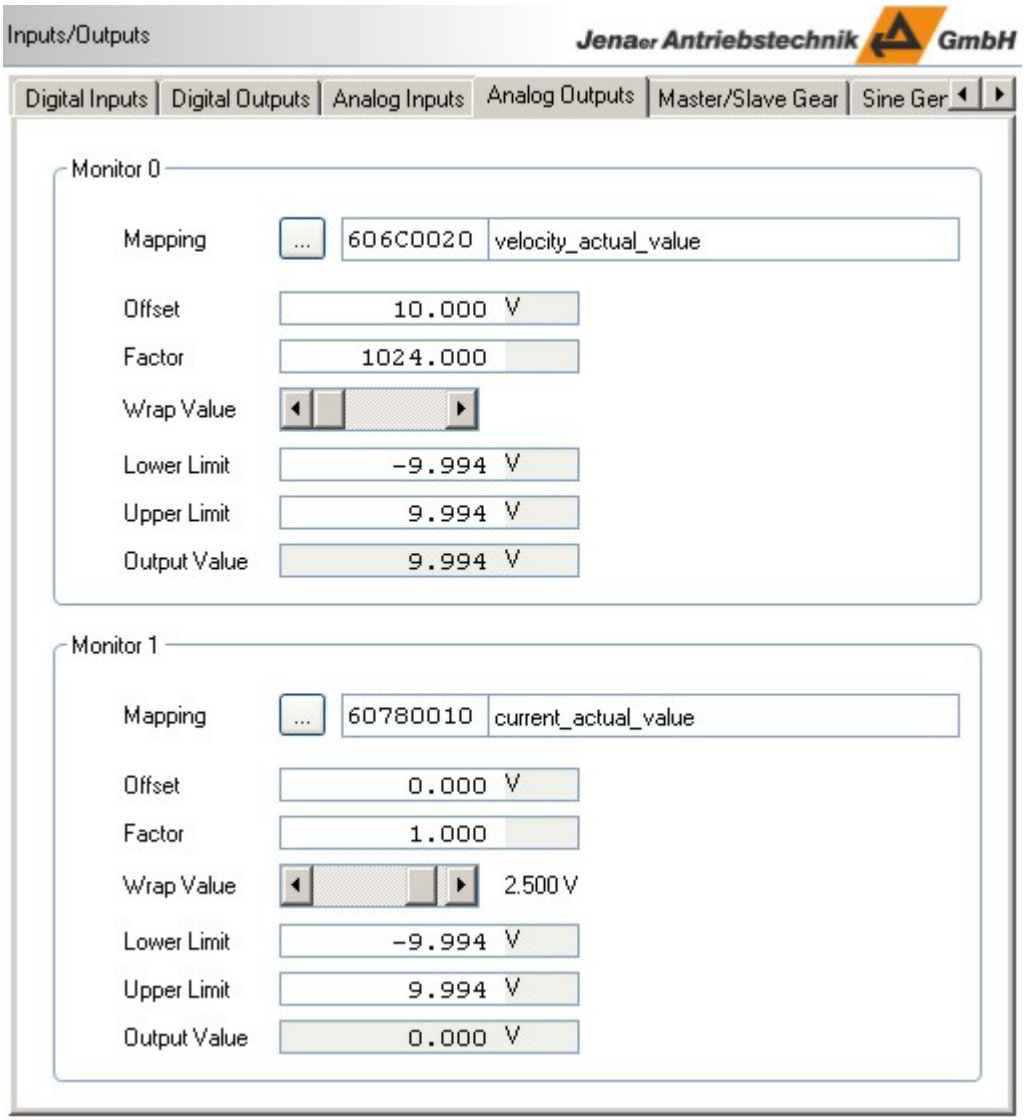
$$= \underline{4166}$$

4.5 Analog Monitor Outputs

ECOSTEP® und ECOVARIO® can output the values of two independent objects as analog voltages in realtime. The value range of the ECOVARIO214/414 is -10V...+10V, i.e. a value of +/- 16383 corresponds to +/-10V. In the ECOSTEP, the value range is 0 ... 5V, i.e. a value of 512 corresponds to 5 V. The ECOSTEP54 supports a value range from -10V (-512) to +10V (+511). The values are updated together with the position controller, i.e. each ms.

The ECOVARIO®114 does not provide an analog monitor output.

The configuration of the analog monitor outputs is done via **Inputs/Outputs** in the **Analog Outputs** tab. The screenshot shows the configuration at ECOVARIO®.



For the ECOVARIO the analog monitor outputs can be parameterized via the following parameters:

Mapping	Object the value of which is used for the calculation of the analog voltage at the respective analog output
Offset	Output voltage offset : +/- 16383 correspond to +/- 10V
Factor	Scaling factor between -8192 ... + 8191
Wrap Value	Each time the specified value is reached the voltage is wrapped around to the respective negative value -> a sawtooth pattern is generated. At n=0 (slider left) wrapping is deactivated.
Lower Limit	If required, a lower limit can be set for the voltage value at the respective analog output. Default setting is the complete usable voltage range, i.e. no limitation.
Upper Limit	If required, an upper limit can be set for the voltage value at the respective analog output. Default setting is the complete usable voltage range, i.e. no limitation.
Output Value	Calculated voltage value which is available at the respective analog output

For ECOSTEP servo amplifiers, the following specifications are required:

Mapping	Object the value of which is used for the calculation of the analog voltage at the respective output
Pre-Shift	Output voltage offset, cf. formula
Factor	Scaling factor between -32768 ... + 32767, cf. formula
Output Value	Calculated voltage value which is available at the respective analog output

Each monitor output can be used for a scaled output of every internal value or object. For the ECOSTEP, scaling is done according to the following formula:

$$U_{MON} = \frac{1V \cdot \text{internal notation of dimension} \cdot \text{Factor}}{256^{(1+\text{byte shift})} \cdot 120}$$

Example 1

The current_actual_value (object 0x6073) shall be mapped to the monitor output MON1 of the ECOSTEP200. The maximum motor current is 12 A, which corresponds to the value 2047 in the object 0x6073. The value **Pre-Shift** is set to 0 and the value **Factor** is set to 30. The aim is that the motor current (range: -12A bis +12A) is mapped proportionally to a voltage in the range 0 ... 5 V at MON1:

$$U_{MON1} = \frac{1V \cdot 2047/12A \cdot 30}{256^{(1+0)} \cdot 120} = 0.166\ V/A$$

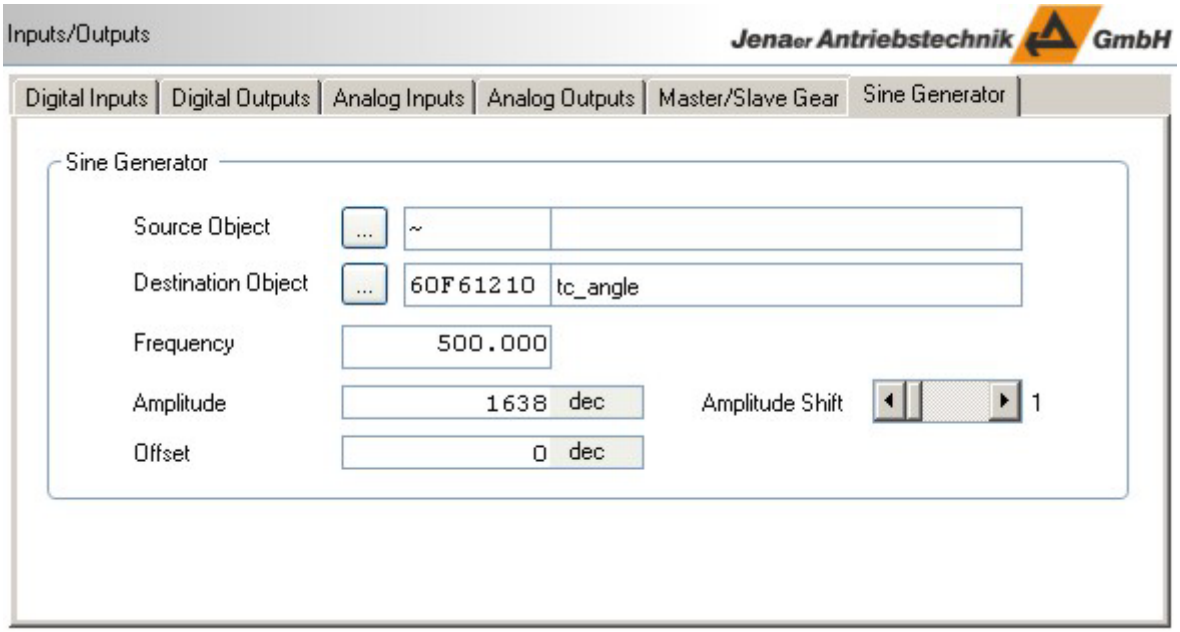
Example 2

The velocity_actual_value (object 0x606C) shall be mapped to the monitor output MON2 of the ECOSTEP200. For the „internal notation of dimension" the result is 853333 = 100 rpm motor speed (with an encoder resolution of 8000 inc/rev). The value **Pre-Shift** is set to 2 and the value **Factor** is set to 256 in order to achieve that the motor speed in the range -2500 ... +2500 U/min is mapped proportionally to a voltage in the range 0 ... 5 V at MON2:

$$U_{MON2} = \frac{1V \cdot 853333/100rpm \cdot 256}{256^{(1+2)} \cdot 120} = 1\ mV/rpm$$

4.6 Sine generator

Sinusoidal signals can be generated at the power stage output of the ECOVARIO® and ECOMPACT. The parameters of the sine generator can be configured under **Inputs/Outputs** in the **Sine Generator** tab.



Source Object	Object which serves a basis for the generation of a sinusoidal signal (can be specified as an option in ECOVARIO Release 5.149 and higher). From the contents of this object the sinusoidal period is derived.
Target Object	Object where the generated sinusoidal signal is written to (in case of the output to the power stage e.g. object 60F61210 (current offset phase A)
Frequency	Frequency of the generated sinusoidal signal in Hz
Amplitude	Amplitude of the generated sinusoidal signal
Amplitude Shift	Factor by which the specified amplitude value is multiplied
Offset	Offset of the generated sine signal

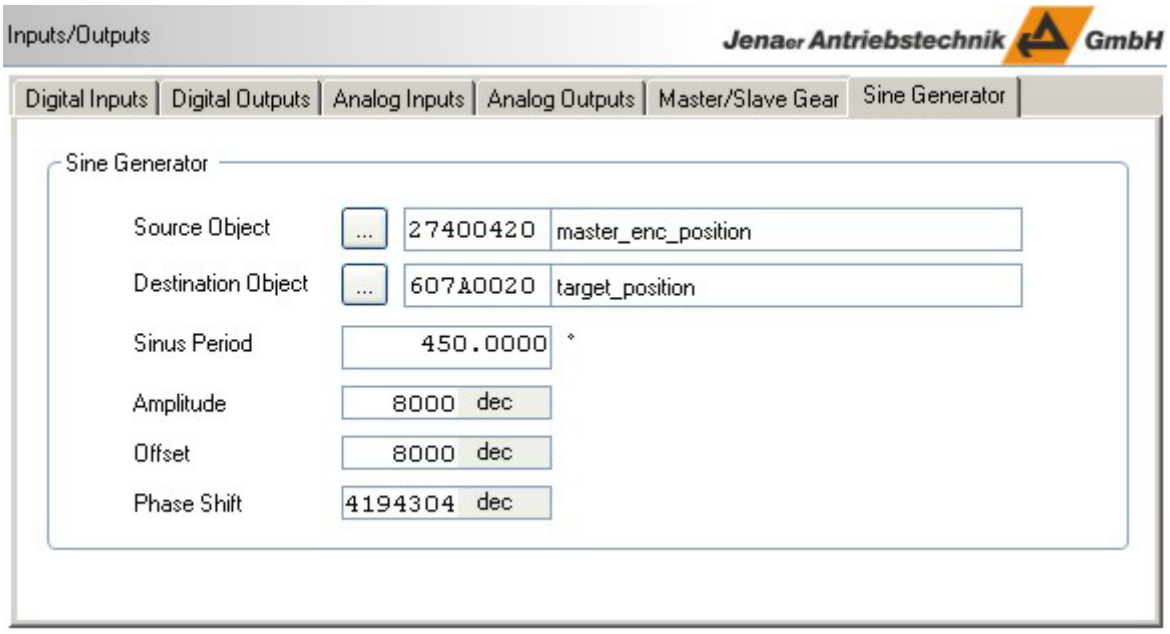
In the example the power stage, phase A, emits a sinusoidal signal of 500 Hz with an amplitude of 2 A.

Proceed as follows:

1. ***Make sure that the signal described above does not lead to any damages to a motor which might be connected to the power stage output!***
2. In the *Expert Mode*, in the window **Analyzer/User-defined Variables** select the object 0x270102 and set it to the value 09 (direct current output).
3. Select the object 606000 and set it to the value -3 (following error monitoring off).
4. Switch on the power stage (**Switch on device**).

5. Specify the **Target Object** 60F61210 (Current offset phase A).
6. Set the **Frequency** to 500 Hz.
7. Enter the required **Amplitude** (1638 corresponds to 2 A).

As soon you have specified a source object, you can use the extended functions (ECOVARIO Release 5.149 and higher) and the window is modified as follows:



In the example the sine of the actual master encoder position is calculated and written to the object target position.

Sine Period	Duration of a sine period in source object units
Phase Shift	Phase shift of the generated sine signal (16777216 = 360°)

5. Standard applications

Motion Control

The servo amplifiers ECOVARIO®, ECOMiniDual, and ECOSTEP® as well as the compact servo drive ECOMPACT are equipped with motion control functionality which allows for an independent travel of a specified motion profile, without a higher-level controller. The specification of the parameters for the motion profiles is done under **Motion**. The following modes are possible:

- Velocity mode
- Positioning mode
- Torque controlled operation

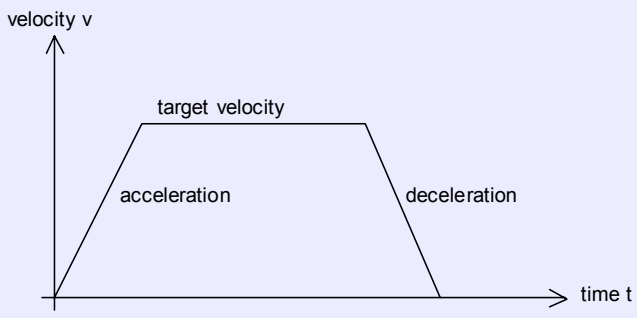
Further the ECOVARIO® can be operated in stepper motor mode from Release 5.86 onwards.

5.1 Velocity mode

In the velocity mode, a target velocity is specified. The servo amplifier determines the velocity_actual_value by means of the encoder evaluation and re-adjusts respectively. The velocitiy mode is configured in the navigation area under **Motion** in the **Velocity Mode** tab.

Target Velocity	A target velocity is specified. The travel mode can be specified either with velocity profile by using the acceleration and deceleration ramps (selection **profile**) or without velocity profile (selection **direct**) and becomes valid by clicking the **Start** button.
Actual Target Velocity	Target velocity valid at the moment. Might deviate from the specification in the **Target Velocity** field if the **Start** button has not yet been clicked after a new value has been entered.

Window area **Settings**



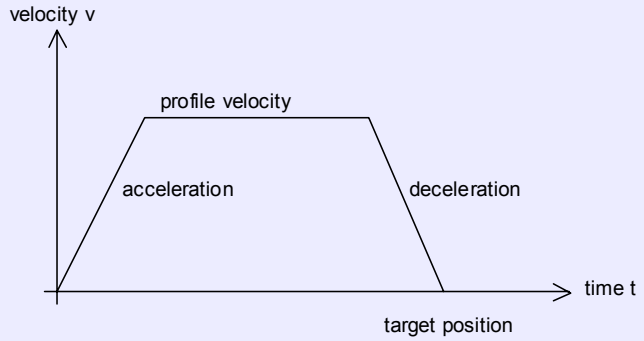
Acceleration Ramp	Maximum acceleration within the trapezoidal profile in order to reach the target velocity
Deceleration Ramp	Maximum decelaration within the trapezoidal profile
Jerk Filter	Factor for jerk limiting filter. The jerk limiting filter provides the possibility to smooth the „corners" of the trapezoidal profile and therefore to achieve a soft motion sequence. The parameter can be set between 0 and 512 ms. The positioning time increases by this value. In the path controlled operation this function is fulfilled by the higher-level controller. In this case, the parameter has to be set to 0.
Position Window	Specification of the position window (symmetrical value range around the target position). If the actual position is within the position window for the time period specified in the **Position Window Time** parameter the „target reached" flag is set in the stauts word.
Position Window Time	If the actual position is within the **Position Window** for the time period specified here the „target reached" flag is set in the status word.
Window area **Limits**	
Maximum Profile Velocity	Velocity limit of the positioning. Depends on the mechanical characteristics ot the complete system.
Following Error Window	Symmetrical value range around the target position. If the actual position value lies outside the following error window a following error occurs and bit 13 in the status word is set.
Buttons	
Start	Start velocity mode with the selected parameters
Stop	Stop action

5.2 Positioning mode

In the positioning mode (also called point-to-point driving) in addition to the velocity controller a higher-level position controller is active which processes the deviations between target position and actual position and translates them into the respective target values for the velocity controller.

In the positioning mode the minimum time for a travel from position A to position B (by taking into account the load) is a performance criteria. Every new target position is checked for the observance of the limits defined in the position window. The positioning range always refers to the zero position of the drive (cf. Chapter 2.7, **Homing**).

The positioning mode is configured in the navigation area under **Motion** in the **Positioning Mode** tab.

Target Position	A target position is specified. The value can be entered either **absolute** or **relative** to the actual position with a resolution of 0.1 µm. The entered value becomes only valid when **Start** has been clicked.
Valid Target Position	Currently valid target position. Might deviate from the specification in the **Target Position** field if the **Start** button has not yet been clicked after a new value has been entered.
Window area **Settings**	
Profile Velocity	Target velocity within the trapezoidal profile 
Acceleration Ramp	Maximum acceleration within the trapezoidal profile in order to reach the target velocity
Deceleration Ramp	Maximum decelaration within the trapezoidal profile
Jerk Filter	Factor for jerk limiting filter. The jerk limiting filter provides the possibility to smooth the „corners" of the trapezoidal profile and therefore to achieve a soft motion sequence. The parameter can be set between 0 and 512 ms. The positioning time increases by this value. In the path controlled operation this function is fulfilled by the higher-level controller. In this case, the parameter has to be set to 0.
Position Window	Specification of the position window (symmetrical value range around the target position). If the actual position is within the position window for the time period specified in the **Position Window Time** parameter the „target reached" flag is set in the status word.
Position Window Time	If the actual position is within the position window (parameter **Position Window**) for the time period specified here the „target reached" flag is set in the status word.
Window area **Limits**	
Maximum Profile Velocity	Velocity limit of the positioning. Depends on the mechanical characteristics ot the complete system.
Positive Software Limit Position	Limit position in positive direction, determined by the mechanics of the machine or by setting a positive software limit position.
Negative Software Limit Position	Limit position in negative direction, determined by the mechanics of the machine or by setting a negative software limit position.
Following Error Window	Symmetrical value range around the target position. If the actual position value lies outside the following error window a following error occurs and bit 13 in the status word is set.
Buttons	
Start	Start positioning mode with the selected parameters
Stop	Stop action

5.3 Torque mode

In the torque mode a certain target torque is specified which the servo amplifier generates in the motor. In this case only the current controller is active because the torque is proportional to the motor current. For the configuration of the torque mode click **Motion** in the navigation area and select the **Torque Mode** tab.

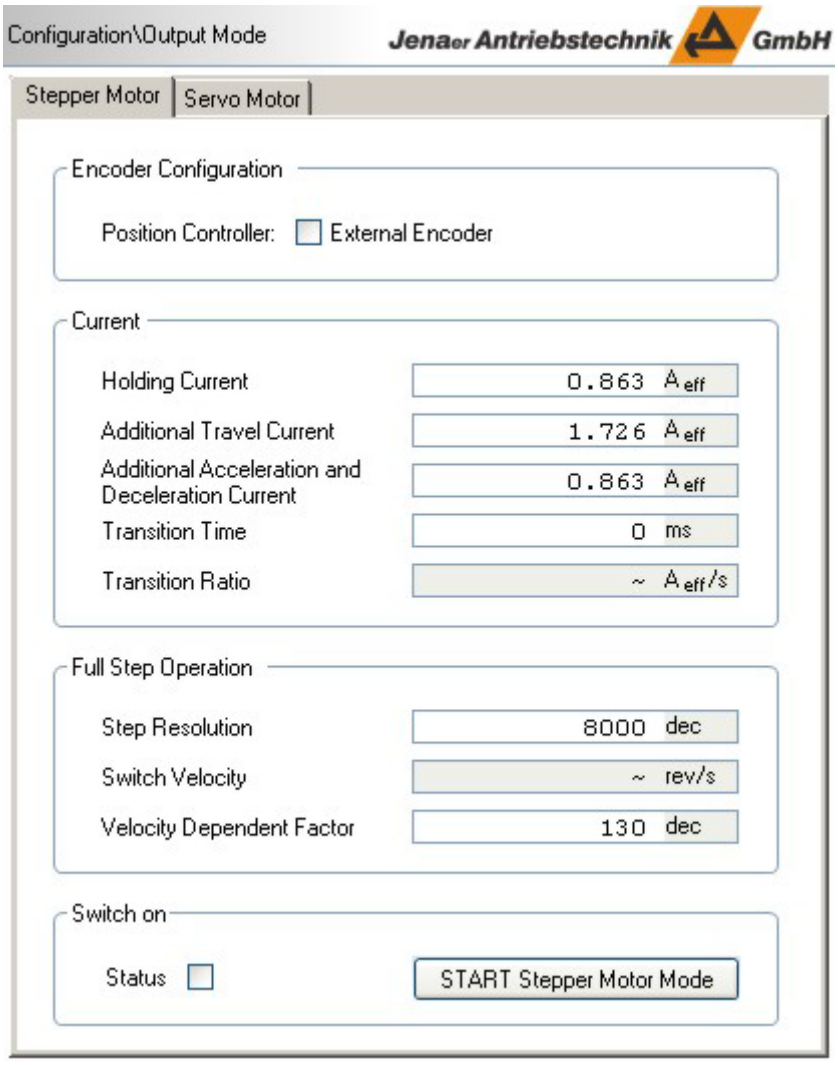
Window area **Torque/Current**	
Target Current	Input field for the target current value for the current controller in the torque mode. The entered value becomes only valid when **Start** has been clicked and is then displayed in the **Valid Target Current** display field as well.
Valid Target Current	Display of the target current valid at the motor
Window area **Limits**	
Maximum Current	Servo motors may be operated in overload for a certain period of time. Here, the highest admissible motor current is set (the value can be taken from the motor data sheet). The value range is limited by the maximum controller current (RMS current). ECOSTEP100: 5,6 A_{RMS} (or 8 A_{DC}) ECOSTEP200: 8 A_{RMS} (or 12 A_{DC}) ECOSTEP216: 17 A_{RMS} (or 24 A_{DC}) ECOVARIO: 14 A_{RMS} (or 20 A_{DC}) ECOMiniDual: 7.5 A_{RMS} (or 10.5 A_{DC}) (5s)
Start	Start torque mode with the selected parameters
Stop	Stop action

5.4 Stepper motor mode ECOVARIO + ECOMPACT (Expert mode)

From Release 5.86 on the servo amplifier ECOVARIO® can also be operated as stepper motor amplifier for 2-phase stepper motors (e.g. series 17S, 23S of Jenaer Antriebstechnik GmbH). The ECOMPACT can be operated in stepper motor mode, too. In order to provide a sufficient torque at high speed there is the possibility to activate a velocity dependent full step switchover. Thus, a smooth transition from microstep operation to full step operation is guaranteed.

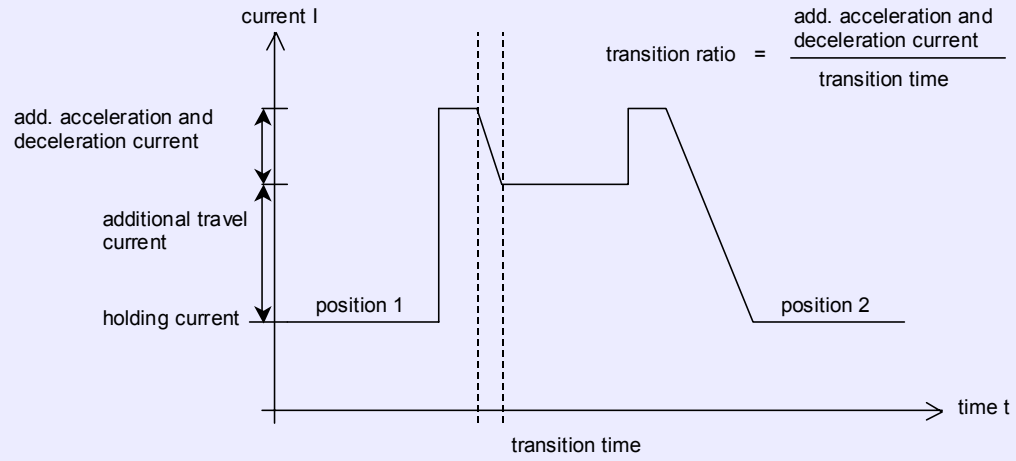
For the configuration of the stepper motor mode proceed as follows:

1. Set the following parameters for the stepper motor operation via the path **Configuration\Output Mode** in the **Stepper Motor** tab. Further settings necessary for the stepper motor operation are made automatically.



Encoder Configuration	Normally, no encoder is used in the stepper mode and the check box is not checked. For applications where a synchronisation to an external measuring system is used the check box has to checked. The encoder has to be configured in the path **Configuration\Inputs/Outputs\Encoder** (cf. Chap.6.1).

Window area **Current**



The diagram shows the variation in time of the current when changing the position from position 1 to position 2.

Holding Current	Holding current which has to be set in order to hold the position of the load.
Additional Travel Current	Current which is needed in addition to the holding current for moving the axis
Additional Acceleration and Deceleration Current	Current which is needed in addition to the holding and the travel current for acceleration and deceleration of the axis
Transition Time	Time period in ms within which the acceleration current has to be reduced to the travel current
Transition Ratio	Displays the ratio of the reduction of the acceleration current per second until the travel current is reached
Window area **Full Step Operation**, *note the configuration hints below this table*	
Step Resolution	Number of steps per revolution
Switch Velocity	Velocity from where on it should be switched to the full step operation continuously. (Default setting: 200 rpm at 8000 inc/rev)
Velocity Dependent Factor	Percentual threshold value for the standstill detection at low velocities. 65536=100% (always triggers); 0=0% (never triggers)

After setting the parameters start the stepper motor operation in the window area **Switch on**. The stepper motor operation is displayed by means of the checked check box **Status**. The stepper motor operation can be stopped by clicking **STOP Stepper Motor Mode**. A warning is displayed which demands the setting of the encoder configuration. After acknowledging the warning you get directly to the **Configuration\Inputs/Outputs\Encoder** window.

For the velocity-dependent switching to the full step operation the values **Switch Velocity**, see above, and the **Velocity Dependent Factor** in the commutation window (path **Configuration\Commutation**) are important. The switch velocity designates the velocity at which the switching to full step operation is done. Below this velocity always microstep operation is active. The velocity dependent factor describes the gradient of the transition to the full step operation.

Note:

- In the stepper motor operation the **Velocity Dependent Factor** does not have the same function as in the normal servo motor operation. A velocity dependent lead of the commutation angle is not possible. Because of this also the respective edit boxes in the **Configuration\Controller\Commutation** window are deactivated.

- If the **Velocity Dependent Factor** is set to 0 the full step operation is disabled.

- A good starting value for the **Velocity Dependent Factor** is 400. The further fine tuning can take place around this value.

Example for the full step operation

Settings in the path **Configuration\Output Mode\Stepper Motor**:
- **Step Resolution**: 8000
- **Velocity Dependent Factor**: 400
- **Switch Velocity**: 1750000 (200 rpm)

Result: From approximately 1000 rpm onwards the motor completely operates in full step operation.

5.5 Stepper motor mode ECOSTEP (Expert mode)

ECOSTEP®100 and ECOSTEP®200 servo amplifiers with the firmware versions 200, 230 and 820 can be operated as stepper motor amplifiers for 2-phase stepper motors (e.g. series 17S and 23S of Jenaer Antriebstechnik GmbH). After execution of the device configuration wizard (**Wizards/Device Configuration**) the parameters are set to default values appropriate for the used motor. Parameters which are not relevant or not available in the stepper motor mode are greyed out in the other windows.

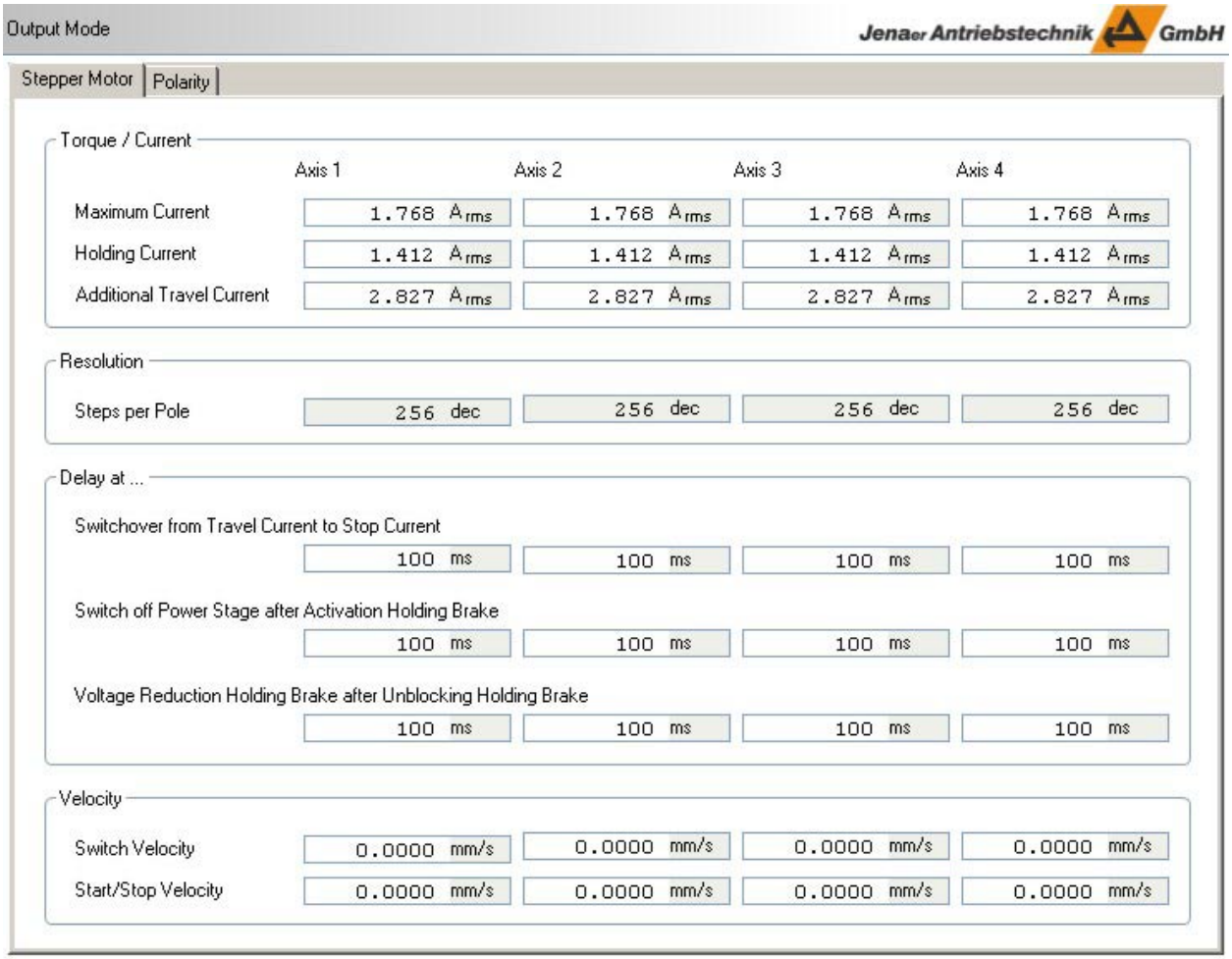
For the configuration of the stepper motor mode set the following parameters via the path **Configuration\Output Mode** in the **Stepper Motor** tab, if adaptations are necessary. Further settings necessary for the stepper motor operation are made automatically.

