ComET4
Commissioning Software

User's Manual

Version N

ETEL

THIS PAGE IS INTENTIONALLY LEFT BLANK

Table of Contents

Record of revisions

Document revisions

Version	Date	Modification
Ver. A	05.05.14	First version
Ver. B	17.12.14	Updated version (with ComET from version 4.12A) - Editor tool window updated
Ver. C	05.05.15	Updated version (with ComET from version 4.13A) - Identification tool updated - New tool
Ver. D	13.07.16	Updated version (with ComET from version 4.15A) - Interface overview modified - Force control tool updated - New QuiET tool
Ver. E	09.12.16	Updated version (with ComET from version 4.16A) - New pre-compile sequence tool - New processor load tool - Force control tool improved - New ZxT tool
Ver. F	28.11.17	Updated version (with ComET from version 4.17A) - New dual-axis force control tool
Ver. G	29.11.18	Updated version (with ComET from version 4.20A) - ZxT tool updated
Ver. H	12.12.19	Updated version (with ComET from version 4.22A) - ULTIMET ADVANCED tools
Ver. I	30.09.20	Updated version (with ComET from version 4.23A) - Document structure revised - Menus refactoring
Ver. J	31.03.21	Updated version (with ComET from version 4.24A) - Major refactoring of the Force Control Tool - Screenshots update (e.g. Setting, ZxT Tool) - Wording review: “Safety” replaced by “Protection”
Ver. K	30.09.21	Updated version (with ComET from version 4.25A) - Additional stroke software limits modes can be selected in the Setting wizard panel #9 (protections) - New option to release the motor brake during Encoder signal adjustment in the Setting wizard panel #5 (position feedback)
Ver. L	31.03.22	Updated version (with ComET from version 4.26A) - Note about the Advanced Feedforward Tuning tool not supporting the Gantry mode - Update of screenshots for the download of the Customer Software Module to the ULTIMET ADVANCED - Update of screenshots of the System Configuration Manager tool
Ver. M	30.09.22	Updated version (with ComET from version 4.27A) - Update of system requirements for installing ComET - Update of screenshots in the Scale mapping section - Update of screenshots in the Download Firmware section, emphasizing the recommendations to be followed to ensure a correct operation - Table title correction in the I/O configuration section
Ver. N	31.03.23	Updated version (with ComET from version 4.50A) - ComET-4.50A supports both AccurET and ACCURET+ controllers running firmware 3.50A - Update of screenshots of the ZxT Tool related to the limit stroke examination - Update of screenshots of the Controller Backup Tool

Safety precautions

The user must have read and understood this documentation as well as those listed in the Section **Related documents** before carrying out any operation with this software. Please contact ETEL S.A. or authorized distributors in case of missing information or questions regarding the installation procedures, safety or any other topic.

ETEL S.A. disclaims all responsibility for accidents and damages if the safety instructions, procedures and usage described in the present User's Manual and in the documentation listed in the Section **Related documents** are not followed.

ComET4 software is not designed or intended for use in the on-line air traffic control, aircraft navigation and communications, as well as critical components in life support systems or in the design, construction, operation and maintenance of any nuclear facility.

Related documents

Document	Description
AccurET Modular Position Controller	Operation & Software Manual
UltimET Light Motion Controller	User's Manual
ULTIMET ADVANCED Motion Controller	User's Manual
EDI4	User's Manual of the ETEL Device Interface API
USB	Technical note explaining installation of the USB driver
UltimET PCI/PCIe drivers	Technical note explaining installation of the PCI/PCIe drivers
Upgrading the Firmware pool	Technical Note explaining how to upgrade the Firmware pool
ETND – ETNE	Technical Note explaining the ETND and ETNE processes

Conventions used in this User's Manual

Text format

Text	Description
Product	Name of an ETEL product/brand
Document	Reference to a related document
`Code`	Code examples
Menu	Menu entry or toolbar option
Tool	Tool name
Option	GUI option

Flagged text

Text (or Icon)	Description
TIP	Note that provides "nice-to-know" information
NOTE	Contains additional information for providing a better understanding
IMPORTANT	Note that contains information that must be observed
WARNING	Note describing a situation that may result in serious body injury or death
DANGER	Note describing a situation that will result in serious body injury or death

1. Introduction

ComET4 is a user-friendly software environment for commissioning and maintaining ETEL's motion control products:

- ***AccurET*** and ***ACCURET+*** (since firmware version 3.50A) position controllers; and
- ***UltimET*** motion controllers.

ComET4 intuitive interface guides the user through the process of setting up a Controller. In just a few minutes, an auto-setting wizard tool provides an initial set of controller parameters.

NOTE

In general, the term Controller is used indistinctly to identify an ***AccurET/ACCURET+*** position controller and an ***UltimET*** motion controller in this User's Manual. The exceptions can be easily understood from the context of the topic under discussion.

Furthermore, for sake of simplicity, it is implicitly considered that all references to ***AccurET*** position controllers also apply to ***ACCURET+*** position controllers. The exceptions will be noted.

ComET4 includes a comprehensive set of tools for:

- Configuration, monitoring and diagnostics;
- Embedded programming, execution and debugging; and
- System configuration management and backup.

For more information about the ***AccurET*** position controllers, please refer to the corresponding *Operation & Software Manual* available under the **Help** menu.

For more information about the ***UltimET Light*** and ***ADVANCED*** motion controllers, please refer to the corresponding *User's Manuals* available under the **Help** menu.

TIP

Updates between two successive versions of this User's Manual are highlighted with a modification stroke in the left margins.

1.1. System requirements

The system requirements for installing ***ComET4*** are:

	Minimum	Recommended
Operating System	Windows 10, 64-bit	
Processor	Intel Core i3	
System memory (RAM)	4 GB	16 GB
Disk storage (HDD / SDD)	7 GB	
Monitor resolution	1280x1024	1920x1080

In addition, the Adobe® Acrobat® Reader software must be installed for accessing ETEL's product documentation available under the **Help** menu.

1.2. Software installation

Follow these steps to install the ***ComET4*** software:

1. Run the "`Setup.exe`" executable file provided by ETEL.
2. Read and accept ETEL's license agreement.
3. Choose the installation folder
   a. By default it is "C:\Program Files (x86)\ETEL SA".
   b. By default, the program folder is named ComET-4.xxY
4. Wait a few minutes until the installation is completed.

NOTE	By default, program shortcuts created during the installation procedure are named as ComET-4.xxY, where xx and Y correspond respectively to the software release minor number and revision letter (e.g. ComET-4.24A).

A shortcut named ComET-4.xxY is created on the Desktop. In addition, a folder with the same name is created in the Windows Start Menu containing the following shortcuts:

- ***ComET4*** software;
- ***ComET4*** software running in verbose mode;
- Documentation;
- ETND software;
- Uninstaller.

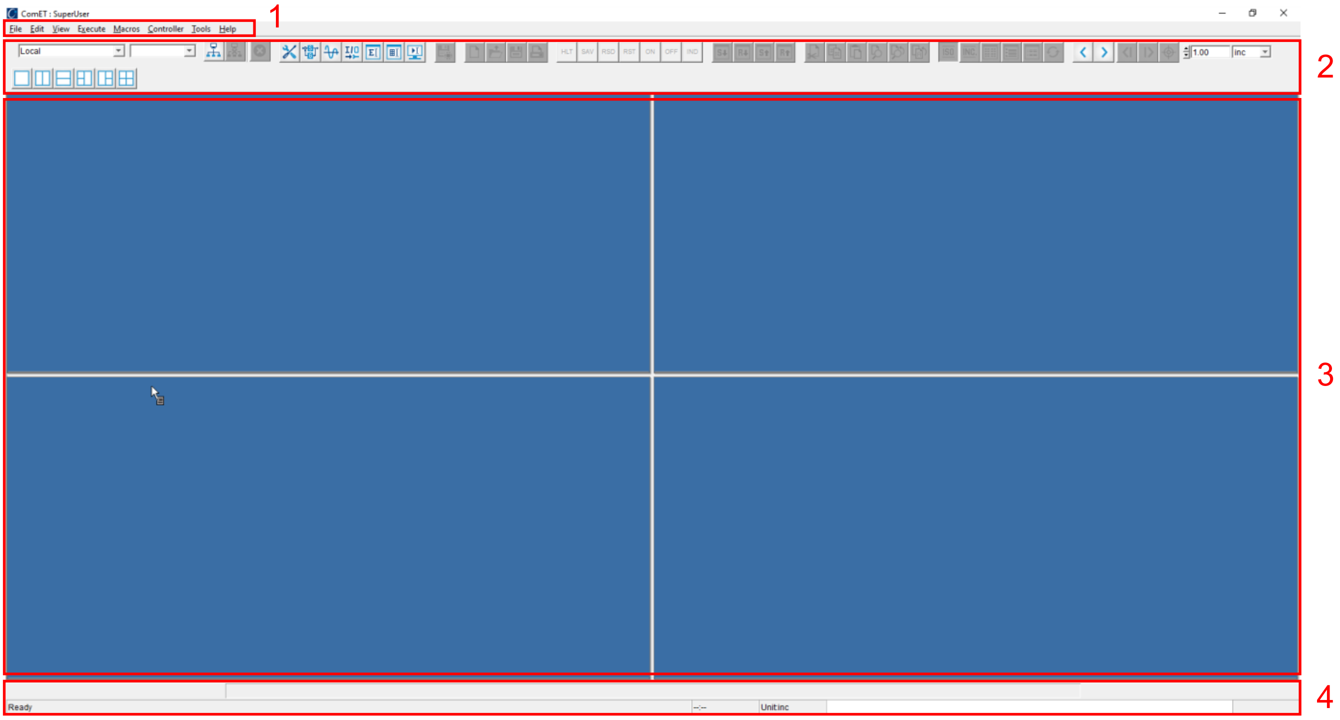
For more information about the ETND software, please refer to the corresponding *ETND-ETNE Technical Note* available under the **Help** menu.

2. Interface overview

To start ***ComET4*** software double-click on the program shortcut that can be found on the Desktop or select the program shortcut that can be found in Windows **Start Menu → ComET-xxY** folder.

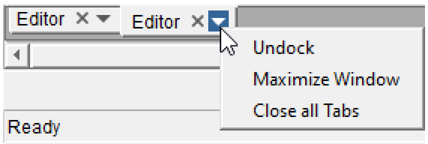
The ***ComET4*** mainframe is divided in four areas:

1. **Menu** bar;
2. **Toolbar**;
3. **Desktop** area composed of four regions for docking tools; and
4. **Status** bar.



In the **desktop** area, each region can contain docked tools following a standard tab arrangement and Drag & Drop mechanism. For each tab, the following functions are provided:

- Close;
- Undock;
- Maximize (also available double-clicking on the tab); and
- Close all tabs in the region.



2.1. Menu bar

ComET4 **Menu** bar gives access to the menus:

- **File**;
- **Edit**;
- **View**;
- **Execute**;
- **Controller**;
- **Tools**;
- **Help**.

2.1.1. File

Some of the options under this Menu are disabled depending on the tool detaining the focus:

New	Create a new window in the *Editor* tool. Equivalent to **Tools** → **Editor** → **New**. For this option to be enabled the focus must be on the *Editor* tool.
Open	Opens a file in the *Editor* tool. The supported file types are: - Parameters (*.par); - Sequences (*.seq); - Compiled Sequences (*.cseq); - Generic text files (*.txt). For this option to be enabled the focus must be on the *Editor* tool.
Save	Save the file being edited in the *Editor* tool. For this option to be enabled the focus must be on the *Editor* tool.
Save As	Save the file being edited in the *Editor* tool under a new name. For this option to be enabled the focus must be on the *Editor* tool.
Save Acquisition	Save an acquisition uploaded from the Controller. An error is displayed if no acquisition is available for saving. For this option to be enabled the focus must be on the *Scope* or *Identification* tools. Refer to Chapter §7 for further information about Controller acquisitions.
Export Acquisition to Excel	Save to Excel an acquisition uploaded from the Controller. An error is displayed if no acquisition is available for saving. For this option to be enabled the focus must be on the *Scope* or *Identification* tools. Refer to Chapter §7 for further information about Controller acquisitions.
Page Setup	Page formatting for hardcopy prints. For this option to be enabled the focus must be on the *Editor* tool.
Print	Print file being edited in the *Editor* tool. For this option to be enabled the focus must be on the *Editor* tool.
Recent Files	List of most recent files that can be opened in the *Editor* tool.
Recover last Downloaded Sequence	Display in the *Editor* tool the last Sequence downloaded from the Controller. For this option to be enabled the focus must be on the *Editor* tool.
Preferences	Configuration of user preferences. Refer to Section §2.5 for further information about user preferences.
Change User	Change user profile. Refer to Section §2.6 for further information about user profiles.
Close Tool	Close the tool with the focus.
Exit ComET	Exit ***ComET4***.

2.1.2. Edit

The options grouped under this Menu are linked to the *Editor* tool:

Undo	Reverse the last editing action.
Redo	Restore the last editing action if no other actions have occurred since the last **Undo**.
Cut	Remove the selected text and place it on the **Clipboard**.
Copy	Copy the selected text onto the **Clipboard**.
Paste	Insert the contents of the **Clipboard** at the current location.
Select All	Select all the text.
Find	Search for the specified text in the **Find** dialog box.
Find Again	Find and select the next occurrence of the text specified in the **Find** dialog box.
Replace	Search for the specified text and replace it with the new text specified in the **Replace** dialog box.
Comment Block	Add the comment character to each line of the selected block of text.
Uncomment Block	Remove the comment character from each line of a selected block of text.
Indent Block	Shift all lines in the selection to the next tab stop.
Unindent Block	Shift all lines in the selection to the previous tab stop.
Insert ISO Header	Insert the ISO header above the first line
Insert Version Header	Insert Version header above the first line related to: - Sequences - K, KL, KF and KD registers - C, CL, CF and CD registers - X, XK, XF and XD registers - LD lookup table - EL trigger - W, WL, WF and WD registers

2.1.3. View

The options grouped under this Menu are linked to the *Registers Editor* tool (refer to Section §11.1 for further information about this tool):

Display in ISO Units	Display information in the *Registers Editor* tool in ISO units.
Display in Incremental Units	Display information in the *Registers Editor* tool in Incremental units.
Display all Registers	Display in the *Registers Editor* tool all registers of ETEL's controllers.
Display all Depths of all Registers	Display in the *Registers Editor* tool all the depths of all registers of ETEL's controllers.
Display only used Registers	Display in the *Registers Editor* tool the registers of the Controller with which the connection is established.
Refresh	Refresh the information displayed in the *Registers Editor* tool.
Full/Normal Scope View	Modify the view of the *Scope* tool. Refer to Section §7.1 for further information on this topic.

2.1.4. Execute

Emergency Stop	Execute an emergency stop of the movement (equivalent to pressing the `Esc` key). The behavior of the **Emergency Stop** can be configured under **File → Preferences → Emergency Stop** (refer to Section §2.5.13 for further details).
Relative Move FORWARDS	Execute a relative movement of the axis in the forward direction. Distance to move is defined on the toolbar relative position control (refer to Section §2.2.10 for further details). Motion settings can be configured under **File → Preferences → Console parameters** (refer to Section §2.5.4 for further details).
Relative Move BACKWARDS	Execute a relative movement of the axis in the backward direction. Distance to move is defined on the toolbar relative position control (refer to Section §2.2.10 for further details). Motion settings can be configured under **File → Preferences → Console parameters** (refer to Section §2.5.4 for further details).
Absolute Move	Execute an absolute movement of the axis to the position defined on the toolbar target position control (refer to Section §2.2.10 for further details). Motion settings can be configured under **File → Preferences → Console parameters** (refer to Section §2.5.4 for further details).
Start/Stop Single Acquisition	Start/Stop a single acquisition in the *Scope* tool. Refer to Section §7.1 for further details.
Start/Stop Continuous Acquisition	Start/Stop a continuous acquisition in the *Scope* tool. Refer to Section §7.1 for further details.
Start/Stop Roll Acquisition	Start/Stop a roll acquisition in the *Scope* tool. Refer to Section §7.1 for further details.

2.1.5. Macros

The options grouped under this Menu correspond to the macros that can be defined in the user preferences dialog box. Refer to Section §2.5.5 for further information on this topic.

2.1.6. Controller

The options grouped under this Menu imply in one way or another the exchange of information with the Controller:

- Download refers to the transmission of information to the Controller;
- Upload refers to retrieving information from the Controller.

Registers	**Download/Upload** Registers to/from the Controller. Registers can be read from/saved to a file or read from/opened in the *Editor* tool. Refer to Section §10.1 for further information on this topic.
Sequence	**Download/Upload** Sequence (program) to/from the Controller. Sequence can be read from/saved to a file or read from/opened in the *Editor* tool. Refer to Section §10.2 for further information on this topic. **Pre-compile** Sequence (program). Sequence to pre-compile can be read from a file or from the *Editor* tool. Refer to Section §8.4.2 for further information on this topic.
Save Configuration to Controller	Save configuration (Registers and Sequence) to the Controller. Refer to Section §10.3 for further information on this topic.

Download Firmware	Download a new firmware to the Controller. Refer to Section §10.4 for further information on this topic.
Controller Backup	Backup Controller configuration and firmware. Refer to Section §10.5 for further information on this topic.
System Configuration Manager	Download/Upload system configuration (***UltimET Light/ADVANCED*** motion controller and one or multiple ***AccurET*** position controllers). Refer to Section §10.6 for further information on this topic.
Download Customer Software Module	Download Customer Software Module to an ***ULTIMET ADVANCED*** motion controller. Refer to Section §8.2.2 for further information on this topic.
Upload Logs	Upload log files from the ***ULTIMET ADVANCED*** motion controller. Refer to Section §7.6 for further information on this topic.

2.1.7. Tools

Startup Wizard	Launches the *Startup Wizard* tool. Refer to Section §2.4 for further details.
Settings	Several tools can be launched from this Menu option: - *Setting* (refer to Section §4.1 for further details); - *Regulation* (refer to Sections §4.2.1 and §4.2.2 for further details); - *Filter Design* (refer to Section §4.2.3 for further details); - *Advanced Feedforward Tuning* (refer to Section §4.2.4 for further details); - *Scale Mapping* (refer to Section §4.2.5 for further details); - *Stage Mapping* (refer to Section §4.2.6 for further details); - *Force Control* (refer to Section §5.1 for further details); - *QuiET* (refer to Section §5.2 for further details); - *ZxT* (refer to Section §5.3 for further details).
Motion	Several tools can be launched from this Menu option: - *S-Curve Profile* (refer to Section §6.1 for further details); - *Console (Point-to-Point)* (refer to Section §6.2 for further details).
Acquisition	Several tools can be launched from this Menu option: - *Scope* (refer to Section §7.1 for further details); - *Viewer* (refer to Section §7.2 for further details); - *Identification* (refer to Section §7.3 for further details); - *Monitor* (refer to Section §7.4 for further details); - *Logging* (refer to Section §7.5 for further details).
Editor	Executes actions related to the *Editor* tool: - **Open**: sets the scope to the last opened window; - **New**: opens a new window.
I/O	Several tools related to I/O can be launched from this Menu option: - *Control*; - *Configuration*. Refer to Chapter §9 for further details.
Registers Editor	Launches the *Registers Editor* tool. Refer to Section §11.1 for further details.
Terminal	Launches the *Terminal* tool. Refer to Section §11.2 for further details.
Unit Converter	Launches the *Unit Converter* tool. Refer to Section §11.3 for further details.
System Reporting	Launches the *System Reporting* tool. Refer to Section §11.4 for further details.
Processor Load	Launches the *Processor Load* tool. Refer to Section §11.5 for further details.
Add-ons	Tools reserved for advanced users (super user profile).

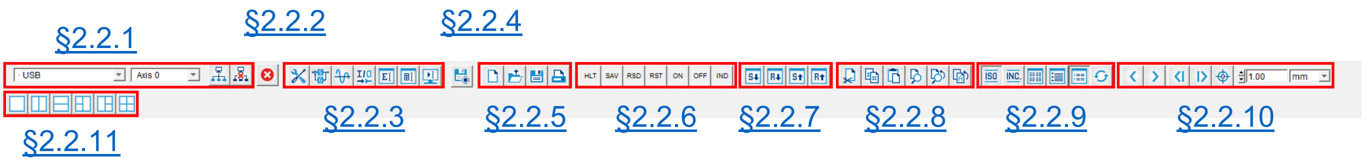
2.1.8. Help

Error List	Open in the default Web browser (HTML format) the list of Controller errors. Besides short description of the error, it includes hints to possible root causes.
Warning List	Open in the default Web browser (HTML format) the list of Controller warnings. Besides short description of the warning, it includes hints to possible root causes.
Software Documentation	Collection of software related documentation of ETEL motion control products. These documents are in PDF format requiring Adobe Acrobat Reader.
Hardware Documentation	Collection of hardware related documentation of ETEL motion control products. These documents are in PDF format requiring Adobe Acrobat Reader.
Technical Notes	Collection of technical notes related to very specific topics. These documents are in PDF format requiring Adobe Acrobat Reader.
License	***ComET4*** and Firmware license agreements. These documents are in PDF format requiring Adobe Acrobat Reader.
About ComET	***ComET4*** about dialog box.

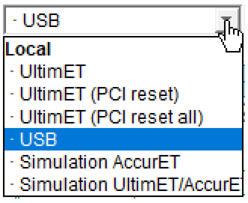
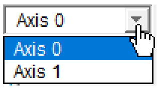
NOTE	Contact an ETEL representative to obtain the latest version of the documentation.

2.2. Toolbar

The toolbar controls are organized in 11 groups according to their functionality.



2.2.1. Connection

	
	**Local connection drop-down list** List of available local connections. The user can configure which options are visible in this drop-down list under **File → Preferences →Start-up → Available connections** (refer to Section §2.5.1 for further details).
 	**Axis drop-down list** List of available axes for the selected connection. When the user selects an option from the **Local connection drop-down list**, ***ComET4*** tries to establish communication with the first available axis on this connection. Refer to Section §3.1 for further details. When two axes are configured to work in Gantry mode, a square bracket is displayed to indicate that both axes are "linked".
	Connection to Host

	Open connection with a remote host. Refer to Section §3.1 for further details.
	Close Bus Close the connection.