Window area **Current**	
Holding Current	Holding current which has to be set in order to hold the position of the load.
Additional Travel Current	Current which is needed in addition to the holding current for moving the axis
Window area **Resolution**	
Step Resolution	Number of steps per revolution
Pole Pairs	Number of pole pairs 2p of the motor, can be taken from the motor data sheet (for series 17S and 23S = 50)
Window area **Controller Parameters**	
p-gain Position Controller	Proportional gain of the position controller
Acceleration Pre-Control	Target acceleration is multiplied with this factor and directly „pre-controlled as target current value.
Actual Following Error	Also in the stepper motor operation a kind of feedback takes place from the current controller output to the position controller input. Deviations are displayed as following errors.
Following Error Window	Maximum admissible following error. If it is exceeded, bit 13 (following error) of the status word is set.
ECOSTEP®100 only: Window area **Resonance Adaptation**	
Current Shift Basic Value	By default, these parameters are set appropriately for the used motor (motor data set). Modifications are admissible only in exceptional cases and must only be carried out by experts of Jenaer Antriebstechnik GmbH or authorized persons !
Velocity Limit for Whisper Mode	

5.6 Stepper motor operation ECOSTEP54

The 4-axis ECOSTEP®54 stepper motor amplifier can be used for 2-phase stepper motors (e.g. series 17S and 23S of Jenaer Antriebstechnik GmbH). After execution of the device configuration wizard (**Wizards/Device Configuration**) the parameters are set to default values appropriate for the used motor. Parameters which are not relevant or not available in the stepper motor mode are greyed out in the other windows.

For the configuration of the stepper motor mode set the following parameters via the path **Configuration\Output Mode** in the **Stepper Motor** tab, if adaptations are necessary. In the window the parameters for all 4 axes of the ECOSTEP®54 are displayed. Further settings necessary for the stepper motor operation are made automatically.



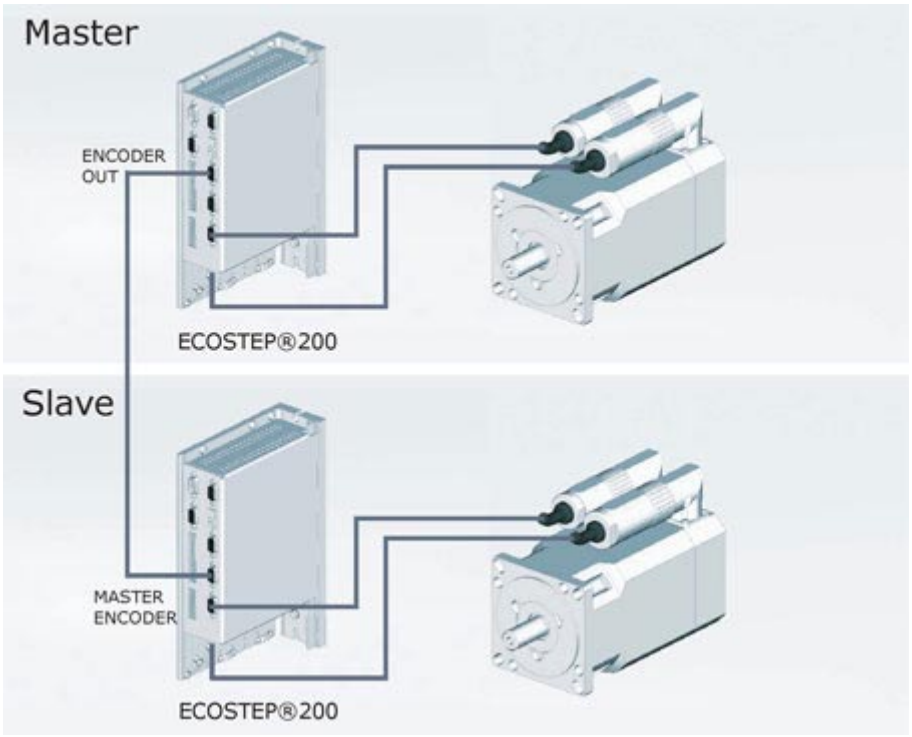
Window area **Torque/Current**	
Maximum Current	Maximum admissible motor current.
Holding Current	Holding current which has to be set in order to hold the position of the load.
Additional Travel Current	Current which is needed in addition to the holding current for moving the axis.
Window area **Resolution**	
Step Resolution	Number of steps per revolution
Window area **Delay at ...**	
Switchover from Travel Current to Stop Current	Delay time (in ms) for switchover from travel current to stop current at the positioning destination.
Switch-off Power Stage after Activation Holding Brake	Delay time (in ms) after activation of the holding brake until switch-off of the power stage.
Voltage Reduction Holding Brake after Unblocking Holding Brake	After unblocking the holding brake the voltage is reduced after the specified delay time (in ms).
Window area **Velocity**	
Switch Velocity	Velocity from where on it should be switched from sinusoidal commutation to rectangular commutation. By switching a higher torque is achieved because only rectangular commutation can make full use of the motor curve. Value = 0 means sinusoidal commutation.
Start/Stop Velocity	Velocity after the target position has been reached, normally = 0.

6. Applications with more than one encoder

The ECOVARIO® and ECOSTEP® servo amplifiers allow for the connection of several encoders for speed and position feedback and for the synchronisation of several servo amplifiers. By processing in the servo amplifier e.g. the coordination of several independent motion processes is possible.

Example: Master/Slave operation

The master operates in velocity mode or position mode while the slave is in synchonized mode. Applications are e.g. electronic gear unit, flying cut/flying saw, register control.
.
The interconnection of the servo amplifiers looks like this:



Synchronisation / parameterize Master

In Master/Slave operation the master emulates an incremental encoder.

Synchronisation / parameterize Slave

In the synchronized mode the slave has to be informed that the encoder information (from the master) is available at the master encoder input.
The necessary settings are made under **Configuration\Inputs/Outputs** in the **Encoder** tab in the **Master** field.

Parameterize electronic gear unit

ECOSTEP® and ECOVARIO® provide the option to configure an electronic gear unit. The necessary settings are made under **Inputs/Outputs** in the **Master/Slave Gear** tab.

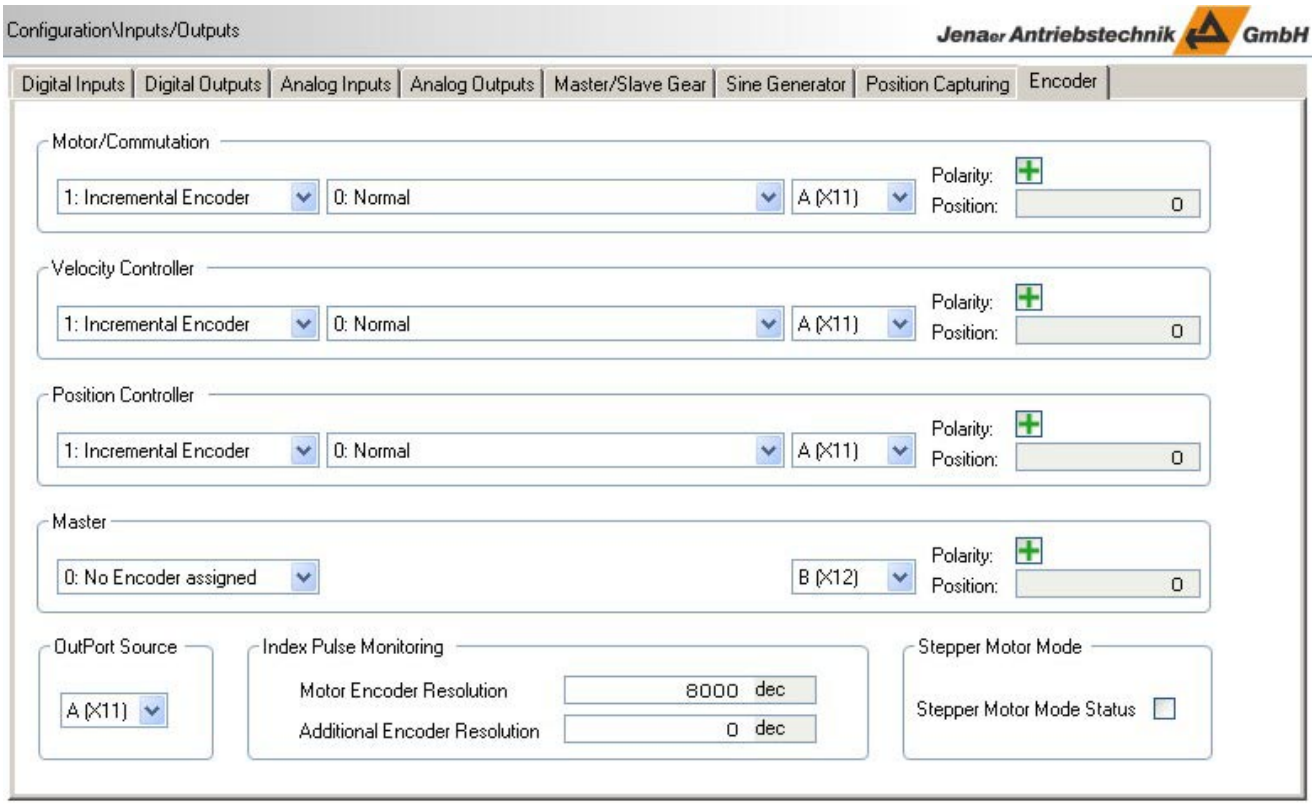
6.1 Encoder assignment

Incremental encoders can be connected to the ports A and B of the ECOVARIO® . Alternatively, intelligent encoders (e.g. absolute value encoders) can be connected to port B. Each of these encoders can be assigned to an encoder user individually.

☞	The basic settings of the motor encoder which is used for commutation are contained in the motor data set. So, if no additional encoder is used no modifications are necessary in this window.

Other configurations, e.g. master encoder, have to be configured here respectively.

The settings for the encoder assignment are made in the *Expert Mode* under **Configuration\Inputs/Outputs** in the **Encoder** tab:



Motor/Commutation	Settings for the motor encoder (among others for the commutation)
Velocity Controller	Encoder mapping for the velocity controller. Default setting is the mapping to the motor encoder.
Position Controller	Encoder mapping for the position controller. Default setting is the mapping to the motor encoder.
Master	Assignment of the master encoder. Default setting is „0: no encoder assigned“

OutPort Source	Selection of the encoder port for the encoder output (encoder emulation). Default setting is the mapping to the motor encoder.
Motor Encoder Resolution	Resolution of the motor encoder in increments/revolution
Additional Encoder Resolution	Resolution of an additional encoder in increments/revolution. 'The value 0 indicates that no additional encoder is present.
Stepper Motor Mode	The check box **Stepper Motor Mode Status** is set automatically if in the motor encoder selection list "6. Stepper Motor" has been selected.

For each encoder in use the encoder type, the encoder port (A or B) and the direction of rotation (polarity "+" or "-") can be set. A display field shows the actual encoder position value for each encoder.

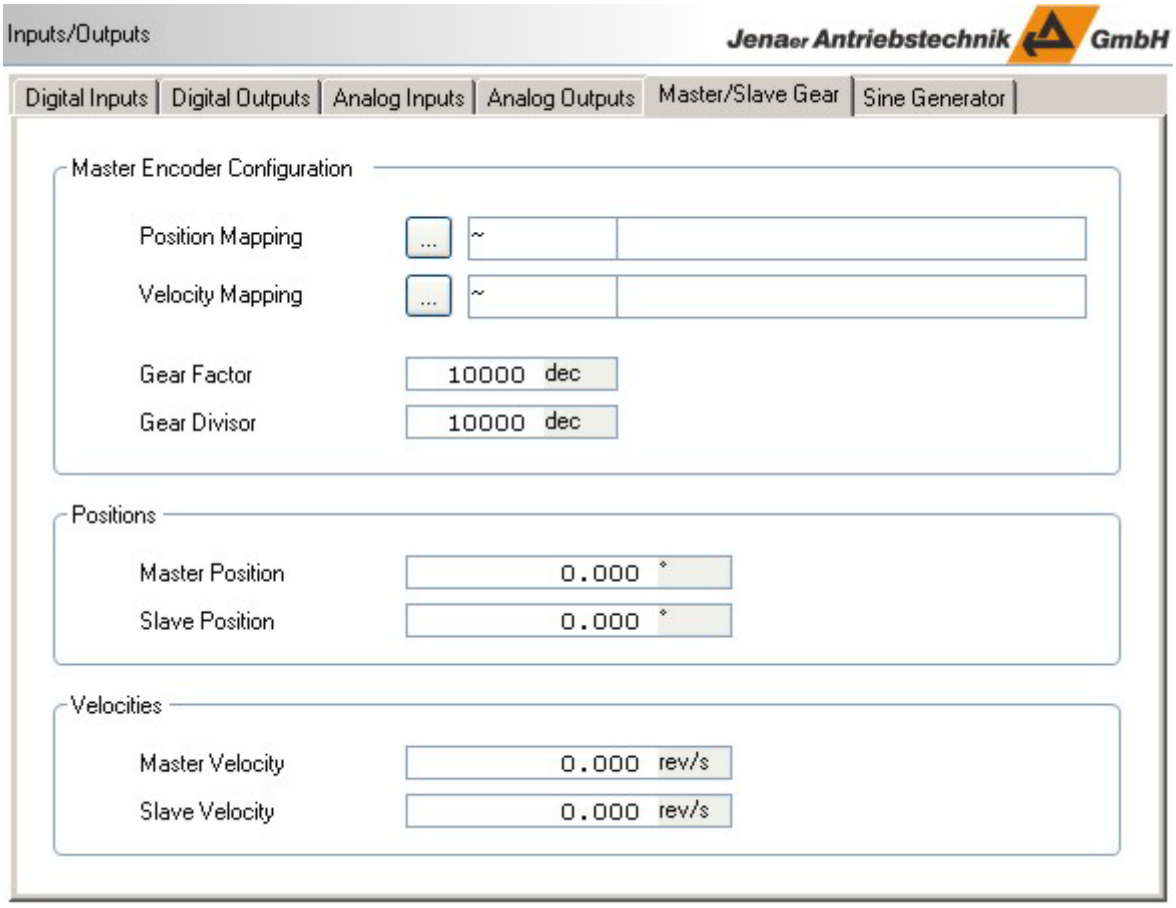
The selection "manuell" (manually) in the encoder selection lists is used if the coding of an encoder not yet listed there has to be entered (e.g. new encoder or third-party encoder). Normally, this selection should only be used in coordination with the application department of Jenaer Antriebstechnik GmbH.

6.2 Electronic gear unit

ECOSTEP® and ECOVARIO® provide the possibility to configure an electronic gear unit. For this a coupling of two servo amplifiers via the master encoder input is necessary (Master/Slave operation).

At the ECOSTEP® the master encoder input is assigned to the encoder input connector X7. At the ECOVARIO® one of the two enocder inputs A or B can be configured as the master encoder under **Configuration\Inputs/Outputs** in the **Encoder** tab.

The gear parameters can be specified under **Inputs/Outputs** in the **Master/Slave Gear** tab.



Window area **Master Encoder Configuration**	
Position Mapping	Object where the master position values are written to
Velocity Mapping	Object where the master velocity values are written to
Gear Factor	Gear ratio: dividend
Gear Divisor	Gear ratio: divisor
Gear Mode	for ECOSTEP® only: Two operation modes are possible: • 0: 4-fold evaluation of the measuring system • 2: Operation mode clock/direction
Window area **Positions**	
Master Position	Master position. Can be read out if a master encoder is connected. Can be written if a virtual or an external master is configured.
Slave Position	Slave position
Window area **Velocities**	
Master Velocity	Master velocity. Can be read out if a master encoder is connected. Can be written if a virtual or an external master is configured.
Slave Velocity	Slave velocity

7. Sequence programming

Besides the online operation (via CANopen, EtherCAT, Ethernet, RS232, RS485, etc.) ECOVARIO®, ECOSTEP® and ECOMPACT are able to control configured sequences independently. Therefore, the so-called sequence programming is used.

ECO Studio offers an easy-to-use graphical Sequence Editor (cf. **chapter 7.1**) which significantly simplifies sequence programming.

Background information on sequences (Expert Mode only, chapters 7.2 to 7.9)

In the *Expert Mode* sequence programming is possible additionally on object level. However, this kind of programming should only be used by experienced users. Background information is given in the following:

A sequence is a concatenation of value allocations to objects which are to be processed one after another. Objects are comparable to memory addresses.

The information about the objects a sequence consists of is written to special sequence objects. A maximum of 256 sequences (ECOMPACT max. 16 sequences) can be stored. Each sequence contains 8 value allocations to objects. Concatenation of sequences is possible as well.

The trigger for the processing of a programmed sequence can be:

- A direct call, e.g. from a higher-level controller
- A digital signal e.g. from a higher-level controller or from other external devices sent to a digital input of ECOSTEP®, ECOVARIO® or ECOMPACT.
- A specified controller event (e.g. target reached, reference found, switched on, etc.)
- A specified comparator event (e.g. actual position > 50,000 inc., etc.). 4 comparators are available.

Furthermore, delay times can be specified if a sequence may not be started immediately after the trigger signal. The required delay is specified in a respective object.

For some sequence triggers it can be assigned whether the sequence should be carried out only once or each time the trigger event occurs.

With the call of a sequence the max. 8 entries are processed one after another without delay. If several concatenated sequences are processed, a time interval of approx. 1 ms (ECOSTEP®) or 0.25 ms (ECOVARIO®, ECOMPACT) lies between them. If by controller events, comparator events or timer events several sequences are called simultaneously or within a very short period of time, the individual sequences are processed in the sequence of their occurence with the above mentioned time interval between them.

A detailed description of the objects is contained in the manual "Object dictionary ECOVARIO® and ECOSTEP®".

7.1 Sequence editor

Under **Sequence Editor** an easy-to-use graphical editor for editing program flows which can run stand-alone in the drive is available.

Editing a program flow

In order to edit a program flow with the graphical sequence editor proceed as follows:

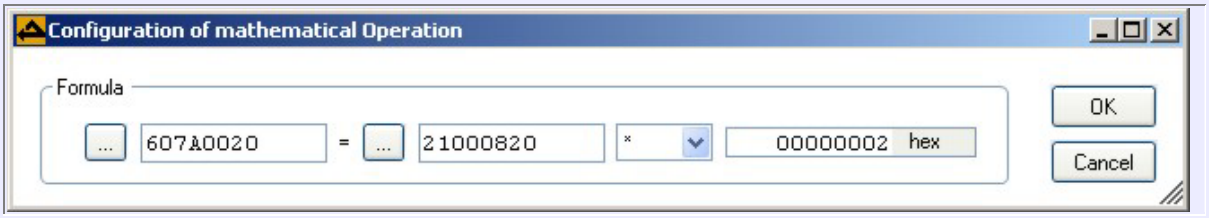
1. The symbols in the symbol bar on the left represent the elements which can be used for editing a program flow (description in the table below). With the left mouse key click to the required element. The element is then displayed in the upper left edge of the editor workplace (with highlighted frame, i.e. the element is selected for further editing).

2. Drag the element with the left mouse key pressed to the required position in the editor workplace. Alternatively, you can also use the arrow keys of the keyboard to position the elements.

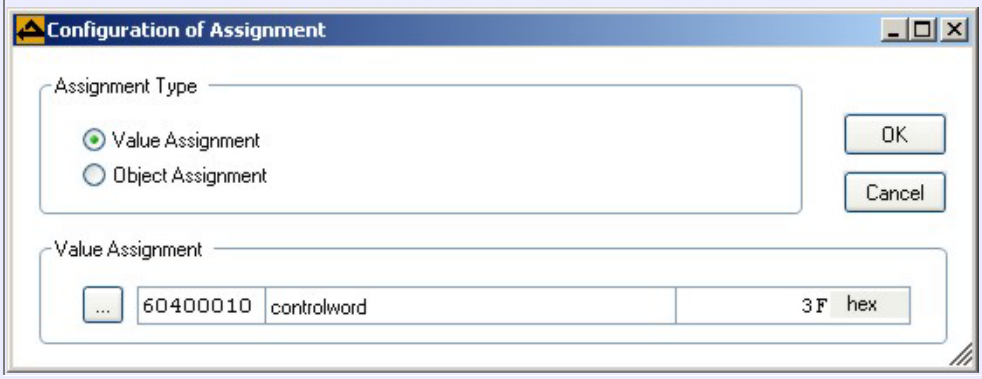
3. Place the mouse cursor on the element and double-click the left mouse key. In the window **Configuration of ...** assign the properties to the element (description in the table below). After clicking **OK** the assigned properties are displayed in the graphical representation of the element in the editor workplace.

Element		***Properties***
Trigger Condition		Trigger for the processing of the program flow (Chap. 7.1.1). ***Note:*** At the beginning of the program flow always a **Trigger Condition** or the element **Comparator** has to be arranged. On the editor workplace several program flows with different trigger conditions can be arranged. At the ECOSTEP servo amplifiers the use of the element trigger condition is only permitted at the beginning of a program flow.
Initialization		Initialization of the elements **Condition** and **Timer**. Note that at the time of initialization all active elements **Condition** and **Timer** are reset, regardless of the function they have.
Error Reset		Reset of an error condition of the servo amplifier. The element can be placed at a specific location of the program flow (error reset **once**) or in a parallel branch as **permanent** error reset for all errors which occur during the processing of a sequence.
Switch On/Off		Switching the servo amplifier on or off
Homing		In the most applications an agreement has to be made about the neutral position the position controller can refer to. This position is called the home position. It has to be determined after each power-on of the servo amplifier. This is achieved in the so-called homing procedure. Several homing methods are available. By means of a program flow homing can be started stand-alone on the drive, e.g. triggered by the boot procedure. If the homing procedure is finished successfully, a status bit is set in the device. This status can be evaluated via field bus or a digital output. For further details cf. Chap. 7.1.2.
Go to Position		For **absolute** positioning: Enter a **Target Position** related to zero which then the axis travels to with a specified **Profile Velocity**. For **relative** positioning: Enter a **Target Position** related to the actual position which then the axis travels to with a specified **Profile Velocity**. Ends as soon as the target position is reached ("Target reached" flag of the status word is set).

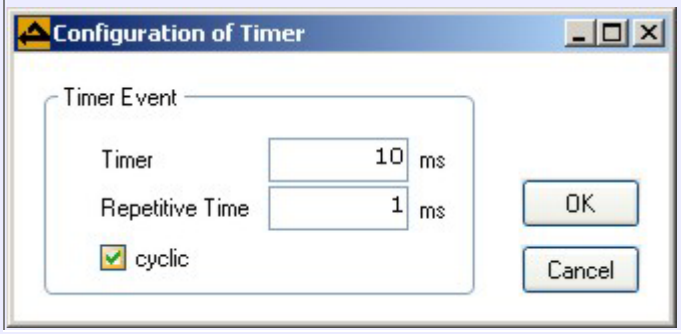
Go by Velocity		Enter a **Target Velocity** for the axis. The **Velocity Mode** can be specified either with velocity profile by using the acceleration and deceleration ramps (selection **profile**) or without velocity profile (selection **direct**). Ends as soon as the target velocity is reached ("Target reached" flag of the status word is set).
Mathematic Operation		Carry out simple arithmetic and logic operations to the contents of a selected object. The result is written to another object (left side). Possible operators are "+", "-", "*", "./.", "AND", "OR", "XOR". For selecting an object see Chap. 7.1.3.



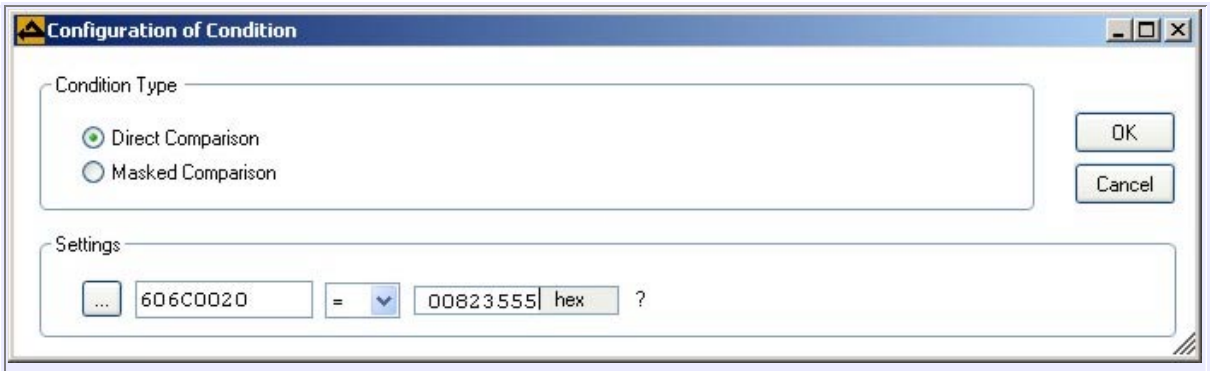
Assignment	A=B	Assign a value to an object or assign the contents of an other object to an object. For selecting an object see Chap. 7.1.3.

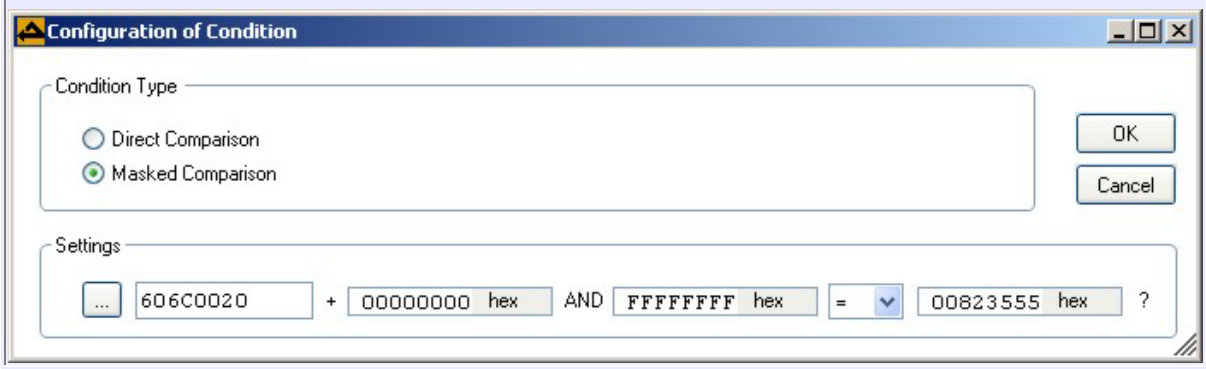


Timer		Set a **Timer** which specifies the time which has to elapse before the next action is executed. E.g if the timer is arranged at the beginning of the program flow, directly below the trigger condition, a time is defined after which the program flow is called. Furthermore, a cyclic repetition of actions can be specified by means of this element. Therefore, a **Repetitive Time** has to be entered and the check box **cyclic** has to be checked. Arrange the timer directly above the program flow part that is to be repeated cyclically.



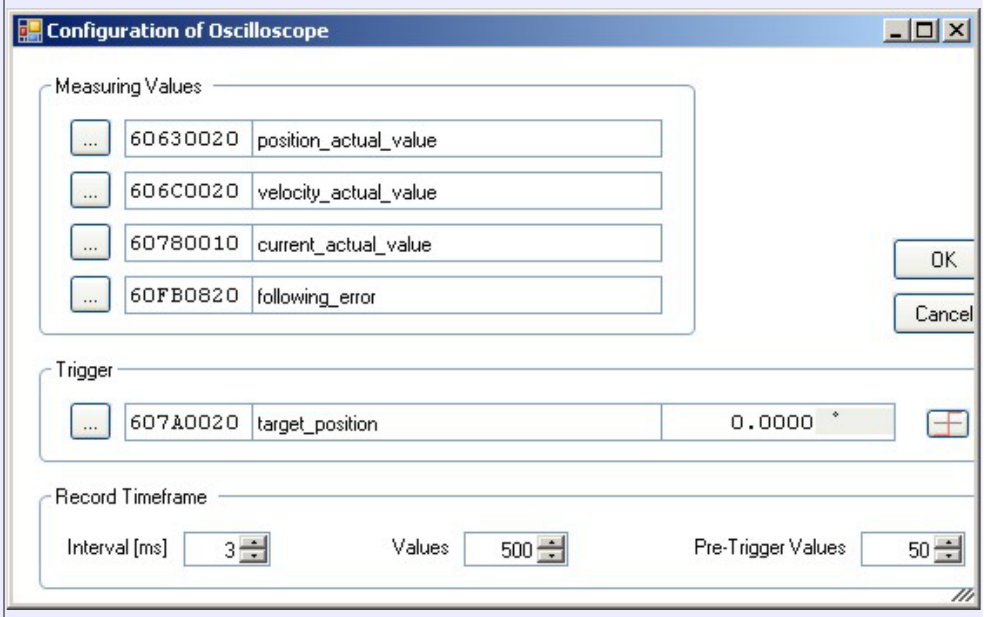
Condition		Query whether the specified condition is true. An object can be specified the value of which is compared to a fixed value (if required, an offset and an AND mask can be taken into account -> can be entered via **Condition Type masked Comparison**). For selecting an object see Chap. 7.1.3. In the example a query is carried out whether the actual velocity value (object 0x606C) has reached a value of 1000 rpm (at an encoder resolution of 8000 inc/rev).





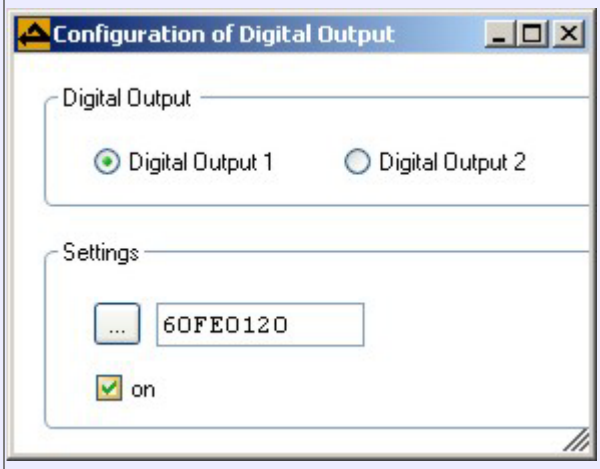
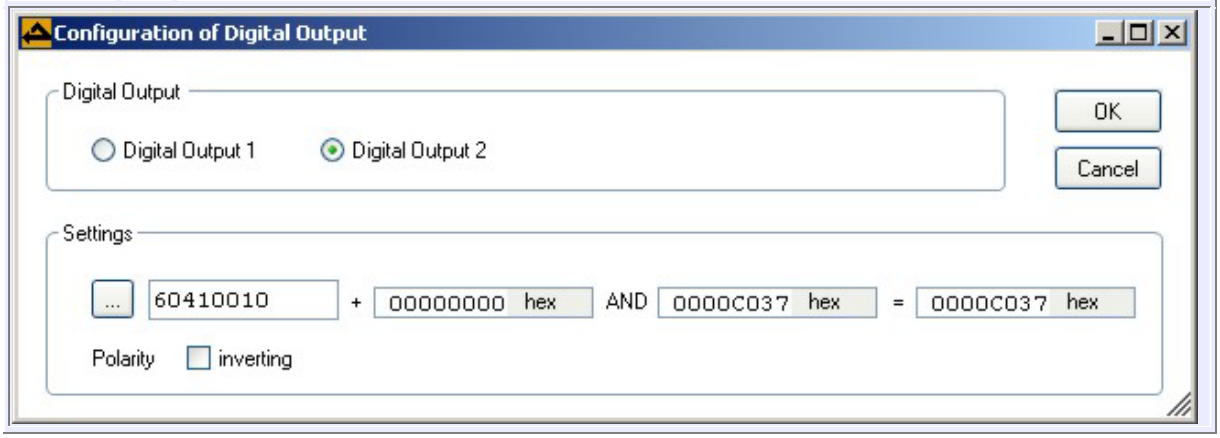
Oscilloscope

In the program flow the oscilloscope function can be used for the recording of data rows. Specify the measuring values to be recorded, the trigger event, and the record timeframe.



The selection of the values is described in chapter 2.6.2.

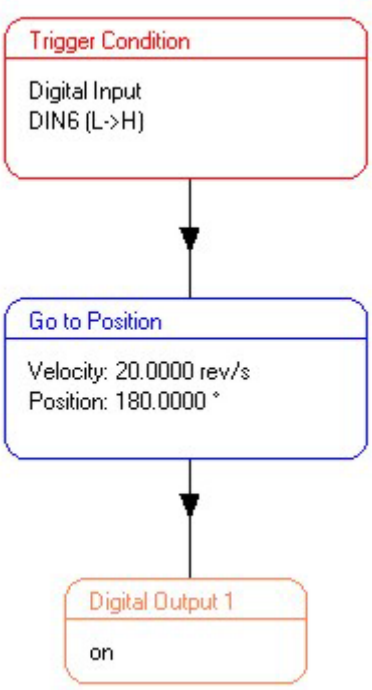
The data rows recorded in the servo amplifier can be viewed via **Analyze** in the **Display Oscilloscope** tab. Click the **Read** button in the displayed window. For a detailed description of the display functions of the oscilloscope see chapter 2.6.3.