2.2.2. Emergency stop

	Emergency Stop Execute an emergency stop of the movement (equivalent to pressing the `Esc` key). The behavior of this button can be configured under **File → Preferences → Emergency Stop** (refer to Section §2.5.13 for further details).

2.2.3. Tools

	The *Setting* tool is used to rapidly configure the parameters of the position controllers and to automatically set the protections of the system. When performing a new setting, the user is guided through a wizard to follow a step-by-step process of configuring the Controller.
	The *Regulation* tool is usually used after the *Setting* tool to fine tune the regulation parameters of the position controllers.
	The *Scope* tool can be used to monitor the parameters (`K` registers), monitoring (`M` registers) and user variables (`X` registers) of any axis. It supports up to 4 simultaneous channels.
I/O	The *I/O Control* tool is used to monitor and manage the different inputs and outputs of the Controller and/or its optional board. Additionally, it allows the user to set specific functions dedicated to the inputs and outputs.
E	The *Editor* tool is used to write and debug a Sequence for a Controller. It includes all basic features of a simple text processing application and an automatic syntax coloring feature.
	The *Registers Editor* tool is used to view and/or modify the Controller's Registers which are organized by categories.
	The *Terminal* tool is used to directly send commands, inquire and modify the value of Registers of the motion controller and of one or several position controllers.

2.2.4. Save configuration to controller

	Save configuration (Registers and Sequence) to the Controller. Refer to Section §10.3 for further information on this topic.

2.2.5. Editor

	Create a new window in the *Editor* tool.
	Open a file in the *Editor* tool.
	Save the file being edited in the *Editor* tool.
	Print file being edited in the *Editor* tool.

Refer to Section §2.1.1 for further information.

2.2.6. Macros

HLT SAV RSD RST ON OFF IND	
HLT	Execute the **HLT** macro.
SAV	Execute the **SAV** macro.
RSD	Execute the **RSD** macro.
RST	Execute the **RST** macro.
ON	Execute the **ON** macro.
OFF	Execute the **OFF** macro.
IND	Execute the **IND** macro.

Refer to Section §2.5.5 for further information about the configuration of Macros.

2.2.7. Registers/Sequence

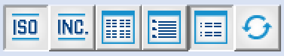
S↓ R↓ S↑ R↑	
S↓	Download Sequence (program) to the Controller. Sequence is read from the *Editor* tool. Refer to Section §10.2 for further information on this topic.
R↓	Download Registers (parameters) to the Controller. Registers are read from the *Editor* tool. Refer to Section §10.1 for further information on this topic.
S↑	Upload Sequence (program) from the Controller. Sequence is opened in the *Editor* tool. Refer to Section §10.2 for further information on this topic.
R↑	Upload Registers (parameters) from the Controller. Registers are opened in the *Editor* tool. Refer to Section §10.1 for further information on this topic.

2.2.8. Edit

✂ ⧉ 📋 🔍	
✂	Remove the selected text in the *Editor* window and place it on the **Clipboard**.
⧉	Copy the selected text in the *Editor* window onto the **Clipboard**.
📋	Insert the contents of the **Clipboard** at the current location in the *Editor* window.
🔍	Search in the *Editor* window for the specified text in the **Find** dialog box.

	Find and select the next occurrence in the *Editor* window of the text specified in the **Find** dialog box.
	Search in the *Editor* window for the specified text and replace it with the new text specified in the **Replace** dialog box.

2.2.9. View



ISO	Display information in the *Registers Editor* tool in ISO units.
INC.	Display information in the *Registers Editor* tool in Incremental units.
▦	Display in the *Registers Editor* tool all registers of ETEL's controllers.
☰	Display in the *Registers Editor* tool all the depths of all registers of ETEL's controllers.
☷	Display in the *Registers Editor* tool the registers of the Controller with which the connection is established.
⟳	Refresh the information displayed in the *Registers Editor* tool.

Refer to Section §11.1 for further information about the *Registers Editor* tool.

2.2.10. Motion

<	Execute a jog movement of the axis in the backward direction. Motion settings can be configured under **File → Preferences → Console parameters** (refer to Section §2.5.4 for further details).
>	Execute a jog movement of the axis in the forward direction. Motion settings can be configured under **File → Preferences → Console parameters** (refer to Section §2.5.4 for further details).
<|	Execute a relative movement of the axis in the backward direction. Distance to move is defined on the relative position control. Motion settings can be configured under **File → Preferences → Console parameters** (refer to Section §2.5.4 for further details).
|>	Execute a relative movement of the axis in the forward direction. Distance to move is defined on the relative position control. Motion settings can be configured under **File → Preferences → Console parameters** (refer to Section §2.5.4 for further details).
⌖	Execute an absolute movement of the axis to the position defined on the target position control. Motion settings can be configured under **File → Preferences → Console parameters** (refer to Section §2.5.4 for further details).
 1.00 mm	Dual-purpose control: Relative position control: distance to move for relative movements; or Target position control: target position for an absolute movement. Select the units accordingly.

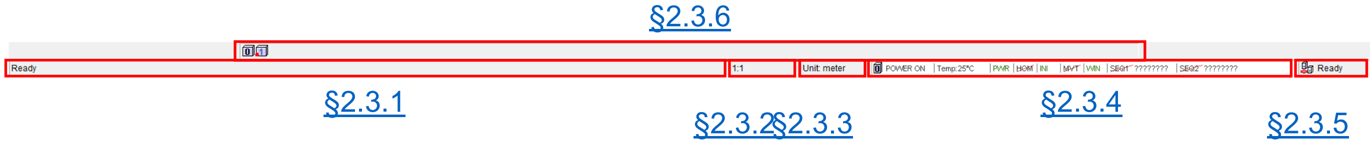
2.2.11. Interface layout

Group of buttons for organizing ***ComET4***'s desktop interface layout according to preferences.

☐ ◫ ⊟ ◫ ◫ ⊞	
☐	Interface layout of a single region (layout 1x1).
◫	Interface layout divided in two regions (layout 1x2).
⊟	Interface layout divided in two regions (layout 2x1).
◫	Interface layout divided in three regions (layout 2-1x2).
◫	Interface layout divided in three regions (layout 1-2x2).
⊞	Interface layout divided in four regions (layout 2x2).

2.3. Status bar

The status of the position and motion controllers is displayed in the **Status bar** at the bottom area of ***ComET4*** application. The information displayed on the **Status bar** can be grouped by 6 topics.



2.3.1. General status

Ready	***ComET4*** general status.

2.3.2. Editor

1:1	Line:Column where the cursor is placed in the *Editor* window.

2.3.3. Units

Unit: meter	Selected default position unit of the current axis (refer to Section §2.5.3 for further information on how to configure the default units used by ***ComET4***).

2.3.4. Status of the selected controller

0 ACCURET READY | Temp:25°C | ~~PWR~~ | ~~HOM~~ | ~~INI~~ | ~~MVT~~ | WIN | ~~SEG1~~ ???????? | ~~SEG2~~ ????????	
0 ACCURET READY	Controller status.
0 POWER ON	If the axis is powered on, the axis number is displayed in **bold**.
0 W SEQUEN BRKPOIN	If the selected axis is in warning, a full orange circle and warning message are displayed (there are many types of warning that can be raised by the Controller; for further information press the `F9` key to open a list of the most common warnings).

SWITCH OFF & ON	If the selected axis is in error, a full red circle and error message are displayed (there are many types of error that can be raised by the Controller; for further information press the `F2` key to open a list of the most common errors).
Temp:25°C	Temperature of the Controller.
~~PWR~~ / PWR	Power off / on
~~HOM~~ / HOM	Homing not done / done
~~INI~~ / INI	Initial phasing not done / done
~~MVT~~ / MVT	Stopped / In motion
~~WIN~~ / WIN	Not in-window / In-window
~~SEQ1~~ ???????? SEQ1 ???????? SEQ1 00003071	Sequence thread #1 not used / used, but not running / running (the number identifies the Sequence line being executed). Refer to Section §8.1 for further information about Sequence programming.
~~SEQ2~~ ???????? SEQ2 ???????? SEQ2 00001092	Sequence thread #2 not used / used, but not running / running (the number identifies the Sequence line being executed). Refer to Section §8.1 for further information about Sequence programming.
~~SEQ3~~ ???????? SEQ3 ???????? SEQ3 00000289	Sequence thread #3 not used, used, but not running / running (the number identifies the Sequence line being executed). Refer to Section §8.1 for further information about Sequence programming. Only ***UltimET Light*** motion controllers can have 3 threads.

2.3.5. Status of communication

Ready	Connection is well established with a Controller.
Warning	A TCP/IP connection is established with an ***AccurET*** position controller, but it is momentarily irresponsive; or multiple parallel USB connections are established with ***AccurET*** position controllers, but the axis identifiers are not unique.
Timeout Erro	Connection with a Controller is interrupted (the error is specified in the text that follows the icon).
Bridge Boot	Connection is well established with an ***UltimET*** motion controller (***TransnET*** master) and ***ComET4*** is downloading firmware to ***AccurET*** position controller(s) (***TransnET*** slave(s)); or multiple parallel USB connections are established with ***AccurET*** position controllers and ***ComET4*** is downloading firmware.
Direct Boot	Connection is well established with an ***UltimET*** motion controller (***TransnET*** master) and ***ComET4*** is downloading firmware to this Controller.

2.3.6. Status of all controllers

0 1	
0	Identifies an axis of an ***AccurET*** position controller (contains an alphanumeric character).
*	Identifies an ***UltimET Light/ADVANCED*** motion controller (contains the * character).
0	Axis powered off (axis number in plain text).
0	Axis powered on (axis number in **bold** text).
1	Axis in warning (full orange circle on left lower corner).
1	Axis in error due to another axis (empty red circle on left lower corner). Occurs when the error propagation feature is enabled and another axis is in error.
1	Axis in error (full red circle on left lower corner).
0 1	Two axis are configured to work in Gantry mode (black square in the background).

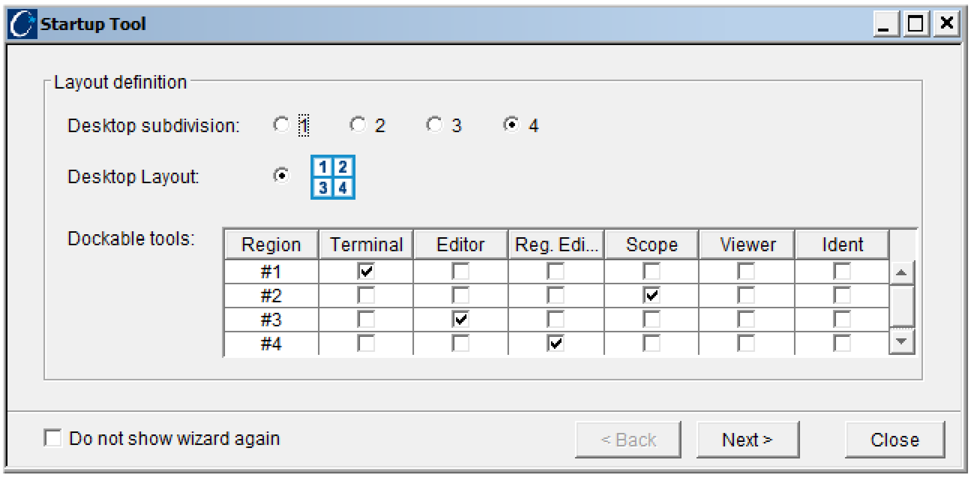
2.4. Startup wizard

By default, the *Startup Wizard* tool is executed automatically at start-up of ***ComET4***. This 5-panel wizard is particularly useful for beginners, guiding through the steps of configuring the desktop layout, establishing a connection with a Controller, performing a basic setting, sending initial commands, moving an axis, performing regulation fine tuning, editing parameters, etc.

TIP	To prevent the *Startup Wizard* tool from executing automatically at start-up, check the option **Do not show wizard again**. It is always possible to revert this action by launching the *Startup Wizard* tool from **Tools → Startup Wizard** and unchecking the option **Do not show this wizard again**.

2.4.1. Panel #1: Layout definition

On this first panel, the user can set the preferences for the desktop's interface layout. This area can be sub-divided up to 4 regions (refer to §2) and the user can select which tools to display at start-up. The options are the *Terminal*, *Editor*, *Registers Editor*, *Scope*, *Viewer* and *Identification*.



Desktop subdivision: ○ 1 ○ 2 ○ 3 ● 4

Desktop Layout: ● 1 2 3 4

Dockable tools:

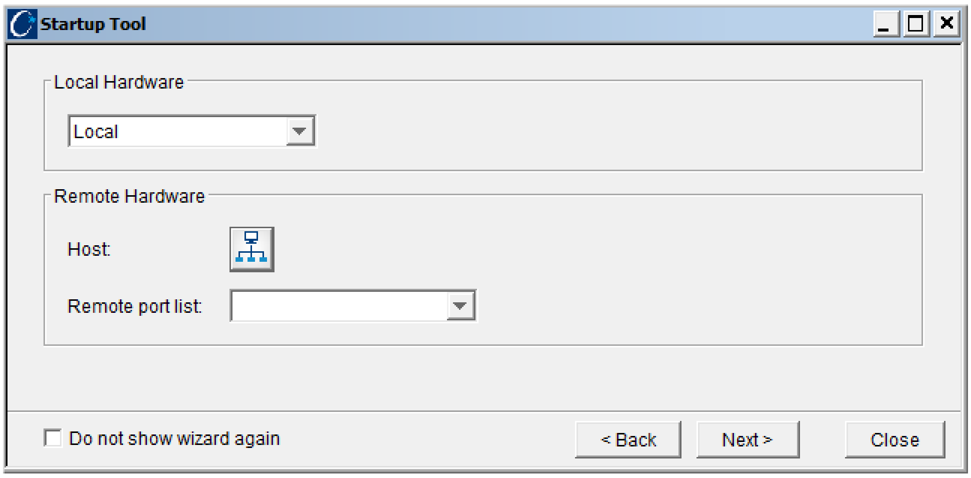
Region	Terminal	Editor	Reg. Edi...	Scope	Viewer	Ident
#1	☑	☐	☐	☐	☐	☐
#2	☐	☐	☐	☑	☐	☐
#3	☐	☑	☐	☐	☐	☐
#4	☐	☐	☑	☐	☐	☐

☐ Do not show wizard again

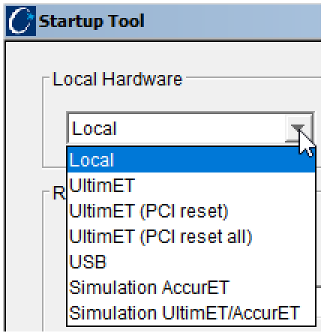
To proceed to the next panel, click on the **Next** button. Alternatively, close the wizard by clicking on the **Close** button.

2.4.2. Panel #2: Connection

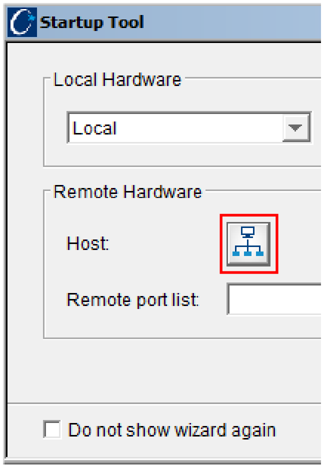
On the second panel the user can establish a connection with a Controller.

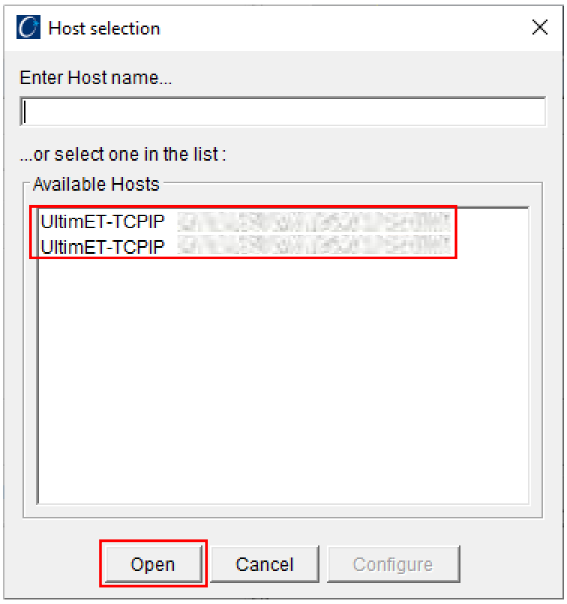


The Controller can be selected from the **Local Hardware** drop-down list:



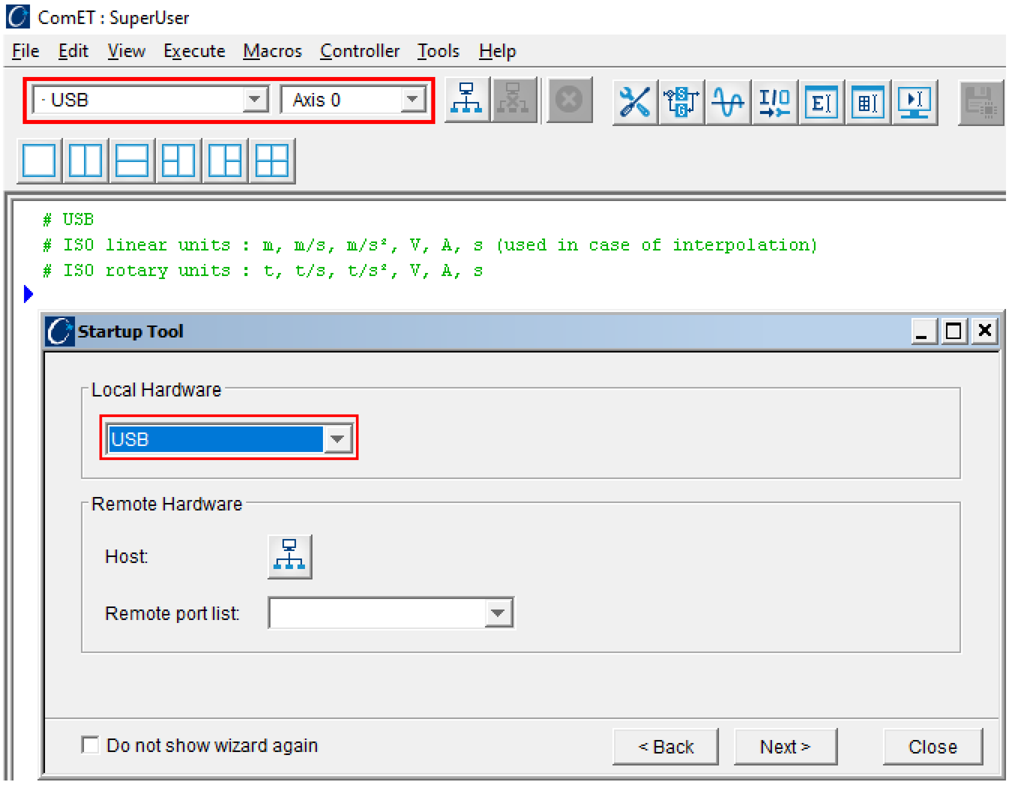
Or, the user can click on the **Remote Hardware** button, select a Controller from the **Available Hosts** list on the **Host selection** dialog box and click the **Open** button to establish the connection.





TIP	The **Toolbar Connection** group buttons can also be used to establish a connection with a Controller. For further information, refer to Section §2.2.1.

When the communication is successfully established, the selected local or remote hardware is displayed in the corresponding panel drop-down list and in the top left corner of the **Toolbar** (USB in this example).

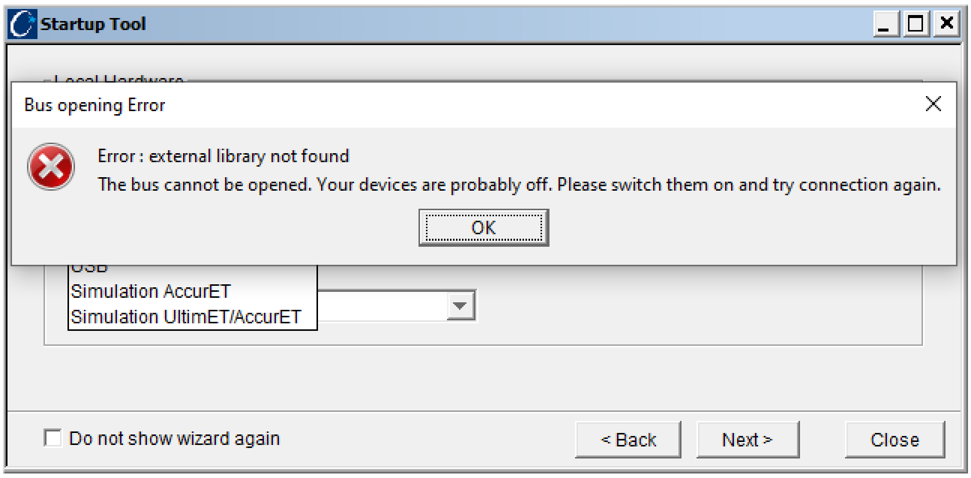


```
# USB
# ISO linear units : m, m/s, m/s², V, A, s (used in case of interpolation)
# ISO rotary units : t, t/s, t/s², V, A, s
```

Local Hardware: USB

Remote Hardware
Host:
Remote port list:

However, if the selected Controller is not reachable, the following error is displayed:



Bus opening Error

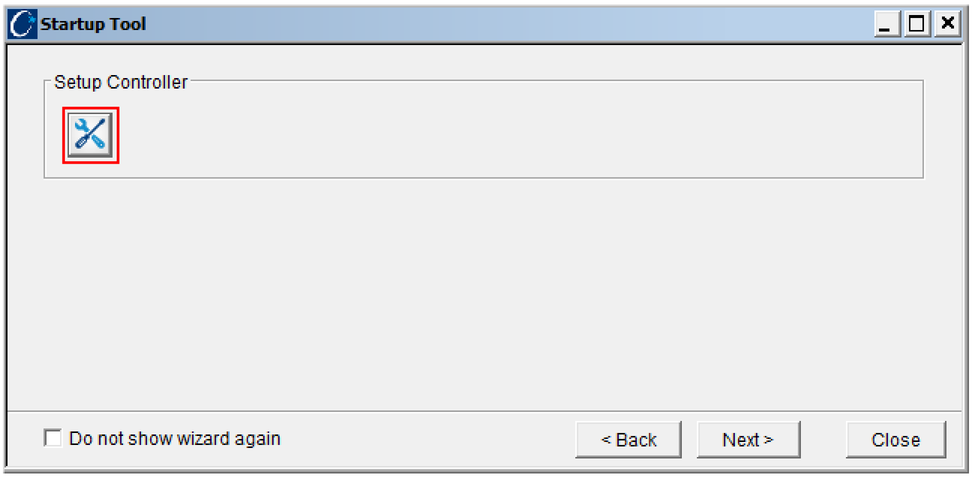
Error : external library not found
The bus cannot be opened. Your devices are probably off. Please switch them on and try connection again.