Digital Output		A digital output can be used for status or control data which is e.g. processed by a higher-level controller. By default, the output object for the digital outputs is set (Object 0x60FE).  When other objects are selected, additionally an **Offset** and an **AND** mask can be defined. For selecting an object see Chap. 7.1.3. In the example the digital output 2 goes to "high" if the servo amplifier has found the commutation and the reference. 

4. Drag further elements to the editor workplace as described above. It is also possible to copy elements which have already been created on the editor workplace including their assigned properties. To do so, place the mouse cursor on the element to be copied and click the right mouse key. Select **Copy** (or key combination *CTRL + C*, respectively). Place the mouse cursor to the location where you want to insert the copied element and click the right mouse key. Click **Paste** (or key combination *CTRL + V*, respectively). For deleting an element select it, click the right mouse key and choose **Delete** (or key DEL, respectively).

   If required, you also can undo the actions for generating, deleting, loading, shifting and editing. Click the right mouse key and select **Undo**. Alternatively, press *CTRL + Z* on the keyboard. Thus, the last action is undone. By multiple clicks on **Undo** or *CTRL + Z* respectively the respective number of actions can be undone.

5. Define the program flow of how the elements are processed. To do so, connect them one by one. Place the mouse cursor on the beginning element and click the right mouse key. In the pop-up menu, select **Connect to** ... and click to the destination element. Between the elements a line with an arrow is displayed.
   Note: For deleting of an arrow, select it (the arrow is then displayed in red colour), click the right mouse key and choose **Delete** (or *Del* key, respectively).



6. On the editor workplace all program flows which are required in the device have to be generated. All program flows are written as a whole into the device (see below). By using the sequence editor, individual program flows cannot be loaded selectively into specific memory areas of the servo amplifier.

Compilation

After you finished editing your program flow in the graphical editor, it has to be translated into object code (compilation). Therefore, place the mouse cursor within the editor workplace, however not on an element. Click the right mouse key. In the pop-up menu select **Compile**. If the program flow is complete, the result of the compilation is displayed in the ***.dat** format. If the definitions in the program flow are incomplete (e.g. **Properties** are missing) the compilation cannot be carried out and in the message area below the editor workplace an error message is generated. Elements concerned are displayed with a yellow background.

Write program flow data into device

For writing the program flow into the servo amplifier click the right mouse key in the ***.dat** tab and in the pop-up menu select the entry **Write data to device**.

Warning: When writing the program flow data to the device all existing program flows are overwritten! All trigger events are reset.

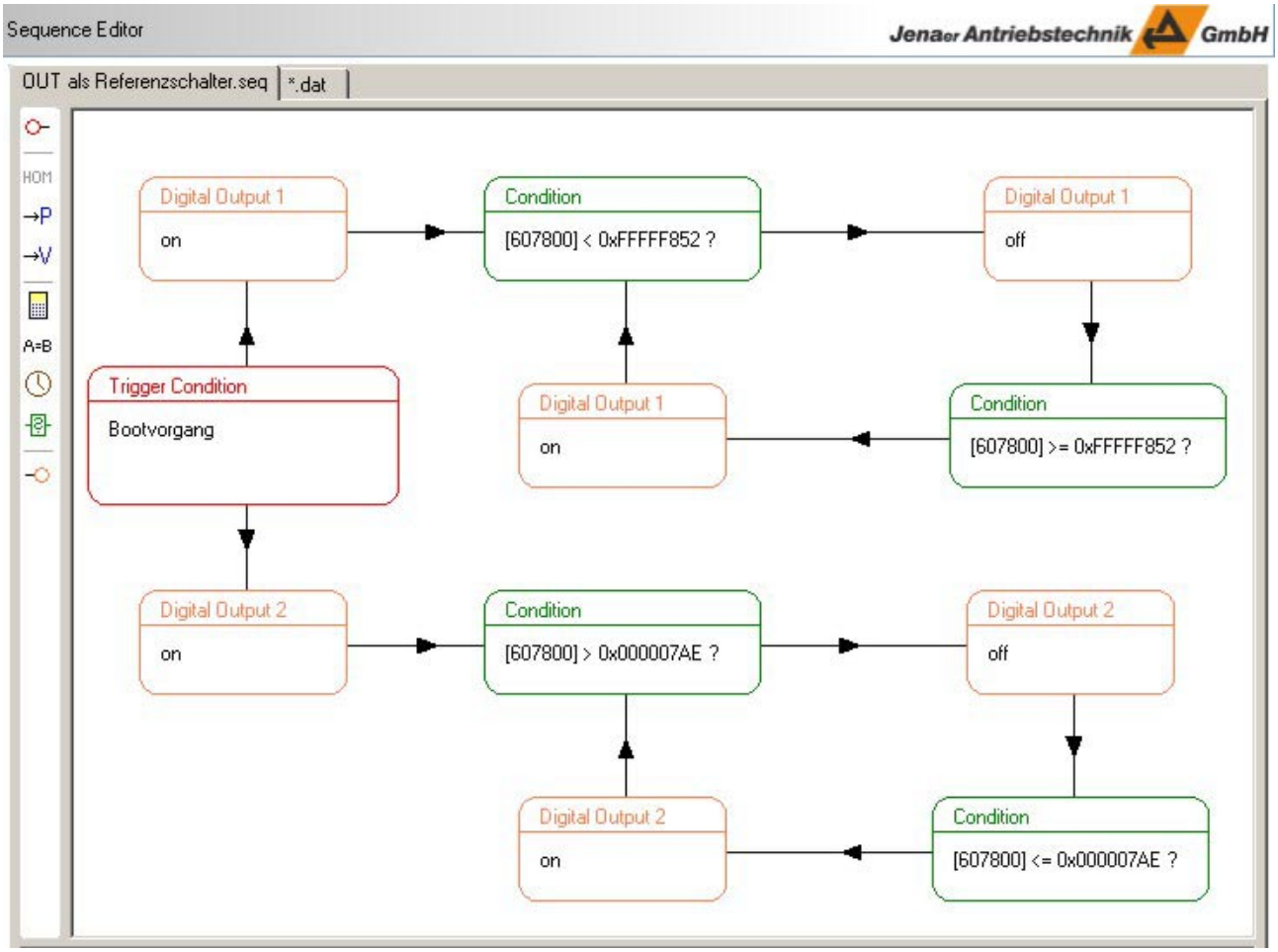
Note: You also can carry out the two steps "Compile" and "Write programm flow data to device" in one. Therefore, place the mouse cursor within the editor workplace, however not on an element. Click the right mouse key. In the pop-up menu select **Compile and write in device**. When writing the program flow data to the device all existing program flows are overwritten! All trigger events are reset.

Load and save program flow data

The edited program flow data can be saved in the graphical format (***.seq**) as well as on object level in the ***.dat** format. In order to save the data in the graphical format place the mouse cursor within the editor workplace, however not on an element. Click the right mouse key. In the pop-up menu select **Save data**. In order to save the data in the ***.dat** format change to the respective tab. Loading data into the sequence editor is only possible in ***.seq** format.

Example

The following example shows the query of the actual current (object 0x6078) regarding the observance of a specified value range. The query starts immediately after the boot procedure of the servo amplifier. As long as the actual current is lower than the upper limit 0xFFFFF852 the Digital Output 1 is not set. If the actual current reaches or exceeds the value 0xFFFFF852 the Digital Output 1 is set. The Digital Output 2 is set if the actual current falls below the value 0x000007AE.



The example is provided as a sequence file (*OUT als Referenzschalter.seq*) in the program directory (*...\JAT\ECO Suite\App\data*).

7.1.1 Sequence Editor: Configuration of Trigger Conditions

In this window you select the trigger for the processing of a program flow. Possible **Trigger Types** are:

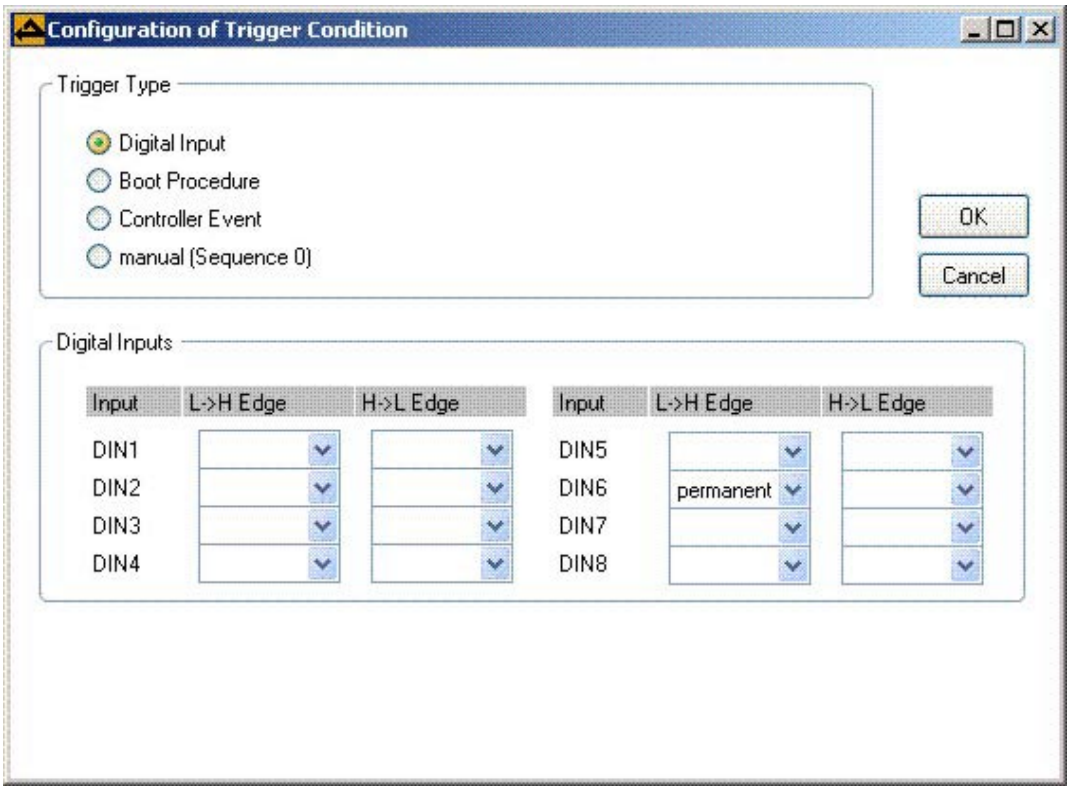
1. a digital signal, output by e.g. of a higher level controller or by other external devices which are connected to a **Digital Input** of the ECOVARIO®, ECOSTEP® oder ECOMPACT®.
2. the **Boot Procedure** of a servo amplifier

	When using the program flow call to **Boot Procedure** no external conditions concerning machine and plant safety are checked. Contact the application department of Jenaer Antriebstechnik if you want to use this function.

3. a specified **Controller Event** (e.g. target position reached, reference found, etc.).
4. a **manual trigger (Sequence 0)**. This trigger type is only available once in a program flow.

Digital Input

When selecting the digital inputs for program flow triggering observe the already existing assignments for the evaluation of the limit position switches and the reference switch, if any.



The example screen shows the input configuration of ECOVARIO (single-axis). Assign the required digital input to the program flow as a trigger type. Maximum two program flows can be activated by one input. You can select which event triggers the program flow:

- a rising edge (level changeover from low to high, **L->H Edge**)
- a falling edge (level changeover from high to low, **H->L Edge**).

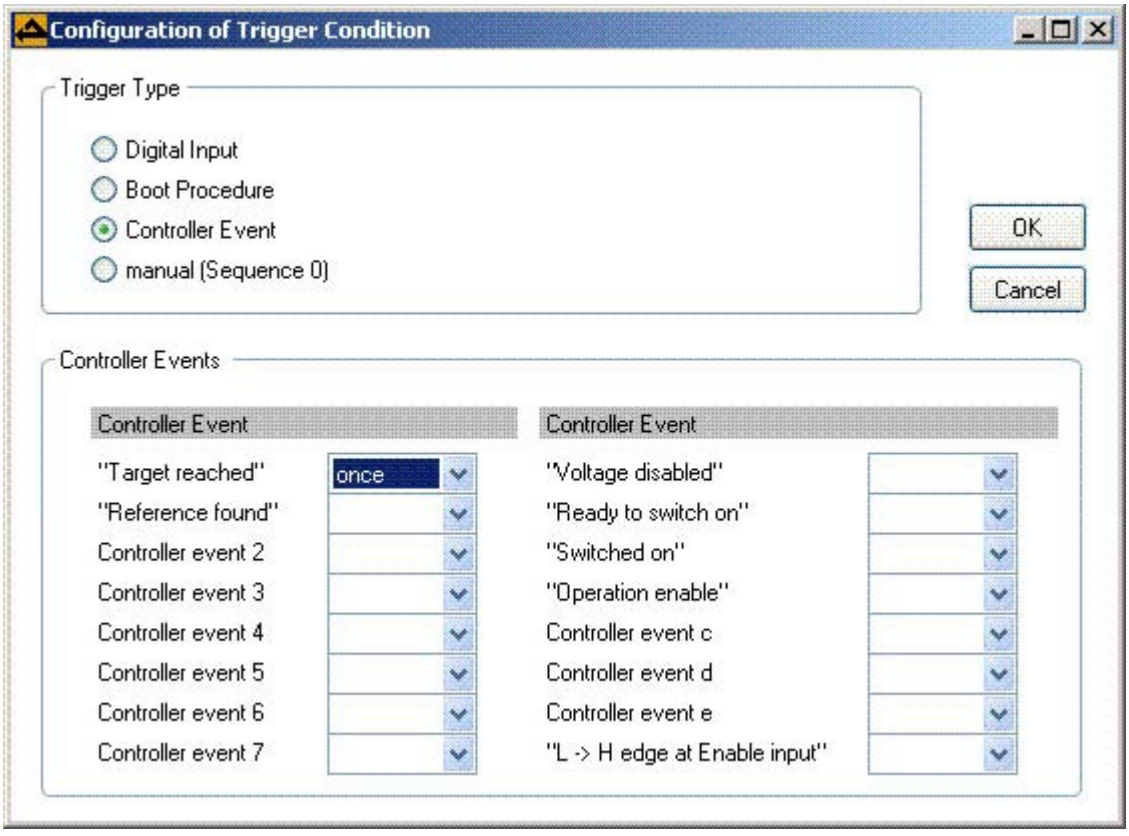
Normally a **permanent** query of the input status is required, however the query can also be done only **once**. If the trigger condition element is *not* located at the beginning of the procedure, you can **lock** a trigger event configured in a preceding trigger condition element.

Note: ECOSTEP servo amplifiers only support the **permanent** query.

Finally confirm the respective assignment by clicking **OK**.

Controller Event

When the **Controller Event** trigger condition is selected, the events are listed which can be assigned a program flow to. This program flow is then called as soon as the event occurs. Select the required controller event. Here you can also specify whether the event should trigger **once** or **permanent**. If the trigger condition element is *not* located at the beginning of the procedure, you can **lock** a trigger event configured in a preceding trigger condition element. Click **OK**.



Manual Trigger (Sequence 0)

The trigger type **manual trigger (Sequence 0)** is intended as a commissioning help and should only be used by experienced users. After specifying the program flow in the sequence editor and writing the data to the device the sequence 0 has to be executed for starting the program flow. Therefore, in the *Expert Mode* select **Control/Sequence Programming/Sequences** and the **Sequences** tab. Select **Sequence Number** 0 and click **Run**.

7.1.2. Sequence Editor: Homing

Limit position switches and homing switch

To set a reference point of a linear or rotative axis at least one electric switch is necessary. Alternatively, homing is also possible by exclusively using the index pulse or by using the mechanical limit positions. „Switch" means mechanic switched as well as electronic sensors. The following table shows the default setting of the digital inputs for connecting the limit position switches or the homing switches to ECOSTEP®, ECOVARIO®, or ECOMPACT.

Input	ECOSTEP® *)		ECOVARIO® **)		ECOMPACT	
	default setting	*free use*	*default setting*	*free use*	*default setting*	*free use*
DIN1	-	✓	Reset	✓	Reset / Enable2	✓
DIN2	-	✓	Enable	-	Enable1	-
DIN3	-	✓	positive limit position	✓	positive limit position	✓
DIN4	-	✓	negative limit position	✓	negative limit position	✓
DIN5	-	✓	homing position	✓	homing position	✓
DIN6	positive limit position	✓	-	✓	-	-
DIN7	negative limit position	✓	Capture input	✓	-	-
DIN8	homing position	✓	Capture input	✓	-	-

*) At **ECOSTEP54** limit position switches can be connected to DIN1 to DIN8 (DIN1, DIN3, DIN5, DIN7: positive limit position axis 1 to 4; DIN2, DIN4, DIN6, DIN8: negative limit position axis 1 to 4). Optionally, the digital inputs can be used freely.
) At the 2-axis servo amplifiers **ECOVARIO 114 D and **ECOMiniDual** the default assignment of the digital inputs 1 to 5 for one axis is the same as for ECOVARIO. However, the naming on hardware side deviates in order to differentiate between the two axes. Axis 1: DIN11 to DIN15, axis 2: DIN21 to DIN25.
The configuration of the digital inputs is done via **Inputs/Outputs\Digital Inputs**.

Note:
All switches must produce a +24 V level at the digital inputs of the servo amplifiers (active HIGH). The HIGH level has to be fed until standstill of the axis. Appropriate switching blocks should be used. If reversed logic levels are used the settings under **Inputs/Outputs\Digital Inputs** have to be adapted accordingly.

Limit position switches and homing switch can be configured differently:

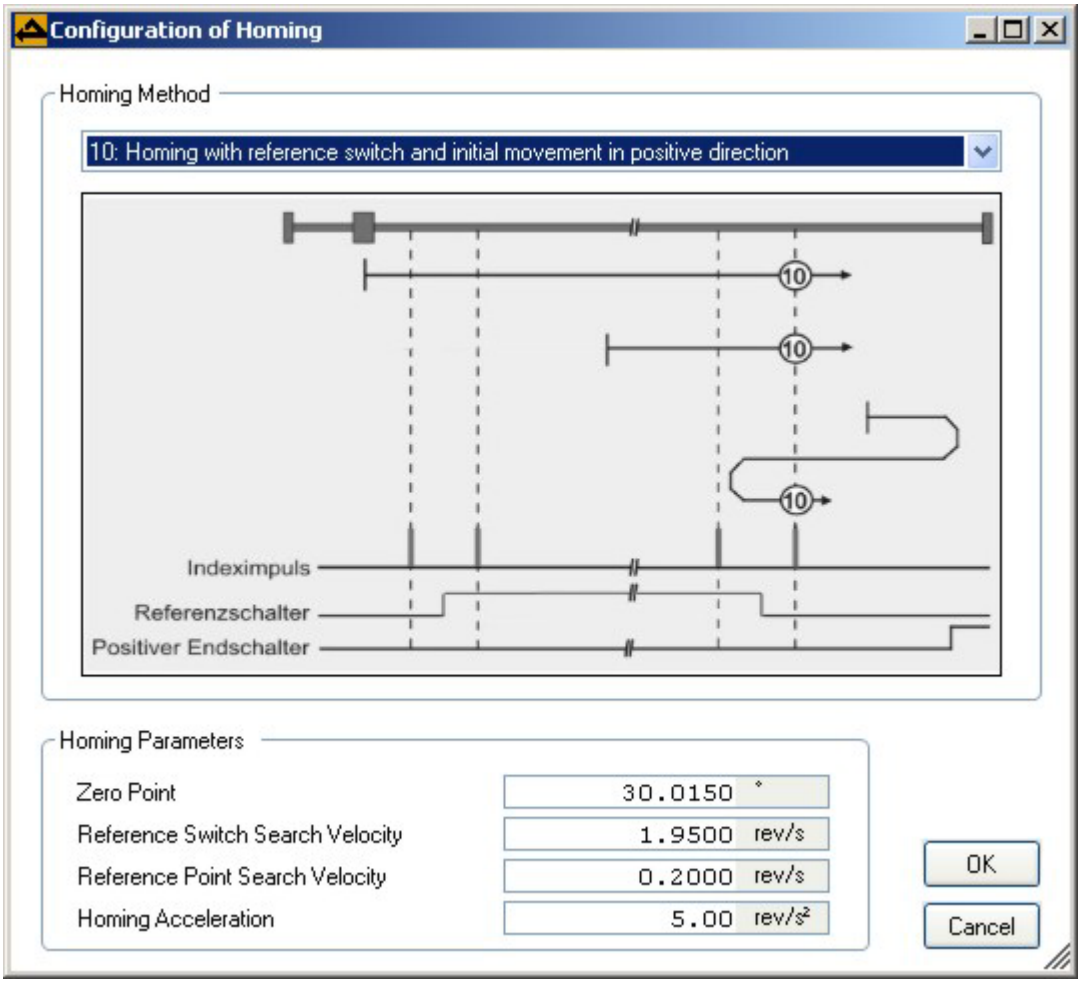
- Using 1 switch, the switch is homing switch as well as limit position switch for one limit position.
- Using 2 switches, each switch monitors one limit position. One of the limit positions is identical to the homing position.
- Using 3 switches, 2 switches monitor the limit positions and the third between the two others is the homing switch.

The homing process is according to CAN specification DS402.
The home position is set off against a freely definable offset. The position counter is set to the resulting value. The actual stop position after homing is not zero because after identifying the reference mark the axis decelerates according to the set homing acceleration till standstill.

Search principle

For reference search CAN operation mode 6 is implemented in the servo amplifiers. Mode 6 is set automatically as soon as homing is selected.
In the ECO Studio navigation area under **Motion** in the **Homing** tab

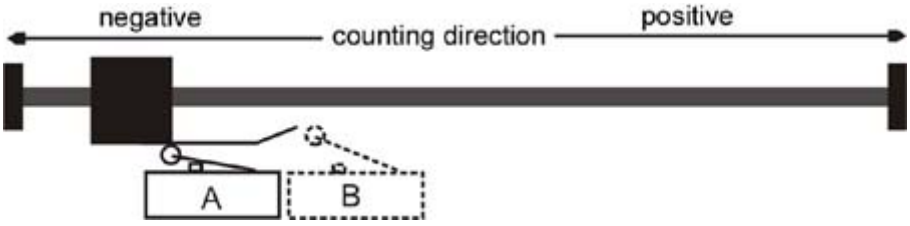
- Adjust the velocity for searching for limit position switch / homing switch
- Define the velocity for searching for the reference point
- Adjust the acceleration/deceleration for homing
- Select the homing method (Explanations to the individual methods can be found in the *Tooltips*)



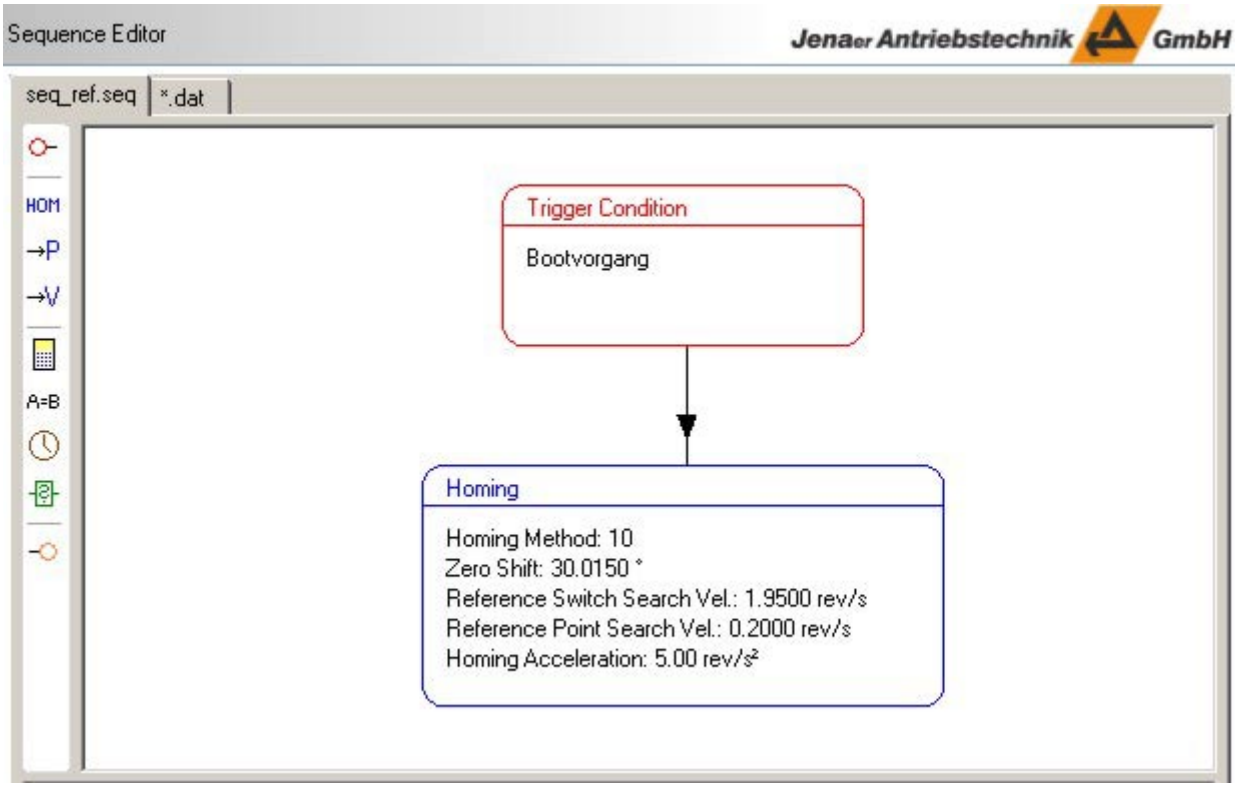
Zero Shift	After homing has been finished the home position can be shifted with this parameter
Two velocity values can be set:	
Reference Switch Search Velocity	Velocity of the search travel for the reference switch
Reference Point Search Velocity	Velocity of the search travel for the home position
Homing Acceleration	Acceleration and deceleration during the homing process
The following parameters can only be set if homing methods -1, -2, -17, or -18 are selected. These methods evaluate the increased current consumption in case of mechanical blocking as switching criteria.	
Max. End Stop Current	Upper limit o the increased current in case of mechanical blocking
Hold Time for End Stop Current	Time period for which the end stop current is provided

Buttons:	
Set Absolute Encoder to Zero	Only available if a motor with absolute value encoder is used: sets the counter of the absolute value encoder to zero
OK	Inserts homing with the specified parameters into the program flow.
Cancel	Quit window without inserting the specified progrem parameters into the program flow.

For the explanations of the individual homing methods the following count and travel directions are defined:



You can look up the count direction of the used system in the display area of the actual device status (in the lower left area of the user interface) in the **Act. Pos.** field.
The program flow for homing could e.g. be as follows:



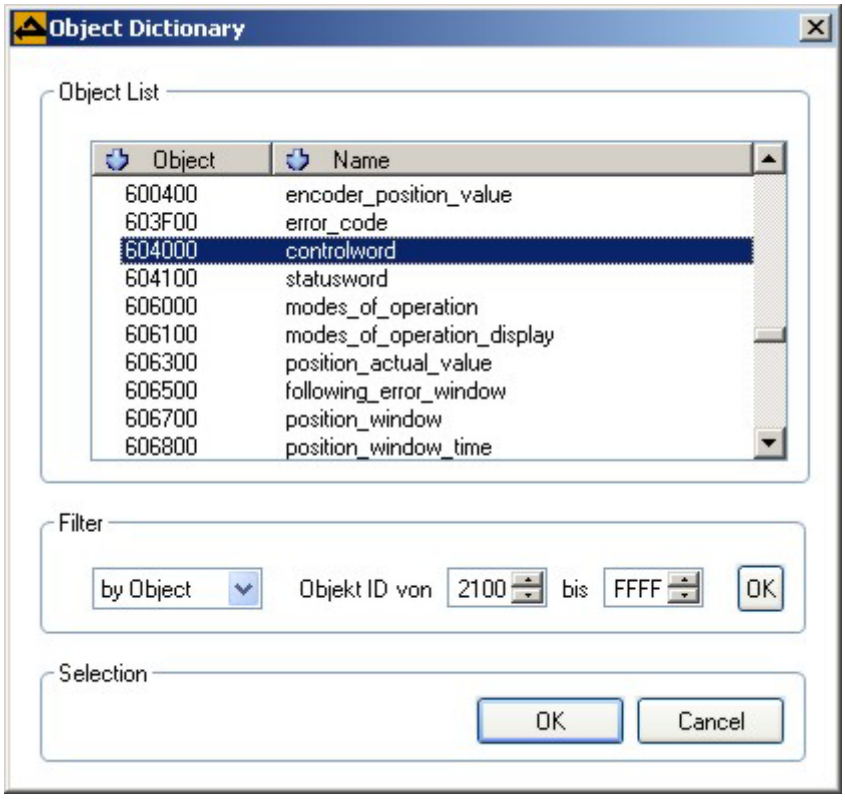
As soon as the reference has been found, „**Reference found**" is displayed in the ECO Studio message area. In the window area **Device Status** the **Referenced** box is displayed in green colour.

7.1.3 Sequence Editor: Select Object

For selecting an object in the dialog box proceed as follows:

1. *If the object number is known* you can enter it directly in the field. Please note that the entry has to consist of 6 digits, besides the 4-digit object number the two-digit sub index has to be specified as well. It is also possible to make incomplete entries, ECO Studio provides a choice of possible completions then.
2. *If the object number is not known* open the **Object Dictionary** window by means of a mouse click to "**...**".

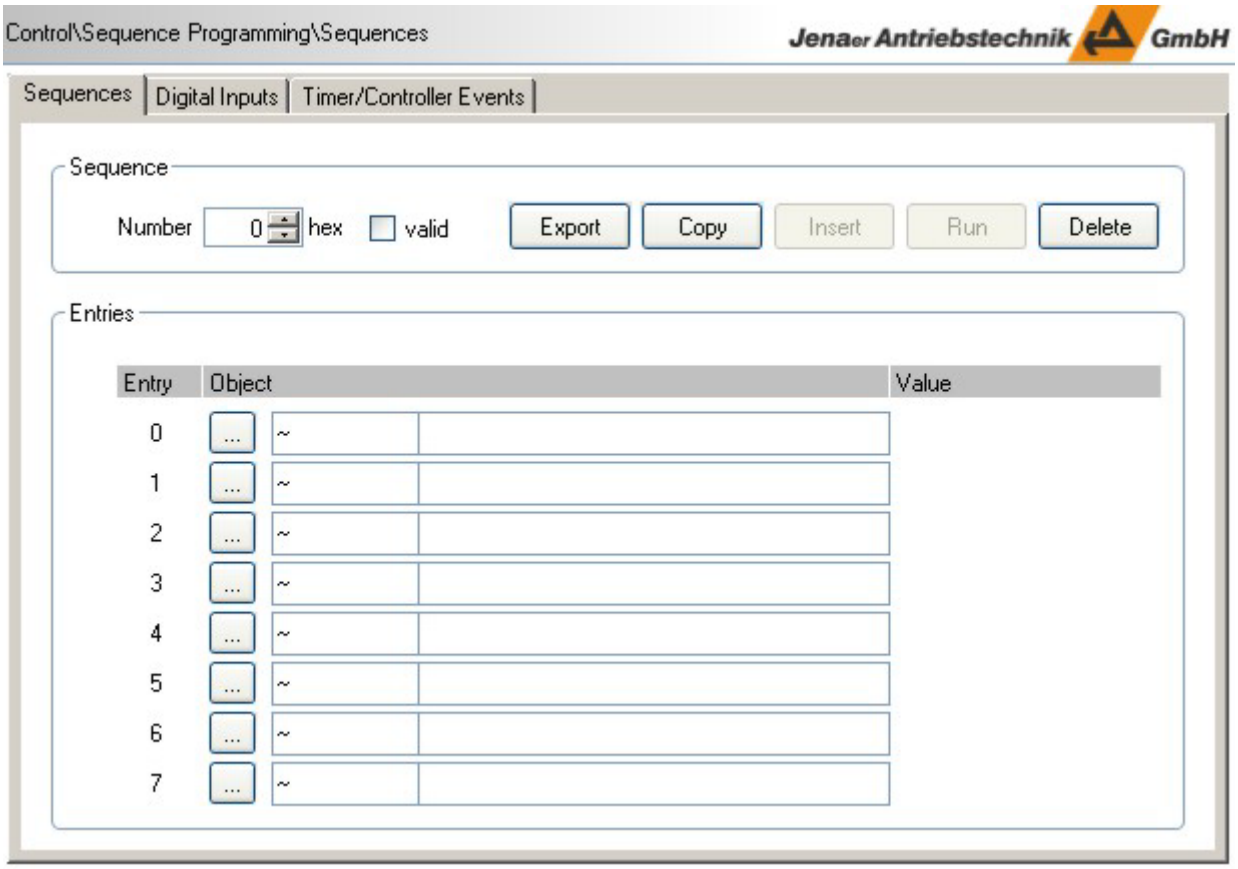
3. From the **Object List** select the object you wish to add to the sequence. If necessary, you find detailed descriptions of the objects in the Object Dictionary Manual. For filtering of the objects displayed in the list you can use the **Filter** functions. The filter criteria **by Name** provides a textual search function. The 6-digit object ID can also be entered directly. To do so, select the filter criteria **ID Entry**.



4. Confirm the selection of the object by clicking **OK**.
The object is entered in the dialog box together with a comment.

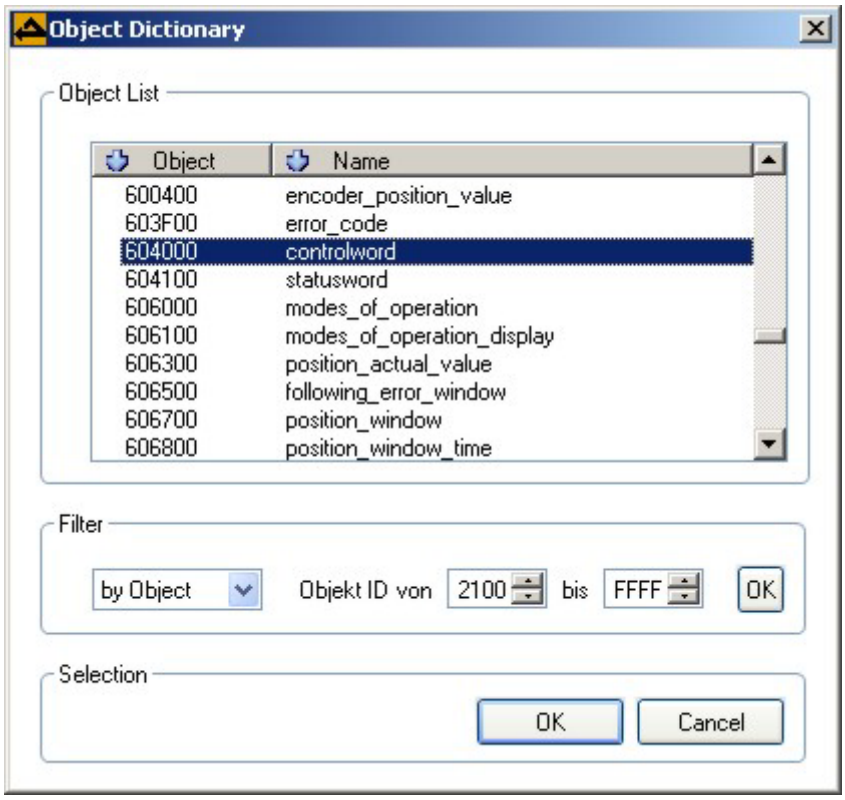
7.2 Sequence programming (Expert Mode): Assign objects

For sequence programming a separate entry window is available.



In this window you can assign 8 objects to each sequence.

1. Select a free sequence number (**Sequence** -> **Number**).
2. Start the assignment of the objects with line **Entry 0**.
3. *If the object number is known* you can enter it directly in the field. Please note that the entry has to consist of 6 digits, besides the 4-digit object number the two-digit sub index has to be specified as well. It is also possible to make incomplete entries, ECO Studio provides a choice of possible completions then. Proceed with step 7.
4. *If the object number is not known* open the **Object Dictionary** window by means of a mouse click to "**...**".
5. From the **Object List** select the object you wish to add to the sequence. If necessary, you find detailed descriptions of the objects in the manual "Objektverzeichnis ECOVARIO® und ECOSTEP®". For filtering of the objects displayed in the list you can use the **Filter** functions. The filter criteria **by Name** provides a textual search function. The 6-digit object ID can also be entered directly. To do so, select the filter criteria **ID Entry**.



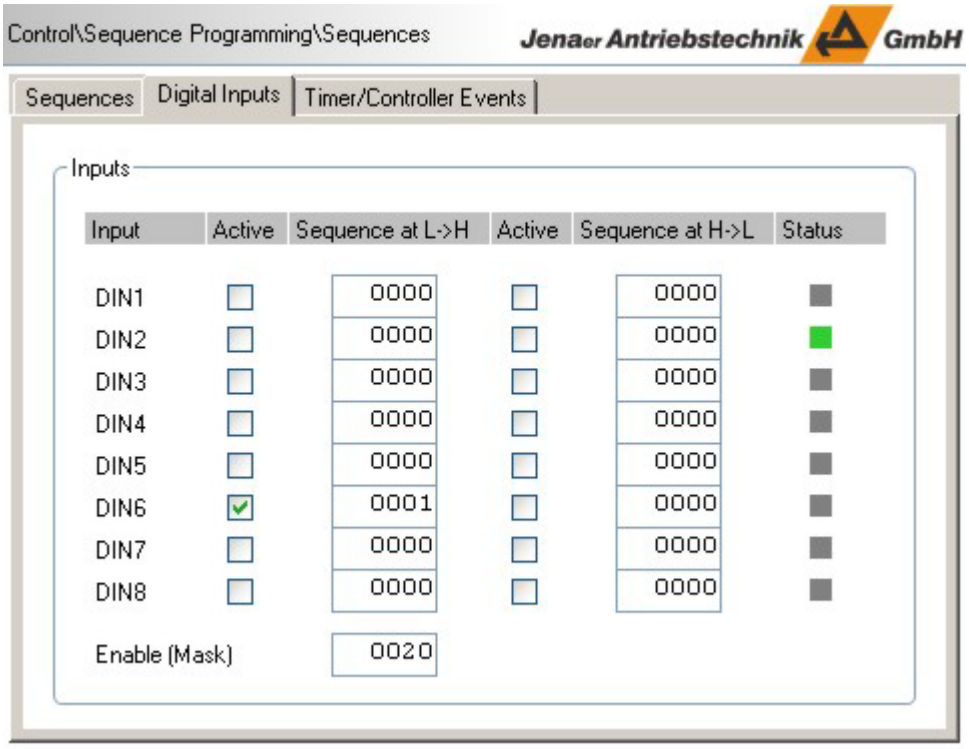
6. Confirm the selection of the object by clicking **OK**.
   The object is entered in the sequence together with a comment.
7. Enter a value for the object.
8. Proceed with the next object entries, if any.
9. Switch the sequence to "**valid**".
10. Set the trigger conditions via the window **Sequences for Digital Inputs**.

Note: If already existing sequences are programmed in a servo amplifier they can be exported to a text file for documentation or analyzing purposes, if required. Use the **Export** button.

By means of the example in Chap. 7.5 you can familiarize yourself with the sequence programming.

7.3 Sequences for digital inputs (Expert Mode)

Via the path **Control\Sequence programming\Sequences** the assignment of the trigger events to the sequences is done in the **Digital Inputs** tab.



When selecting the digital inputs for sequence triggering observe the already existing assignments for the evaluation of the limit position switches and the reference switch, if any.

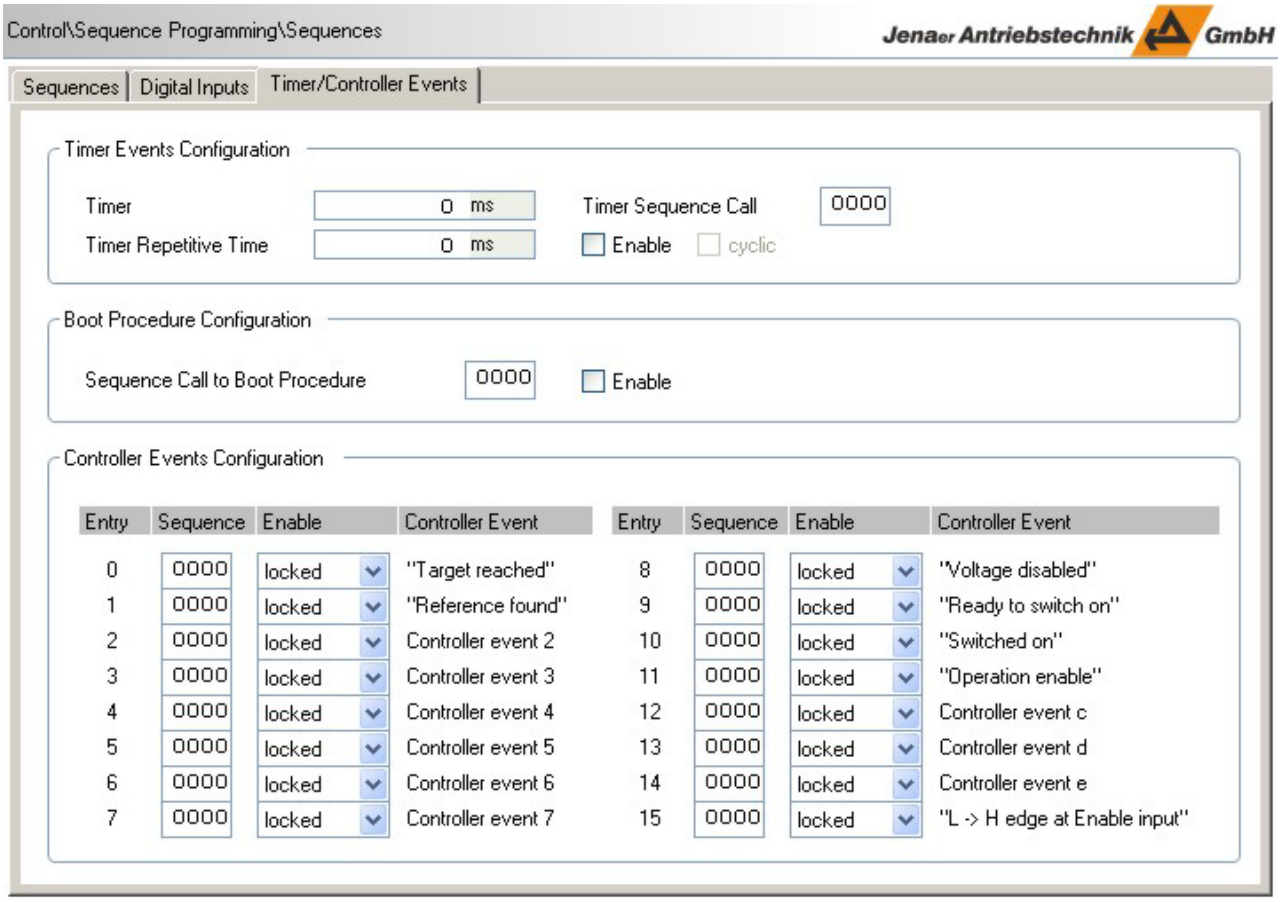
Assign the sequence numbers to the digital inputs. Maximum two sequences can be activated by one input. You can select which event triggers the sequence:

- a rising edge (level changeover from low to high, **Sequence at L->H**)
- a falling edge (level changeover from high to low, **Sequence at H->L**).

Finally set the respective assignment to „active" (check box **Aktiv**).

7.4 Sequence programming (Expert Mode): Timer/Controller Events

Sequence programming provides the possibility to start sequences dependent from the occurence of a specified triggering event (e.g. target position reached, reference found, etc.). Such triggering events can be configured via **Control\Sequence Programming\Sequences** in the **Timer/Controller Events** tab.



Window area **Timer Events Configuration**	
Timer	Setting the delay time which should be elapsed until the specified sequence number is called. No trigger event is necessary here, the sequence is started immediately after the timer has elapsed, provided that **Enable** is set.
Timer Repetitive Time	Setting the repetitive time if the sequence should be started cyclically. In the case of cyclic processing the first **Timer** has to be set to a value > 0.
Timer Sequence Call	Number of the sequence which is called after the timer delay time has elapsed
Enable	Enables the sequence which then can be called
cyclic	Activates the cyclic execution of the specified sequence
Window area **Boot Procedure Configuration**	
⚠	When using the function „**Sequence Call to Boot Procedure**" no external conditions concerning machine and plant safety are checked. Contact the application department of Jenaer Antriebstechnik if you want to use this function.

Sequence Call to Boot Procedure	Specification of a sequence which is executed directly after the boot-up procedure of the servo amplifier
Enable	Enable of the boot-up sequence

In the window area **Controller Events Configuration** the events are listed which can be assigned a sequence to. This sequence is then called as soon as the event occurs. The function has to be activated for each entry individually in the **Enable** column.

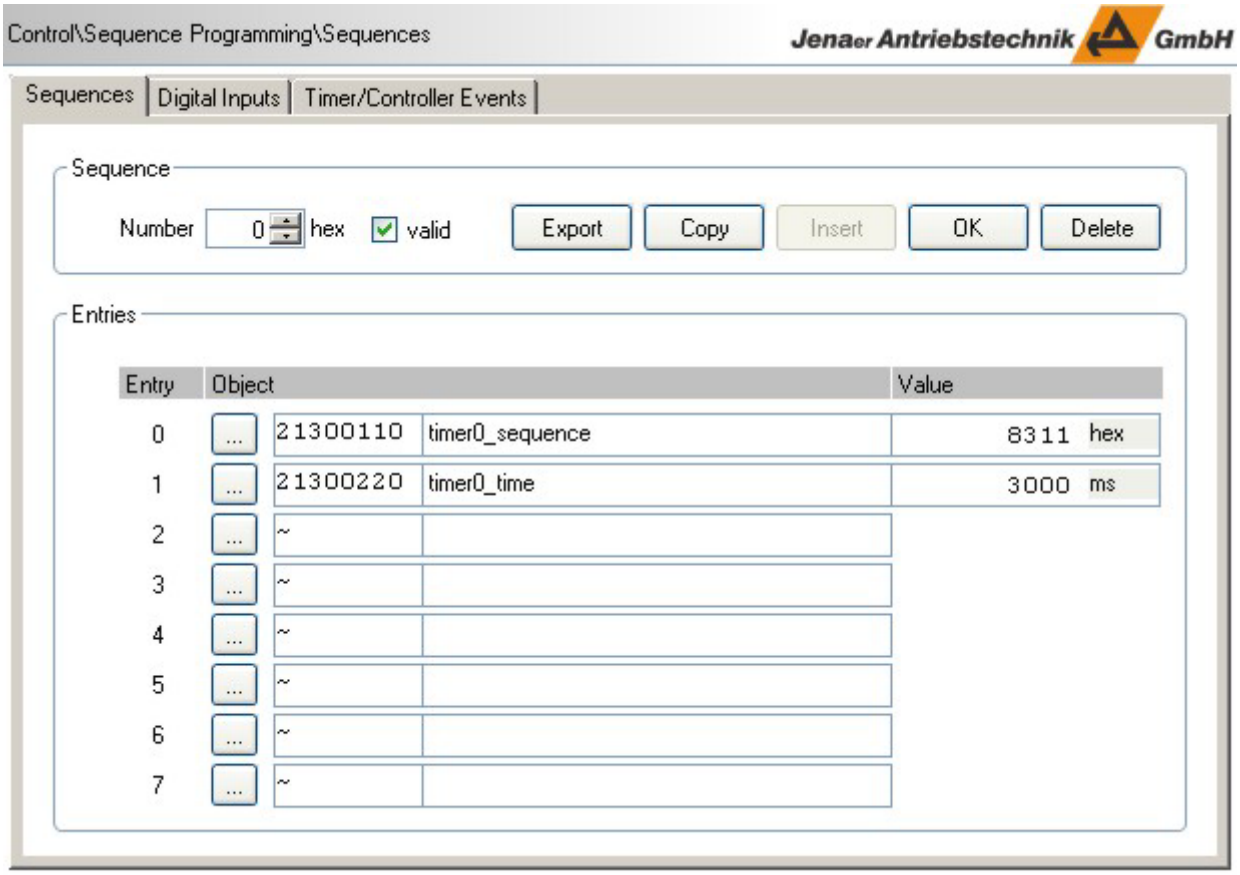
Timer programming procedure

1. In the window area **Timer Events Configuration** define a sequence which is called after the specified time period has elapsed
2. Enter a time period [ms] in the **Timer** edit box
3. Check the **Enable** check box and observe how the time period is decremented to 0.
4. The specified sequence is called and processed.

In order to include the timer function into sequences, call the timer function object 0x2130:

- Object 21300110 contains the sequence number which is started after the delay time
- Object 21300220 contains the delay time [ms]

Assign values to the objects 21300110 and 21300220. The specified sequence is called automatically after the specified delay time. The number of the called sequence (maximum 0xFF) has to be entered to the lower byte. In the high byte the entry 0x80 is necessary which serves as an enable flag for the sequence.

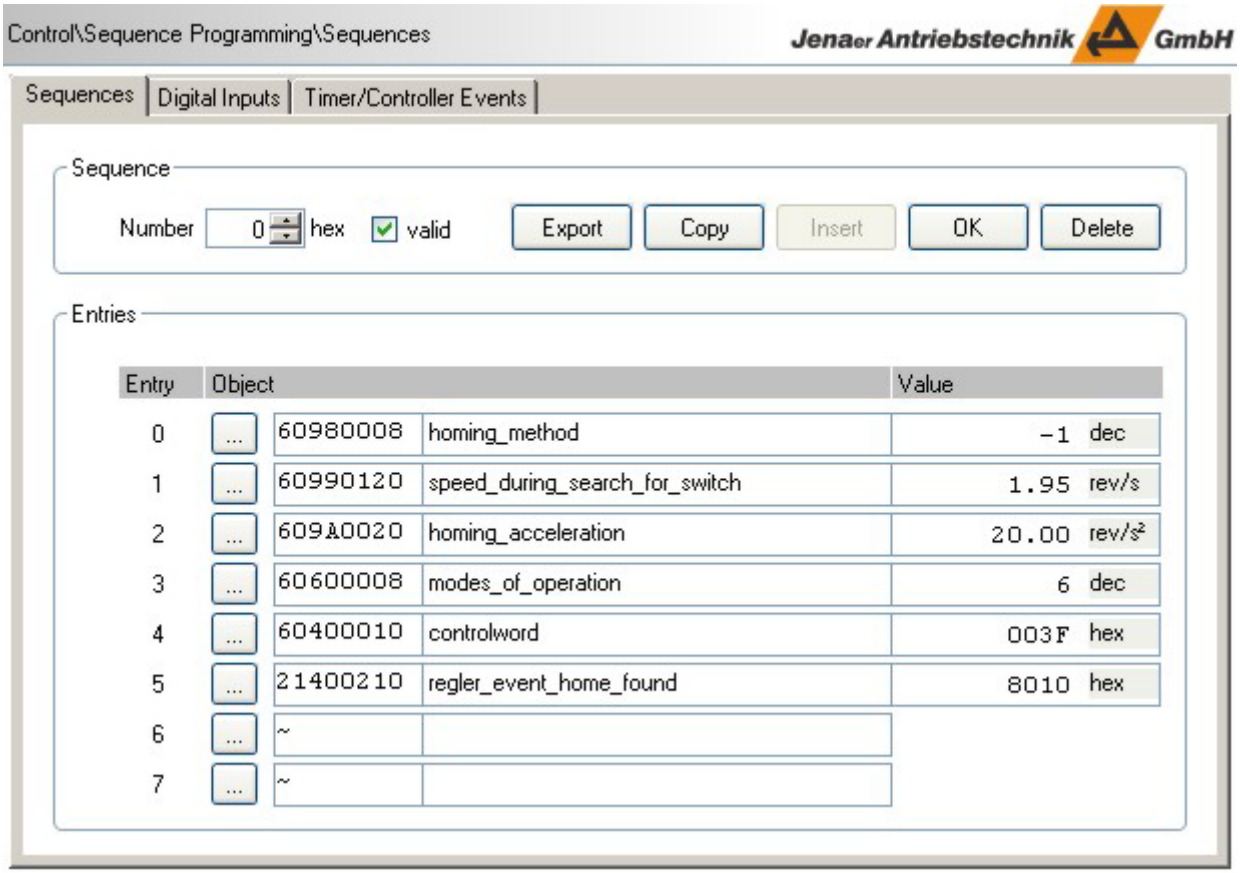


7.5 Sequence programming (Expert Mode): Example

In the following example two sequences are concatenated.

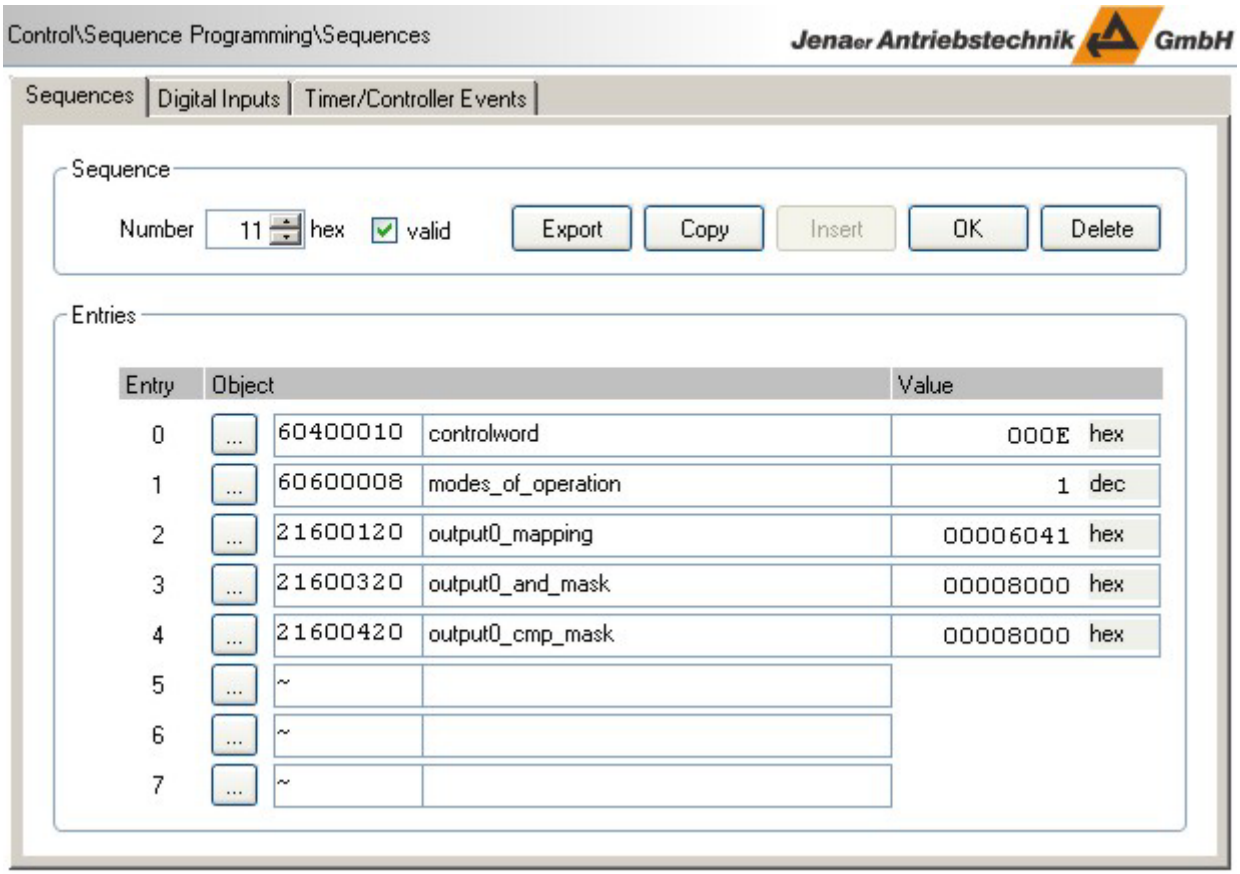
In this example a homing procedure is initiated, triggered by a switching condition. Via the output OUT1 is signalized that the reference has been found. Subsequently the operating mode is switched to 1 (position mode) for direct position entry, e.g. by means of target values via one of the interfaces.

Sequence 0:



- In sequence 0, entry 0, the homing mode is set to -1.
- Entry 1 specifies the velocity for reference switch searching to 1.95 revolutions/s.
- Entry 2 defines homing acceleration and deceleration.
- Entry 3 sets the operating mode to homing mode.
- Entry 4 activates the motor and starts homing mode
- Entry 5 jumps to sequence 0x10 if the reference has been found.

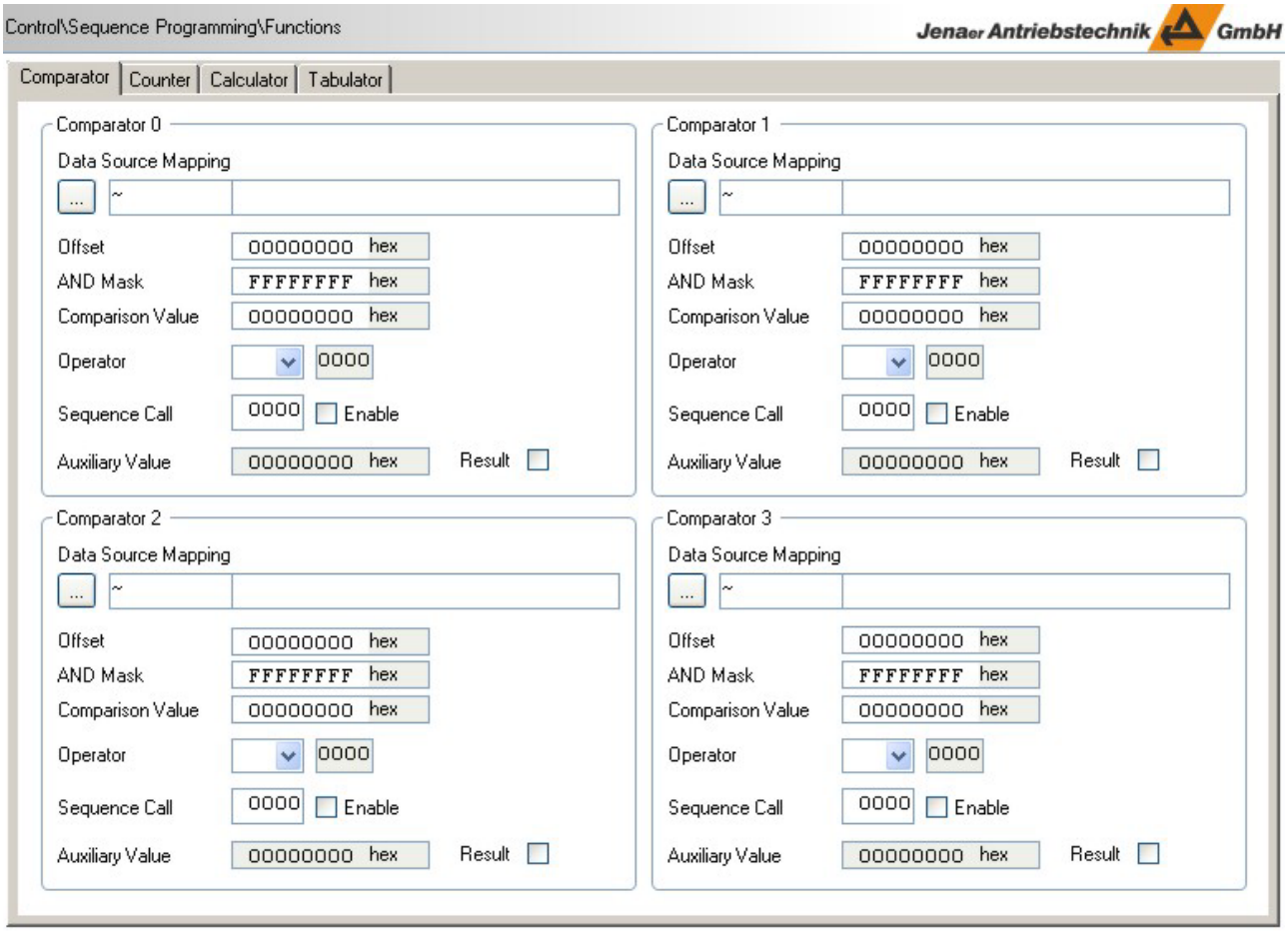
Sequence 0x10:



- In entry 0 the motor is deactivated; the axis is free to rotate
- Entry 1 switches the operating mode to positioning mode
- Entry 2 maps the status word, object 0x6041, to the object for output OUT1
- Entry 3 AND-operates the object 0x6041 with 0x8000. By means of this logical operation the bit „reference found" is masked.
- Entry 4 compares the object entry to 0x8000; the comparison is 1 if the bit „reference found" is set to 1 internally
- The output OUT1 takes High level when the reference has been found.

7.6 Sequence programming (Expert Mode): Comparator

In the servo amplifier 4 comparators for common tasks are integrated.



1. In the navigation area select **Control\Sequence Programming\Functions**
2. In the **Comparator** tab enter the object to be compared in the edit box **Data Source Mapping**.
3. Define **Offset**, **AND Mask** and the **Comparison Value**.
4. Select the **Operator**.
5. In the **Sequence Call** edit box enter the sequence that is called if the comparison is positive.
6. Confirm your entries by clicking the **Enable** check box.
7. If the comparison is positive, the **Result** check box is checked.

The comparator is initialized in a sequence. Once activated, every comparator is independent of sequences and is executed by the machine cycle. Every comparator can be overwritten.

Background: Related objects

The objects 0x2180 to 0x2183 are assigned to the comparators 1 to 4. The sub index values are related to the comparator parameters as shown in the table.

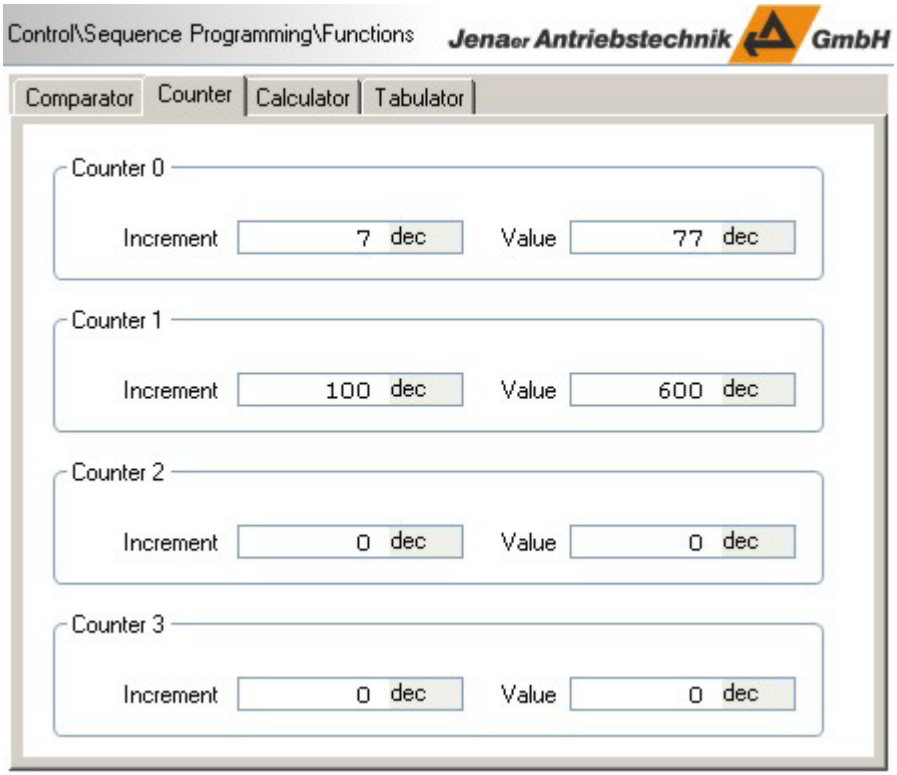
Index [hex]	Sub index [hex]	Comparator parameter
2180 - 2183	01	Data source mapping
	02	Offset
	03	AND mask
	04	Comparison value
	05	Operator
	06	Sequence call in the format 0x80xx
	07	Not used

The sequence number in sub index 06 (maximum 0xFF) has to be entered into the Low byte. In the High byte the entry 0x80 is necessary to enable the sequence.

Each comparator is active until the result of the comparision is positive, i.e. the result is „true“. Subsequently the flag is set, the comparator is reset and therefore no more executed. For further use of the comparator a new call is necessary. For this call the original sequences can be used.

7.7 Sequence programming (Expert Mode): Counter

For general tasks 4 counters are integrated in the servo amplifier.



1. In the navigation area select **Control\Sequence Programming\Functions**.
2. In the **Counter** tab enter a value for the counter **Increment**; positive and negative values are allowed.
3. Confirm the entry.
4. Watch the counter.

The objects 0x2190 to 0x2193 are assigned to the counters 0 to 3.

If the counter object, sub index 0x01, is called, the value of the object is added to the counter content. A trigger marker is not necessary.

Example:

A sequence is started by a triggering event at a digital input. In this sequence object 0x2190, sub index 01, (corresponds to **Counter 0**) is called and the **Increment** is set to 7. Each sequence call by a trigger event at the digital input increases the counter **Value** by 7. In the upper screenshot the value is 77, i.e. the trigger event has occured 11 times up to now.