NOTE	Check if the Controller is powered on, if there are no problems with the cabling (power and communication cables), USB or PCI/PCIe drivers' installations. If necessary, contact ETEL's technical support team.

To proceed to the next panel, click on the **Next** button. Alternatively, close the wizard by clicking on the **Close** button.

2.4.3. Panel #3: Setup Controller

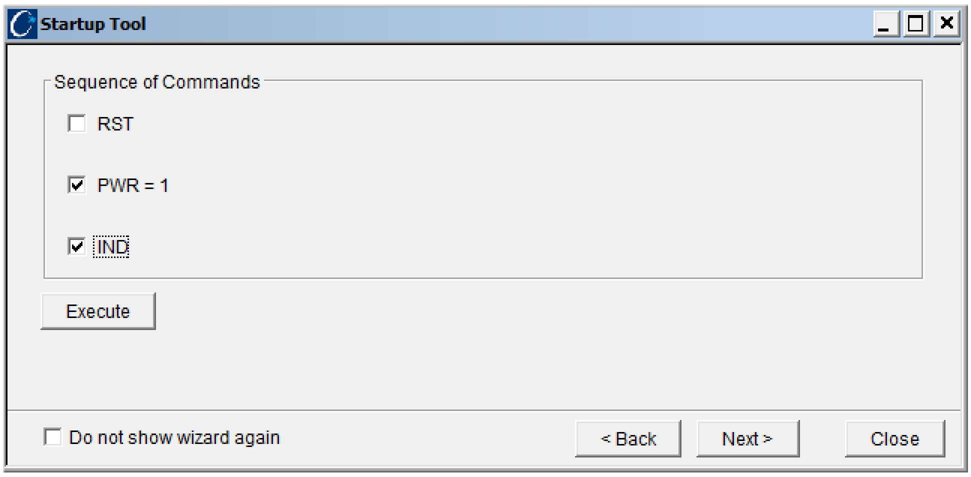
On this third panel the user can launch the *Setting* tool to configure the Controller. For further information on how to use this tool, please refer to Section §4.1.



☐ Do not show wizard again

2.4.4. Panel #4: Initial commands

On the fourth panel the user can select a set of basic commands to send to the Controller.



☐ RST

☑ PWR = 1

☑ IND

☐ Do not show wizard again

The three commands that can be selected are:

Commands	Description
`RST`	Reset the Controller
`PWR = 1`	Power on the position controller axis
`IND`	Execute a homing of the position controller axis

Click on the **Execute** button to send the selected commands to the Controller. These are executed one by one on the same order as they are displayed.

NOTE

If the connection is established with a Controller that does not support these commands (e.g. `PWR` and `IND` are not supported by the ***UltimET Light/ADVANCED*** motion controllers), these are simply ignored.

No warning or error is raised by the *Startup* wizard tool while sending these commands if the connection with the Controller has been lost for some reason in the meantime.

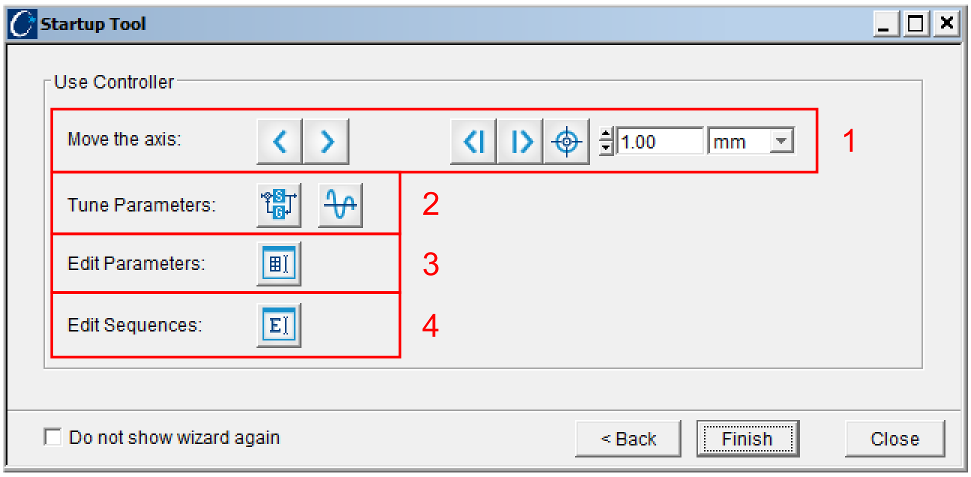
For more information about these commands, please refer to the *AccurET Modular Position Controller Operation & Software Manual* available under the **Help** menu.

To proceed to the next panel, click on the **Next** button. Alternatively, close the wizard by clicking on the **Close** button.

2.4.5. Panel #5: Use Controller

On the last panel of the *Startup Wizard* tool, the user can perform several operations:

1. Move an axis using the **Motion** controls. These controls are the same as the **Motion** controls on the toolbar (refer to Section §2.2.10 for further details);
2. Perform fine tuning of the Controller's motion control parameters (refer to Section §4.2 for further details);
3. Edit Controller parameters using the *Registers Editor* tool (refer to Section §11.1 for further details); and
4. Edit a Sequence using the *Editor* tool (refer to Chapter §8 for further details).

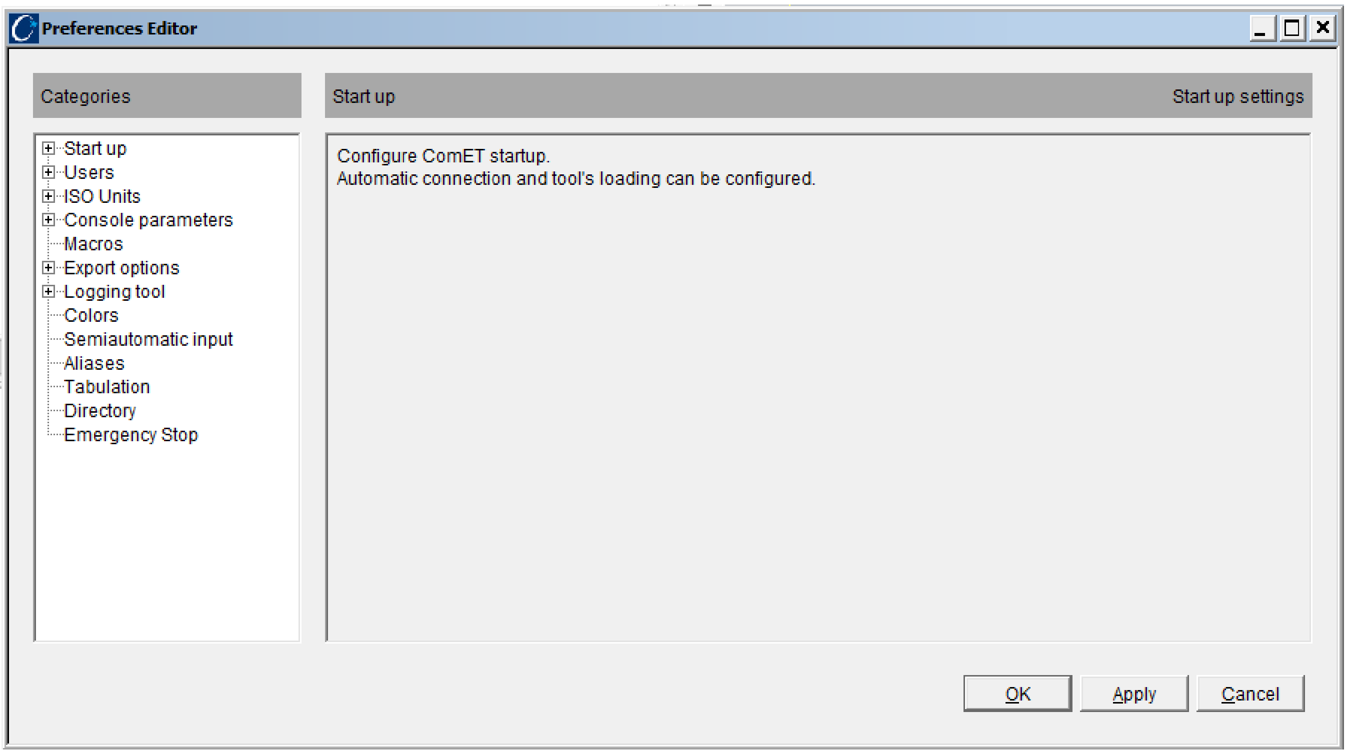


WARNING

Always ensure that the proper safety precautions are taken when powering on a Controller and executing movements with a motion system.

2.5. User preferences

To customize ***ComET4*** interface select the Menu option **File → Preferences**.

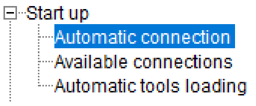


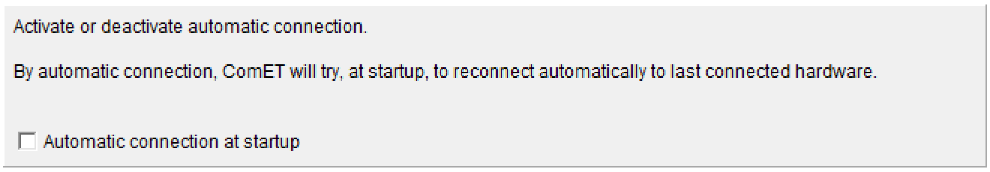
Configure ComET startup.
Automatic connection and tool's loading can be configured.

2.5.1. Startup

Configure the behavior of ***ComET4*** at start-up:

- **Automatic connection**: automatically establish connection with the last hardware connected during the previous session.
- **Available connections**: configure which connections are available for selection in the connection combo box located in the toolbar left side (refer to Section §2.2.1 for further details about the Communication controls located on the Toolbar).
- **Automatic tools loading**: automatically load all tools being executed last during the previous session.

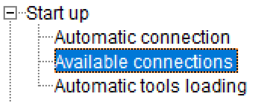


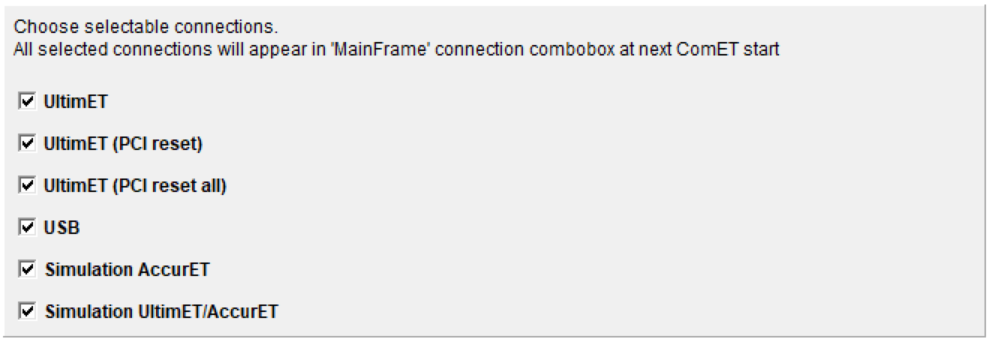


Activate or deactivate automatic connection.

By automatic connection, ComET will try, at startup, to reconnect automatically to last connected hardware.

☐ Automatic connection at startup





Choose selectable connections.
All selected connections will appear in 'MainFrame' connection combobox at next ComET start

☑ **UltimET**

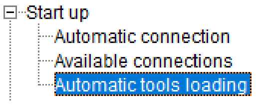
☑ **UltimET (PCI reset)**

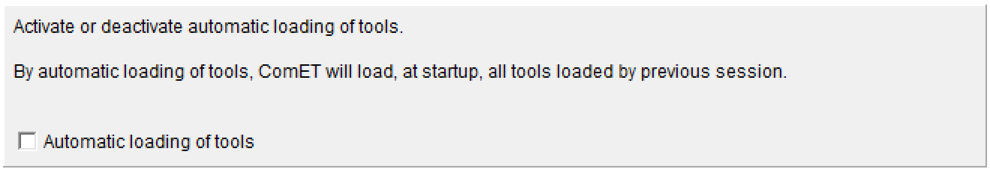
☑ **UltimET (PCI reset all)**

☑ **USB**

☑ **Simulation AccurET**

☑ **Simulation UltimET/AccurET**





Activate or deactivate automatic loading of tools.

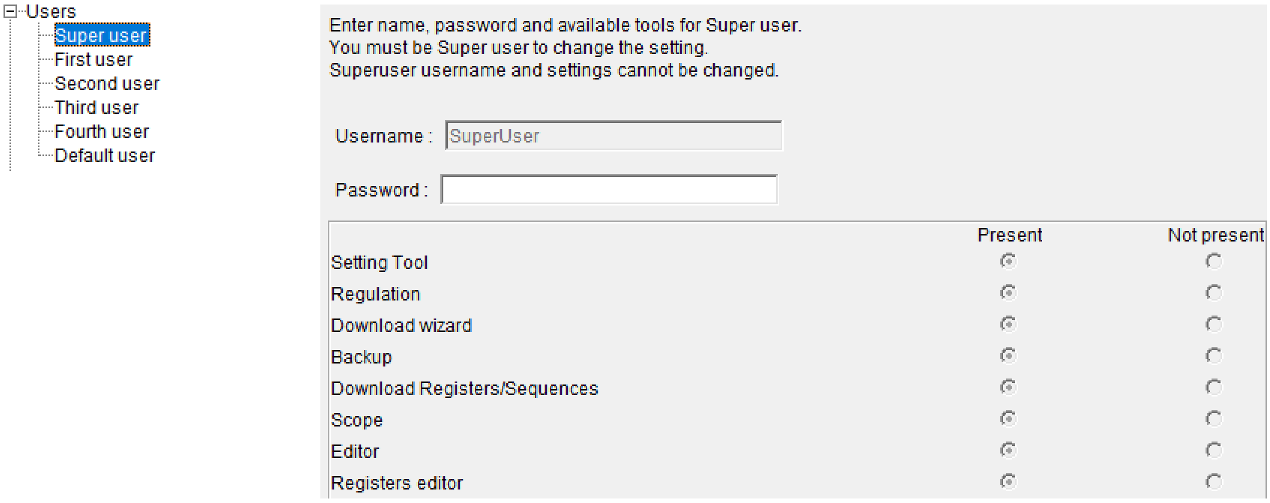
By automatic loading of tools, ComET will load, at startup, all tools loaded by previous session.

☐ Automatic loading of tools

2.5.2. Users

Modify the configuration of the user profiles, more specifically:
- Username and password;
- Selection of tools that can be used by the corresponding profile.

The username of the "SuperUser" profile cannot be modified. The password of the "Default user" profile cannot be modified. ***ComET4*** will start-up with the first user profile not having any password defined. If all users have a password defined, ***ComET4*** will use the "Default user" profile.



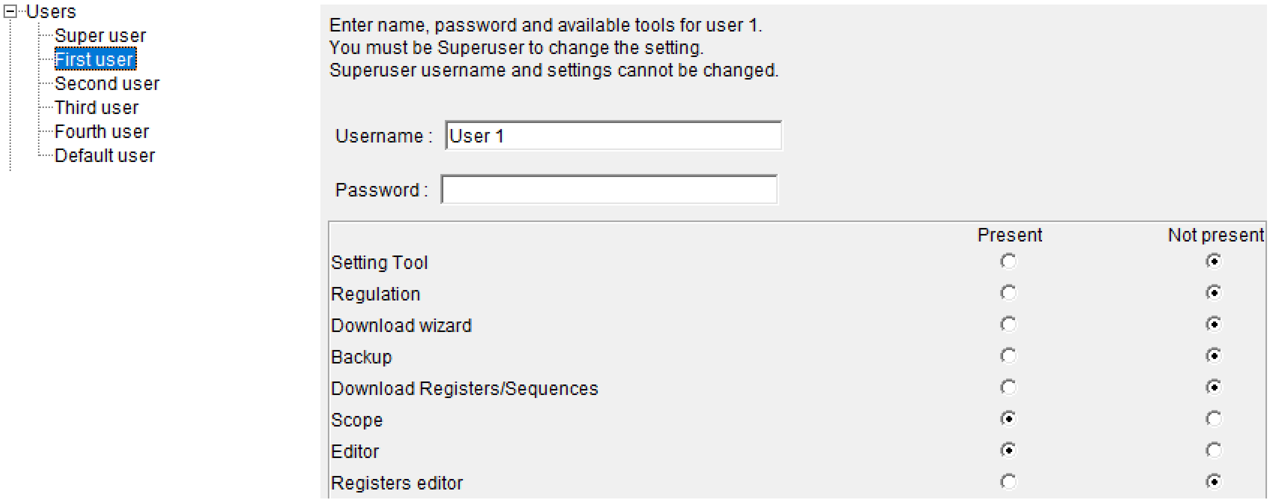
- Users
  - Super user
  - First user
  - Second user
  - Third user
  - Fourth user
  - Default user

Enter name, password and available tools for Super user.
You must be Super user to change the setting.
Superuser username and settings cannot be changed.

Username : SuperUser

Password :

	Present	Not present
Setting Tool	●	○
Regulation	●	○
Download wizard	●	○
Backup	●	○
Download Registers/Sequences	●	○
Scope	●	○
Editor	●	○
Registers editor	●	○



- Users
  - Super user
  - First user
  - Second user
  - Third user
  - Fourth user
  - Default user

Enter name, password and available tools for user 1.
You must be Superuser to change the setting.
Superuser username and settings cannot be changed.

Username : User 1

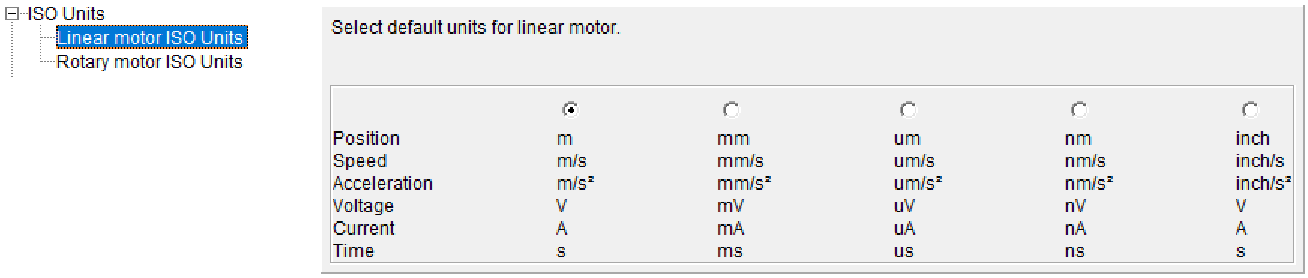
Password :

	Present	Not present
Setting Tool	○	●
Regulation	○	●
Download wizard	○	●
Backup	○	●
Download Registers/Sequences	○	●
Scope	●	○
Editor	●	○
Registers editor	○	●

IMPORTANT	Make sure the "SuperUser" password is stored in a secure location, as it cannot be recovered nor reset. ***ComET4*** software needs to be reinstalled if the "SuperUser" password is lost. Other passwords can be reset only if the "SuperUser" password is known.

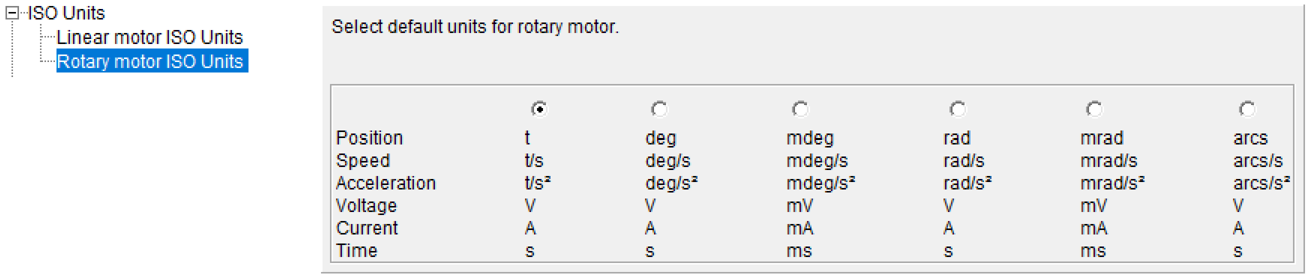
2.5.3. ISO Units

Modify the units (linear and rotary axis) used by the *Terminal* tool.



Select default units for linear motor.