7.8 Sequence programming (Expert Mode): Calculator

The calculator can carry out simple arithmetic and logic operations.

1. In the navigations area select **Control\Sequence Programming\Functions**.
2. In the **Calculator** tab first enter the **Source Object** which is the basis for the operation
3. Enter a value for the **Operand** which is to be operated with the value of the source object
4. Select the **Operator**. Possible operations are "copy" (copies the value of the source object to the destination object), "+", "-", "·", "./.", "AND", "OR", "XOR"
5. Specify the **Destination Object** where the result of the operation is written to.

The calculation starts immediately after the entry of the destination object.

Note: If the parameters are entered in an other order as described here the calculation can be initiated by clicking **OK**.

Background: Related Object

Arithmetic-logic operations are executed via object 0x21A0.

Index [hex]	Sub index [hex]	Explanation
21A0	01	Source object
	02	Destination object (contains result of the arithmetical or logical operation; a valid writing to the object triggers the calculation)
	03	Number (operand), which is operated with the value of the source object
	04	Operator (mathematic-logic operation)
	05	Displays the result of the operation after sub index 2 (destination object) has been written

Example

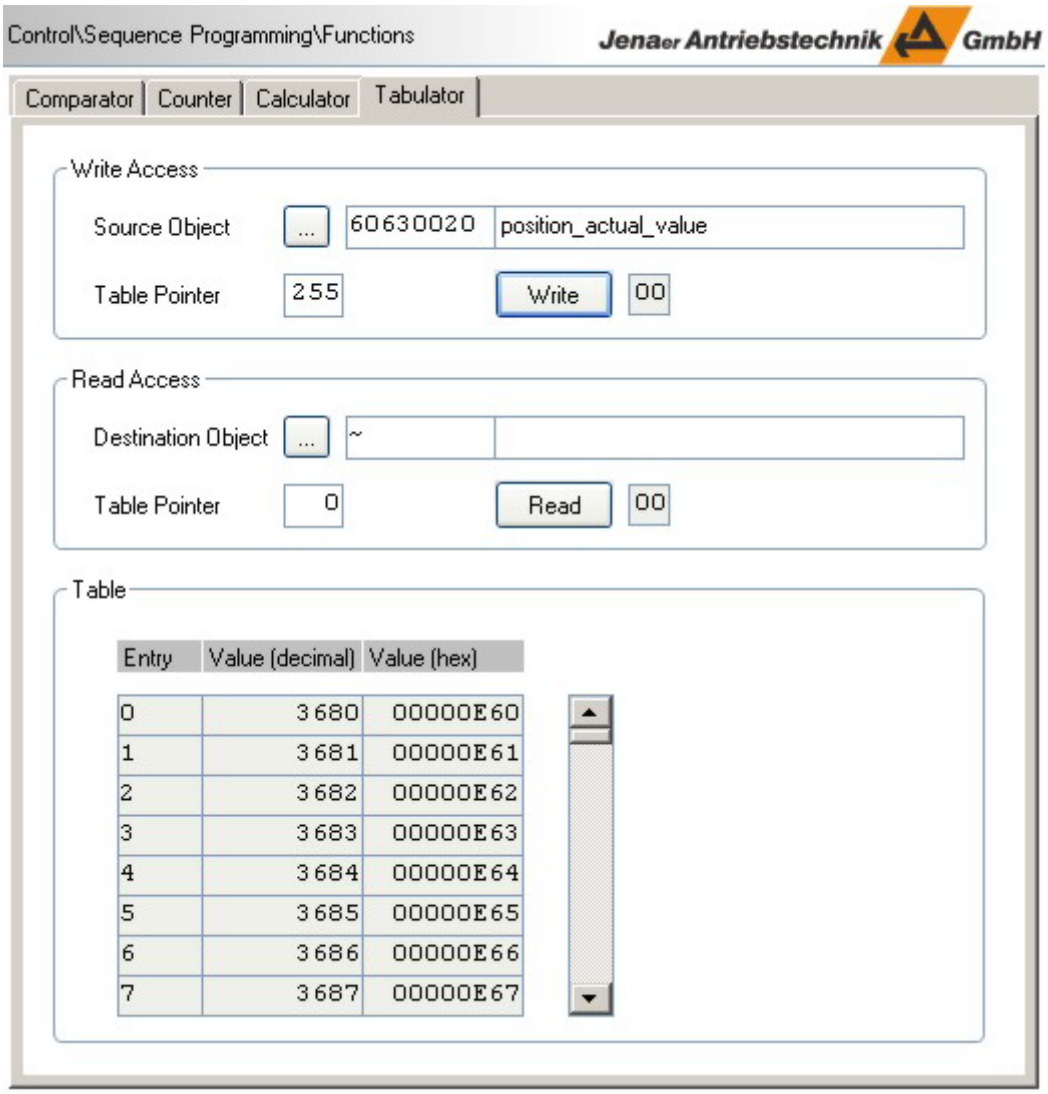
The value in the table object [1] is multiplied by 2 and copied to the destination object „target positon".

Sub index 01 → 0x2D010020 value from table[1]
Sub index 03 → 0x00000002
Sub index 04 → 0x0003 (*)
Sub index 02 → 0x607A0020 (target position)

7.9 Sequence programming (Expert Mode): Tabulator

The servo amplifiers ECOVARIO and ECOSTEP feature an integrated array of 255 positions organised in the form of a table. The table positions are addressed by a pointer. In the ECOVARIO write access and read access are possible. In the ECOSTEP only write access is possible. The table can be filled with any values, e.g. position values.

For evaluation the stored values can be transferred to a PC e.g. via CANopen.



1. In the navigation area select **Control\Sequence Programming\Functions**.

2. In case of a **Write Access** to the table, in the **Tabulator** tab enter the **Source Object** the value of which should be written into the table. In case of a **Read Access** specify the **Destination Object** where the value from the table position should be written to.

3. Enter the **Table Pointer**, i.e. the number of the **Entry** to be written or read, respectively.
4. Click **Write** or **Read**.
5. In the window area **Table** the table is displayed with all its entries.

Background: Related objects

Write access to the table is addressed by means of the object 0x21B0.

Index [hex]	Sub index [hex]	Explanation
21B0	01	Source object, the value of which shall be written in the table (mapping is possible for any object)
	02	Writing command (table pointer is incremented)
	03	Table pointer (position within the table)

Read access (ECOVARIO only) to the table is addressed by means of the object 0x21B1.

Index [hex]	Sub index [hex]	Explanation
21B0	01	Destination object
	02	Get value from the table and write it to the destination object (table pointer is incremented)
	03	Table pointer (position within the table)

8. CAN Communication

The ECOSTEP®, ECOVARIO® and ECOMiniDual servo amplifiers as well as the ECOMPACT compact servo drive can be operated as slaves in CANopen networks (cf. "Draft Standard 301" originated by the standardization group "CAN in Automation (CiA)") and are conforming to the "CANopen Device Profile for Drives and Motion Control" (compare CiA Draft Standard Proposal 402"). Additional functions are implemented by using the "Manufacturer Specific Data" area.

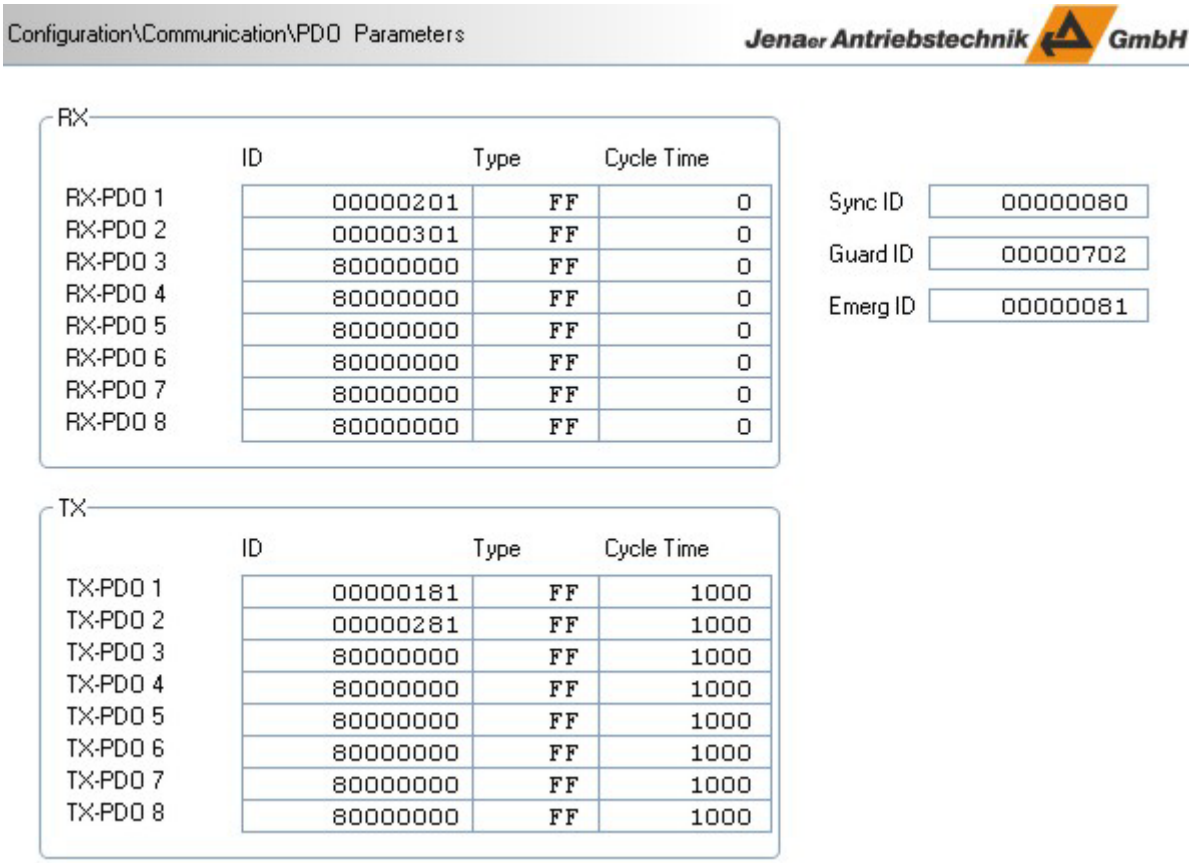
CAN communication is parameterized in the following steps:

- Specifying the communication parameters
- TX PDO mapping
- RX PDO mapping
- Baudrate and ID setting.

Furthermore CAN communication can be realized in the interpolated mode.

8.1 Specifying the CAN communication parameters (Expert mode)

The communication parameters (in the *Expert Mode* under **Configuration\Communication\ PDO Parameter**) are structured equally for all PDOs:



ID	COB-ID for PDO. RX PDO: Default value 0x200 + node address TX PDO: Default value 0x180 + node address
Type	Transmission Type • synchronous receive PDOs get valid by the next SYNC pulse • Default setting: 0xFF = the TX-PDO is sent if at least 1 bit has changed in the PDO data. Further types which are supported: • TX-PDO type 0xFE (manufacturer specific/profile dependent) is processed asynchronous and cyclic • TX-PDO type 0x01 ... 0xF0 • TX-PDO type 0 (not supported in ECOVARIO® synchronous mode, have to be defined as type „0xFF" in this case) • TX-PDO type 0xFC/0xFD (not RTR triggered)

Cycle Time	If type = 0xFF additionally the minimum distance between the sending of two PDOs can be specified here in steps of 100 µs
On the right: Message objects	
Sync ID	Synchronization Message: Synchronization of several CAN nodes
Guard ID	Node-Guarding: Monitoring of the communication participants by means of periodic messages
Emerg ID	Emergency Message: Transfer of error messages

8.2 RX PDO Mapping (Expert mode)

After the identifier and the transmission type have been defined, the servo amplifier is informed in the path **Configuration\CAN Communication\RX PDO Mapping** where the received data shall be transferred to. This is called mapping. As each PDO can transfer a maximum of 8 bytes, it is possible to assign a maximum of 8 objects with 1 byte each.

In the mapping objects, the **Number** of objects to be transferred is defined first. After that, those objects are entered, the data of which shall be sent to or to which the received data shall be assigned.

The mapping entries are structured as follows:

- Main index of the object to be mapped (hexadecimal)
- Sub index of the object to be mapped (hexadecimal)
- Length coding of the object to be mapped (hexadecimal)

Length codings are:

- 0x08 for 8-bit objects
- 0x10 for 16-bit objects
- 0x20 for 32-bit objects

If the object number is not known open the **Object Dictionary** window by means of a mouse click to "**...**" in the respective entry line. From the **Object List** select the object you wish to add to the sequence. If necessary, you find detailed descriptions of the objects in the manual "Objektverzeichnis ECOVARIO® und ECOSTEP®". For filtering of the objects displayed in the list you can use the **Filter** functions. The filter criteria **by Name** provides a textual search function.

By clicking „**>>**" in the **PDOx** area the object names can be displayed in an additional table column.

With the length specification even parts of the object can be written byte by byte, beginning with the LSB (e.g. lower 8 bytes of a 32-bit object), into the PDO. The length specification of each object is registered in the object dictionary (described in the manual "Objektverzeichnis ECOVARIO® und ECOSTEP®").

8.3 TX PDO Mapping (Expert mode)

After the identifier and the transmission type have been defined, the servo amplifier is informed in the path **Configuration\CAN Communication\TX PDO Mapping** about the data to be sent. This is called mapping. As each PDO can transfer a maximum of 8 bytes, it is possible to assign a maximum of 8 objects with 1 byte each.

In the mapping objects, the **Number** of objects to be transferred is defined first. After that, those objects are entered, the data of which shall be sent to or to which the received data shall be assigned.

The mapping entries are structured as follows:

- Main index of the object to be mapped (hexadecimal)
- Sub index of the object to be mapped (hexadecimal)
- Length coding of the object to be mapped (hexadecimal)

Length codings are:

- 0x08 for 8-bit objects
- 0x10 for 16-bit objects
- 0x20 for 32-bit objects

If the object number is not known open the **Object Dictionary** window by means of a mouse click to "**...**" in the respective entry line. From the **Object List** select the object you wish to add to the sequence. If necessary, you find detailed descriptions of the objects in the manual "Objektverzeichnis ECOVARIO® und ECOSTEP®". For filtering of the objects displayed in the list you can use the **Filter** functions. The filter criteria **by Name** provides a textual search function.

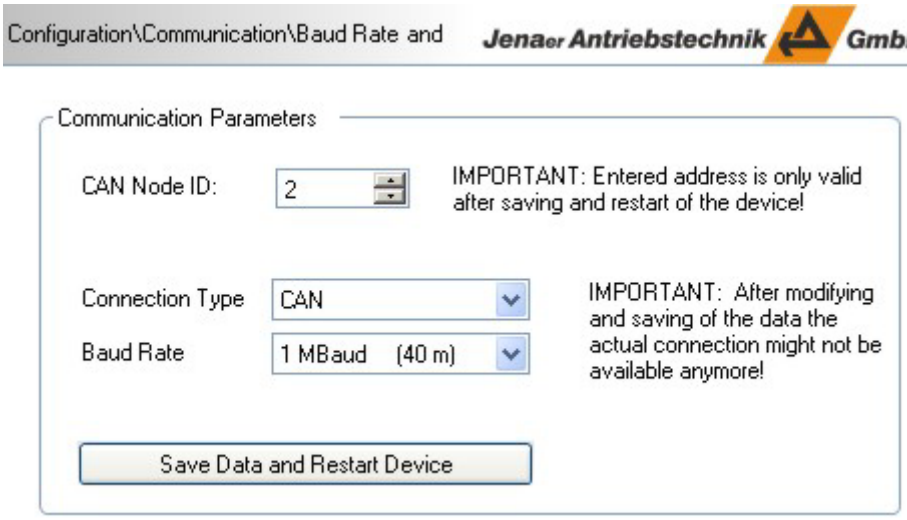
By clicking „**>>**" in the **PDOx** area the object names can be displayed in an additional table column.

With the length specification even parts of the object can be written byte by byte, beginning with the LSB (e.g. lower 8 bytes of a 32-bit object), into the PDO. The length specification of each object is registered in the object dictionary (described in the manual "Objektverzeichnis ECOVARIO® und ECOSTEP®").

8.4 Baud rate and ID (Expert mode)

You can modify the settings of the communication parameters of the PC interface *in the servo amplifier* in the *expert mode* via the path **Configuration\Communication\Baud Rate and ID**.

	The modified parameters are only valid after saving and restart of the servo amplifier. After this the actual connection between servo amplifier and PC might not be available anymore!



1. Enter the interface parameters:

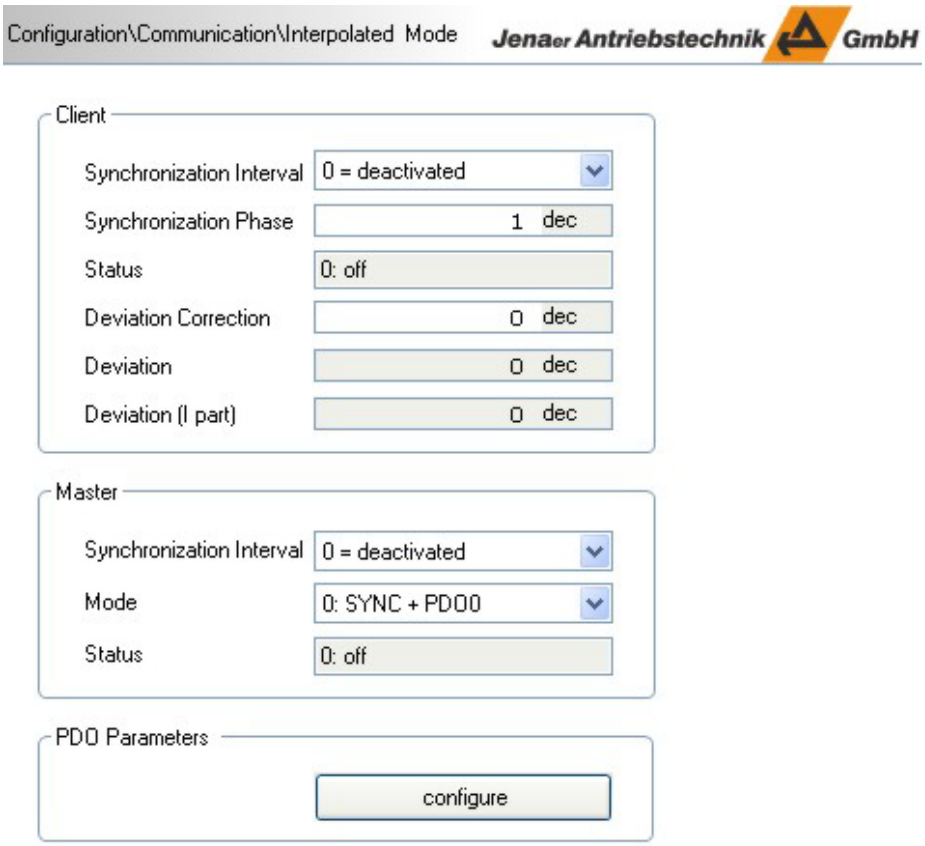
CAN Node ID (at ECOVARIO®)	Device address in the range 0 ... 126. At ECOVARIO® the device address can be additionally via the keys at the front plate.
CAN Node Offset (at ECOSTEP® ECOMPACT)	Offset to the device address set via DIP switches at ECOSTEP® or ECOMPACT.
Connection Type	CAN or RS232/RS485
Baud Rate	At CAN transmission the maximum configurable baud rate depends on the used cable length

2. Load the parameters to the servo amplifier by clicking **Save Data and Restart Device**. After the restart of the servo amplifier the connection between PC and servo amplifier is re-established automatically with the new parameters.

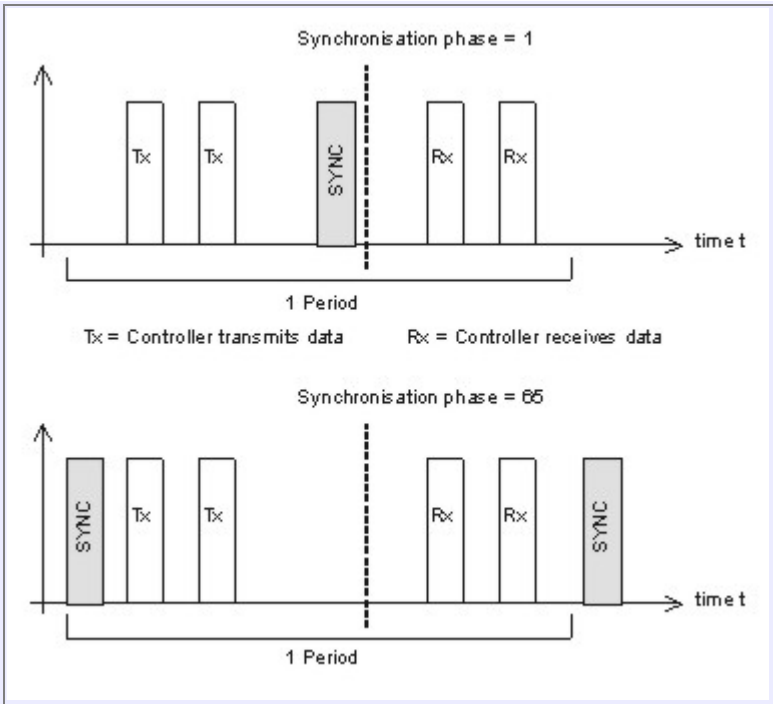
8.5 Interpolated Mode (Expert mode)

One of the operating modes of the ECOVARIO®, the ECOMiniDual and the ECOMPACT® is the interpolated mode (mode 7). In this mode, the target values and the actual values of an axis are periodically exchanged with a higher-level controller.

The required settings for the interpolated mode can be made in the *expert mode* under **Configuration\Communication\Interpolated Mode**. The interpolated mode is activated in the navigation area under **Control\Motion** in the **Expert Mode** tab by entering „7" in the **Operating Mode** edit box. Also note the controller settings in the interpolated mode described at the end of the section.



Window area **Client**	
Synchronization Interval	The values 0.5 ms, 1 ms, 2 ms and 4 ms can be selected. Default setting is 0 = deactivated. Please note that these are no „real" milliseconds because the second is divided by 1024 here. If e.g. the value "1 ms" is selected, this does not correspond exactly to one millisecond but to 0.976 ms. If necessary, the deviation can be corrected by means of the parameter **Deviation Correction**.
Synchronization Phase	The parameter provides the option to adapt the time period between sending of the target values (PDO data) and the SYNC pulse to the bus counterpart. Default setting is 1, i.e., the SYNC pulse is sended directly after the PDO data. The time period can be increased by increasing the synchronization phase value. The value 128 corresponds to a SYNC pulse shift of a full period.

	 ***Note:*** When using "CoDeSys" or "Schleicher" controllers at a **Synchronization Interval** of 4 ms, it is recommended to set the value 65 here, i.e. a SYNC pulse shift of half a period.
Status	This parameter is used to specify whether the device operates as a CAN bus client: 0 = deactivated 1 = initialization phase 2 = operates as a client (Run) Settings for the CAN bus master see window area **Master**.
Deviation Correction	The parameter corrects deviations of the **Synchronization Interval**, if this is necessary e.g. for the used higher-level controller
Deviation	PLL error, ideal are values between -1...0...1
Deviation (I part)	PLL integral, ideal are values between -1...0...1
Window area **Master**	
Synchronization Interval	The values 0.5 ms, 1 ms, 2 ms and 4 ms can be selected. Default setting is 0 = deactivated. Please note that these are no „real" milliseconds because the second is divided by 1024 here. If e.g. the value "1 ms" is selected, this does not correspond exactly to one millisecond but to 0.976 ms
Mode	If the device is configured as a CAN bus master this parameter is used to specify whether a separate SYNC pulse is output for bus synchronization (default setting **0: SYNC+PDO**): or whether the transmitted PDO data are used as a SYNC pulse (setting **1: PDO**).
Status	This parameter is used to specifiy whether the device operates as a CAN bus master: 0 = deactivated 1 = no node 2 = operates as a master (Send) Settings for the CAN bus slave see window area **Slave**.
Window area **PDO Parameters** For the interpolated mode a special configuration of the PDO parameters is necessary. -> **configure**	

All instructions necessary to secure the data exchange between the servo amplifier and a higher level controller are listed in the table below.

Index [hex]	Sub [hex]	Byte	Value [hex]	Description
0x1800	1	4	0x181	Setting the COB-ID for the transmit (Tx) PDO1 to 0x181
0x1800	2	1	0x01	Setting the COB-ID for the transmit PDO1 to synchronous mode
0x1400	1	4	0x201	Setting the ID for the receive (Rx) PDO1 to 0x201
0x1400	2	1	0x01	Setting the operating mode for the PDO to synchronous mode
0x1600	1	4	0x60400010	Mapping of the first two bytes of the receive PDO1 to the control word of the servo amplifier
0x1600	2	4	0x607A0020	Mapping of the next 4 bytes of the receive PDO1 to the control word of the servo amplifier
0x1600	0	1	0x02	Number of the mapped variables of the receive PDO1
0x1A00	1	4	0x60410010	Mapping the status word of the servo amplifier to the first two bytes of the transmit PDO1
0x1A00	2	4	0x60630020	Mapping the actual position of the servo amplifier to the next 4 bytes of the transmit PDO1
0x1A00	0	1	0x02	Number of the mapped variables of the transmit PDO1

The synchronous data transfer is always started by the higher-level controller.

Depending on the width of the synchronizing window an asynchronous telegram is sent each millisecond, i.e. at a **Synchonization Interval** of 4 ms 4 PDO oder SDO. Depending on the number of axes it might occur that the CAN bus is overfilled, and thus the SYNC message is shifted. Generally, it is recommended to use the first half betwen two SYNC telegrams for the answer telegrams of the devices and the second half for the specifications of the process control.

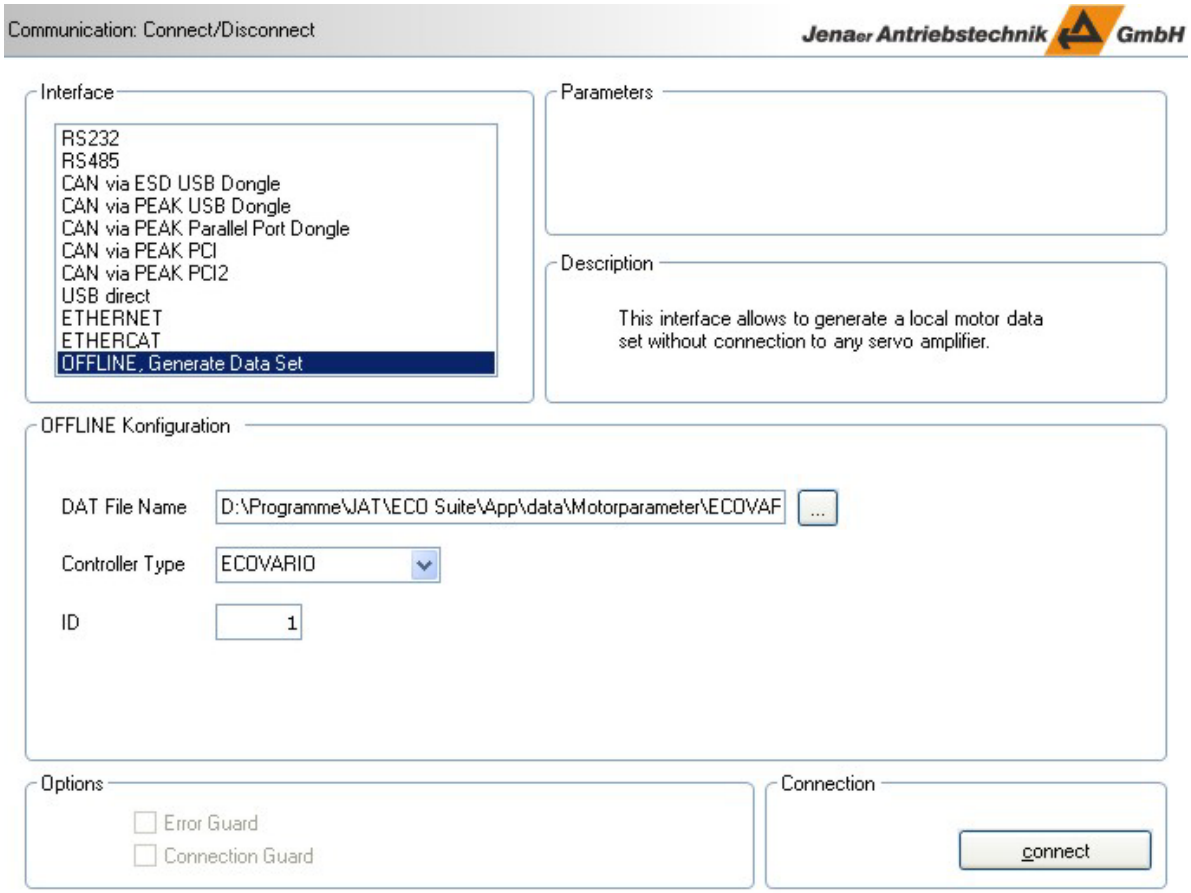
Notes on the controller settings

Velocity Controller: The values for the **Velocity Pre-Control** are dependent on the used CNC. Recommended values are in the range between 90% and 95%. A criterion for a good setting is the minimization of the following error. For the **Acceleration Pre-Control** generally the value 0 is set.

9. Generating data sets in the Offline Mode

ECO Studio can be used to generate data sets for the servo amplifer in the offline mode, i.e., without a connection between the servo amplifier and ECO Studio. The generated data set can be loaded into the target servo amplifier later on.

1. After starting ECO Studio select in the **Communication: Connect/Disconnect** window in the **Interface** selection list the option **OFFLINE, Generate Data Set**.



2. Select an existing motor data set (.DAT) you want to modify or use as a basis for generating a new data set in the **DAT File Name** field.

   Note: By means of offline parameterization only objects contained in the selected motor data set can be modified. Therefore, it is recommended to use the file <servo amplifier type>_default.dat because it contains all objects which can be modified for this servo amplifier type.

3. In the field **Controller Type** specify the servo amplifier the data set shall be generated for.

4. Enter an **ID**. By means of assigning ID numbers several offline data sets can be edited simultaneously.

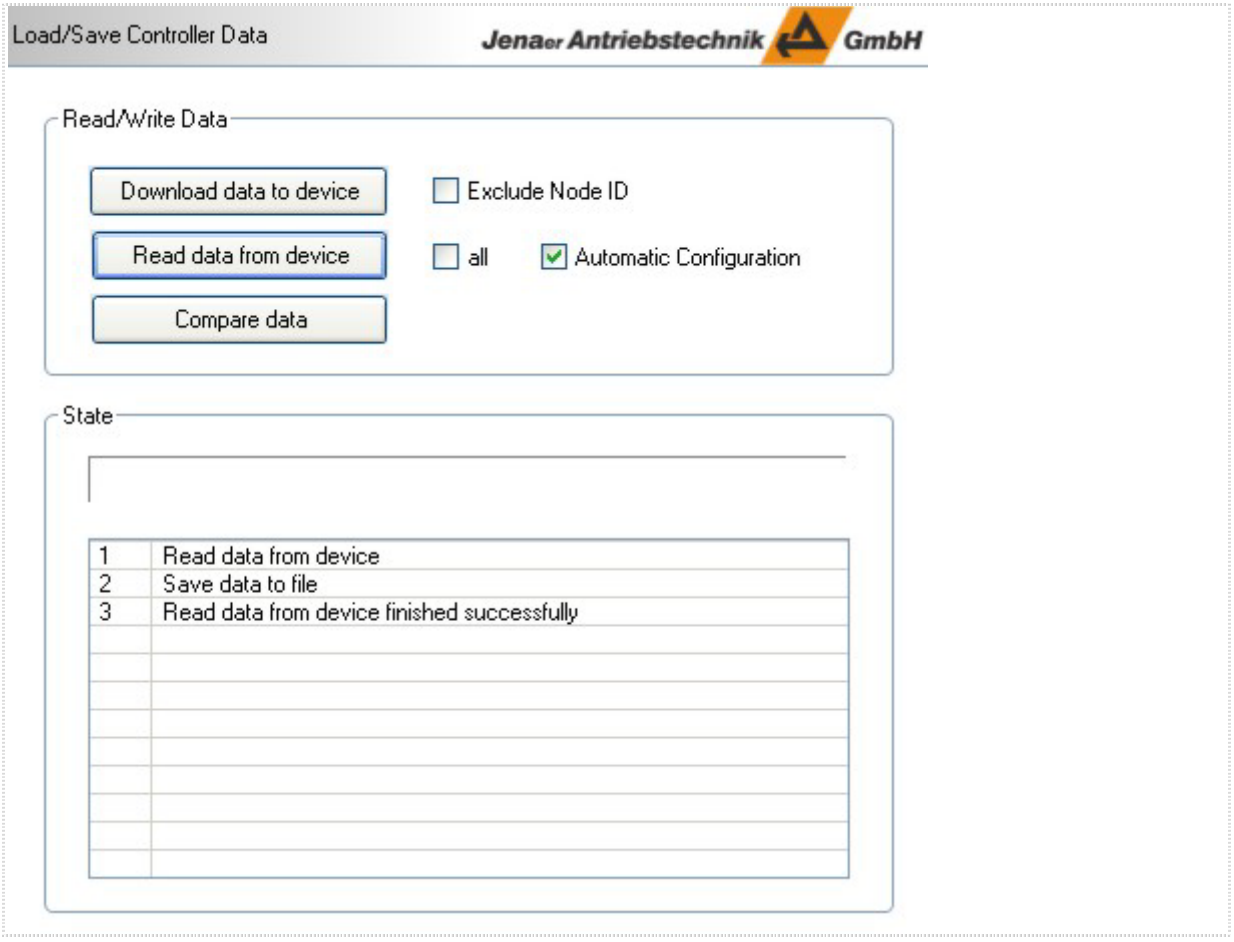
5. Click **connect**.