	●	○	○	○	○
Position	m	mm	um	nm	inch
Speed	m/s	mm/s	um/s	nm/s	inch/s
Acceleration	m/s²	mm/s²	um/s²	nm/s²	inch/s²
Voltage	V	mV	uV	nV	V
Current	A	mA	uA	nA	A
Time	s	ms	us	ns	s

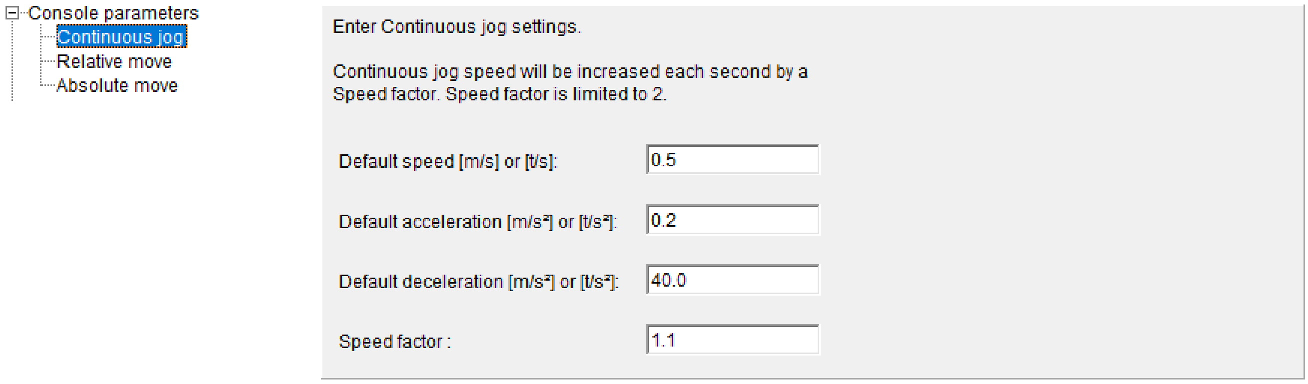


Select default units for rotary motor.

	●	○	○	○	○	○
Position	t	deg	mdeg	rad	mrad	arcs
Speed	t/s	deg/s	mdeg/s	rad/s	mrad/s	arcs/s
Acceleration	t/s²	deg/s²	mdeg/s²	rad/s²	mrad/s²	arcs/s²
Voltage	V	V	mV	V	mV	V
Current	A	A	mA	A	mA	A
Time	s	s	ms	s	ms	s

2.5.4. Console parameters

Modify the parameters values for the Toolbar motion controls and *Startup Wizard* tool:
- Continuous jog;
- Relative move;
- Absolute move.



Enter Continuous jog settings.

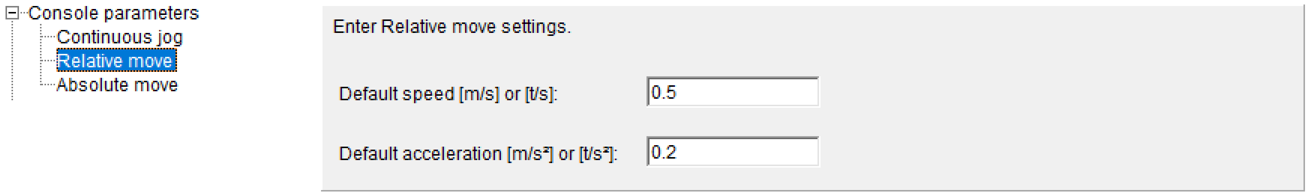
Continuous jog speed will be increased each second by a Speed factor. Speed factor is limited to 2.

Default speed [m/s] or [t/s]: 0.5

Default acceleration [m/s²] or [t/s²]: 0.2

Default deceleration [m/s²] or [t/s²]: 40.0

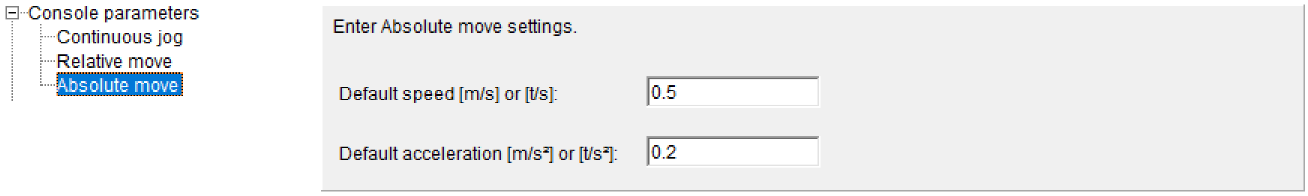
Speed factor : 1.1



Enter Relative move settings.

Default speed [m/s] or [t/s]: 0.5

Default acceleration [m/s²] or [t/s²]: 0.2



Enter Absolute move settings.

Default speed [m/s] or [t/s]: 0.5

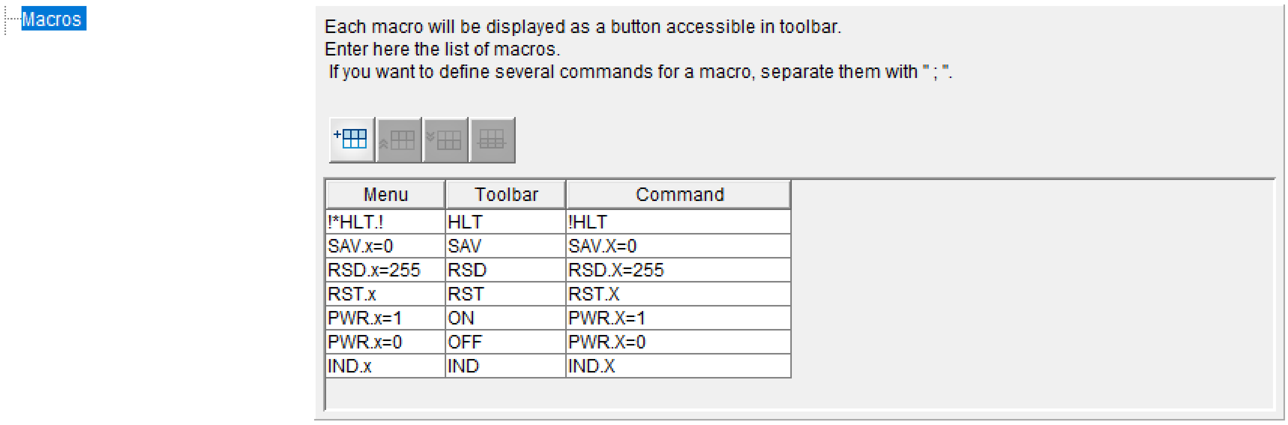
Default acceleration [m/s²] or [t/s²]: 0.2

2.5.5. Macros

Define customized buttons on the Toolbar for executing one or several commands. The default macros are:

- `!HLT`: (urgent) command for stopping the movement with maximum deceleration supported by the Controller and interrupting the execution of the Sequence running;
- `SAV.x = 0`: command for saving Sequence, Registers (`LD`, `K`, `C`, `EL`, `X`), `P` stage error mapping variables and axis number to Controller flash memory;
- `RSD.x = 255`: command for resetting Controller hardware;
- `RST.x`: command for resetting Controller error flags;
- `PWR.x = 1`: command for powering on the axis;
- `PWR.x = 0`: command for powering off the axis;
- `IND.x`: command for performing a homing of the axis.

For more information about these commands, refer to the *AccurET Modular Position Controller Operation & Software Manual*.



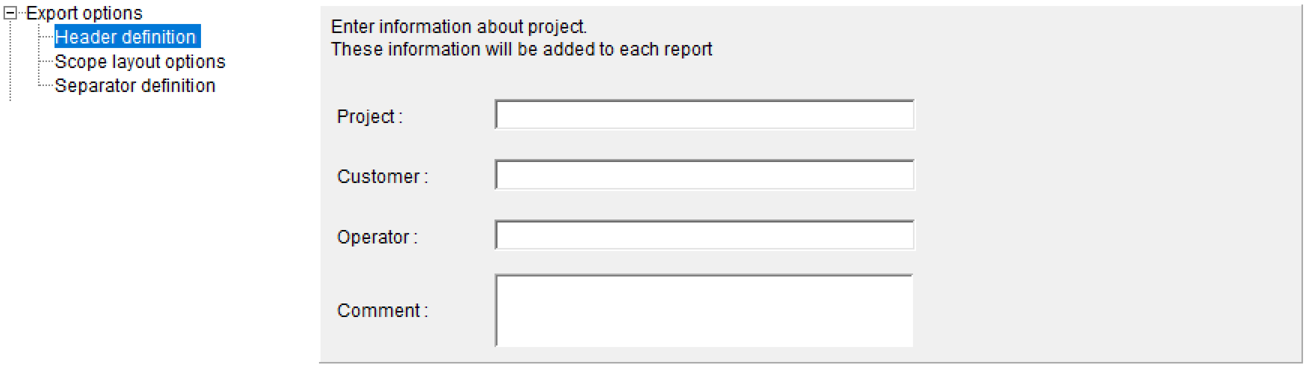
Each macro will be displayed as a button accessible in toolbar.
Enter here the list of macros.
If you want to define several commands for a macro, separate them with " ; ".

Menu	Toolbar	Command
!*HLT.!	HLT	!HLT
SAV.x=0	SAV	SAV.X=0
RSD.x=255	RSD	RSD.X=255
RST.x	RST	RST.X
PWR.x=1	ON	PWR.X=1
PWR.x=0	OFF	PWR.X=0
IND.x	IND	IND.X

2.5.6. Export options

Configure the layout of the data exported to file:

- Header definition: configure the header information to be included on every file;
- Scope layout options: configure how to save data acquired with a mix of sampling rates;
- Separator definition: configure the character used to separate information saved to file.



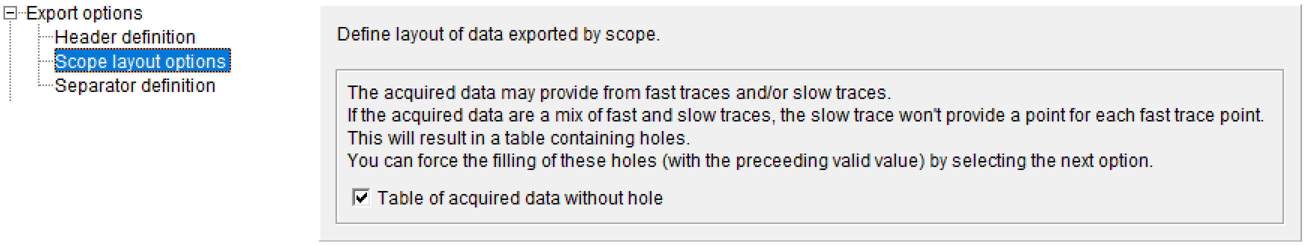
Enter information about project.
These information will be added to each report

Project :

Customer :

Operator :

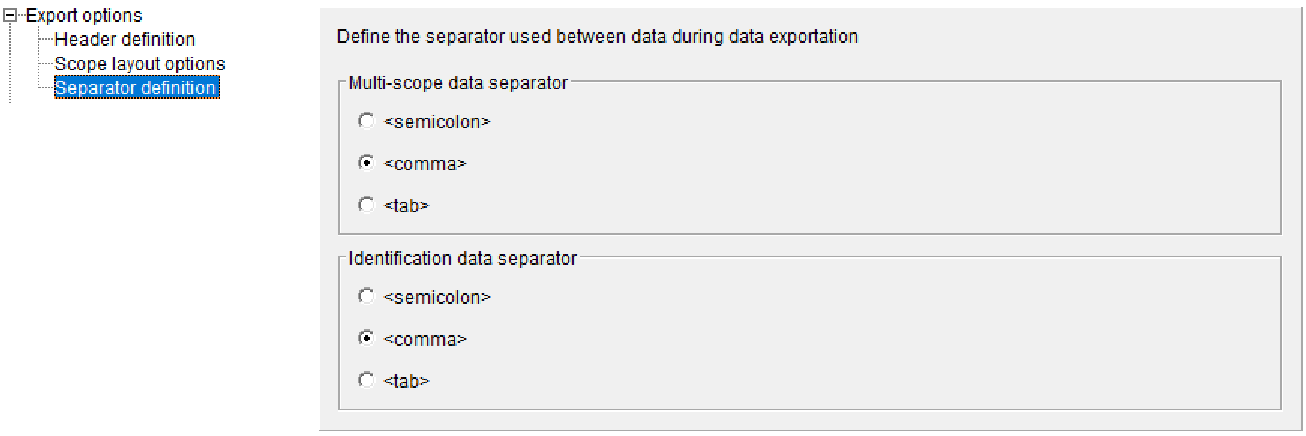
Comment :



Define layout of data exported by scope.

The acquired data may provide from fast traces and/or slow traces.
If the acquired data are a mix of fast and slow traces, the slow trace won't provide a point for each fast trace point.
This will result in a table containing holes.
You can force the filling of these holes (with the preceeding valid value) by selecting the next option.

☑ Table of acquired data without hole



Define the separator used between data during data exportation

Multi-scope data separator

○ <semicolon>
● <comma>
○ <tab>

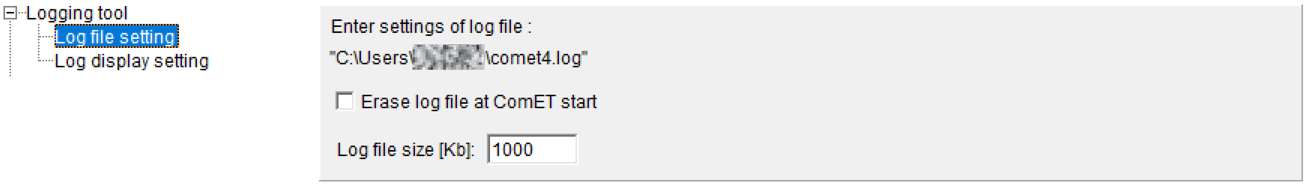
Identification data separator

○ <semicolon>
● <comma>
○ <tab>

2.5.7. Logging tool

Configure the behavior of the *Logging* tool:

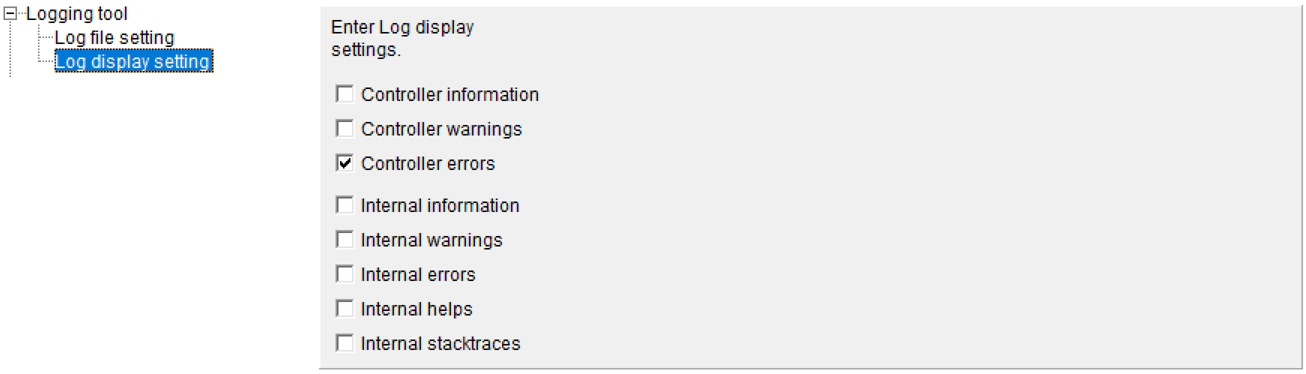
- Should the log file be erased at each start-up of ***ComET4***;
- What is the maximum file size (when the maximum file size is reached a new log file is created);
- What information to display and log.



Enter settings of log file :
"C:\Users\[redacted]\comet4.log"

☐ Erase log file at ComET start

Log file size [Kb]: 1000

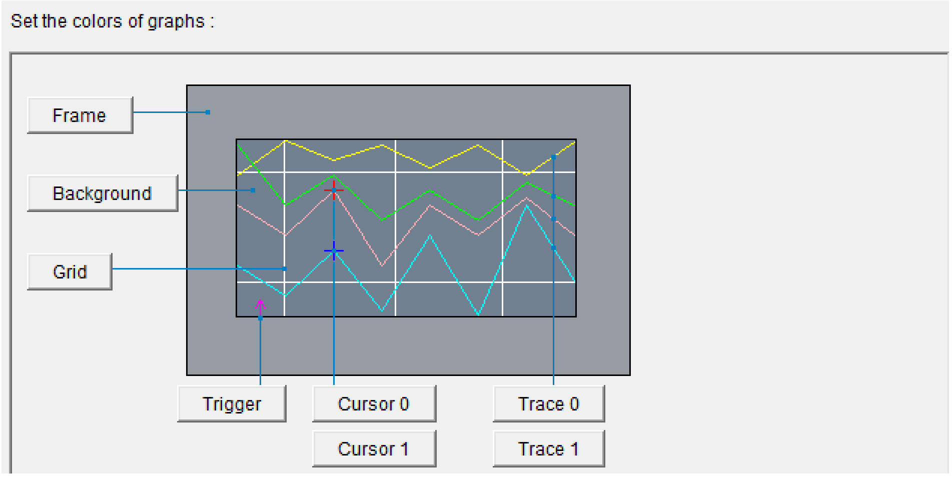


Enter Log display settings.

☐ Controller information
☐ Controller warnings
☑ Controller errors
☐ Internal information
☐ Internal warnings
☐ Internal errors
☐ Internal helps
☐ Internal stacktraces

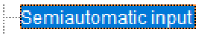
2.5.8. Colors

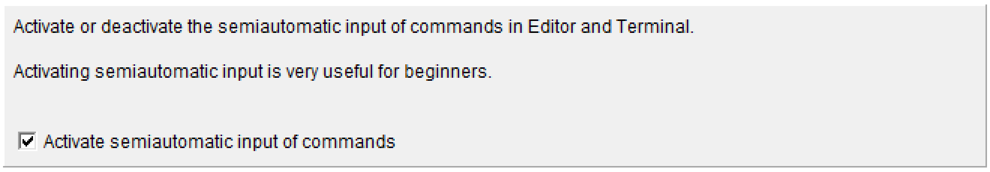
Configure the color scheme used by the *Scope* tool.


Set the colors of graphs :

2.5.9. Semiautomatic input

Configure the use of the semiautomatic input feature when typing commands in the *Editor* and *Terminal* tools.
Refer to Sections §8.1.1 and §11.2 for further information on this topic.



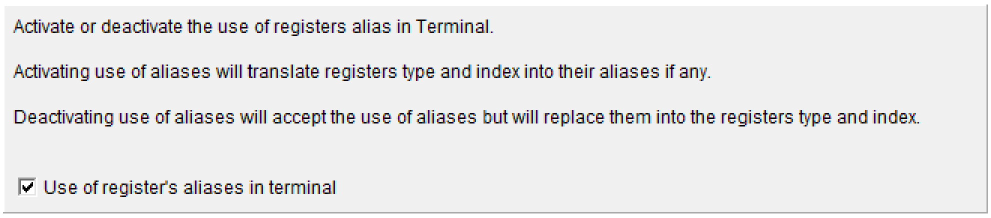

Activate or deactivate the semiautomatic input of commands in Editor and Terminal.

Activating semiautomatic input is very useful for beginners.

☑ Activate semiautomatic input of commands

2.5.10. Aliases

Configure the use of registers' alias in the *Terminal* tool. Refer to Section §11.2 for further information on this topic.
For more information about alias, refer to the *AccurET Modular Position Controller Operation & Software Manual* and *UltimET Light Motion Controller User's Manual*.


Activate or deactivate the use of registers alias in Terminal.

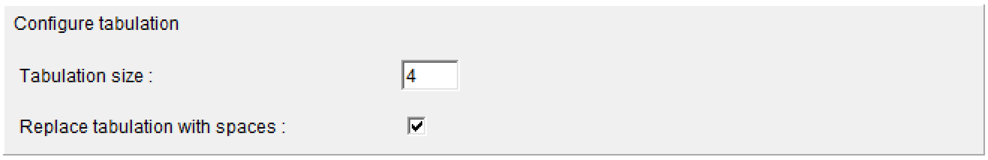
Activating use of aliases will translate registers type and index into their aliases if any.

Deactivating use of aliases will accept the use of aliases but will replace them into the registers type and index.

☑ Use of register's aliases in terminal

2.5.11. Tabulation

Configure the tab settings used in the *Editor* tool for text alignment.

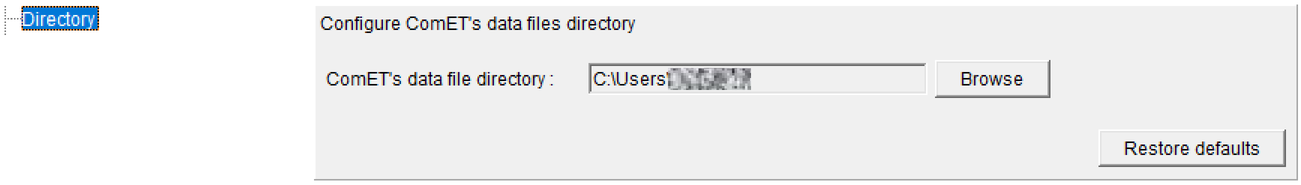

Configure tabulation

Tabulation size : 4

Replace tabulation with spaces : ☑

2.5.12. Directory

Configure ***ComET4***'s default folder for data files.

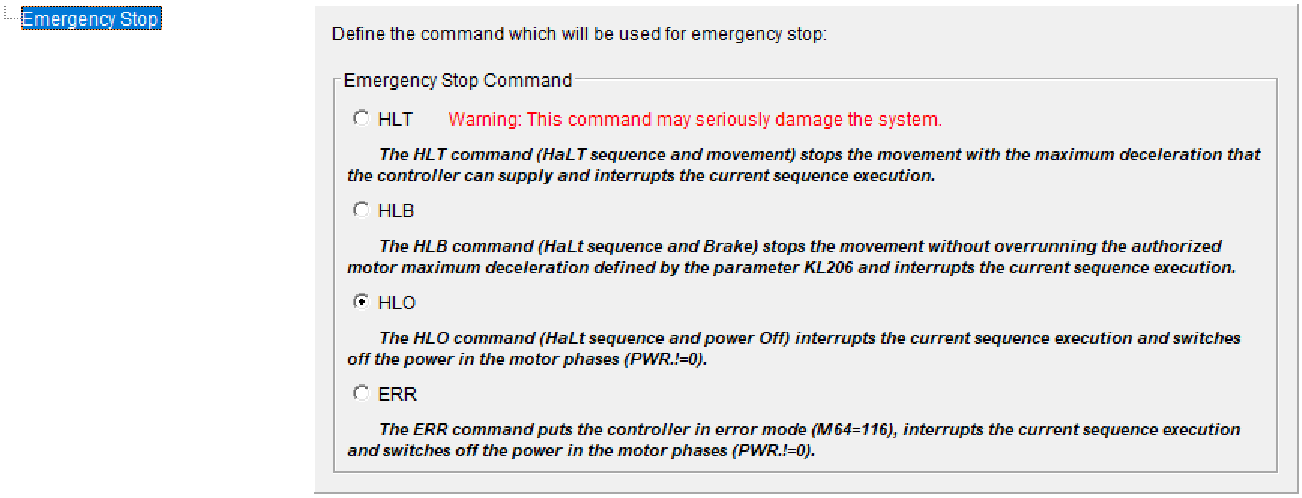


Configure ComET's data files directory

ComET's data file directory : C:\Users\[redacted]

2.5.13. Emergency stop

Configure the action performed when using the **Emergency Stop** button or hitting the `Esc` button.
For more information about these options, refer to the *AccurET Modular Position Controller Operation & Software Manual*.



Define the command which will be used for emergency stop:

Emergency Stop Command

○ HLT Warning: This command may seriously damage the system.

The HLT command (HaLT sequence and movement) stops the movement with the maximum deceleration that the controller can supply and interrupts the current sequence execution.

○ HLB

The HLB command (HaLt sequence and Brake) stops the movement without overrunning the authorized motor maximum deceleration defined by the parameter KL206 and interrupts the current sequence execution.

● HLO

The HLO command (HaLt sequence and power Off) interrupts the current sequence execution and switches off the power in the motor phases (PWR.!=0).

○ ERR

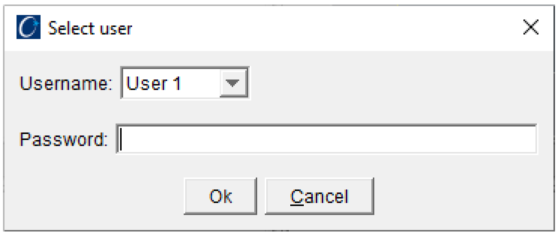
The ERR command puts the controller in error mode (M64=116), interrupts the current sequence execution and switches off the power in the motor phases (PWR.!=0).

2.6. User profile

ComET4 software supports multiple user profiles. Each user profile has its own privilege settings for executing ***ComET4*** tools. This feature is particularly useful for deploying ***ComET4*** for different use cases and roles (e.g. R&D, Support, Maintenance, Operations…). Refer to Section §2.5.2 for further details about setting user profiles.

NOTE	***ComET4*** will start-up with the first user profile not having a password defined. If all users have a password defined, ***ComET4*** will use the **Default** user profile.

To change to a different user, go to **File → Change User**, select the user name, type in the corresponding password and press the **OK** button.



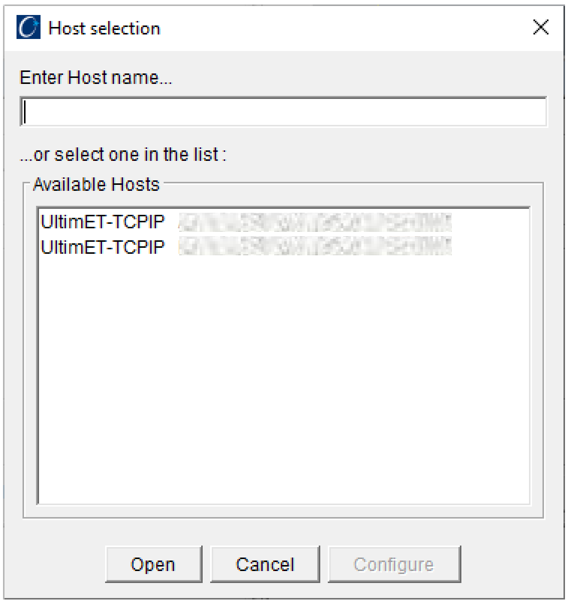
NOTE	Any tools running for which the selected user has no execution rights will close automatically. If ***ComET4*** is restarted, it will not login with the last selected user. Instead, it will login with the first user profile not having any password defined. If all users have a password defined, ***ComET4*** will use the **Default user** profile.

3. Quick start

3.1. Connecting to a controller

A connection must be established with a Controller prior executing any operation with the Tools included in ***ComET4***. There are two ways of establishing communication with a Controller, namely the following:

1. In the *Startup Wizard* tool, 'Panel #2 – Connection', select either a **local hardware** from the drop-down list or a **remote hardware** by clicking on the button 🖧.



Host selection

Enter Host name...

...or select one in the list :

Available Hosts

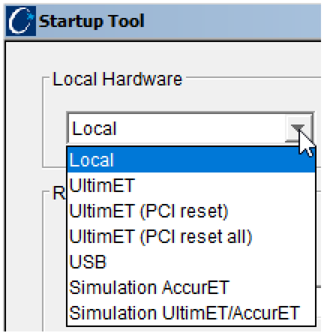
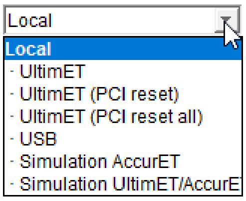
UltimET-TCPIP [redacted]
UltimET-TCPIP [redacted]

2. On the **Toolbar Connection** group, select either a **local hardware** from the corresponding drop-down list or a **remote hardware** by clicking on the button 🖧.

Local

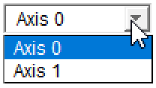
3.1.1. Local hardware

Select the local hardware from the drop-down list:

Startup Wizard tool	**Toolbar Connection** group
 Startup Tool Local Hardware Local Local UltimET UltimET (PCI reset) UltimET (PCI reset all) USB Simulation AccurET Simulation UltimET/AccurET	 Local Local UltimET UltimET (PCI reset) UltimET (PCI reset all) USB Simulation AccurET Simulation UltimET/AccurE

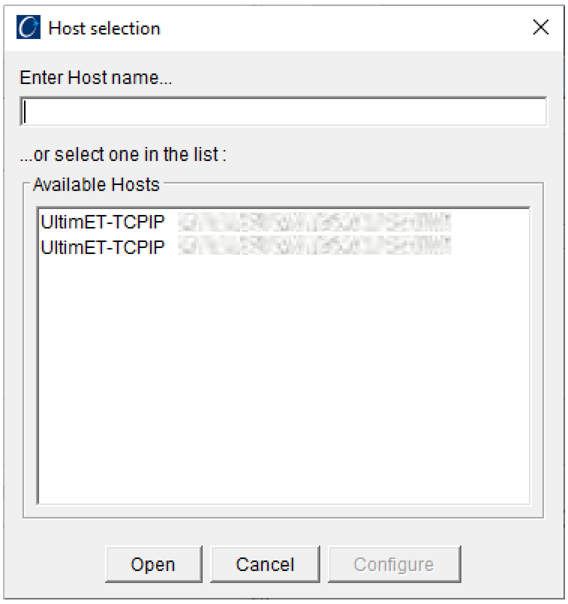
Once the selection is done, ***ComET4*** will try to establish connection to the axis with the lowest number. E.g. if USB is selected to connect to an ***AccurET*** position controller configured with axes #3 and #4, then by default the communication will be established with axis #3. Similarly, if the connection is established with an ***UltimET Light/ADVANCED*** motion controller having several ***AccurET*** position controllers connected via ***TransnET***, being #0 the lowest axis number, then by default the connection is established with the axis #0.

The user can always change the connection to another axis using the corresponding drop-down list on the **Toolbar Connection** group.



3.1.2. Remote hardware

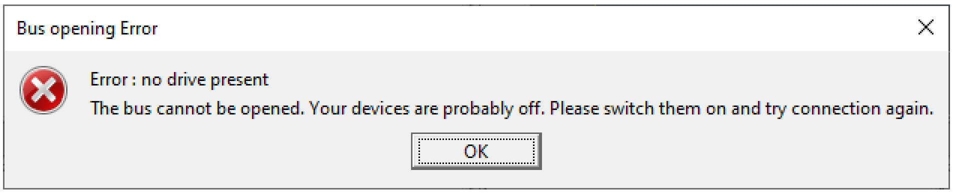
Select the hardware from the list of available hosts and press the **Open** button.



NOTE	A remote host can be an ***UltimET TCPIP*** motion controller or a TCP/IP connection with an ***AccurET*** position controller.

3.1.3. Connection failure

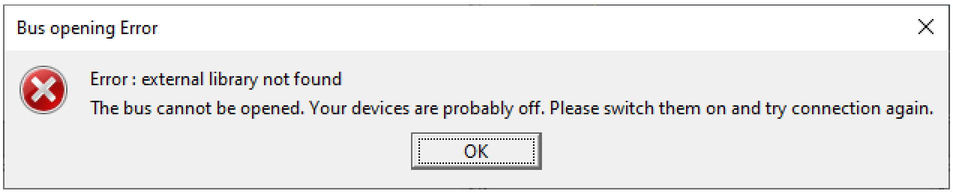
Different errors are raised for different types of connection failures. Take the example of a failed attempt to establish a local connection to a Controller via the USB bus.



Bus opening Error

Error : no drive present
The bus cannot be opened. Your devices are probably off. Please switch them on and try connection again.

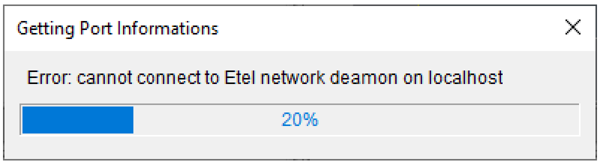
Here is another example of a failed local connection to an ***UltimET Light*** motion controller.



Bus opening Error

Error : external library not found
The bus cannot be opened. Your devices are probably off. Please switch them on and try connection again.

Finally, this is the type of error raised if a remote connection to a Controller fails.



Getting Port Informations

Error: cannot connect to Etel network deamon on localhost

3.1.4. Reconnection to another hardware

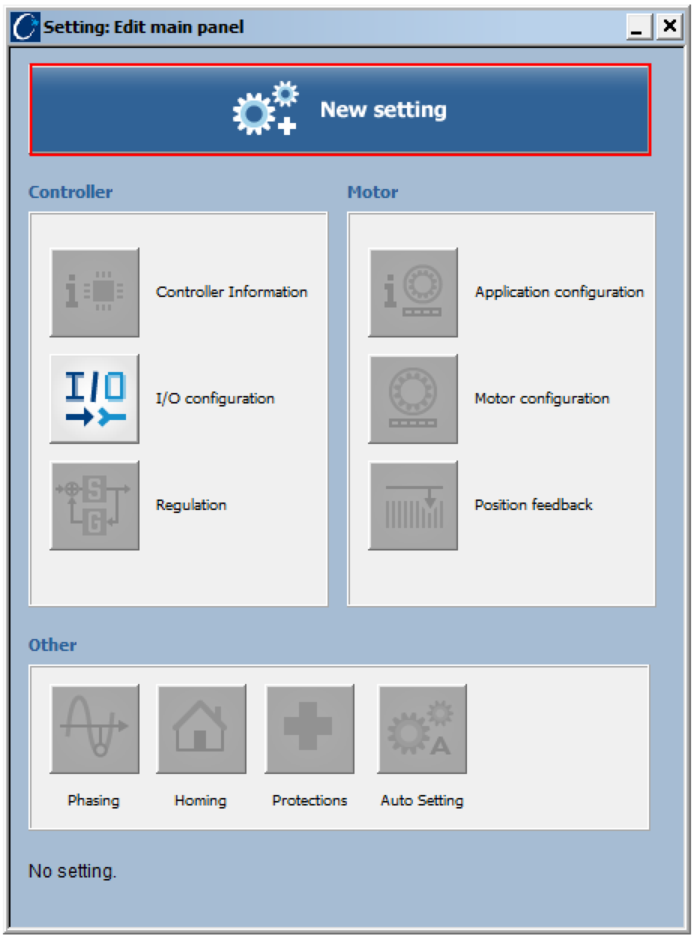
If the user wants to establish a new connection (e.g. with another hardware), the communication bus must be closed by clicking on this icon on the **Toolbar Connection** group. Only then a new connection with another hardware can be established.

3.2. Setting up a controller

The *Setting* tool allows the user to perform a first basic setting of the Controller. The most straightforward way to launch this tool is to click on the button on the **Toolbar Tools** group (refer to Section §2.2.3).

NOTE	Before executing the *Setting* tool, please ensure that ***ComET4*** has a connection established with the target hardware.

Then click on the **New setting** button on the **Edit main panel** to initiate the configuration of the selected axis.



No setting.

From this point on, the user is guided through a setup wizard containing several panels for configuring:

- Controller general information;
- Application configuration;
- Motor environment;
- Type of motor;
- Type of position feedback;
- Phasing mode;
- Homing mode;
- Perform a quick auto setting without requiring any manual adjustment from the user;
- Configure system protections; and
- Select the error propagation groups.

Refer to Section §4.1 for further information about the **New setting** wizard.

Once the setting is completed, the user is directed back to the **Edit main panel**, where it is possible to verify and/or modify any of configuration parameters as needed.

With the axis configured, the user can power on the motor by clicking on **Toolbar Macro** power on button ON.

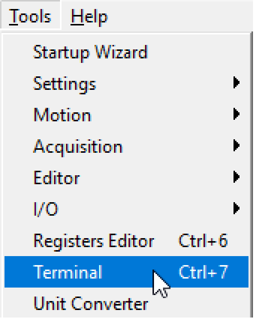
WARNING	Always ensure that the proper safety precautions are taken when powering on a Controller and executing movements with a motion system.

3.3. Sending commands

A command can be sent to a Controller using the *Terminal* tool. There are several ways to launch this tool, namely the following:

1. On the **Toolbar Tools** group, click on the button .

2. Select the Menu option **Tools → Terminal**.

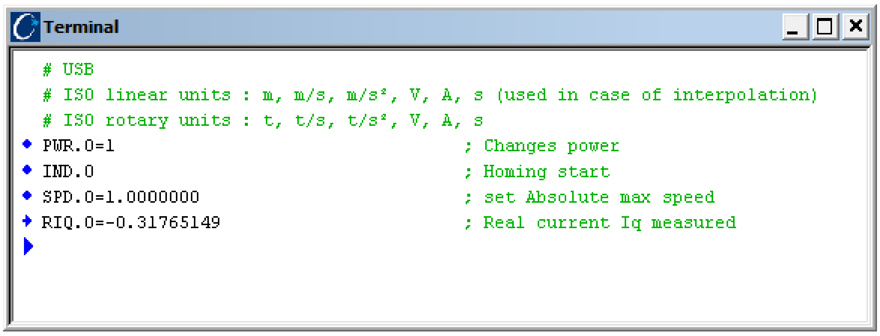


To send a command, type it in the *Terminal* window respecting the following syntax:

`<cmd_name>.<axis>[=<P1>][,<P2>]`	
`<cmd_name>`	Command name
`<axis>`	Axis number
`<P1>`	Parameter #1
`<P2>`	Parameter #2

Press `Enter` to send the command to the Controller.

NOTE	The fields in between 'square brackets' are optional and certain commands might require more than 2 parameters. Refer to the *AccurET Modular Position Controller Operation & Software Manual* and *UltimET Light/ADVANCED Motion Controllers User's Manuals* for more information about the commands and their syntaxes.



```
  # USB
  # ISO linear units : m, m/s, m/s², V, A, s (used in case of interpolation)
  # ISO rotary units : t, t/s, t/s², V, A, s
◆ PWR.0=1                                 ; Changes power
◆ IND.0                                   ; Homing start
◆ SPD.0=1.0000000                         ; set Absolute max speed
◆ RIQ.0=-0.31765149                       ; Real current Iq measured
▶
```

Refer to Section §11.2 for more detailed information about the *Terminal* tool.

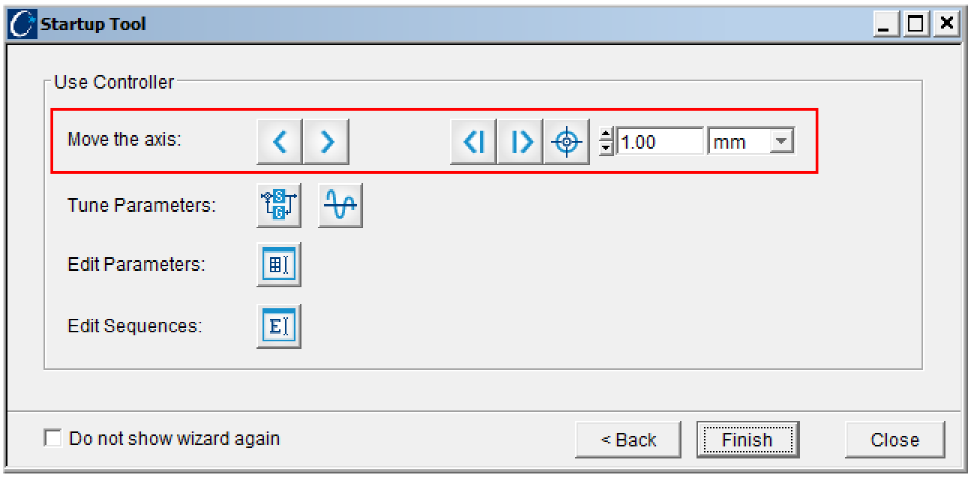
3.4. Executing simple movements

Before being able to execute movements with an axis, the user must have first realized the following actions:

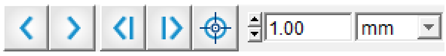
- Connect to a Controller;
- Perform a setting of the Controller (refer to Sections §3.2 and §4.1 for further details);
- Power on the axis, e.g. by clicking on the **Toolbar Macro** button ON or by sending the equivalent command to the Controller from the *Terminal* tool;
- Home the axis, e.g. by clicking on the **Toolbar Macro** button IND or by sending the equivalent command to the Controller from the *Terminal* tool.

Only then the user can execute movements, using one of the many options available:

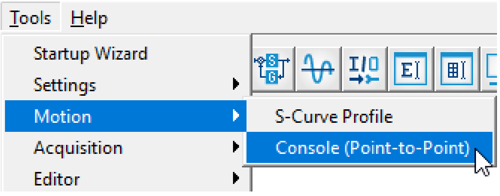
1. Go to the *Startup Wizard* tool, 'Panel #5 – Use Controller', and use the motion controls.
   Refer to Section §2.4.5 for further details.



2. Use the **Toolbar Motion** controls.
   Refer to Section §2.2.10 for further details.



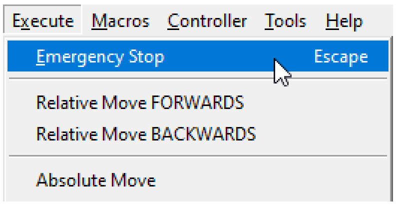
3. Select Menu option **Tools → Motion → Console (Point-to-Point)** to launch the *Console* tool.
   Refer to Section §6.2 for further details about the *Console* tool.



3.5. Emergency stop

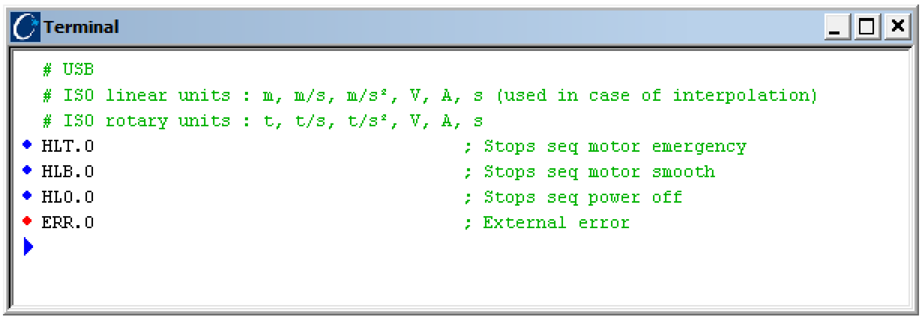
Whatever the running process, it is always possible to execute an emergency stop using one of the following options:

1. Press the `Esc` key.
2. Click the **Toolbar Emergency Stop** button ⊗.
3. Select the Menu option **Execute → Emergency Stop**.



4. Send to the Controller one of the following urgent commands from the *Terminal* tool:
   - `HLT`, `HLB`, `HLO`, `ERR`.

   Refer to the *AccurET Modular Position Controller Operation & Software Manual* for further information about these commands.



```
  # USB
  # ISO linear units : m, m/s, m/s², V, A, s (used in case of interpolation)
  # ISO rotary units : t, t/s, t/s², V, A, s
◆ HLT.0                                 ; Stops seq motor emergency
◆ HLB.0                                 ; Stops seq motor smooth
◆ HLO.0                                 ; Stops seq power off
◆ ERR.0                                 ; External error
▶
```

NOTE The behavior of the **Emergency Stop** can be configured under **File → Preferences → Emergency Stop**. Refer to Section §2.5.13 for further details.

3.6. Monitoring

ComET4's most useful tools for monitoring the operation of a Controller are:

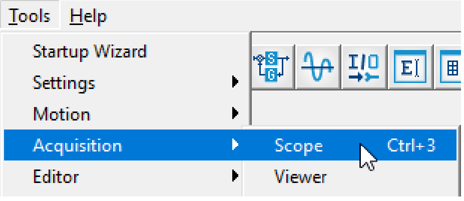
- *Scope* tool;
- *Monitor* tool.

3.6.1. Scope tool

There are several ways to launch the *Scope* tool, namely the following:

1. On the **Toolbar Tools** group, click on the button .

2. Select the Menu option **Tools → Acquisition → Scope**.



The *Scope* tool can display up to 4 traces simultaneously belonging to any axis. Only basic register types can be monitored:

- `K` (parameters);
- `M` (monitorings);
- `X` (user variables);
- `C` (common).

NOTE

A **Trace** is an advanced register type (`T` register) which allows the acquisition of the Controller's basic register types `K`, `M`, `X` and `C` versus time.

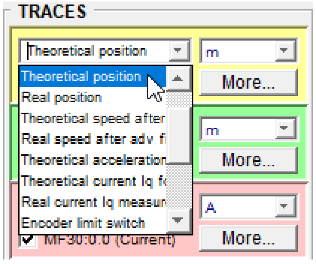
Once the data is acquired by the Controller, the trace is uploaded to ***ComET4*** and displayed on the *Scope* tool.