6. Make the required settings via the ECO Studio user interface. The user interface offers all functions which are available for the selected servo amplifier.

7. In order to save the data set select the menu item **File/Load/Save Controller Data**. In the window **Load/Save Controller Data** activate the check box **Automatic Configuration**. Thus, it is guaranteed that exactly the objects which are contained in the motor data set selected in step 2 are read out, including the modifications made.

8. Click **Read data from device**. Specify the directory and the .DAT filename where you intend to store the data set.

9. Status information about the storing process can be retrieved from the **State** window area.



10. Firmware Update

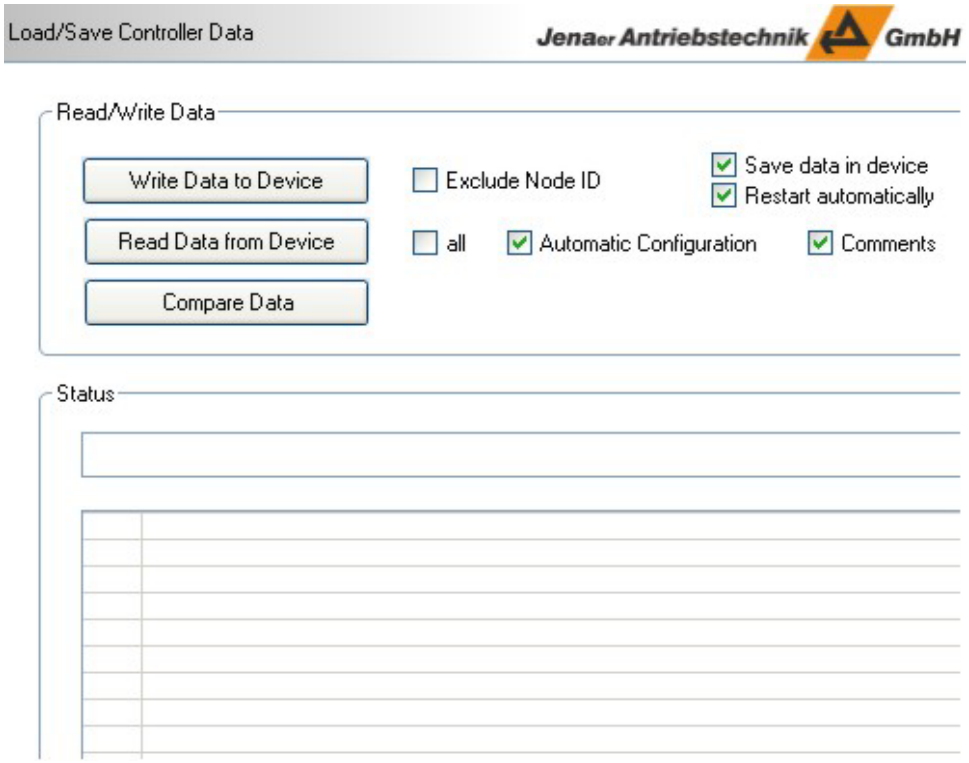
ECOVARIO® and ECOSTEP® servo amplifiers as well as ETHERNET2CAN gatewys provide the firmware update feature to implement new or modified functionality. In the following, the procedure for downloading a new firmware into the servo amplifiers ECOVARIO® and ECOSTEP® or the ETHERNET2CAN gateway, respectively, is described.

Note: If several devices of the same type can be reached by ECO Studio via the connection interface (click **search** in the connection window) the firmware file can be loaded sequentially to the specified devices. Prerequisite is that no active connection has been established to one of the devices before calling the flash firmware function (step 5).

⚠	A firmware update should be carried out only if it is imperative. It should be carried out only by experienced users with highest caution and care. The firmware may only be carried out if the drive is brought to standstill and shut down before. Check the status of the axes and if necessary switch power off. During firmware update all parameters will be reset to default values! If the warnings are not observed, serious malfunctions are possible, cumulating in a total failure of the device.

☞	For firmware update, the ECOSTEP® has to be connected to the PC via the *RS232 interface*. Other interfaces do not support this functionality.

1. If the parameter settings stored in the device are to be retained, they have to be saved first. To do so, select **File \ Save/Load Controller Data** in the menu bar.



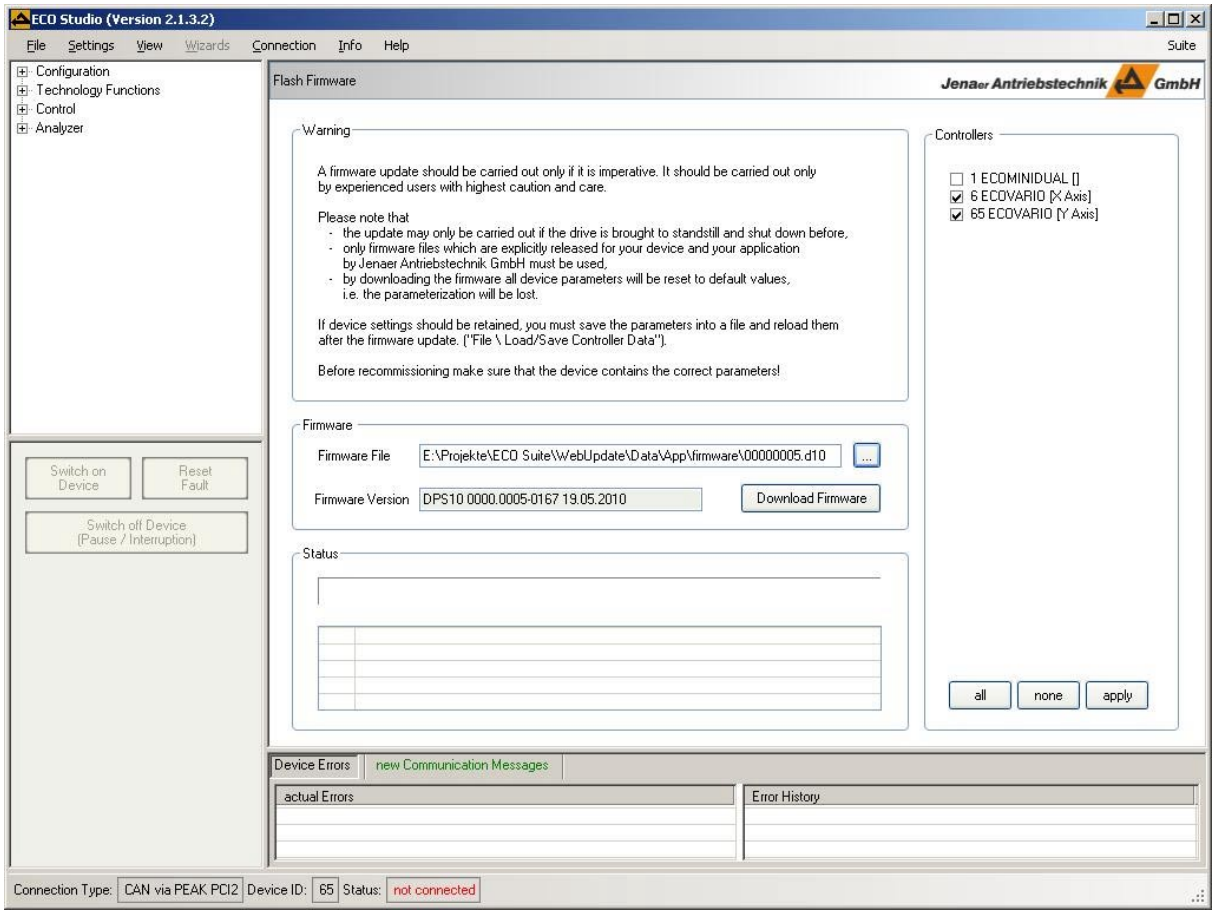
2. Click **Read Data from Device**. Specify a folder and a filename (".DAT") where the data should be written to. Confirm with **Save**.

3. If **Automatic Configuration** has been deactivated or, in case of ECOSTEP® servo amplifiers, is not possible, enter the configuration file (.CFG) to be used now. Only the files relevant for the device type in use are shown in the dialog. For ECOVARIO, the file with the appropriate software version number should be used. The amendment "Exclude Node ID" means that the node ID is not saved.

4. If you wish to load the same data to several devices establish the connection to each device and carry out steps 1 to 3.

5. In the menu bar select **File \ Flash Firmware**.

   If no connection to a device has been established and if *several* devices can be reached via the connection interface they are listed in the window area **Controllers** on the right side.



6. In the **Firmware** group box select the appropriate **Firmware File**.

   Note: Alternatively you can drag & drop the required firmware file (ending .D10 or .zip) from the windows explorer into the ECO Studio connection window. The window **File\Flash Firmware** is displayed then with the selected file name in the **Firmware File** field.

   Note: If *several* devices can be reached via the connection interface (however, no active connection has been established) they are listed in the window area on the right side. The selected firmware file is appropriate for the checked devices. You can manually exclude devices from being flashed by deactivating the respective check box. You can use the buttons on the bottom of the right window area e.g. for selecting or de-selecting **all** devices. Furthermore you can **adapt** the device selection to the firmware file if the selection has been modified manually before.

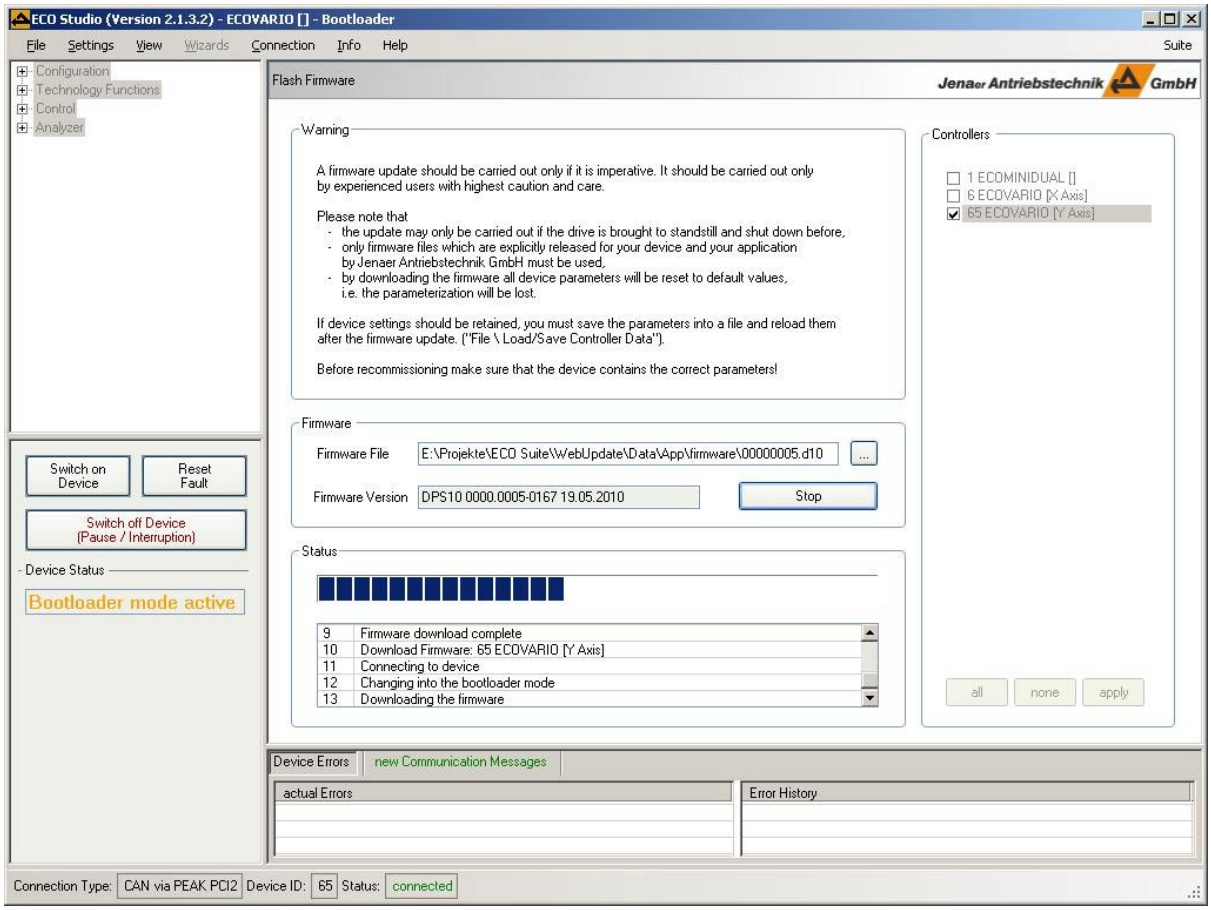
⚠	Only firmware files which are explicitly released for your device and your application by Jenaer Antriebstechnik GmbH must be used!

7. By means of the **Firmware Version** check again whether the appropriate firmware file has been selected.

8. Click **Download Firmware**.

   The progress is displayed in the window. When flashing several devices the device which is currently processed is highlighted in the window area **Controllers**. If because of an error the flashing of a device could not be finished an error message is displayed in the status list and the check box of the device entry remains checked.

   When flashing several devices the process can be stopped by clicking the **STOP** button. In this case the loading procedure for the device in progress is still finished.



9. As soon as the download process has been finished successfully, write the parameter settings saved in step 2 back into the device. Proceed as described in Chap. 2.2.1.

⚠	Before recommissioning make sure that the device contains the correct parameters!

11. Trouble shooting

11.1 Trouble shooting ECOVARIO (one axis) device errors

The device specific error messages are displayed in the bottom area of the ECO Studio basic window in the **Device Errors** list.

In the following tables the possible error messages and the appropriate trouble shooting measures are listed.

- Group A: General errors
- Group B: Bus errors
- Group D: Device and axis errors
- Group E: Encoder errors

Group A: General errors

Error message	Error	Measure
A00	Incorrect checksum of a bootloader section or overall checksum	Incorrect checksum of a bootloader section or overall checksum
A01	Error during deleting a flash section	Repeat action. If the error reoccurs, send in device to manufacturer
A02	Error during activating the flash memory	If the error reoccurs, send in device to manufacturer
A03	Error during programming the flash memory	Repeat action. If the error reoccurs, send in device to manufacturer
A04	Error during addressing the flash memory	Repeat action. If the error reoccurs, send in device to manufacturer
A10	Error during reading/writing the EEPROM	If the error reoccurs, send in device to manufacturer
A11	Incorrect checksum of an EEPROM section	Communication and/or application parameters have not (yet) been stored. This behaviour is normal with new devices and has been implemented for signalling this to the user.
A12	RAM test error	If the error reoccurs send in the device to manufacturer
A20	Incorrect calibration data	Send in device to manufacturer
A21	Watchdog error of standard loadware	If the error reoccurs send in the device to manufacturer
A22	PLD firmware unsuitable for loadware	Send in device to manufacturer
A23	Loadware does not support this unit	Contact service hotline of Jenaer Antriebstechnik GmbH

Group B: Bus errors

Error message	Error	Measure
B00	CAN-Nodeguarding error. No messages are sent. Synchronization in interpolated mode exceeded.	Check bus connection and device function, check supply voltage of the CAN bus
B01	CAN bus parameters incorrect. No messages are sent.	Enter parameters again, check node ID and Baud rate

Group D: Device and axis errors

Error message	Error	Measure
D00	Restart lock blocks switch on	Check function of the restart lock
D01	No external enable	Check ENABLE signal
D02	Heat sink temperature > 85°C	Switch off unit and let it cool down, Check whether the device is mounted in the correct mounting position. Make sure that no heat accumulation can occur in the cabinet.
D03	Device temperature > 60 °C	
D04	Temperature error motor (encoder input A (X11))	Let motor cool down. Check temperature sensor connectors.
D05	Temperature error motor (encoder input B (X12))	Let motor cool down. Check temperature sensor connectors.
D06	Negative limit position reached	Reset if an error message is raised
D07	Positive limit position reached	Reset if an error message is raised
D10	Short circuit of motor phases or ground fault of the power stage respectively	Check motor and supply cables. Check whether the shield wires are connected correctly.
D11	Overcurrent in the motor phases	Check motor and supply cables. Check wether the shield wires are connected correctly.
D12	Exceeding i2t limitation of device	Check parameters and operating conditions. Check is axis is freely movable.
D13	Exceeding i2t limitation of motor	
D20	External 24 V supply at X1 has fallen below 17 V	Check 24 V power supply. Are there disturbances on the power supply line? Check output power specification of power supply whether it is dimensioned sufficiently
D21	DC link voltage too high, short circuit of ballast circuit	Check DC link and ballast circuit. Is the ballast resistor connected correctly? Check supply voltage (might be too high).
D22	DC link voltage too low	Check power supply and connections. Check output power specification of power supply whether it is dimensioned sufficiently.
D23	Overload ballast circuit	Check dimensioning and correct connection of ballast resistor. Resistor might be defective.
D24	Charging time of DC link exceed	Check voltage
D25	Short circuit or overload of the digital outputs or the brake control respectively	Check Ready, OUT1, OUT2 and brake. Check whether the shield wire of the motor cable is connected correctly.
D30	Following error too high	Check axis parameters and operating conditions. Check whether the axis is freely movable. Check whether the(second) position measuring system still counts correctly.
D31	Commutation not found	Check if axis is freely movable. Check whether the motor phases are connected correctly, whether the encoder counts correctly and whether the commutation settings (Chap. 2.5.1) are correctly.

D32	Internal software reset	If error reoccurs send in device to manufacturer
D33	Controller watchdog error	If error reoccurs send in device to manufacturer
D34	Error supervision of external position measuring system	Check adjustment of the machine. If error reoccurs send in device to manufacturer.
D35	Gantry system only: Error of an axis in the gantry interconnection	

Group E: Encoder errors

Error message	Error	Measure
E00	1. Antivalence error of incremental encoder A 2. No encoder has been selected 3. Correction error of SINCOS encoder (from R5.34 onwards) Error code is not supported for clock/direction encoders	Check encoder and supply cables for wire breakage. If no encoder is configurated, select encoder. Check whether the correct encoder port has been selected. In case of externally powered encoders check supply voltage.
E10	1. Antivalence error of incremental encoder B. 2. Error at external encoder output 3. Signal error absolute value encoder 4. Correction error of SINCOS encoder (from R5.34 onwards) Error code is not supported for clock/direction encoders	Check encoder and supply voltage for wire breakage. Check whether the correct encoder port has been selected. In case of externally powered encoders check supply voltage.
E01	Capture error incremental encoder A	Check whether the monitoring is set correctly. Error reasons might also be disturbances on the lines or a defective encoder.
E11	Capture error incremental encoder B	
E02	Interpolation error SINCOS encoder A	Check encoder and supply cables. Error reason might be strong electromagnetic interferences
E12	Interpolation error SINCOS encoder B	
E03	Too high speed of encoder A or cannot be read	Check parameters (overall speed of the motor). Error reason might be contamination or damage of the measuring system.
E13	Too high speed of encoder B or cannot be read	
E14	Selected encoder type is wrong or not supported	Check configuration, enter appropriate encoder type
E15	Invalid motor data (not supported)	-
E16	Error during reading user data	Check encoder and supply cables and configuration. If the error reoccurs send in encoder.
E17	Invalid user data or motor and servo amplifier do not fit	Error occurs upon initial commissioning of a new encoder because no user data has been stored yet in the encoder EEPROM. Writing to the object 0x607C „home_offset“ removes the error cause. User data is only stored in multiturn absolute value encoders.
E18 (used in firmware version 5.164 and lower)	Mismatch between stored position value and actual encoder value (more than 1/2 revolution)	Carry out homing procedure.
E19 (used in firmware version 5.164 and lower)	Incorrect multiturn value	Error cause is a contamination or a defect of the revolution counter of the multiturn absolute value encoder.

E20 (used in firmware version 5.164 and lower)	Stored position value and actual position value of the technology function "Modulo positioning" outside the tolerance window. Only use for motors with holding brake (all encoders)!	
E20 (used in firmware version 5.165 and higher)	Mismatch between stored position value and actual encoder value (more than 1/2 revolution)	Carry out homing procedure.
E21 (used in firmware version 5.165 and higher)	Incorrect multiturn value	Error cause is a contamination or a defect of the revolution counter of the multiturn absolute value encoder.
E22 (used in firmware version 5.165 and higher)	Stored position value and actual position value of the technology function "Modulo positioning" outside the tolerance window. Only use for motors with holding brake (all encoders)!	
E23 (used in firmware version 5.165 and higher)	Quadrant correction error of SINCOS encoder A	Check encoder and supply cables for wire breakage. If no encoder is configured, select encoder. Check whether the correct encoder port has been selected. In case of externally powered encoders check supply voltage.
E24 (used in firmware version 5.165 and higher)	Quadrant correction error of SINCOS encoder B	

11.2 Trouble shooting ECOSTEP device errors

The decivce specific are displayed in the bottom area of the ECO Studio basic window in the **Device Errors** list.

In the following tables the possible error messages and the appropriate trouble shooting measures are listed.

Error Message	Measure
Internal controller error	Send device to manufacturer
Antivalence error of the motor encoder signals	Check encoder
Encoder A capture error detected axis X or no encoder has been selected	Check encoder and supply cables for wire breakage. If no encoder is configurated, select encoder
Encoder B capture error detected axis X	Check encoder and supply cables for wire breakage.
Heat sink temperature > 85 °C	Switch off device. Check heat dissipation
Heat sink temperature too high (> 80 °C)	Check heat dissipation
Logic voltage < 18 V	Check voltage
Overvoltage DC link	Check DC link voltage
Undervoltage DC link	Check DC link voltage
Undervoltage power supply (< 15 V)	Check power supply
Short-circuit phase A/B	Check cabeling
Short-circuit phase A/B (before: short-circuit Phase B)	Check cabeling
Short-circuit digital outputs: Ready or OUT1, OUT2 or brake	Check cabling at the digital outputs. Check connected devices.
External Enable is Low, although the servo amplifier is switched on	Check Enable signal
Following error too high	Check configured axis parameters and operation conditions
Speed too high, encoder can not be read	Check configured parameters (speed limit of the motor)
Commutation not found	Check whether the axis can rotate freely
Bus error	Check bus connection and device function
i^2t error	Check configured parameters and operating conditions
Negative limit position reached	Change setting of limit position, if necessary
Positive limit position reached	Change setting of limit position, if necessary
Temperature error motor	Let motor cool down
Error during reading user data	Check encoder and supply cables. If error reoccurs, send in encoder.
Invalid user data or motor and servo amplifier do not fit	Validate by software command
Error during reading motor data sheet	Check encoder and supply cables. If error reoccurs, send in encoder.
Invalid motor data sheet	Validate by software command
Restart lock blocks switch on	Check restart lock

11.3 Trouble shooting ECOMPACT device errors

The device specific error messages are displayed in the bottom area of the ECO Studio basic window in the **Device Errors** list.

In the following tables the possible error messages and the appropriate trouble shooting measures are listed.

- Group A: General errors
- Group B: Bus errors
- Group D: Device and axis errors
- Group E: Encoder errors

Group A: General errors

Error message	Error	Measure
A00	Incorrect checksum of a bootloader section or overall checksum	Repeat action. If the error reoccurs, send in device to manufacturer
A01	Error during deleting a flash section	Repeat action. If the error reoccurs, send in device to manufacturer
A02	Error during activating the flash memory	If the error reoccurs, send in device to manufacturer
A03	Error during programming the flash memory	Repeat action. If the error reoccurs, send in device to manufacturer
A04	Error during addressing the flash memory	Repeat action. If the error reoccurs, send in device to manufacturer
A10	Error during reading/writing the EEPROM	If the error reoccurs, send in device to manufacturer
A11	Incorrect checksum of an EEPROM section	Communication and/or application parameters have not (yet) been stored. This behaviour is normal with new devices and has been implemented for signalling this to the user.
A20	Incorrect calibration data	Send in device to manufacturer
A21	Watchdog error of standard loadware	If the error reoccurs, send in device to manufacturer
A23	Loadware does not support this unit	Contact service hotline of Jenaer Antriebstechnik GmbH

Group B: Bus errors

Error message	Error	Measure
B00	CAN-Nodeguarding error. No messages are sent. Synchronization window in interpolated mode exceeded.	Check bus connection and device function, check supply voltage of the CAN bus

B01	CAN bus parameters not available, incorrect saving of parameters. No messages sent.	Enter parameters again, check node ID and Baud rate

Group D: Device and axis errors

Error message	Error	Measure
D00	Restart lock blocks switch on	Check function of the restart lock
D01	No external enable	Check ENABLE signal
D03	Device temperature > 70 °C	Switch off unit and let it cool down. Make sure that no heat accumulation can occur in the mounting space.
D04	Temperature error motor	
D06	Negative limit position reached	Reset if an error message is raised
D07	Positive limit position reached	Reset if an error message is raised
D11	Overcurrent in the motor phases	Check motor and supply cables
D12	Exceeding i2t limitation of device	Check parameters and operating conditions. Check if axis is freely movable.
D13	Exceeding i2t limitation of motor	
D20	External 24 V supply at X1 has fallen below 17 V	Check 24 V power supply
D21	DC link voltage too high	Check DC link
D22	DC link voltage too low	Check voltage
D24	Charging time of DC link exceeded	Check voltage
D30	Following error too high	Check axis parameters and operating conditions
D31	Commutation not found	Check if axis is freely movable
D32	Internal software reset	If error reoccurs send in device to manufacturer
D33	Error controller watchdog	If error reoccurs send in device to manufacturer

Gruppe E: Encoder errors

Error message	Error	Measure
E00	Correction error of the encoder	If error reoccurs send in device to manufacturer
E01	Capture error of the encoder	If error reoccurs send in device to manufacturer
E02	Interpolation error of the encoder	Error reason might be strong electromagnetical interferences
E03	Too high speed of encoder or cannot be read	Check parameters (overall speed of the motor). Error reason might be contamination or damage of the measuring system.

11.4 Trouble shooting ECOMiniDual device errors

The device specific error messages are displayed in the bottom area of the ECO Studio basic window in the **Device Errors** list. In the following tables the possible error messages and the appropriate trouble shooting measures are listed.

- Group A: General errors
- Group B: Bus errors
- Group D: Device and axis errors
- Group E: Encoder errors

The error messages of groups D and E are related to the axis which is connected to the individual ECO Studio session.

Group A: General errors

Error message	Error	Measure
A00	Incorrect checksum of a bootloader section or overall checksum	Repeat action. If the error reoccurs, send in device to manufacturer
A01	Error during deleting a flash section	Repeat action. If the error reoccurs, send in device to manufacturer
A02	Error during activating the flash memory	If the error reoccurs, send in device to manufacturer
A03	Error during programming the flash memory	Repeat action. If the error reoccurs, send in device to manufacturer
A04	Error during addressing the flash memory	Repeat action. If the error reoccurs, send in device to manufacturer
A10	Error during reading/writing the EEPROM	If the error reoccurs, send in device to manufacturer
A11	Incorrect checksum of an EEPROM section	Communication and/or application parameters have not (yet) been stored. This behaviour is normal with new devices and has been implemented for signalling this to the user.
A20	Incorrect calibration data	Send in device to manufacturer
A21	Watchdog error of standard loadware	If the error reoccurs, send in device to manufacturer
A23	Loadware does not support this unit	Contact service hotline of Jenaer Antriebstechnik GmbH

Group B: Bus errors

Error message	Error	Measure
B00	CAN-Nodeguarding error. No messages are sent. Synchronization window in interpolated mode exceeded.	Check bus connection and device function, check CAN bus power supply
B01	CAN bus parameters not available, incorrect saving of parameters. No messages sent.	Enter parameters again, check node ID and Baud rate

Group D: Device and axis errors

Error message	Error	Measure
D00	Restart lock blocks switch on	Check function of the restart lock
D01	No external enable	Check ENABLE signal
D03	Device temperature > 85 °C	Switch off unit and let it cool down. Make sure that no heat accumulation can occur in the mounting space.
D04	Temperature error motor	
D06	Negative limit position reached	Reset if an error message is raised
D07	Positive limit position reached	Reset if an error message is raised
D10	Short circuit of motor phases or ground fault of the power stage resp.	Check motor and supply cables. Check whether the shield wires are connected correctly.
D11	Overcurrent in the motor phases	
D12	Exceeding i2t limitation of device	Check parameters and operating conditions. Check if axis is freely movable.
D13	Exceeding i2t limitation of motor	
D20	External 24 V supply at XS5/XS6 has fallen below 17 V	Check 24 V supply. Are there disturbances on the supply line? Check output power specification of power supply whether it is dimensioned sufficiently
D21	DC link voltage too high	Check supply voltage (might be too high).
D22	DC link voltage too low	Check power supply and connections. Check output power specification of power supply whether it is dimensioned sufficiently.
D24	Charging time of DC link exceeded	Check voltage
D30	Following error too high	Check axis parameters and operating conditions. Check whether the axis is freely movable.
D31	Commutation not found	Check if axis is freely movable. Check whether the commutation settings (Chap. 2.5.1) are correctly.
D32	Internal software reset	If error reoccurs send in device to manufacturer
D33	Error controller watchdog	If error reoccurs send in device to manufacturer

Gruppe E: Encoder errors

Error message	Error	Measure
E00	1. Antivalence error of incremental encoder 2. No encoder has been selected	Check encoder and supply cables for wire breakage. If no encoder is configured, select encoder. If error reoccurs send in device to manufacturer
E01	Capture error of the encoder	If error reoccurs send in device to manufacturer
E02	Interpolation error of the encoder	Error reason might be strong electromagnetic interferences
E03	Too high speed of encoder or cannot be read	Check parameters (limit speed of the motor). Error reason might be contamination or damage of the measuring system.
E14	Selected encoder type is wrong or not supported.	Check configuration, enter appropriate encoder type
E16	Error during reading user data	Check encoder and supply cables and configuration, if the error reoccurs send in encoder

11.5 Trouble shooting ECOVARIO 114 D (dual axes) device errors

The device specific error messages are displayed in the bottom area of the ECO Studio basic window in the **Device Errors** list.

In the following tables the possible error messages and the appropriate trouble shooting measures are listed.

- Group A: General errors
- Group B: Bus errors
- Group D: Device and axis errors
- Group E: Encoder errors

The error messages of groups D and E are related to the axis which is connected to the individual ECO Studio session.

Group A: General errors

Error message	Error	**Measure**
A00	Incorrect checksum of a bootloader section or overall checksum	Repeat action. If the error reoccurs, send in device to manufacturer
A01	Error during deleting a flash section	Repeat action. If the error reoccurs, send in device to manufacturer
A03	Error during programming the flash memory	Repeat action. If the error reoccurs, send in device to manufacturer
A04	Error during addressing the flash memory	Repeat action. If the error reoccurs, send in device to manufacturer
A10	Error during reading/writing the EEPROM	If the error reoccurs, send in device to manufacturer
A11	Incorrect checksum of an EEPROM section	Communication and/or application parameters have not (yet) been stored. This behaviour is normal with new devices and has been implemented for signalling this to the user.
A20	Incorrect calibration data	Send in device to manufacturer
A21	Watchdog error of standard loadware	If the error reoccurs send in the device to manufacturer
A24	Firmware/loadware does not fit to device	Load firmware/loadware. First letter of the file name has to be "D". If in doubt, contact service hotline of Jenaer Antriebstechnik GmbH.
A25	FPGA could not be started	
A26	Device could not be started	Contact service hotline of Jenaer Antriebstechnik GmbH

Group B: Bus errors

Error Message	Error	Measure
B00	CAN-Nodeguarding error. No messages are sent. Synchronization in interpolated mode exceeded.	Check bus connection and device function, check supply voltage of the CAN bus
B01	CAN bus parameters incorrect. No messages are sent.	Enter parameters again, check node ID and Baud rate

Group D: Device and axis errors

The error code on the display of the servo amplifier is preceded by an axis code ("1" or "2").