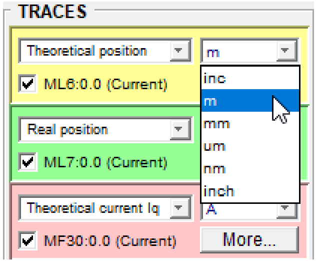
A trace contains the values of the selected register, sampled at the frequency set by the user and with the acquisition starting from the moment the trigger conditions, also set by the user, are valid.

Refer to the *AccurET Modular Position Controller Operation & Software Manual* and the *UltimET Light/ADVANCED Motion Controllers User's Manuals* for more information about register types.

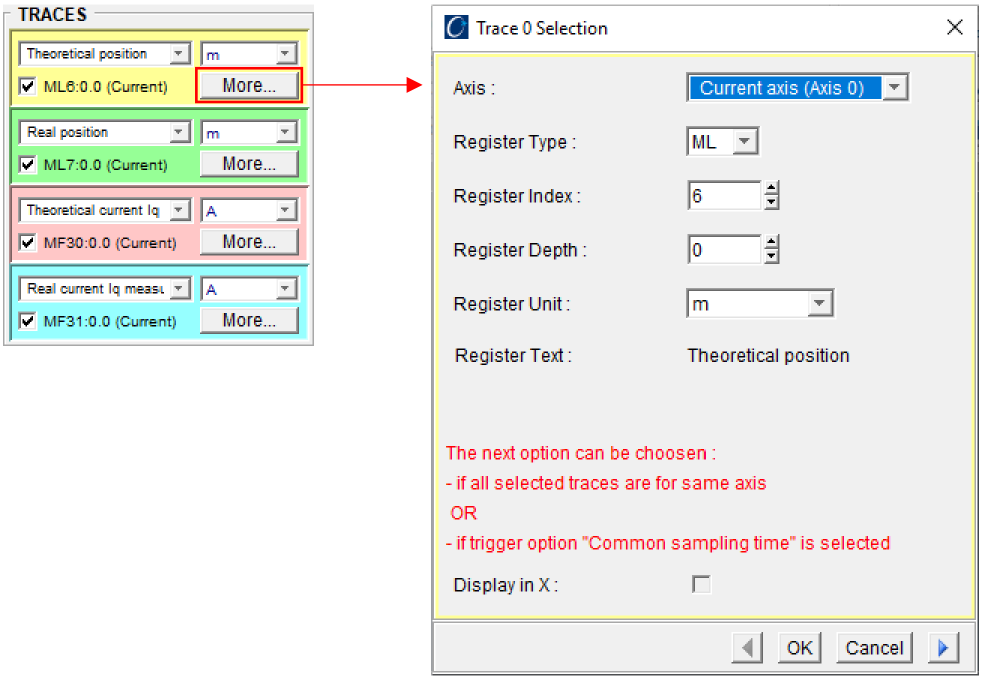
Under the **TRACES** group control, the user can select which registers to monitor on each trace, following one of two possible options:

1. Select the register from the left drop-down list. Only the most frequently used registers are listed and these are related to the current axis (i.e. axis with which the connection is established). The units used to display the trace can also be selected on the right drop-down list.





2. Click on the **More** button and configure the trace selection:
    - Axis (can be any "visible" axis);
    - Register type, index and depth;
    - Units used to display the trace.



Axis : Current axis (Axis 0)

Register Type : ML

Register Index : 6

Register Depth : 0

Register Unit : m

Register Text : Theoretical position

The next option can be choosen :
- if all selected traces are for same axis
OR
- if trigger option "Common sampling time" is selected

Display in X : ☐

It is possible to monitor the selected register(s) using different acquisition modes:

- Roll;
- Single;
- Continuous.

and configure the acquisition settings clicking on the **Setup** button:

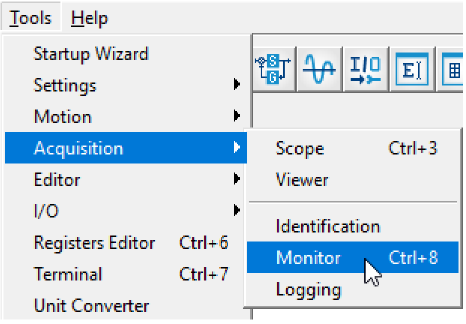
- Trigger mode, delay and source;
- Acquisition resolution.

Refer to Section §7.1 for more detailed information about the *Scope* tool.

3.6.2. Monitor tool

The *Monitor* tool can be launched from the Menu **Tools**:

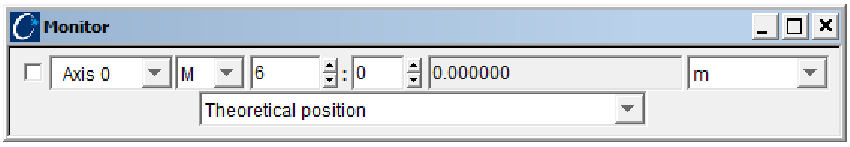
1. Select the Menu option **Tools → Acquisition → Monitor**.



Compared to the *Scope*, the *Monitor* tool can be used to monitor a wider selection of register types (basic and advanced) belonging to any axis:

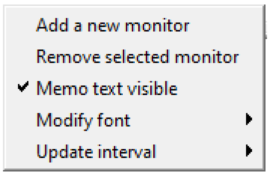
- `K`, for parameters;
- `M`, for monitorings;
- `X`, for user variables;
- `C`, for common;
- `L`, for look-up table;
- `T`, for trace;
- `P`, for mapping;
- `E`, for triggers.

However, only the most recent sample is displayed.



☐ Axis 0 | M | 6 : 0 | 0.000000 | m
Theoretical position

To add/remove a monitor from the tool or modify its refresh rate (i.e. update interval), right-click on the tool's window to display the contextual menu.



NOTE	The *Monitor* tool can display as many registers as wanted. But, there is a practical limit since the tool window size is constrained to ***ComET4***'s desktop area and there is no vertical scrollbar. To remove a monitor, check before the corresponding checkbox control on the left side. If several monitors are selected, they all will be removed in one single action. The remove action cannot be reverted (i.e. undo).

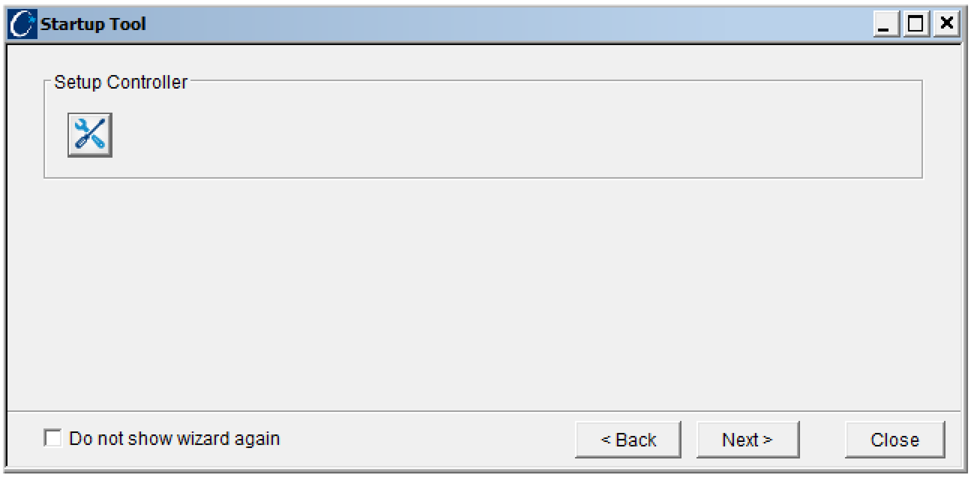
Refer to Section §7.4 for more detailed information about the *Monitor* tool.

4. Motion control settings

4.1. Basic setting

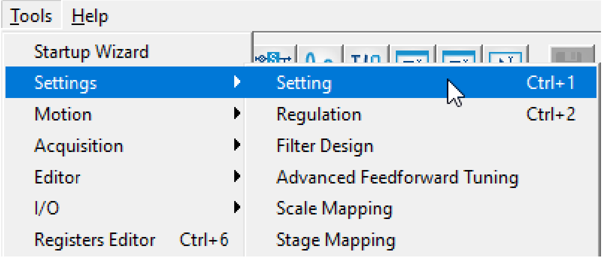
ComET4's *Setting* tool allows the user to easily configure a Controller for a specific application. There are several ways to launch this tool, such as:

1. In the *Startup Wizard* tool, 'Panel #3 – Setup Controller', click on the button .



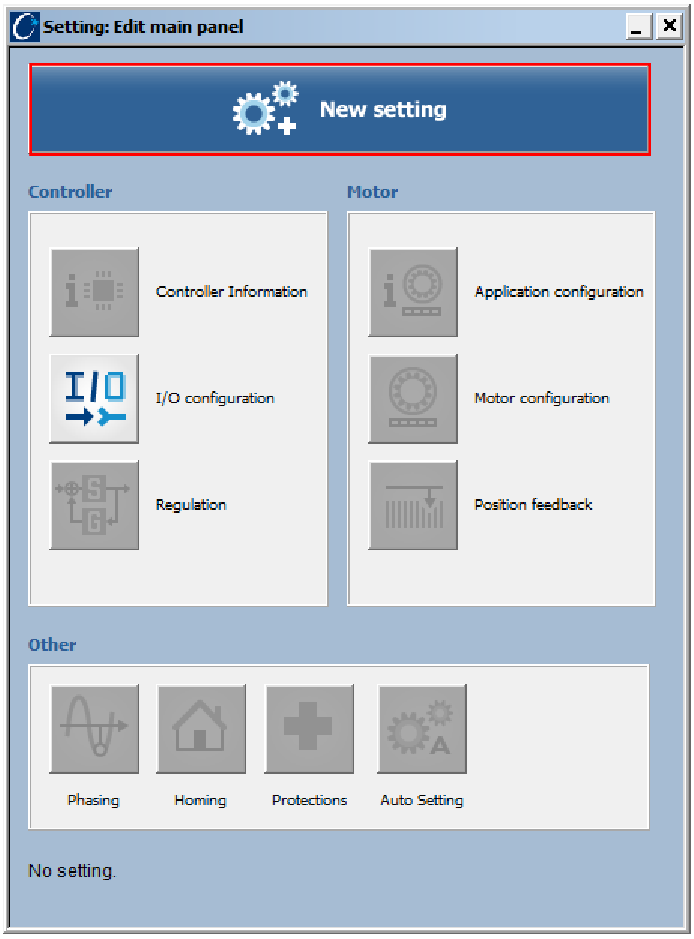
2. On the **Toolbar Tools** group, click on the button .

3. Select the Menu option **Tools → Settings → Setting**.



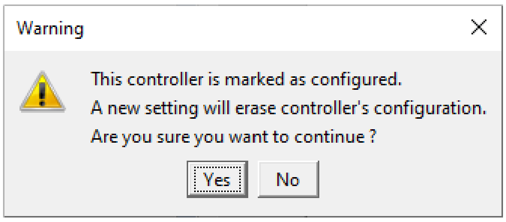
NOTE	Before executing the *Setting* tool, please ensure that ***ComET4*** has a connection established with the target hardware.

Once the *Setting* tool has been launched, click on the **New setting** button on the **Edit main panel** to initiate the configuration of the selected axis.



No setting.

If the Controller has already been configured, the following warning message pops-up:



This controller is marked as configured.
A new setting will erase controller's configuration.
Are you sure you want to continue ?

The user can abort the setting or proceed by clicking on the **Yes** button. The *New setting* wizard is launched and the first panel displayed.

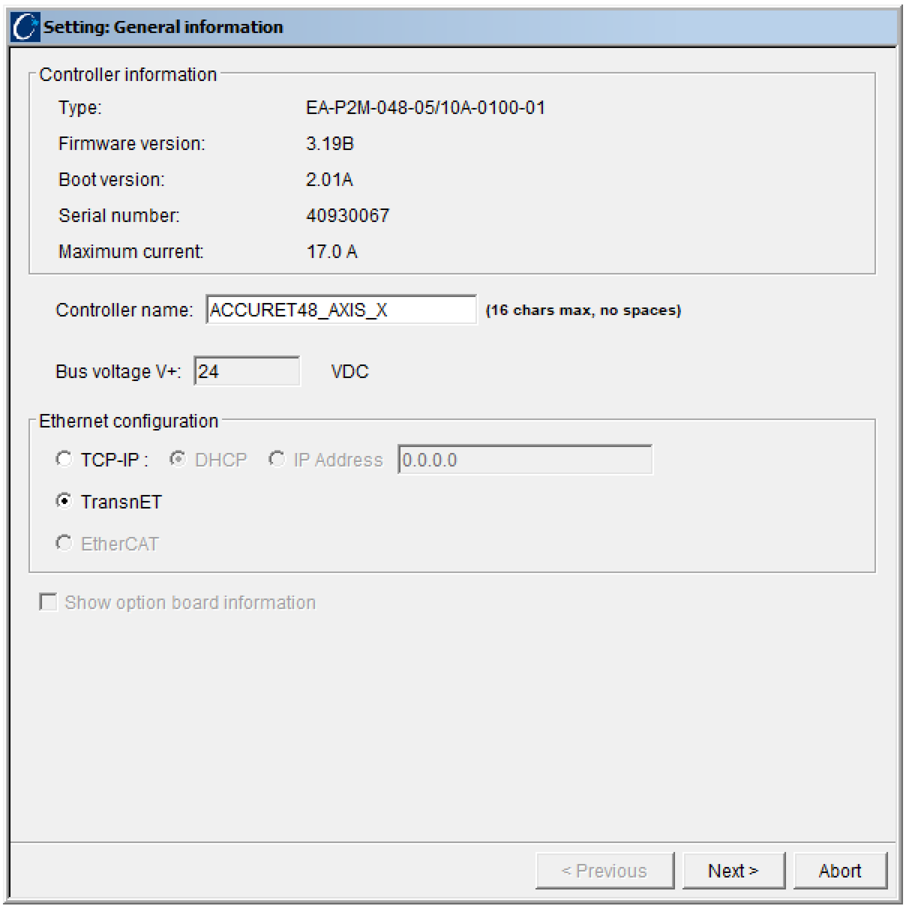
4.1.1. Setting wizard panel #1: general information

In this panel the user can view information related to the Controller:

- Controller type, following ETEL's product coding;
- Firmware version;
- Boot version;
- Serial number;
- Maximum rated current.

In addition, the user is requested to input the following information:

- Unique name to identify the Controller (max. 16 characters without spaces);
- Controller power input voltage (only if the power input connector is unplugged; otherwise this value is measured and provided by the Controller);
- Select the communication protocol used by the Controller.



Setting: General information

Controller information

Type: EA-P2M-048-05/10A-0100-01

Firmware version: 3.19B

Boot version: 2.01A

Serial number: 40930067

Maximum current: 17.0 A

Controller name: ACCURET48_AXIS_X (16 chars max, no spaces)

Bus voltage V+: 24 VDC

Ethernet configuration

○ TCP-IP : ● DHCP ○ IP Address 0.0.0.0

● TransnET

○ EtherCAT

☐ Show option board information

NOTE

The Controller's common parameter `C1` is set according to the selected communication protocol.

The ***EtherCAT*** option is only available if the Controller supports this communication protocol (reserved for specific products).

Refer to the *AccurET Modular Position Controller Operation & Software Manual* for further information about the common parameter `C1` and the supported communication protocols.

To proceed to the next panel, click on the **Next** button.

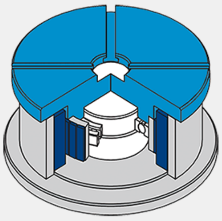
4.1.2. Setting wizard panel #2: application configuration

In this panel the user can select the application configuration:

Generic linear

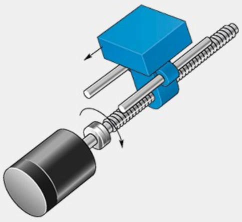
This configuration corresponds to a typical direct drive topology with a linear motor driving directly the linear movement of the payload without any mechanical transformations in between. A single position feedback is used for controlling the payload's position.

Generic rotary



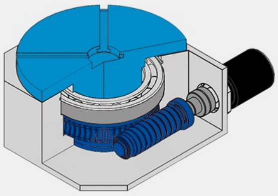
This configuration corresponds to a typical direct drive topology with a rotary motor driving directly the rotary movement of the payload without any mechanical transformations in between. A single position feedback is used for controlling the payload's position.

Generic indirect linear



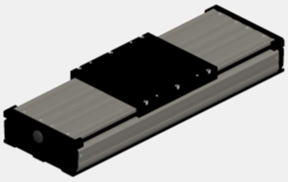
This configuration corresponds to a typical indirect drive topology, where there is a mechanical transformation between the rotary driving motor and the linear movement of the payload (e.g. lead screw drive system).
In this configuration, there can be two position feedback sensors, one measuring the motor's angular position and another measuring the payload's linear position.

Generic indirect rotary



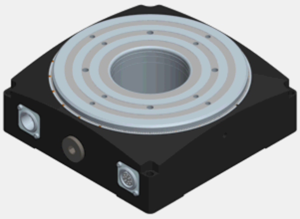
This configuration corresponds to a typical indirect drive topology, where there is a mechanical transformation between the rotary driving motor and the rotary movement of the payload (e.g. worm gear system).
In this configuration, there can be two position feedback sensors, one measuring the motor's angular position and another measuring the payload's angular position.

DynX linear axis



This configuration corresponds to ETEL's standard single linear axis product portfolio.

DynX rotary axis



This configuration corresponds to ETEL's standard single rotary axis product portfolio.

NOTE

The product family corresponding to the **DynX rotary axis** configuration has been renamed to ***DXR***.

To proceed to the next panel, click on the **Next** button.

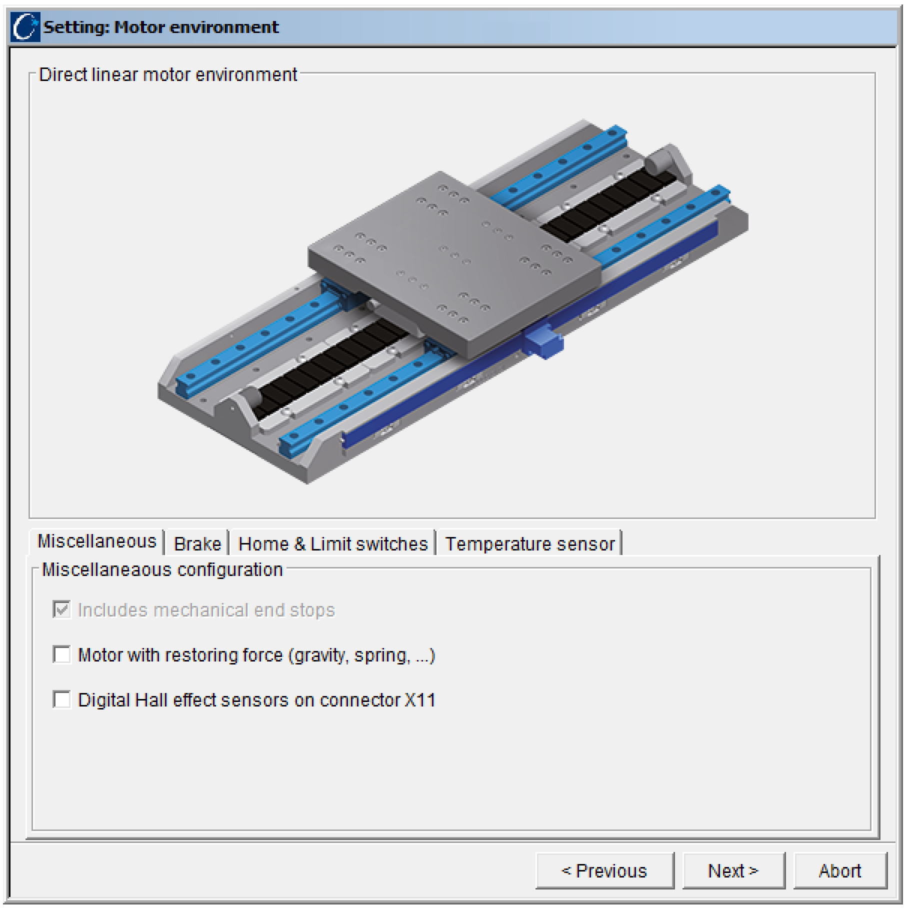
4.1.3. Setting wizard panel #3: motor environment

This panel actually depends on the application configuration selected by the user in the previous panel. Nevertheless, there is collection of basic settings common to all configurations that the user must configure.

NOTE

For the sake of clarity, all panels presented next and corresponding screenshots are related to the **Generic linear** application configuration.

Please contact an ETEL representative in case of questions related to other application configurations.



☑ Includes mechanical end stops

☐ Motor with restoring force (gravity, spring, ...)

☐ Digital Hall effect sensors on connector X11

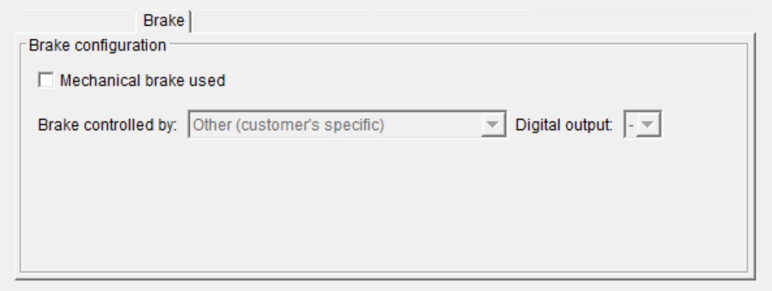
These settings are grouped on the four configuration sub-panels:

Miscellaneous

Miscellaneous
Miscellaneaous configuration
☑ Includes mechanical end stops
☐ Motor with restoring force (gravity, spring, ...)
☐ Digital Hall effect sensors on connector X21

- Are there mechanical end-stops?
- Is there a restoring force acting on the motor?
- Is there a digital Hall Effect sensor connected?

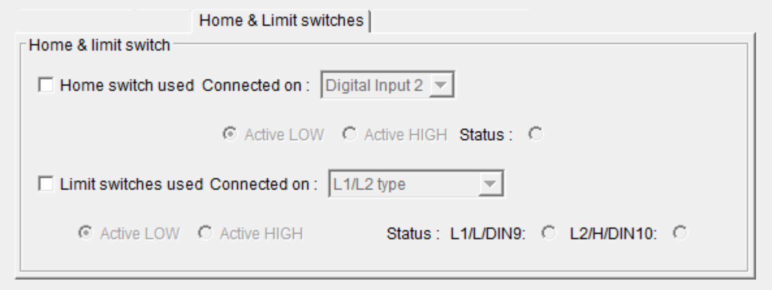
Brake



Brake
Brake configuration
☐ Mechanical brake used
Brake controlled by: Other (customer's specific) Digital output: -

- Is there a mechanical brake?
- How is this brake controlled?

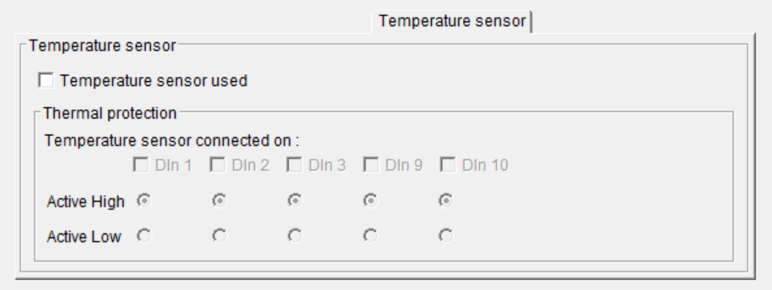
Home & Limit switches



Home & Limit switches
Home & limit switch
☐ Home switch used Connected on : Digital Input 2
● Active LOW ○ Active HIGH Status : ○
☐ Limit switches used Connected on : L1/L2 type
● Active LOW ○ Active HIGH Status : L1/L/DIN9: ○ L2/H/DIN10: ○

- Is there a Home switch?
- To which input is this switch connected?
- Are there Limit switches?
- To which inputs are these switches connected?

Temperature sensor



Temperature sensor
Temperature sensor
☐ Temperature sensor used
Thermal protection
Temperature sensor connected on :
☐ DIn 1 ☐ DIn 2 ☐ DIn 3 ☐ DIn 9 ☐ DIn 10
Active High ● ● ● ● ●
Active Low ○ ○ ○ ○ ○

- Is there a temperature sensor?
- To which input is this sensor connected?

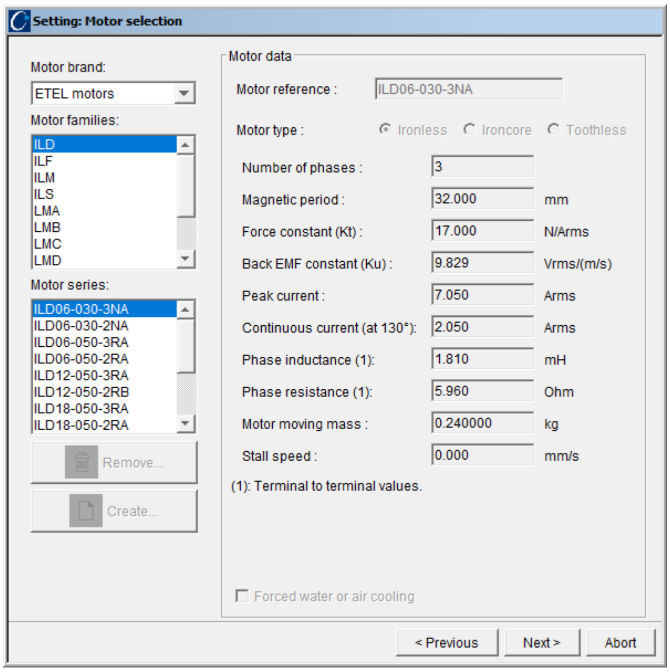
To proceed to the next panel, click on the **Next** button.

4.1.4. Setting wizard panel #4: motor selection

This is the panel where the user selects the type of motor. On the **Motor brand** drop-down list there is the option of selecting a standard motor from ETEL's product portfolio or from another non-specified vendor.

For an ETEL's standard motor, the user must in addition select the motor family and series from the corresponding drop-down lists. The **Motor data** is automatically filled with the specifications of the selected motor.

Alternately, the user can manually input the specifications of a motor from another vendor by selecting **Other** in the **Motor brand** drop-down list. The user can even create its own database of motor types using the **Create** and **Remove** buttons.



Motor brand: ETEL motors

Motor families: ILD, ILF, ILM, ILS, LMA, LMB, LMC, LMD

Motor series: ILD06-030-3NA, ILD06-030-2NA, ILD06-050-3RA, ILD06-050-2RA, ILD12-050-3RA, ILD12-050-2RB, ILD18-050-3RA, ILD18-050-2RA

Motor data

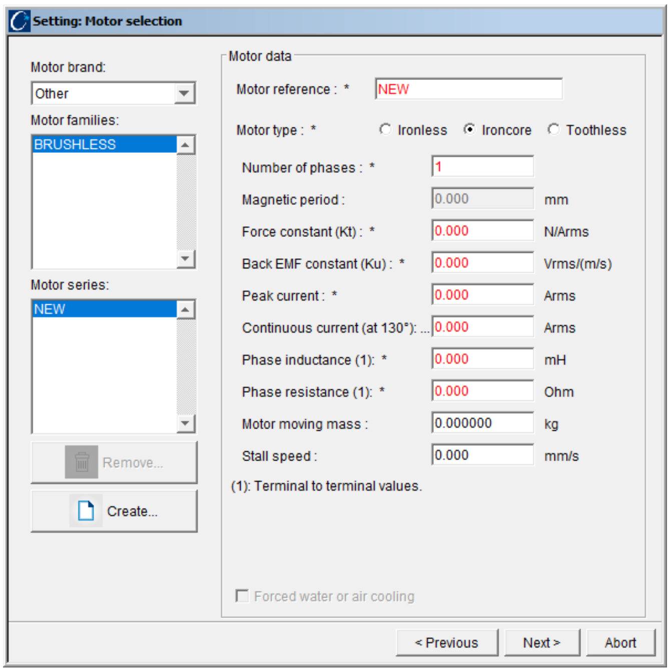
Motor reference : ILD06-030-3NA

Motor type : ● Ironless ○ Ironcore ○ Toothless

Number of phases :	3	
Magnetic period :	32.000	mm
Force constant (Kt) :	17.000	N/Arms
Back EMF constant (Ku) :	9.829	Vrms/(m/s)
Peak current :	7.050	Arms
Continuous current (at 130°):	2.050	Arms
Phase inductance (1):	1.810	mH
Phase resistance (1):	5.960	Ohm
Motor moving mass :	0.240000	kg
Stall speed :	0.000	mm/s

(1): Terminal to terminal values.

☐ Forced water or air cooling



Motor brand: Other

Motor families: BRUSHLESS

Motor series: NEW

Motor data

Motor reference : * NEW

Motor type : * ○ Ironless ● Ironcore ○ Toothless

Number of phases : *	1	
Magnetic period :	0.000	mm
Force constant (Kt) : *	0.000	N/Arms
Back EMF constant (Ku) : *	0.000	Vrms/(m/s)
Peak current : *	0.000	Arms
Continuous current (at 130°): ...	0.000	Arms
Phase inductance (1): *	0.000	mH
Phase resistance (1): *	0.000	Ohm
Motor moving mass :	0.000000	kg
Stall speed :	0.000	mm/s

(1): Terminal to terminal values.

☐ Forced water or air cooling

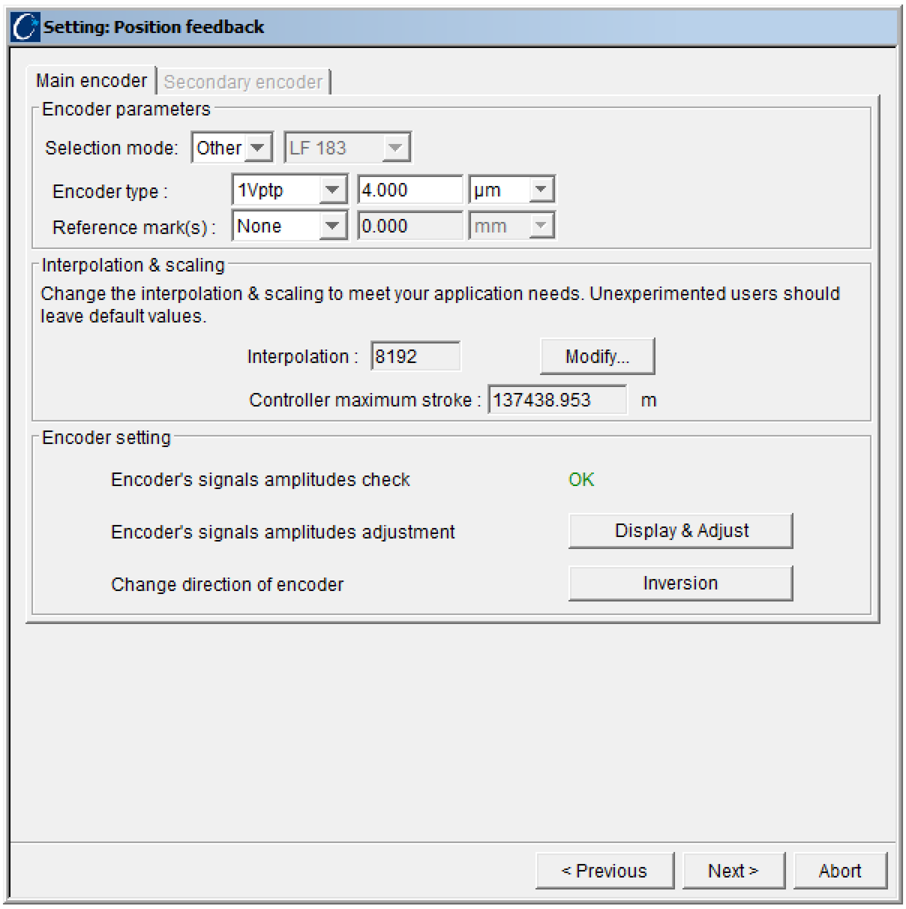
To proceed to the next panel, click on the **Next** button.

4.1.5. Setting wizard panel #5: position feedback

In this panel, the user must configure the position feedback being used by the application.

There are two sub-panels for configuring the Main and Secondary encoder (if any).

NOTE	The **Secondary encoder** sub-panel is only accessible if the user selected previously in panel #2 – application configuration the **Generic indirect linear** or **Generic indirect rotary** configurations. In addition, if the option **permanent dual encoder feedback** was checked, these sub-panels **Main encoder** and **Secondary encoder** are renamed respectively as **Payload encoder** and **Motor encoder**.



Setting: Position feedback

Main encoder | Secondary encoder

Encoder parameters

Selection mode: Other LF 183

Encoder type : 1Vptp 4.000 µm

Reference mark(s) : None 0.000 mm

Interpolation & scaling

Change the interpolation & scaling to meet your application needs. Unexperimented users should leave default values.

Interpolation : 8192

Controller maximum stroke : 137438.953 m

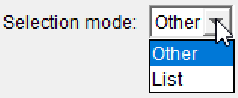
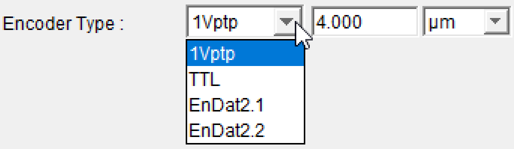
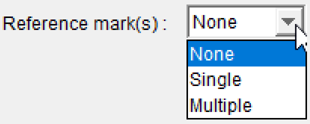
Encoder setting

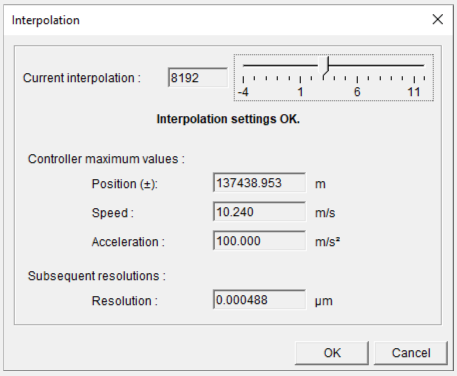
Encoder's signals amplitudes check OK

Encoder's signals amplitudes adjustment

Change direction of encoder

These are the configuration options available in each of these sub-panels:

<table>
<tr><th colspan="2">Selection mode</th></tr>
<tr><td>
Selection mode: Other
Other
List</td><td>The user can select a standard encoder from a pre-defined list available at the drop-down list just to the right or can manually input the encoder characteristics encoder type, resolution and reference marks(s).</td></tr>
<tr><th colspan="2">Encoder Type</th></tr>
<tr><td>
Encoder Type : 1Vptp 4.000 µm
1Vptp
TTL
EnDat2.1
EnDat2.2</td><td>This control is automatically filled if the user has selected previously an encoder from the pre-defined list. Alternately, the user can select the encoder type amongst the options:
- 1 Vptp;
- TTL;
- EnDat 2.1 or 2.2.
- EnDat 3 (only supported by <i>ACCURET+</i> position controllers).
In addition, the encoder resolution must be defined.</td></tr>
<tr><th colspan="2">Reference mark(s)</th></tr>
<tr><td>
Reference mark(s) : None
None
Single
Multiple</td><td>This control is automatically filled if the user has selected previously an encoder from the pre-defined list. Alternately, the user can select the reference mark type amongst the options:
- No reference mark;
- Single reference mark;
- Multiple reference marks (the user also has to provide the distance between indexes).</td></tr>
<tr><th colspan="2">Interpolation</th></tr>
</table>



Interpolation

Current interpolation : 8192

Interpolation settings OK.

Controller maximum values :

Position (±): 137438.953 m

Speed : 10.240 m/s

Acceleration : 100.000 m/s²

Subsequent resolutions :

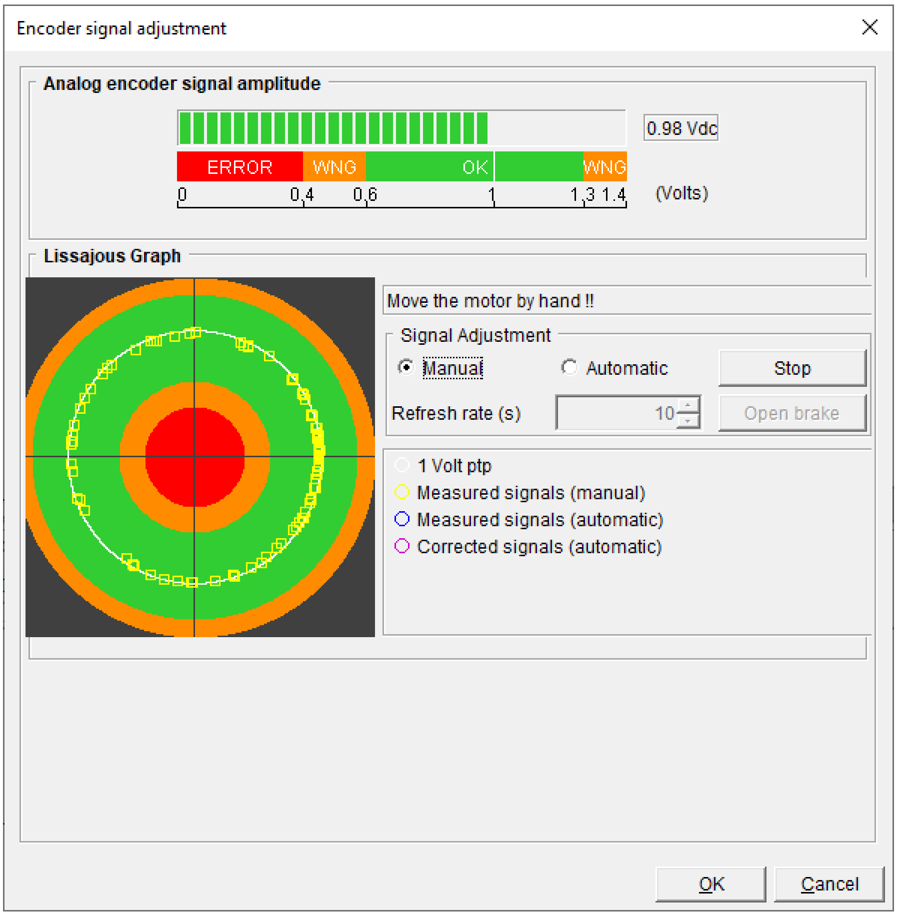
Resolution : 0.000488 µm

The user can define which interpolation factor to use by clicking on the **Modify** button. The default value is 8192.

For the given interpolation factor, the following information is presented to the user:

- Maximum position range (accounting for the encoder interpolated resolution and number of bits available in the Controller to represent a position);
- Maximum speed and acceleration the Controller can cope without losing position information.
- Position resolution.

Click on the **Display & Adjust** button in order to check and adjust manually or automatically the 1Vptp encoder's signals (amplitude, offset, reference marks…). There is now an option to release the motor brake during Encoder signal adjustment if one exists (**Open brake**).



Encoder signal adjustment

Analog encoder signal amplitude

0.98 Vdc

Lissajous Graph

Move the motor by hand !!

Signal Adjustment

● Manual ○ Automatic

Refresh rate (s) 10

NOTE

The encoder signal amplitude and Lissajous graph must be within the green zones of the graphs for a reliable operation of the Controller.

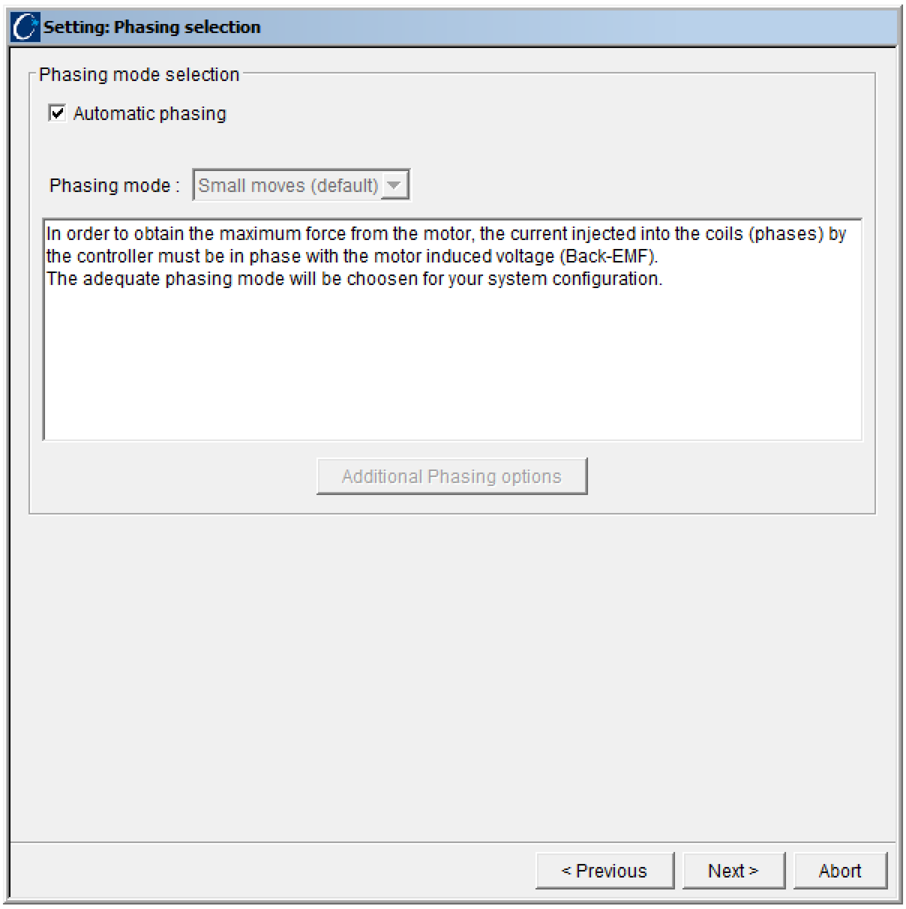
If this is not the case, try to clean the encoder scale and verify if the signal quality is good. If still insufficient, mechanically adjust the encoder head position relative to the encoder scale until a good signal quality is obtained. Move the axis by hand along the full axis travel range to ensure the encoder signal quality remains good all the time.

Refer to the corresponding *System User's Manual* for instructions on how to execute the procedure of adjusting the encoder signal.

To proceed to the next panel, click on the **Next** button.

4.1.6. Setting wizard panel #6: phasing selection

In this panel the user selects the mode used to find the motor phasing. The phasing procedure determines the position of the motor's coils towards the magnets poles in order to inject the good current shape into the coils (giving the maximum force/torque to the motor).

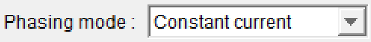


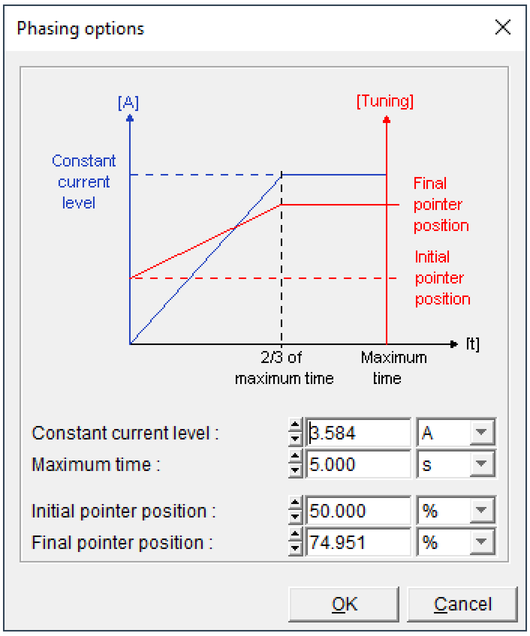
☑ Automatic phasing

Phasing mode : Small moves (default)

In order to obtain the maximum force from the motor, the current injected into the coils (phases) by the controller must be in phase with the motor induced voltage (Back-EMF).
The adequate phasing mode will be choosen for your system configuration.