Error message	Error	Measure
D00	Restart lock blocks switch on	Check function of the restart lock
D01	No external enable	Check ENABLE signal
D02	Heat sink temperature > 85°C	Switch off unit and let it cool down. Check whether the device is mounted in the correct mounting position. Make sure that no heat accumulation can occur in the cabinet.
D03	Device temperature > 60 °C	
D04	Temperature error motor	Let motor cool down. Check temperature sensor connectors.
D06	Negative limit position reached	Reset if an error message is raised
D07	Positive limit position reached	Reset if an error message is raised
D10	Short circuit of motor phases or ground fault of the power stage respectively	Check motor and supply cables. Check whether the shield wires are connected correctly.
D11	Overcurrent in the motor phases	Check motor and supply cables. Check whether the shield wires are connected correctly.
D12	Exceeding i2t limitation of device	Check parameters and operating conditions. Check if axis is freely movable.
D13	Exceeding i2t limitation of motor	
D20	External 24 V supply at X1 has fallen below 17 V	Check 24 V supply. Are there disturbances on the supply line? Check output power specification of power supply whether it is dimensioned sufficiently
D21	DC link voltage too high, short circuit of ballast circuit	Check DC link and ballast circuit. Is the ballast resistor connected correctly? Check supply voltage (might be too high).
D22	DC link voltage too low	Check power supply and connections. Check output power specification of power supply whether it is dimensioned sufficiently.
D23	Overload ballast circuit	Check dimensioning of ballast resistor. Is the ballast resistor connected correctly? Error cause might be a defective ballast resistor (high-resistance)
D25	Short circuit or overload of the digital outputs or the brake control respectively	Check digital outputs and brake. Check whether the shield wire of the motor cable is connected correctly.
D30	Following error too high	Check axis parameters and operating conditions. Check whether the axis is freely movable. Check whether the(second) position measuring system still counts correctly.

D31	Commutation not found	Check if axis is freely movable. Check whether the motor phases are connected correctly, whether the encoder counts correctly and whether the commutation settings (Chap. 2.5.1) are correctly.
D32	Internal software reset	If error reoccurs send in device to manufacturer
D33	Controller watchdog error	If error reoccurs send in device to manufacturer
D34	Error supervision of external position measuring system	Check adjustment of the machine. If error reoccurs send in device to manufacturer.
D35	Gantry system only: Error of an axis in the gantry interconnection	

Group E: Encoder errors

The error code on the display of the servo amplifier is preceded by an axis code ("1" or "2").

Error message	Error	Measure
E00	- Antivalence error of 1st incremental encoder of the axis or - No encoder has been selected, however the power stage is switched on	Check encoder and supply cables for wire breakage. If no encoder is configured, select encoder. Check whether the correct encoder port has been selected. In case of externally powered encoders check supply voltage.
E10	Signal error absolute value encoder	Check encoder and supply cables for wire breakage. Check whether the correct encoder port has been selected. In case of externally powered encoders check supply voltage.
E01	Capture error of 1st incremental encoder of the axis	Check whether the monitoring is set correctly. Error reasons might also be disturbances on the lines or a defective encoder.
E02	Interpolation error SINCOS encoder (circle monitoring)	Check encoder and supply cables. Error reason might be strong electromagnetic interferences
E03	Too high speed of encoder or cannot be read	Check parameters (limit speed of the motor). Error reason might be contamination or damage of the measuring system.
E14	Selected encoder type is wrong or not supported	Check configuration, enter appropriate encoder type
E17	Invalid user data or motor and servo amplifier do not fit	Error occurs upon initial commissioning of a new encoder because no user data has been stored yet in the encoder EEPROM. Writing to the object 0x607C „home_offset" removes the error cause. User data is only stored in JAT motors with multiturn absolute value encoders.
E21	Incorrect multiturn value	Error cause is a contamination or a defect of the revolution counter of the multiturn absolute value encoder.
E23	Quadrant correction error of SINCOS encoder	Check encoder and supply cables for wire breakage. If no encoder is configured, select encoder. Check whether the correct encoder port has been selected. In case of externally powered encoders check supply voltage.

11.6 Trouble shooting communication and application errors

The error and status messages concerning the communication between ECO Studio and the servo amplifier are displayed in the bottom area of the ECO Studio basic window in the **Communication Messages** list. In the following tables the possible error messages and the appropriate trouble shooting measures are listed.

Error	Measure
No connection to device	1. Check whether device is ready for operation 2. Check cabling 3. Establish connection (cf. Chap. 1.8)
Interface could not be opened	1. Check PC output 2. Check interface specific drivers 3. Establish connection
Connection to device could not be established	at ERR_TIMEOUT: 1. Check whether device is ready for operation 2. Check physical connection to device 3. Check/correct connection parameters 4. Establish connection (cf. Chap. 1.8) at ERR_NO_DRV: 1. Check EcoConnect and interface specific DLLs ***Note:*** If you have installed a new PEAK driver make sure that the driver dll file "pcan_*.dll" in the Windows directory "system32" of your PC is identical to the file in the ECO Studio installation directory ../Programs/JAT/ECO Suite/App (time stamp). 2. Establish connection (cf. Chap. 1.8)
ID search could not be started	at ERR_NO_DRV: 1. Check EcoConnect and interface specific DLLs 2. Start ID search
Device cannot be identified	It has been tried to establish a connection to a device which is not supported by ECO Studio. Supported devices are: all ECOVARIO types, ECOSTEP100, ECOSTEP200, ECOSTEP216, ECOSTEP54, ECOMPACT
Invalid parameter (DAT filename), data set cannot be generated	1. Enter valid motor data set (DAT file) 2. Establish connection.

Note concerning the interface specific drivers:

Please note that outdated or wrong interface specific drivers, e.g. of the CAN dongle, can lead to faulty system behaviour up to system crash. Therefore, always make sure that you work with the appropriate interface specific drivers in the latest version. Further notes on the interface specific drivers can be found on the ECO software CD-ROM.

If an error occurs while starting ECO Studio this is displayed in the bottom area of the ECO Studio basic window in the **Application Errors** list.

In the following table the possible error messages and the appropriate trouble shooting measures are listed.

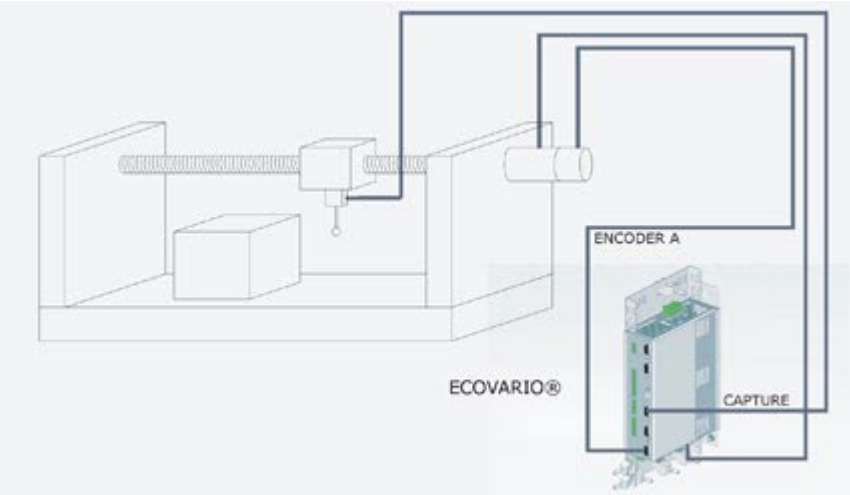
Error	**Measure**
ECO Studio instance could not be started	1. Quit software and start again 2. If not successful: Deinstall software and start new installation
Error on loading the navigation tree	1. Quit software, check the presence of the file "\App\data\TreeStructure.xml" in the installation directory and start again 2. If not successful: Deinstall software and start new installation
Internal ECO Studio error, restart of ECO Studio required	1. Quit software and start again 2. If not successful: Deinstall software and start new installation

Appendix: Technology Functions

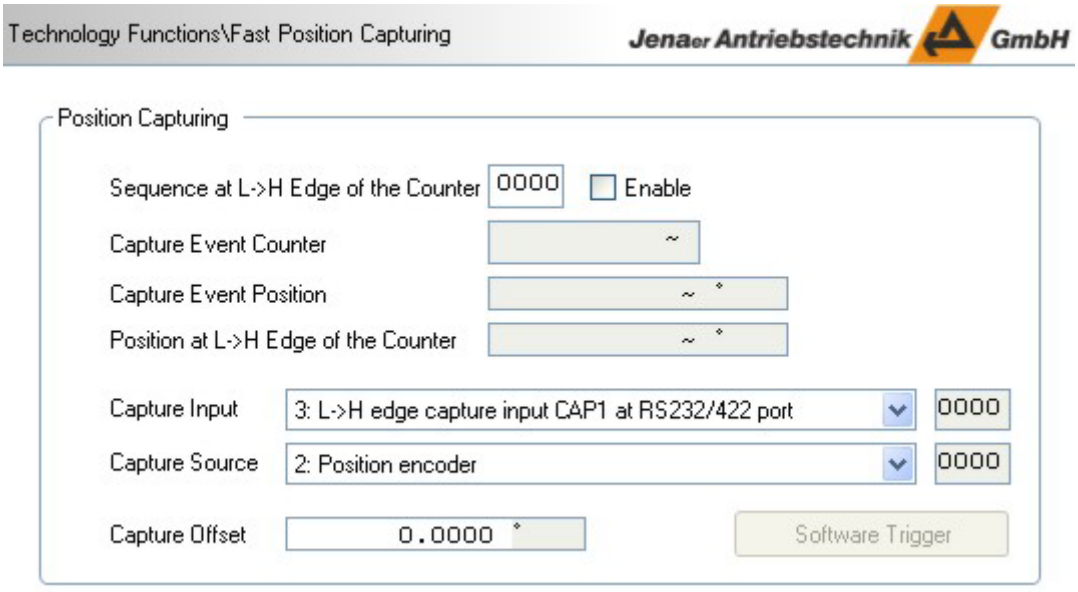
T1 Fast position capturing

In conjunction with the very fast inputs CAP1 and CAP2 at ECOVARIO®214/414 or the input "N" of the interface X7, pin 4 at ECOSTEP® the actual position of the axis is determined and stored in the object 0x21C0, sub index 0x03 and 0x04 (position_capture). The ECOVARIO® provides the possibility to use also the digital inputs DIN5 (HOME) and DIN6 for position capturing.

At every capture event (normally index pulse) of the selected input the actual position value is stored and the counter is incremented by 1. Every counter transition from 0 to 1 is used as a strobe for the processing of a specified sequence. The counter provides write access and therefore can be reset to 0.



☞	Fast position capturing must not be used during the homing procedure.



1. In the *Expert mode* in the navigation area select **Technology Functions\Fast Position Capturing**.

2. In the **Position Capturing** tab in the field **Sequence at L->H Edge of the Counter** specify a sequence which is called after the position capturing and enable the sequence call by checking the **Enable** check box. Alternatively, you can read out the captured position value via the interfaces.

3. For ECOVARIO® only: In the selection list **Capture Input** select an input to be used for fast position capturing. For your application take into account the different delay times of the individual inputs shown in the table below.

   Note: Some older ECOVARIO firmware versions do not support the Fast Position Capturing function. In this case no input can be selected, the field falls back to the entry "0: Function deactivated". Contact the support team of Jenaer Antriebstechnik in order to obtain an appropriate firmware version.

4. For ECOVARIO® only: In the selection list **Capture Source** select the encoder where the positioning values should be taken from.

5. The displayed value in the field **Capture Event Counter** is incremented if a L->H edge is detected at the selected capture input.

6. The actual position is taken over to the fields **Capture Event Position** and **Position at L->H Edge of the Counter** with the transition from value 0 to value 1. The counter has to be reset to 0 before a new position can be taken over. Counter increments from a number higher than 0 to the next number do not take effect as a strobe!

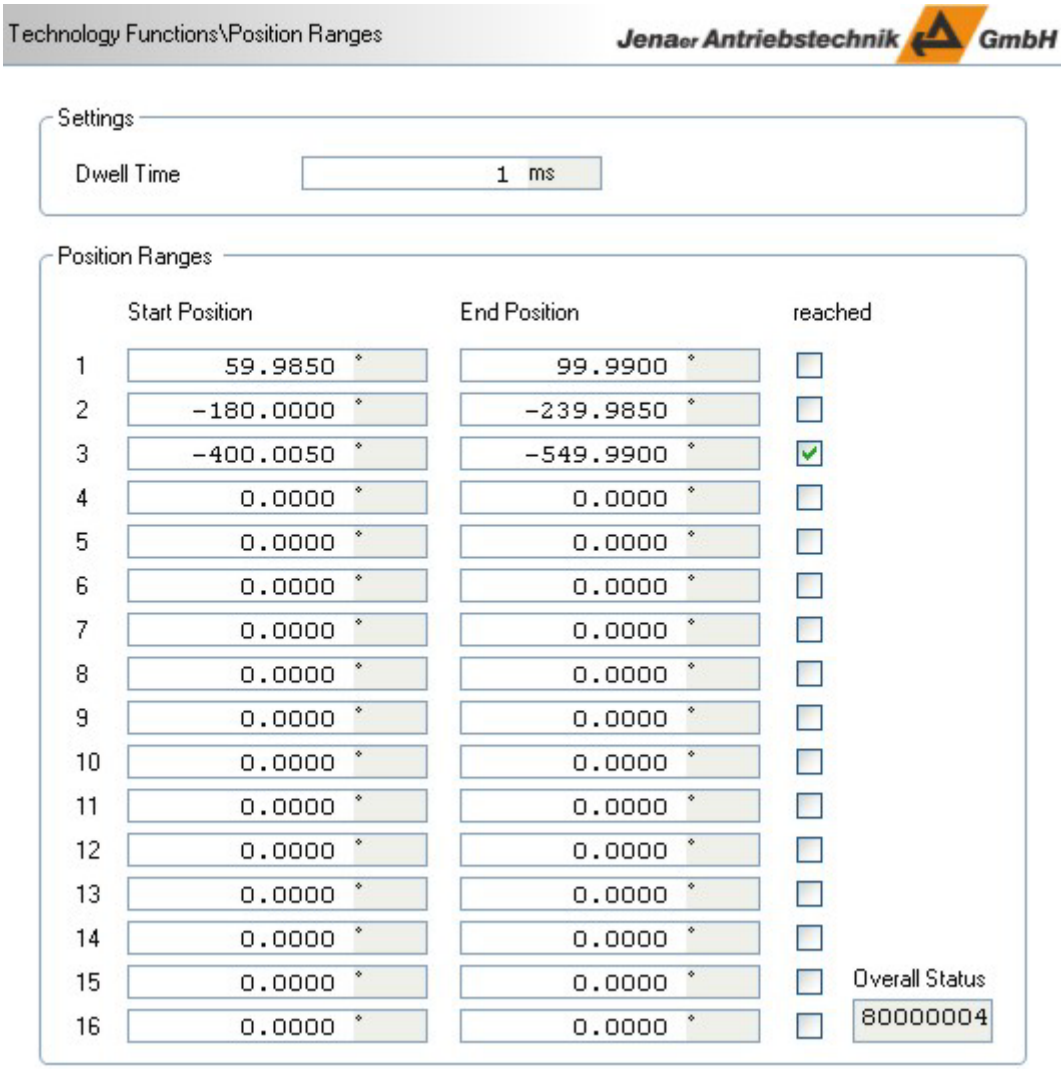
7. For further processing use the value **Position at L->H Edge of the Counter**.

Delay times of the inputs of the ECOVARIO®:

CAP1, CAP2	40 ns at 12V (ECOVARIO 214/414 only)
DIN5 (HOME), DIN6	90 µs at 24V, 90 µs at 12V (min. level 8 V, ECOVARIO 214/414 only)
DIN7 (CAP1), DIN8 (CAP2)	H-L edge: 1,6 ms at 24 V, 1 ms at 12 V (minimum level 8 V, ECOVARIO 114 only) L-H edge: 400 µs at 24 V, 700 µs at 12 V (minimum level 8 V, ECOVARIO 114 only)
Index pulse capture incremental/SINCOS port A/B	approx. 40 ns
Delay time SDO capturing	Runtime of a CAN frame (approx. 100 µs) + max. 1 ECOVARIO main loop run (approx. 500 µs)

T2 Displaying position ranges

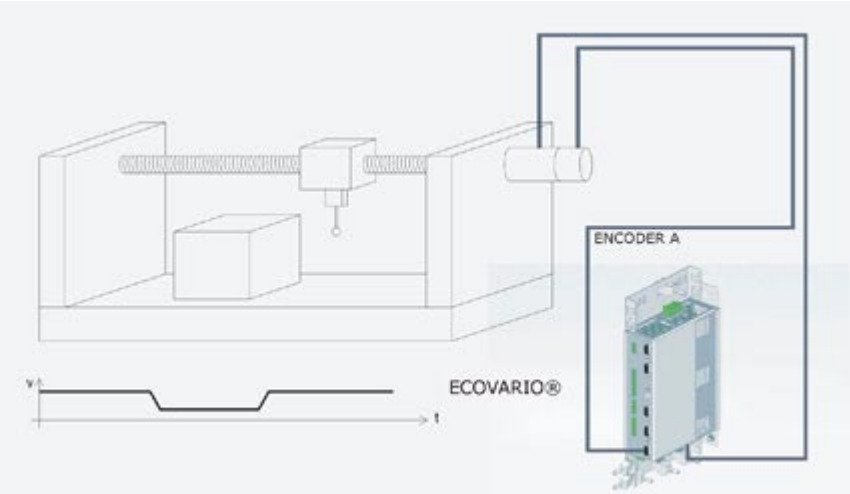
This technology function provides the possibility to define up to 16 position ranges. As soon as a position range is reached, a status flag is set after a defined dwell time. When the position range is left the status flag is cleared without delay. Normally, the status flags are evaluated by a higher-level PLC.



Window area **Settings**	
Dwell Time	Dwell time which has to elapse after reaching the defined position range before the flag "reached" is displayed.
Window area **Position Ranges**	
Start Position	Start Position of the defined position range
End Position	End Position of the defined position range
reached	The defined position range has been reached, the specified **dwell time** has elapsed and the axis is still in the position range. When the position range is left the respective status bit and thus the display is cleared without delay.
Overall Status	Statusbits "reached" of all 16 position ranges + 1 overall bit, which is set as soon as one of the defined position ranges is reached.

T3 Velocity profile

Some applications make it necessary to divide the positioning track into several sections. Each section is assigned an individual velocity, e.g. if the track consists of straight sections and curves or if further actions are carried out during positioning.



In the ECOVARIO®, up to 16 position segments can be parameterized with individual velocities. For all segments a parameterized maximum velocity cannot be exceeded.

Position	Position value up to which the specified **Velocity** value is valid
Velocity	Velocity value which is valid up to the **Position** specified above
off	Selective deactivation of position segments
Profile Velocity	If the check box is set the **Profile Velocity** specified under **Control/Motion/Positioning Mode** is used as the velocity value for the respective section.

T4 Weight Compensation

This technology function provides a compensation of the force the motor has to provide in order to hold the weight of a vertical axis (z axis). Therefore, positioning of z axes is possible with a force less than the holding force.

Procedure:

1. Before activating the function the axis has to be brought into a start position. Wait until positioning is finished.
2. In the field **Compensation Current Limit** specify the maximum current which should be available to the "normal" controller path (position controller, velocity controller, without holding current).
3. Activate the compensation by clicking **active**. The actual current value (holding current) is used as offset current in order to compensate the weight of the vertical axis.

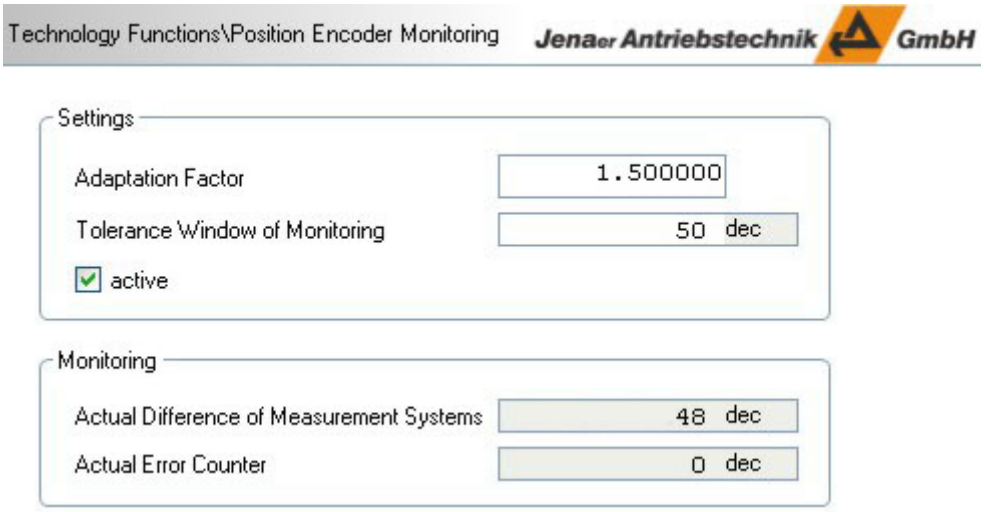
Note:
The absolute upper limit of the controller current (including the offset current) is always the **Maximum Current** specified under **Configuration/Limits**!

Compensation Current Limit	Maximum current which should be available to the "normal" controller path (position controller, velocity controller, without holding current).
active	Activation of the technology function weight compensation

T5 Position encoder monitoring

This technology function can be used for the monitoring of an external position encoder by means of the internal velocity encoder (motor encoder). Thus, an additional functional check can be implemented for the external encoder.

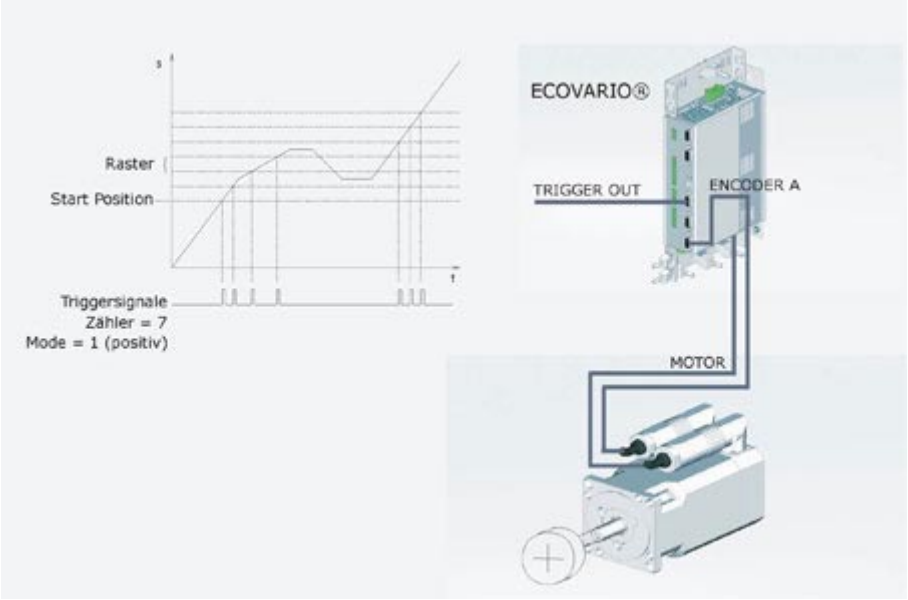
Different directions of rotation and the deviation between the two encoders are monitored. If the deviation exceeds a value set in a tolerance window for more than 30 ms the device error "Error external position measuring system" is raised (on the 7-segment display on the ECOVARIO: D34).



Window area **Settings**	
Adaptation Factor	Factor for adaptation of the number of increments of the position encoder to the velocity encoder: Position encoder increments · *Factor* = Velocity encoder increments Example: Velocity encoder increments: 40,000 Position encoder increments: 8,000 --> Factor: 5 Factors > 0 activate the monitoring function.
Tolerance Window of Monitoring	Maximum admissible deviation between the encoders in increments of the velocity encoder. When setting up the function first set the tolerance window to a higher value and observe the **Actual Difference of Measuring Systems** in normal operation. Then specify a tolerance window value which is a little higher than the actual difference.
active	Activation status of the technology function position encoder monitoring
Window area **Monitoring**	
Actual Difference of Measurement Systems	displays the actual deviation between the measuring systems. In normal operation the tolerance window should be higher than this deviation.
Actual Error Counter	displays the time period [in ms] during which the deviation between the encoders exceeds the value specified in the **Tolerance Window**. As soon as the time period is higher than 30 ms, the error message ""Error external position measuring system" is raised (on the 7-segment display on the ECOVARIO: D34). The error message is displayed in the bottom window area of ECO Studio in the **Device Errors** list.

T6 Position-dependent output trigger

Similar to a mechanical camshaft an output is set dependent of reaching specified positions. The function is suitable e.g. for measuring tasks which are carried out during movement of the axis and where position-dependent trigger signals are required.



This technology function is supported by the following configuration:
Hardware: ECOVARIO 114, 214, 414, option AJ or FJ
Software: 000.020

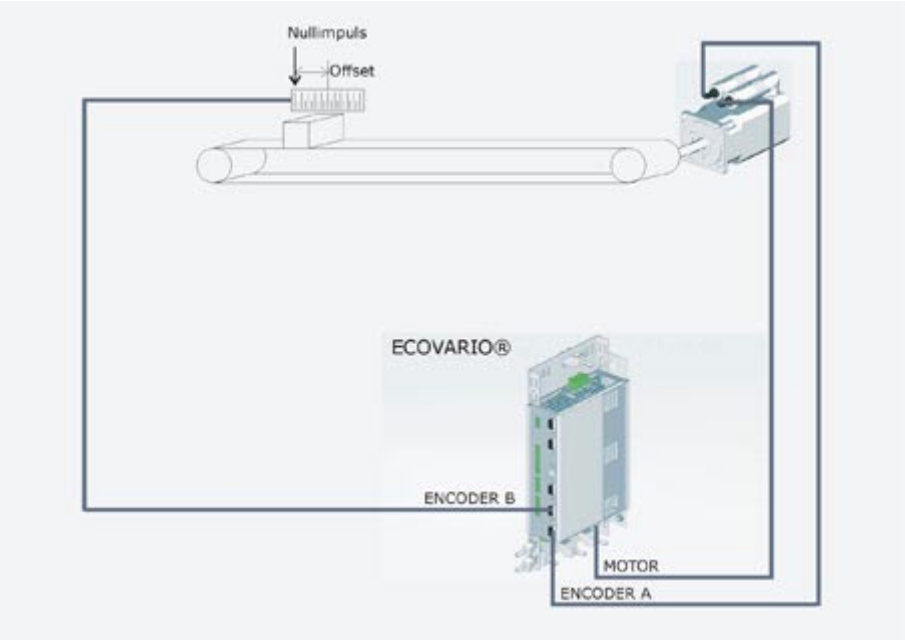
In this special ECOVARIO firmware the RS485 interface at the connector X13 is modified for the output of position-dependent trigger signals. The sampling of the actual positon is done with a clock of 16 kHz.
This function is controlled by the following parameters:

Window area **Settings**	
Mode	Determines the count direction (**+**/**-**), where the next trigger positions are set. Furthermore, the direction of movement of the drive has to be in the same direction, otherwise no output pulse is set when the trigger position is reached. If a filled square is displayed/selected here, the technology function is switched off. The selection of "**+**" or "**-**" switches on the function.
Start Position	Beginning with this position the counting is activated
Grid	If the axis reaches the next calculated trigger position, a trigger pulse with a width of 15 µs is generated at X13.
Counter	By setting the counter value the trigger function is started and the number of trigger positions is specified.
Window area **Signal Position**	
Signal Position	Displays the last position where a trigger signal has been generated.

The output of the trigger signals is independent from the switch-on status of the axis. Once activated via the "Mode" parameter the trigger signals also can be generated by shifting the axis manually.

T7 Fine Position Mode

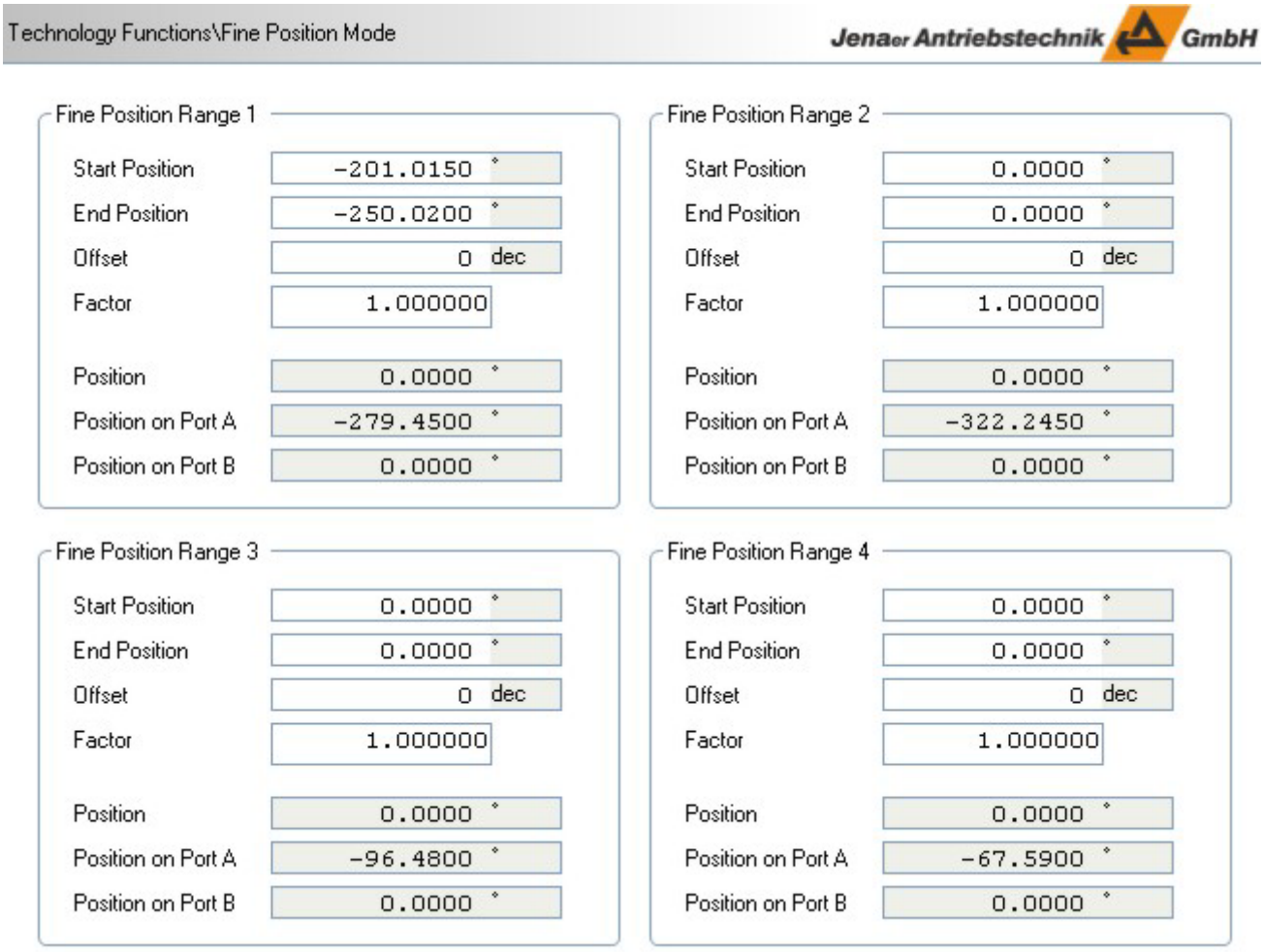
This function is suitable for applications with long travels where positioning has to be very precise only in defined ranges around the target position. Thus it is sufficient to implement a very precise measuring system only in defined position ranges around the target position. Fine positioning is carried out by means of this additional precise measuring system, in the other position ranges a lower resolution is sufficient.



With the motor encoder positioning is carried out to a target value which is in the window range of the second measuring system. During the positioning process the zero position of the second measuring system is passed. As second measuring system an incremental encoder or a SINCOS encoder is used which is set to zero every time the zero position is passed. After that the second measuring system takes over the positioning to a specified offset value. The offset value has to be located in the window range of the second measuring system. It has to be made sure that based on the configured deceleration ramp the axis is able to stop at the offset value.

By means of the technology function also fine positioning of several slides running on one track is possible to several positions. The position values are written to the CAN bus every 10 ms and can be read by all servo amplifers working at the bus.

4 fine position ranges can be defined via ECO Studio:



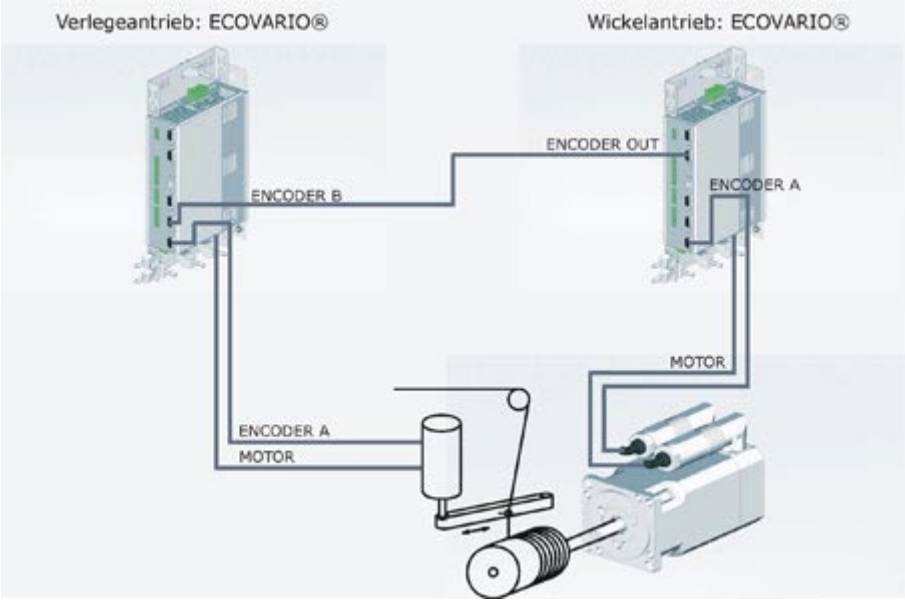
Window area **Fine Position Range x**	
Start Position	Beginning of the fine position range
End Position	End of the fine position range
Offset	Offset related to the zero position of the second measuring system
Factor	Alignment of the both measuring systems
Position	Position of the second measuring system by mapping (e.g. via CAN every 10 ms).
Position on Port A	Position of the second measuring system at Port A, becomes zero when passing through the zero position.
Position on Port B	Position of the second measuring system at Port B, becomes zero when passing through the zero position.

Function:

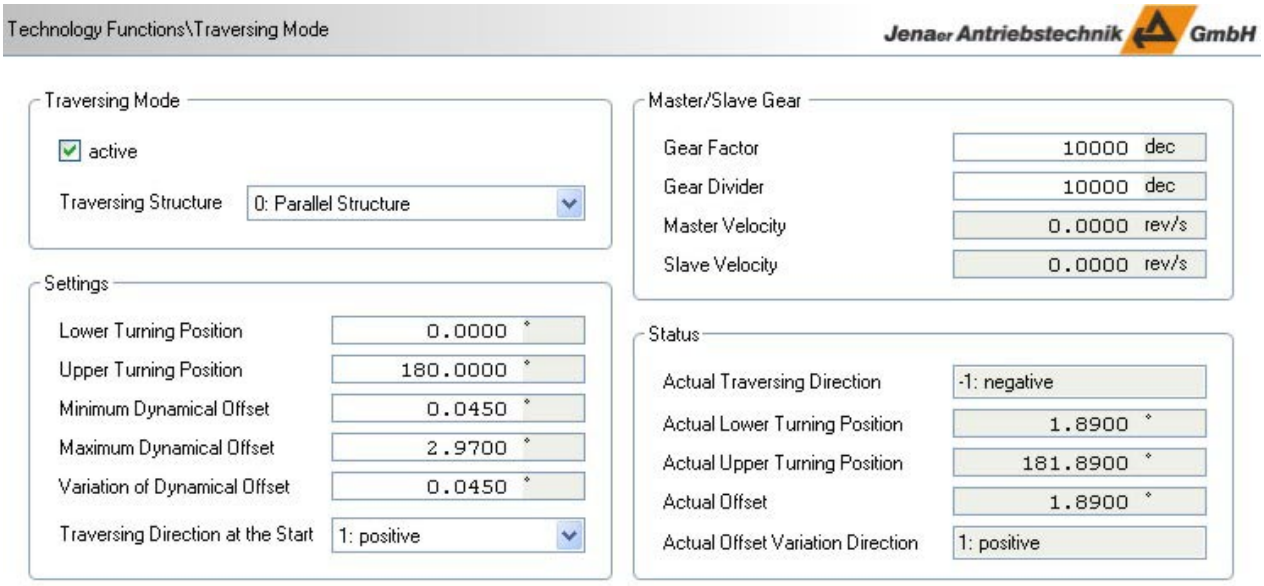
The second measuring system writes a position value into the parameter **Position** (e.g. via CAN every 10 ms). Via the parameter **Offset** the zero position is set by adjustment. In the respective parameters, the **Start Position** and the **End Position** of the window are specified. If positioning is now done into this window the controller carries out the fine adjustment after the target position has been reached. The controller controls to the zero position which is derived from the measuring system minus the offset. An incremental encoder is used as second measuring system. This measuring system is set to zero each time the zero position is passed through.

T8 Traversing mode

During the winding process, the traversing drive distributes thread or wire on a spool via a thread guidance. Spool axis and traversing drive are coupled by means of an electronic gear unit. Thus, the thread guidance is moved on a defined way per spool revolution (the so-called traversing width). The servo amplifier functions velocity pre-control and current pre-control allow for a high-dynamic reversal of the thread guidance at the ends of the spool. Furthermore, the pre-control allows for a rigid coupling between the spool movement and the traversing process. Following errors cannot occur because they are responded to immediately.



In the traversing mode the axis travels between the two turning positions with the **Master Velocity** which is calculated from the **Gear Factor** and the **Gear Divider**. At the turning positions (parameters **Lower Turning Position**, **Upper Turning Position**) a fast directional reversal is carried out. The initial direction is defined in the parameter **Traversing Direction at the Start**. In order to avoid beading of the wound material at the edges a dynamic offset can be specified.



Window area **Traversing Mode**	
active	Activation of the technology function traversing
Traversing Structure	Currently the **Parallel Structure** is supported. For other structures, please contact us.
Window area **Settings**	
Lower Turning Position	Basic positions where the reversal of the axis movement is carried out. The difference between upper and lower turning position specifies the winding width. If dynamic offset values are used, the actual turning positions may variate from the values specified here (please refer to **Actual Lower Turning Position** and **Actual Higher Turning Position**).
Upper Turning Position	
Minimum Dynamical Offset	In order to avoid beading of the wound material at the edges a dynamic offset can be specified. After each double travel the offset is increased by the value **Variation of Dynamical Offset** until the value **Maximum Dynamical Offset** is reached. After that the offset is reduced by the value **Variation of Dynamical Offset** after each double travel until the value in the field **Minimum Dynamical Offset** is reached. This cycle is repeated continuously.
Maximum Dynamical Offset	
Variation of Dynamical Offset	
Traversing Direction at the Start	Definition of the initial direction of movement of the axis in the traversing mode. May either be positive or negative.
Window area **Master/Slave Gear**	
Gear Factor	Gear ratio: dividend
Gear Divider	Gear ratio: divisor
Master Velocity	Velocity the axis travels with between the **Lower Turning Position** and the **Upper Turning Position**
Slave Velocity	Slave velocity
Window area **Status**	
Actual Traversing Direction	displays the actual direction the axis moves to during the traversing process
Actual Lower Turning Position	displays the actual turning positions (may deviate from the turning positions specified above because of the dynamical Offset)
Actual Upper Turning Position	
Actual Offset	displays the offset value which is currently used at the turning positions
Actual Offset Variation Direction	displays whether the **Actual Offset** currently is increased (**positive** variation direction) or reduced (**negative** variation direction)

☞	If possible, the reversing process should be fast and without overshoot (trapezoid profile). This can only be achieved if under **Control/Motion/ Velocity Controller** the parameters **Acceleration Ramp** and **Deceleration Ramp** are adapted accurately to the acceleration power of the motor in use. The settling behaviour can be optimized under . **Configuration/Controller/Velocity Controller** mainly via the following parameters: • **P-gain** • **I-gain** • **Output Filter** and under **Configuration/Controller/Position Controller** via the parameter **Velocity Pre-Control**.

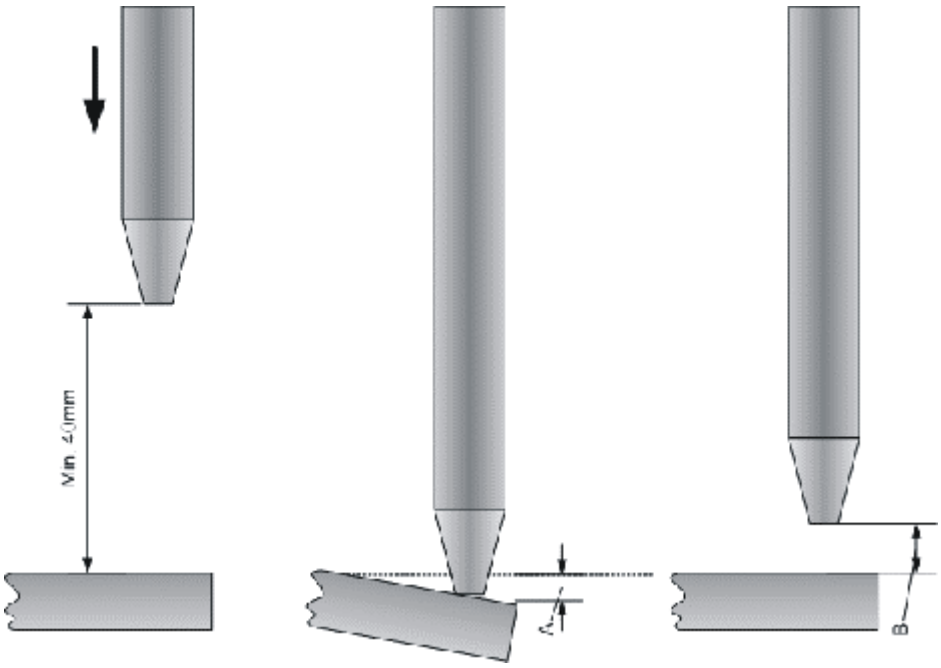
T9 Mechanical stop detection

By means of the technology function "Mechanical stop detection" which is implemented in the ECOMPACT® a mechanical stop with variable elasticity can be detected. The detection of the stop is achieved by the evaluation of internal measuring values (dynamic measuring of the friction current). Thus, very small resistances can be detected. E.g. at a vertical axis a sheet metal (thickness 1 mm) can be touched at a velocity of 30 mm/s. A bending of the sheet metal of 0.3 mm and a prestressing of less than 15 N results.

Generally, the technology function can be used as an additional safety measure which shuts down the drive if an obstacle is detected.

The technology function can be used in the operating modes 1 (positioning mode with profile generator) and 7 (interpolated mode).

The meaning of the parameters now is explained by means of the following figure.



Window area **Mechanical Stop Detection**	
off	displays whether the technology function is switched on or off. The function is switched on by specifying the **Switch-Off Threshold Touching Value**.
Window area **Switch-Off Threshold Touching Value**	
Manual Threshold Value	The threshold value determines the size of the area marked with an A in the figure above. A smaller value reduces A, however makes the complete system more susceptible to external disturbances. Recommended value is 60. For resilient sheet steel the mechanical stop detection can be improved by reducing the threshold value to 40.
Standard Threshold Value	Normally, the pre-configured standard threshold value should be used. In case of problems a manual threshold value can be specified instead. As soon as a value is entered here or the standard threshold value is selected the technology function is activated.
Window area **Setting**	
Time Period until Monitoring Activation	Time period (in ms) after accelaration ramp until the monitoring is activated.
Correction Value of Touching Position	For a more precise setting of the touching position a fixed correction value can be used. Normally, this is not required. The specification is in increments and is calculated from the formula: x [inc] = correction distance [in mm] x 6400 inc/mm
Position Detection Threshold	With the position detection threshold the accuracy of position detection can be increased. If the value is reduced the accuracy increases. However, in this case there is also a higher probability of a faulty position determination. Recommended value is 15.
Window area **Status**	
Mechanical Stop reached	If the actual difference between the values **Virtual Zero** and **Touching Value** exceeds the threshold value the axis is stopped. If the mechanical stop has been detected the status remains set until either the axis travels in the opposite direction or the function is switched off. The function is activated again automatically after travelling back. ***Note: The distance to the next touching position has to be at least 40 mm in order to guarantee a safe touching.***
Touching Value	The parameter displays the relative load torque. This reflects the dynamical vertical forces effective in the system. If the touching tip enters the range marked with A in the figure above, this value increases dependent on the material.
Touching Position	After the touching process has been accomplished successfully, the actual touching position is displayed in increments here. The recalculation to full mm is done according to the following formula: x [mm] = Position [inc] x 1.5625 x 10^{-4} mm/inc
Virtual Zero	For explanation cf. **Mechanical Stop reached**

T10 Modulo positioning

Up to 4 sliding carriages travel on one mechanical system (e.g. guide rail) to the specified processing positions. In order to achieve this, each sliding carriage is equipped with its own servo drive which receives a motion command at any time.

The ECOVARIO® ensures that:

- the sliding carriages only travel to the forward direction,
- the sliding carriages keep a selectable minimum distance, i.e. in front of a processing position one or more sliding carriages can wait with a safety distance to each other. As soon as the processing position is free, the next sliding carriage travels towards the processing position (still keeping the safety distance to other carriages) until the position is reached.
- the position value related to the mechanics is set to zero for each circulation.

The communication between the individual servo amplifiers is carried out via CAN-PDO.

Hardware and Software Requirements

The technology function modulo positioning is supported by the following hardware and software configuration:

- ECOVARIO®x14 from release 5.129 on, software version 10
- ECOSTEP® servo motors series 23S, 34S with multiturn absolute value encoder (Option -xx7Wx)
- ECOSPEED servo motors with multiturn absolute value encoder (Option -xx7Wx).

For operation via Profibus DP use the GSD file ECOVA_MO.GSD.

Function

Positioning is carried out related to the modulo position of an axis. A controller transfers a new target position in the manufacturer specific CANopen object 0x2FA0, sub index 01. Positioning can be carried out in positive direction as well as in negative direction. For commissioning or test purposes the target position can be set via ECO Studio as well.

The following restrictions have to be observed:

- The new target position has to be less than encoder increments/2. Higher values are rejected.
- Positioning to the negative direction (reverse direction) to the zero position is not permitted.

The movement to the target position is carried out starting at the actual position, thus the target position is dependent on the actual position. If the target position value is lower than the actual position value a complete round is travelled automatically. In order to eliminate an unexpected behaviour of the axis in case of small deviations a tolerance window is defined. The tolerance window is defined around the actual target position under **Motion** in the **Positioning Mode** tab (**Position Window** field).

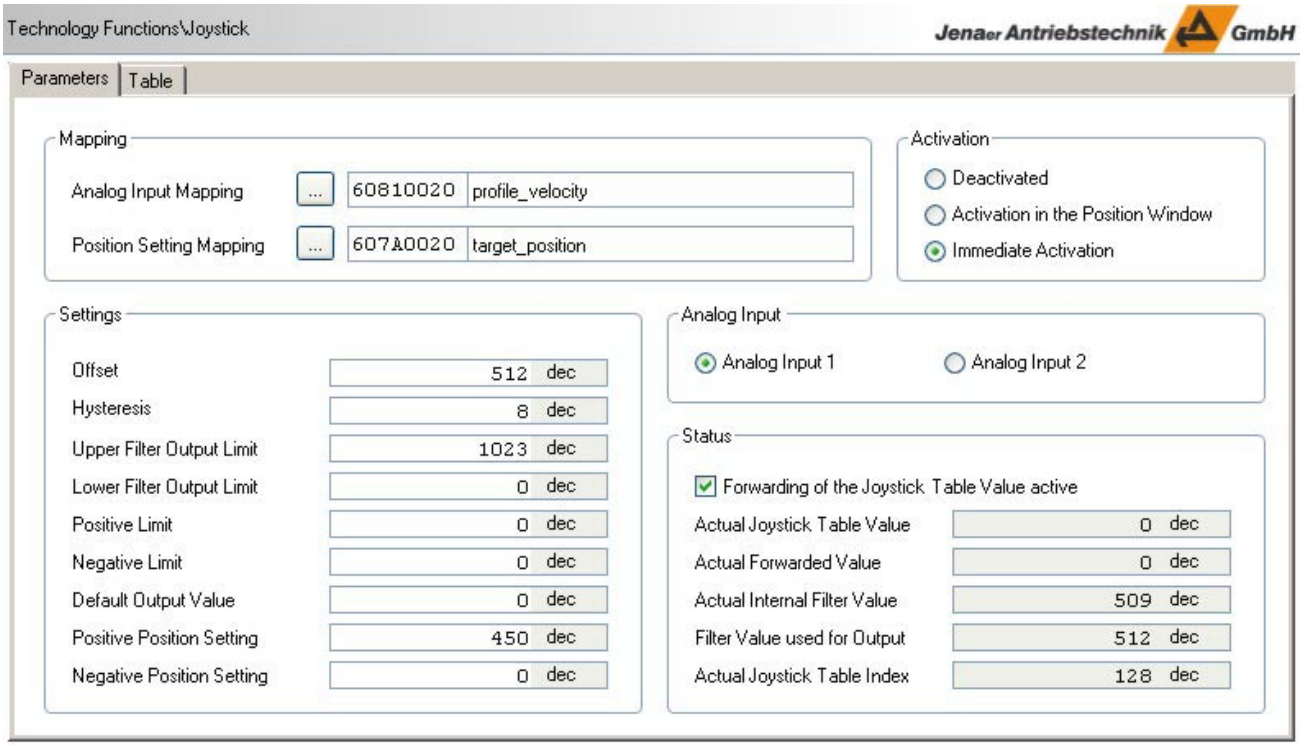
Window area **Settings**	
Target Position	Target position (see above)
Actual Position	Independently from the real position of the encoder specifies the modulo position value in one round
Max. Round Position	The maximum position of one round: Encoder resolution/2
Min. Round Position	The minimum position of one round
Maximum Position	Here the sliding carriage which travels ahead of the current sliding carriage transmits its actual position via a PDO.
Timeout	Timeout in 0.1 ms. If no PDO is received, "Abort Connection" is raised. The consequences can be specified via the navigation area under **Reaction Behaviour** in the **CAN Communication** list box.
Status Word	Here the status word of the sliding carriage ahead is set via PDO. If the sliding carriage ahead is in error state, the current sliding carriage is automatically set to Quick Stop.
Minimum Distance	Minimum distance to the sliding carriage ahead in increments
Brake	Switching the holding brake on (check box active) or off (check box inactive)
Window area **Mode** **Mode changes become effective only after a restart of the servo amplifier.**	
Mode	- Bit 0 =‘1‘ Modulo operation activated - Bit 1 =‘1‘ Internal storage of the decimal multiturn information - Bit 2 =‘1‘ Reverse travel permitted - Bit 3 =‘1‘ No distance monitoring (e.g required for single operation) - Bit 4 =‘1‘ Quick Stop behaviour is activated - Bit 5 ='1' Position comparison (real round position) active with the stored value. Compared is to +/- position_window, i.e. twice the value of object 0xXXXX. For operation bit 0 has to be set.

The window area **Extended** is for internal use only. Modifications of the parameters may only be carried out by experts of Jenaer Antriebstechnik GmbH or by authorized personnel.

T11 Joystick control

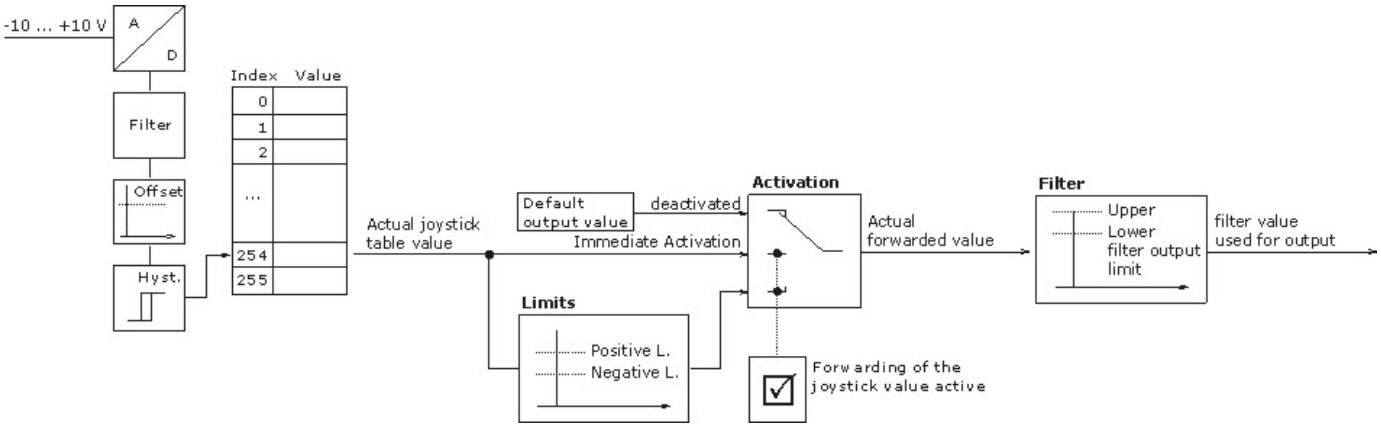
The joystick function makes it possible to move the drive according to a table stored in the device which contains the joystick voltage values and their corresponding velocities. The joystick voltage can be applied as +/- 10-V signal at the differential analog input or as 0...+20-V signal at the AIN input (or 0...+10V at AIN+). For further information on the analog input please consider the installation manual of the respective servo amplifier. The full control range, however, is only available at +/-10 V. In the other cases it is only half the control range. By using sequence programming the drive can also be operated stand-alone, it is e.g. switched on by means of the Enable signal and activates the joystick function.

The technology function joystick control can be configured in the expert mode via **Technology Functions\Joystick** in the **Parameters** tab. Step by step commissioning of the joystick function is described at the end of this chapter.



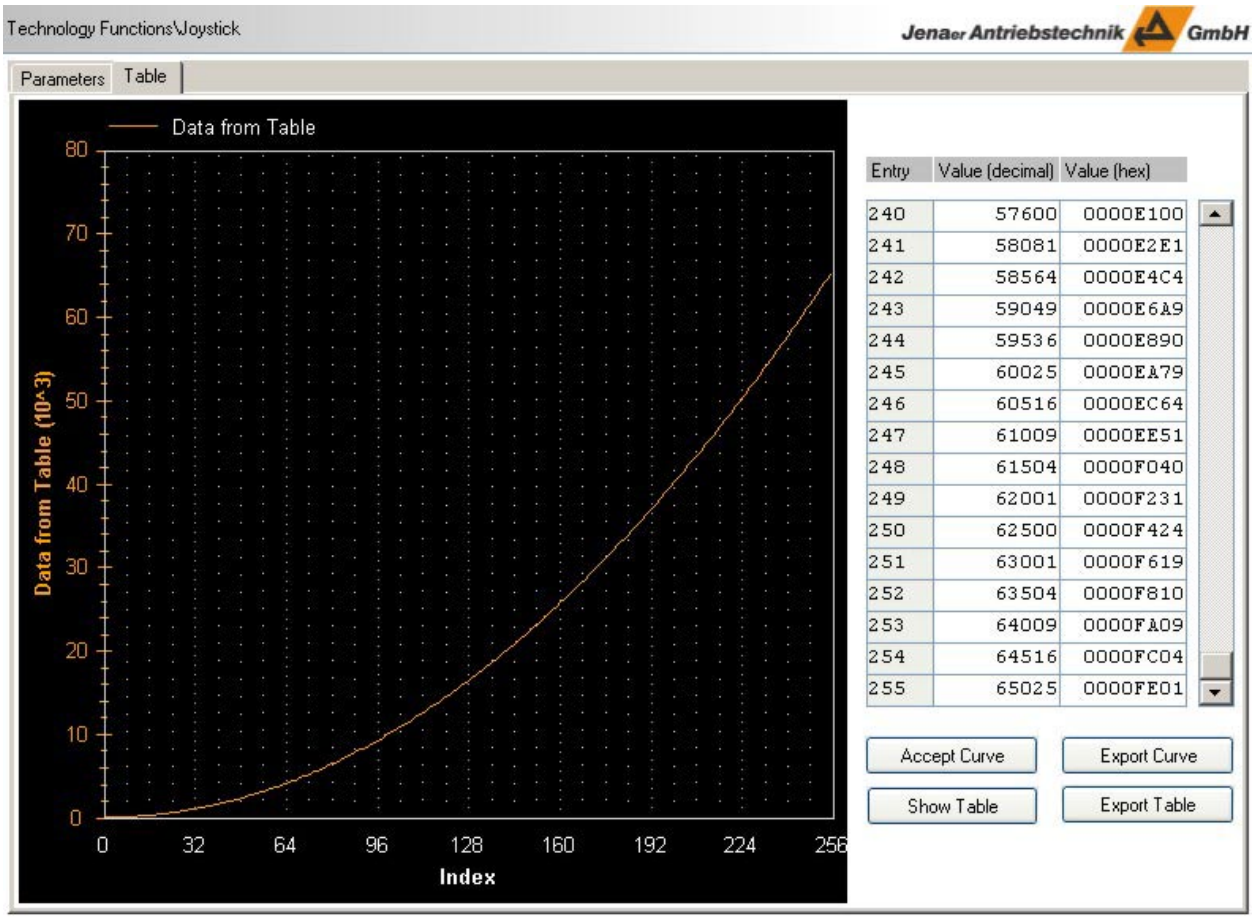
Window area **Mapping** In special cases also other mapping objects can be entered in the fields **Position Value Mapping** and **Velocity Value Mapping**. For details please contact the application department of Jenaer Antriebstechnik.	
Analog Input Mapping	Object the output value of the joystick function is mapped to. Velocity mode with position control with guidance (operating mode =3): Object 60FF00 (target velocity) Positioning mode with guidance (operating mode = 1): Object 608100 (profile velocity)

Position Setting Mapping	Only active if under **Analog Input Mapping** the object 608100 has been selected and at least one **Position Setting** (see below) has been set to a value different from 0. In this case object 607A00 (target position) is selected here. Dependent on the sign of the **Actual Forwarded Value** (in the window area **Status**) either the **Positive Position Settting** value or the **Negative Position Setting** value is written to the object set here.
Window area **Settings** After the A/D conversion the joystick voltage is available in the servo amplifier in the value range -512 ... +511. Subsequently, the value is filtered 16-fold (time constant approx. 16 ms) and evaluated under consideration of the parameters **Offset** and **Hysteresis**. The result of the filter function generates an index (0...255) for the velocity table.	
Offset	shifts the analog zero point. For symmetrical operation the value 512 has to be entered.
Hysteresis	Necessary difference to the filtered previous value, is a decisive factor for the resolution of the analog input value (step size between a change of values)
Upper Filter Output Limit	
Lower Filter Output Limit	
Positive Limit	Between these two values a position window can be defined in which the joystick function is active (window area **Activation -> Activation in the Position Window**)
Negative Limit	
Default Output Value	Output value in case of deactivation of the joystick function in the window area **Activation**
Positive Position Setting	Dependent on the sign of the **Actual Forwarded Value** (in the window area **Status**) either the **Positive Position Settting** value or the **Negative Position Setting** value is written to the object set under **Position Value Mapping**
Negative Position Setting	
Window area **Activation** The joystick function can either be activated in the position window (set by the values **Positive Limit** and **Negative Limit**) or by **Immediate Activation**.	
Window area **Analog Input** Selection of the analog input the joystick is connected to	
Window area **Status**	
Forwarding of the Joystick Table Value active	The forwarding is active if in the window area **Activation** either the **Activation in the Position Window** or the **Immediate Activation** is selected
Actual Joystick Table Value	the value read directly from the joystick table which is stored under the **Actual Joystick Table Index** (assigned to the voltage which is present at the analog input)
Actual Forwarded Value	the forwarded value is the **Actual Joystick Value** if in the window area Activation either **Activation in the Position Window** or **Immediate Activation** is selected. Otherwise the **Default Output Value** is forwarded.
Actual Internal Filter Value	
Filter Value used for Output	
Actual Joystick Table Index	The result of the filter function after the A/D conversion of the voltage present at the analog input generates an index (0...255) for the joystick table



Joystick table

The settings of the target velocity values are contained in the so-called joystick table (256 entries are possible). In this table signed 32-bit velocitiy values are stored. The direction of movement is determined by the sign. If no values are contained in the joystick table the respective values must be entered. Therefore, select the **Table** tab. ECO Studio provides a convenient graphical user interface for the joystick function. By clicking the right mouse key within the diagram area (black) a **New Curve** can be generated. A mathematical function can be specified which contains the required assignment between joystick voltage and velocity. The function is then displayed as a curve.



The following operations are possible:

Note: The designation *term* represents an arithmetic concatenation out of numbers and mathematic functions. The term can also contain variables which represent the curve values. In a simple case the term is a constant value.

Operation	Description	Syntax
+	Addition	
-	Subtraction or sign	
*****	Multiplication	
/	Division	
sin	Sinus function	sin (*Term*)
cos	Cosinus function	cos (*Term*)
pot	Power of	pot (*Term; Exponent*)
sqrt	Square root	sqrt (*Term*)
abs	Absolute value	abs (*Term*)
lim	Limitation function. Limits the curve to a value range between the given limits.	lim (*x; Limit1; Limit2*) wheras *Limit1* and *Limit2* are specified in the curve specific unit. Also terms can be entered for Limit1 and Limit2.
min	Minimum function. The lower value out of the two values is used.	min (*Term1*; *Term2*)
max	Maximum function. The higher value out of the two values is used.	max (*Term1*; *Term2*)
pi	Constant number PI	
e	Constant number Eulersche Zahl	

Any number of arithmetic operations can be combined to a function. It is not necessary to enter blanks, however, they can be used for a better transparency. Please observe that the arithemtic operations are executed in the sequence in which they are entered. For other sequences of execution parentheses () have to be used. Any number of parenthesis levels are possible.
By means of the button **Accept Curve** you can transfer the displayed curve as values to the table. Furthermore, an export of the curve or of the table data, respectively, is possible. After clicking the button **Export Curve** or **Export Table** a window is displayed where you can enter a file name. The format of the saved file is *.dat. The file can be opened and edited by means of a normal text editor. Please observe that the existing format must not be modified and the object numbers have to be retained. The value of the object entries must not exceed the maximum values of the controller because otherwise faults might occur during operation.

Commissioning of the joystick function in the velocity mode with position control

1. Under **Technology Functions/Joystick** in the **Table** tab specify the required joystick table.
2. Under **Control/Motion** in the **Expert Mode** set the **Operating Mode** to 3.
3. Under **Technology Functions/Joystick** select in the **Parameters** tab in the window area **Mapping** under **Analog Input Mapping** the object 60FF00 (target velocity).
4. The **Offset** value should be set to 512, the **Upper Filter Output Limit** to 1023 (default settings).
5. If the joystick function shall only be activated in a defined position window, enter values for the **Negative Limit** and for the **Positive Limit** of the position window.
6. If required, enter a **Default Output Value** which is used as an output value of the joystick function if the function is deactivated.
7. In the window area **Activation** specify whether activation of the joystick function should be carried aout immediately or within a specified position window (cf. step 5).
8. Make sure that the travel range of the drive is free and that there is no danger for any persons.

9. Check the error status of the drive, if required **Reset Fault** in the main window on the left.
10. Switch on the servo amplifier (**Switch on device** in the main window on the left).
11. Test the function by operating the joystick.
12. Adapt the function to your application (modification of parameters, etc.).

Commissioning of the joystick function in indirect positioning mode

1. Under **Technology Functions/Joystick** in the **Table** tab specify the required joystick table.
2. Under **Control/Motion** in the **Expert Mode** set the **Operating Mode** to 1.
3. Under **Technology Functions/Joystick** select in the **Parameters** tab in the window area **Mapping** under **Analog Input Mapping** the object 608100 (profile velocity).
4. In the fields **Positive Position Setting** and **Negative Position Setting** enter the positions which the axis shall reach dependent on the sign of the joystick output value.
5. Under **Position Setting Mapping** select the object 607A00 (target position).
6. The **Offset** value should be set to 512, the **Upper Filter Output Limit** to 1023 (default settings).
7. If the joystick function shall only be activated in a defined position window, enter values for the **Negative Limit** and for the **Positive Limit** of the position window.
8. If required, enter a **Default Output Value** which is used as an output value of the joystick function if the function is deactivated.
9. In the window area **Activation** specify whether activation of the joystick function should be carried aout immediately or within a specified position window (cf. step 7).
10. Make sure that the travel range of the drive is free and that there is no danger for any persons.
11. Check the error status of the drive, if required **Reset Fault** in the main window on the left.
12. Switch on the servo amplifier (**Switch on device** in the main window on the left).
13. Test the function by operating the joystick.
14. Adapt the function to your application (modification of parameters, etc.).