The supported phasing modes are:

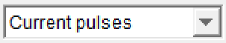
Constant current	
 Phasing mode : Constant current	Consists of injecting a current ramp in the motor coils and moving the mobile part of the motor until the current and induced voltage are aligned. This mode is suited for all types of motors. Unselecting the **Automatic phasing** checkbox and clicking on the **Additional Phasing options** button opens the following dialog box to adjust these parameters: - **Constant current level** corresponding to parameter `KF92`; - **Maximum time** corresponding to parameter `K94`; - **Initial pointer position** corresponding to parameter `K97`; - **Final pointer position** corresponding parameter `K93`.



Phasing options

Constant current level : 3.584 A
Maximum time : 5.000 s
Initial pointer position : 50.000 %
Final pointer position : 74.951 %

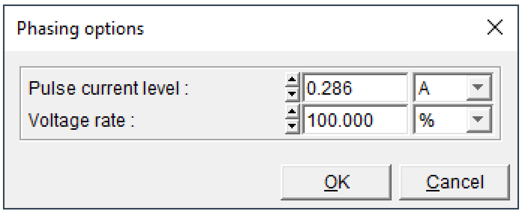
Current pulses



Phasing mode : Current pulses

Consists of injecting current pulses in the motor coils and measuring the offset between the current and the induced voltage signals.
This mode is only suited for iron core motors with medium and high inductances.
Unselecting the **Automatic phasing** checkbox and clicking on the **Additional Phasing options** button opens the following dialog box to adjust these parameters:

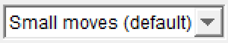
- **Pulse current level** corresponding to parameter `KF91`;
- **Voltage rate** corresponding to parameter `K98`.



Phasing options

Pulse current level : 0.286 A
Voltage rate : 100.000 %

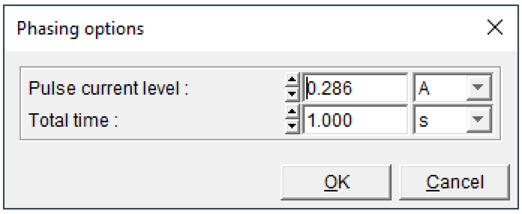
Small moves



Phasing mode : Small moves (default)

Consists of injecting current pulses in the motor coils and measuring the resulting displacements. The current pulses induce small movements whose amplitude is proportional to the encoder resolution and the current pulse amplitude.
This mode is suited for all types of motors.
Unselecting the **Automatic phasing** checkbox and clicking on the **Additional Phasing options** button opens the following dialog box to adjust these parameters:

- **Pulse current level** corresponding to parameter `KF91`;
- **Total time** corresponding to parameter `K101`.



Phasing options

Pulse current level : 0.286 A
Total time : 1.000 s

NOTE

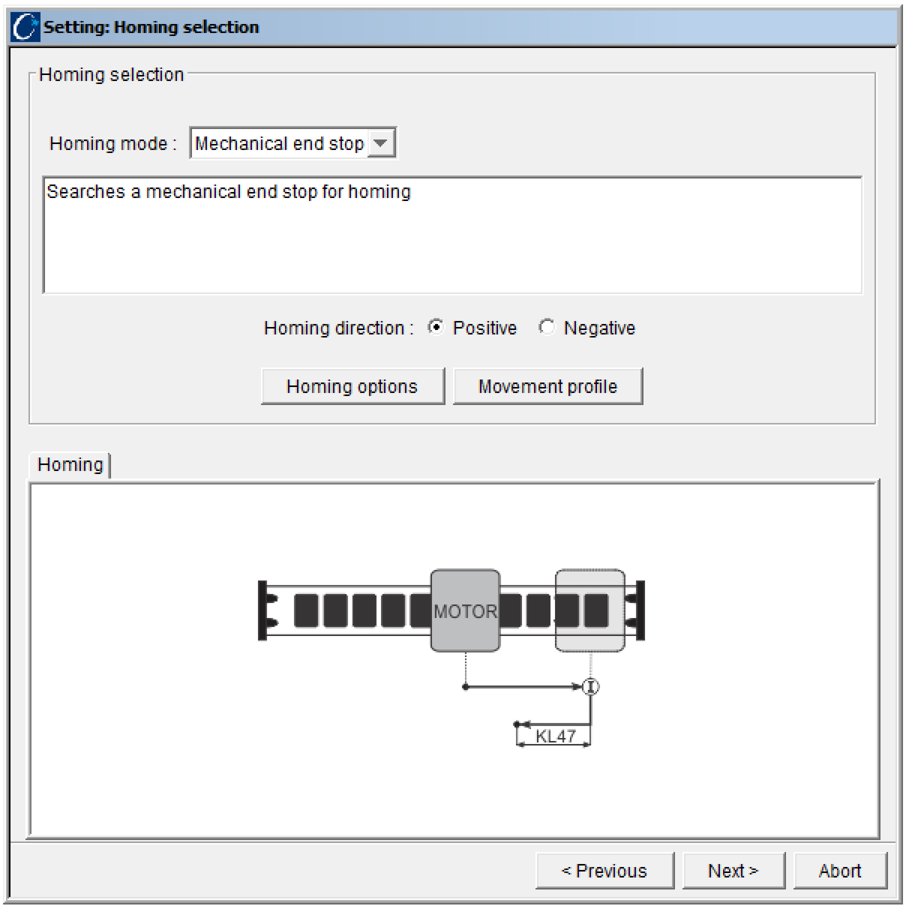
The ***AccurET*** position controller supports other phasing modes. Refer to the *AccurET Modular Position Controller Operation & Software Manual* for further information about the different phasing modes supported by the ***AccurET*** position controller.

The most suite phasing mode is selected by checking the **Automatic phasing** checkbox.

To proceed to the next panel, click on the **Next** button.

4.1.7. Setting wizard panel #7: homing selection

In this panel the user selects the homing mode:



Setting: Homing selection

Homing selection

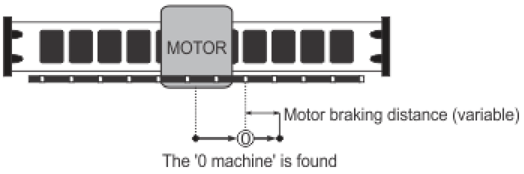
Homing mode : Mechanical end stop

Searches a mechanical end stop for homing

Homing direction : ● Positive ○ Negative

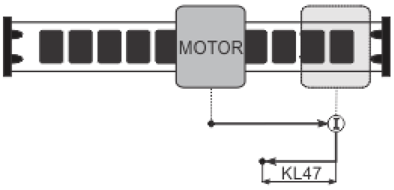
The supported homing modes are:

Multiple reference mark



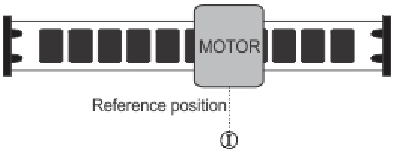
Homing with a multi-reference mark with the selected movement direction. The motor needs to find only two successive reference marks to determine its absolute position (the '0 machine' is always positioned at the same place regardless the two reference marks found).

Mechanical end stop



Homing against a mechanical end stop with the selected movement direction. After having found the mechanical end stop, the motor moves back the distance given by the parameter `KL47`.

Immediate homing



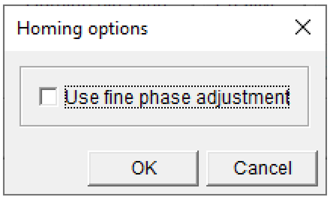
The current position is the reference position.

NOTE

The ***AccurET*** position controller supports many more homing modes. The ones available for selection on this panel depend upon certain choices made on previous panels, like e.g. the type of reference mark of the selected encoder, are limit switches used…

Refer to the *AccurET Modular Position Controller Operation & Software Manual* for further information about the different homing modes supported by the ***AccurET*** position controller.

Except for the **Immediate homing** mode, the user can select to use the fine phase adjustment option by clicking on the **Homing options** button. Refer to the *AccurET Modular Position Controller Operation & Software Manual* for further details about this homing option.



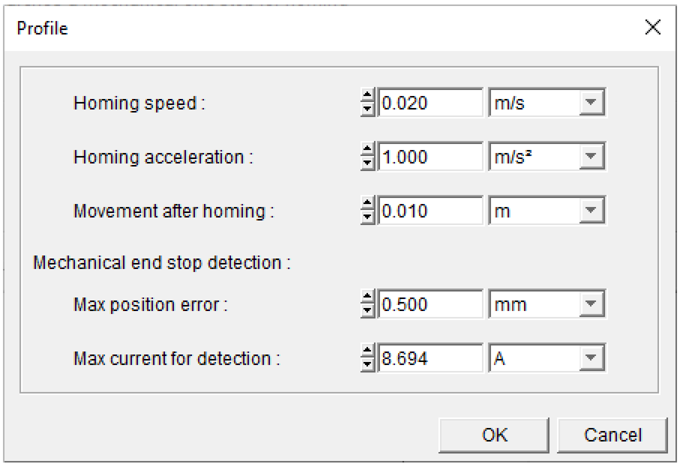
☐ Use fine phase adjustment

Finally, click on the **Movement profile** button to configure:

- Speed and acceleration profile of the homing search movement;
- Movement to realize after homing;

- For the particular case of the mechanical end stop homing mode, current and maximum position error for an end stop detection.

Refer to the *AccurET Modular Position Controller Operation & Software Manual* for further information about these settings.



Profile

Homing speed : 0.020 m/s

Homing acceleration : 1.000 m/s²

Movement after homing : 0.010 m

Mechanical end stop detection :

Max position error : 0.500 mm

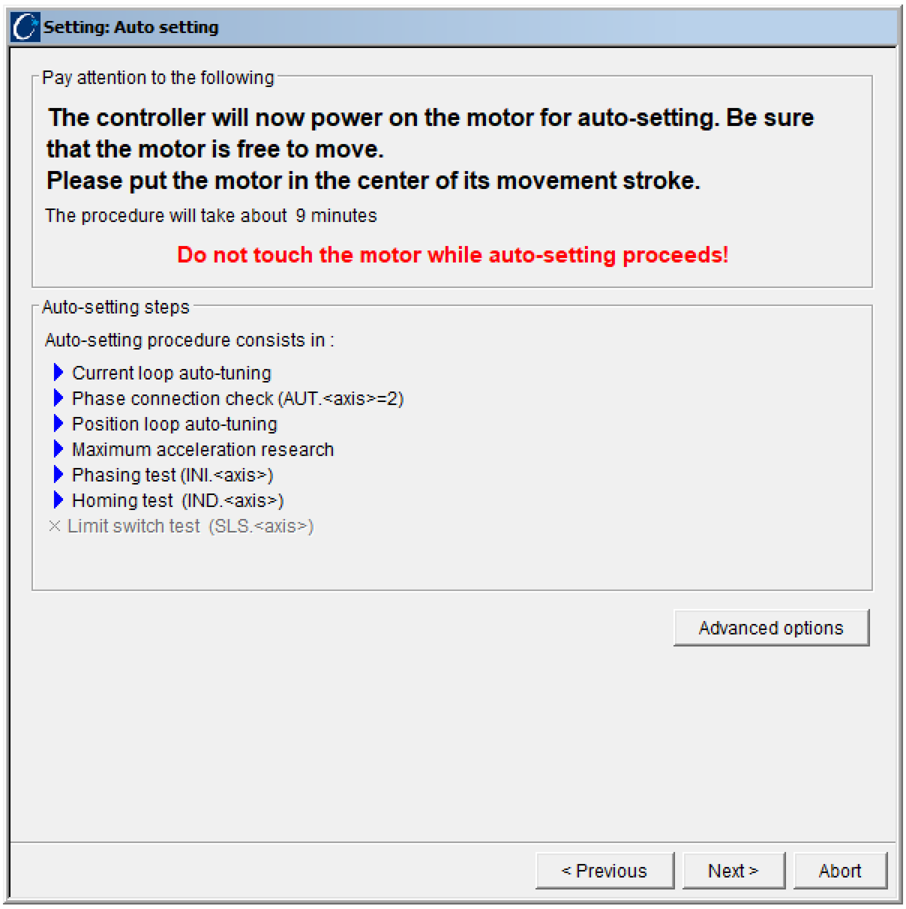
Max current for detection : 8.694 A

To proceed to the next panel, click on the **Next** button.

4.1.8. Setting wizard panel #8: auto setting

The auto-setting procedure is configured in this panel. The steps of the procedure are:

- Auto-tuning of the current loop;
- Checking the connection of the motor phases;
- Auto-tuning of the position loop;
- Searching for the maximum acceleration;
- Executing the phasing procedure;
- Executing the homing procedure;
- Searching for the limit strokes.



Pay attention to the following

The controller will now power on the motor for auto-setting. Be sure that the motor is free to move.
Please put the motor in the center of its movement stroke.

The procedure will take about 9 minutes

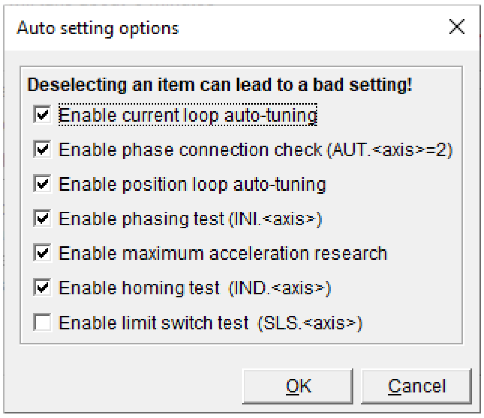
Do not touch the motor while auto-setting proceeds!

Auto-setting steps

Auto-setting procedure consists in :

- Current loop auto-tuning
- Phase connection check (AUT.<axis>=2)
- Position loop auto-tuning
- Maximum acceleration research
- Phasing test (INI.<axis>)
- Homing test (IND.<axis>)
- × Limit switch test (SLS.<axis>)

Click on the **Advanced options** button to define which of these steps are executed during the auto-setting procedure.



Deselecting an item can lead to a bad setting!

☑ Enable current loop auto-tuning
☑ Enable phase connection check (AUT.<axis>=2)
☑ Enable position loop auto-tuning
☑ Enable phasing test (INI.<axis>)
☑ Enable maximum acceleration research
☑ Enable homing test (IND.<axis>)
☐ Enable limit switch test (SLS.<axis>)

To initiate the auto-setting procedure, click on the **Next** button.

IMPORTANT	Before starting the auto-setting procedure, ensure the motor is free to run. Place the motor at the center of its movement stroke.

WARNING

The Controller will power on the motor for executing the auto-setting procedure. Always ensure that the proper safety precautions are taken when powering on a Controller and executing movements with a motion system.

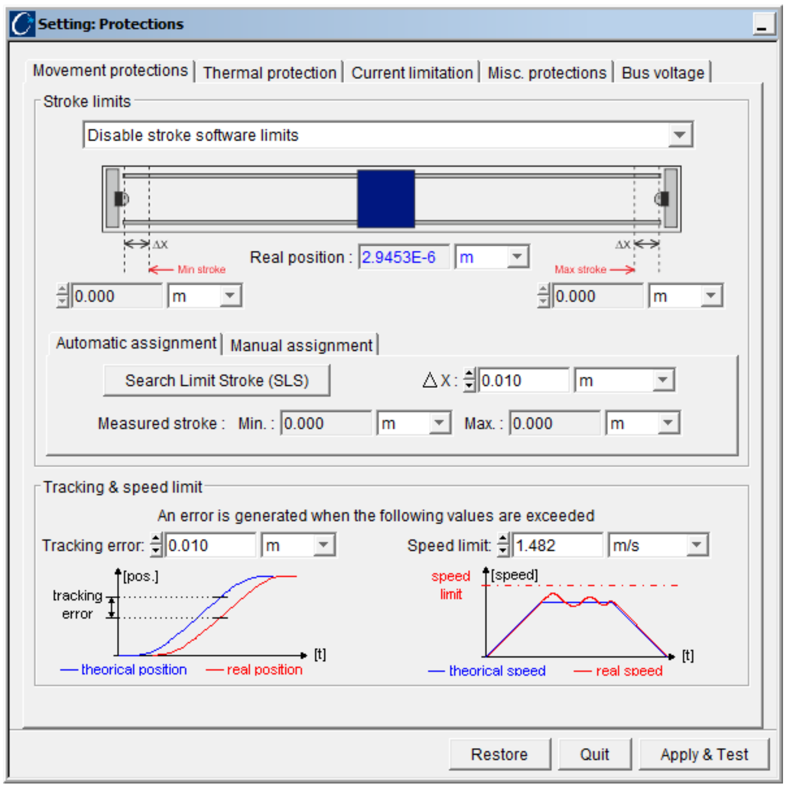
The auto-setting procedure takes approximately 10 minutes to be completed. Once it has finished, click on the **Next** button to proceed to the next panel.

4.1.9. Setting wizard panel #9: protections

In the last panel of the *Setting* wizard, the user can configure the protections of the application. These settings are distributed over five configuration sub-panels:

Movement protections

- Stroke limits: movement stroke is constrained to these limits. The user can select one of the options available, which result on a different behavior of the position controller when the limits are reached (refer to the description of parameter `K36` in the *AccurET Modular Position Controller Operation & Software Manual*). In addition, two methods can be used to define the stroke software limits: automatic and manual.
- Tracking limit: error is raised if the tracking error exceeds this limit.
- Speed limit: error is raised if the speed exceeds this limit.



Setting: Protections

Stroke limits: Disable stroke software limits

Real position : 2.9453E-6 m

0.000 m

0.000 m

ΔX : 0.010 m

Measured stroke : Min. : 0.000 m Max. : 0.000 m

Tracking & speed limit

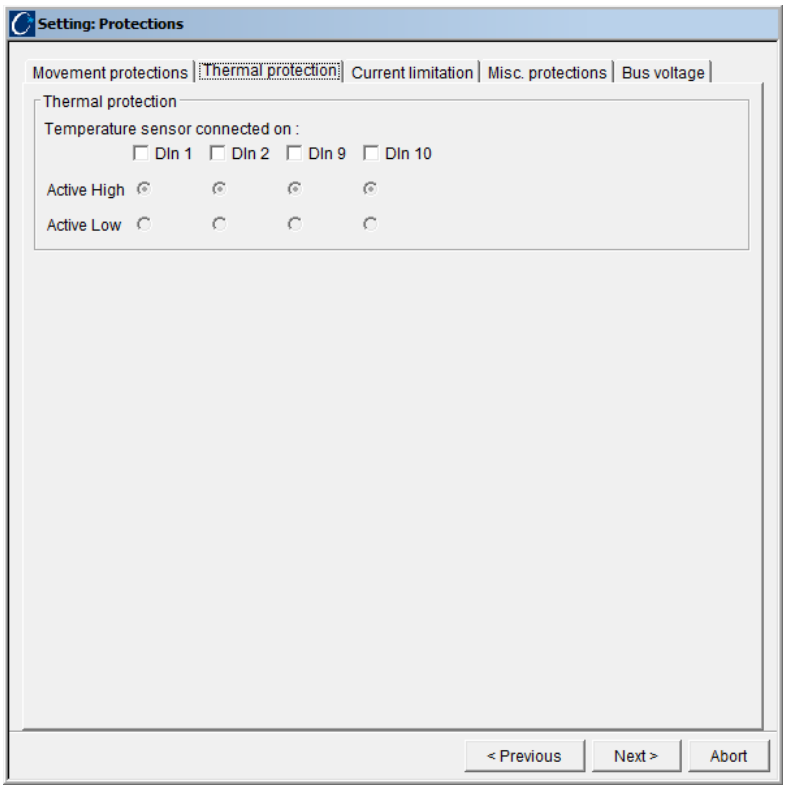
An error is generated when the following values are exceeded

Tracking error: 0.010 m

Speed limit: 1.482 m/s

Thermal protection

This panel is only enabled if the user has confirmed the existence of a temperature sensor back in panel #3, sub-panel **Temperature sensor**.



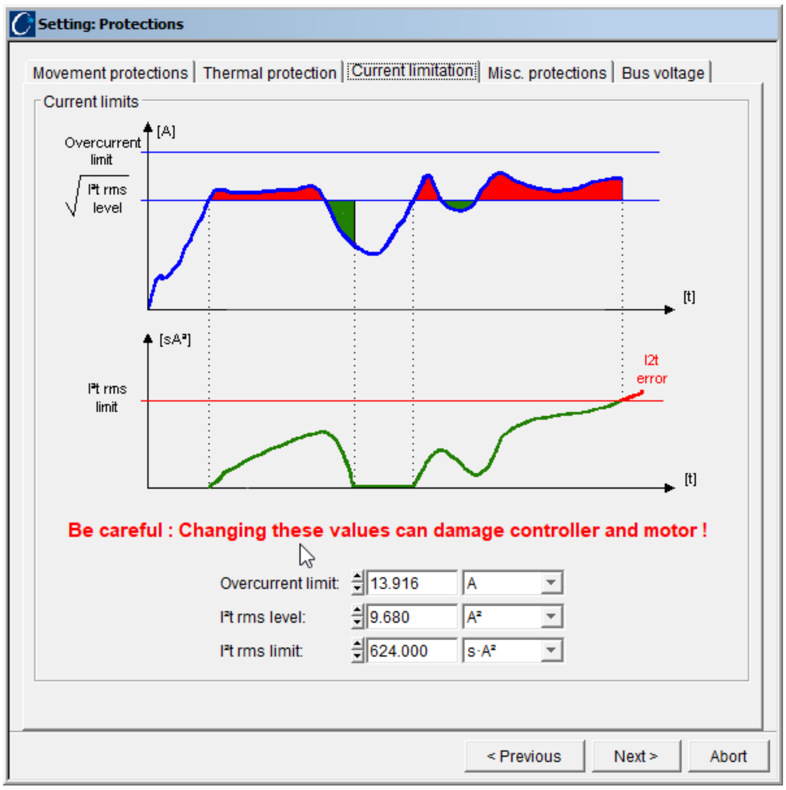
Thermal protection

Temperature sensor connected on :

	DIn 1	DIn 2	DIn 9	DIn 10
	☐	☐	☐	☐
Active High	●	●	●	●
Active Low	○	○	○	○

Current limitation

- Overcurrent limit: an error is raised if the current on the motor phases exceeds this limit.
- I²t rms level: the integration of current starts when the motor current is higher than this level.
- I²t rms limit: an error is raised if the integral of the motor current exceeds this limit.



Be careful : Changing these values can damage controller and motor !

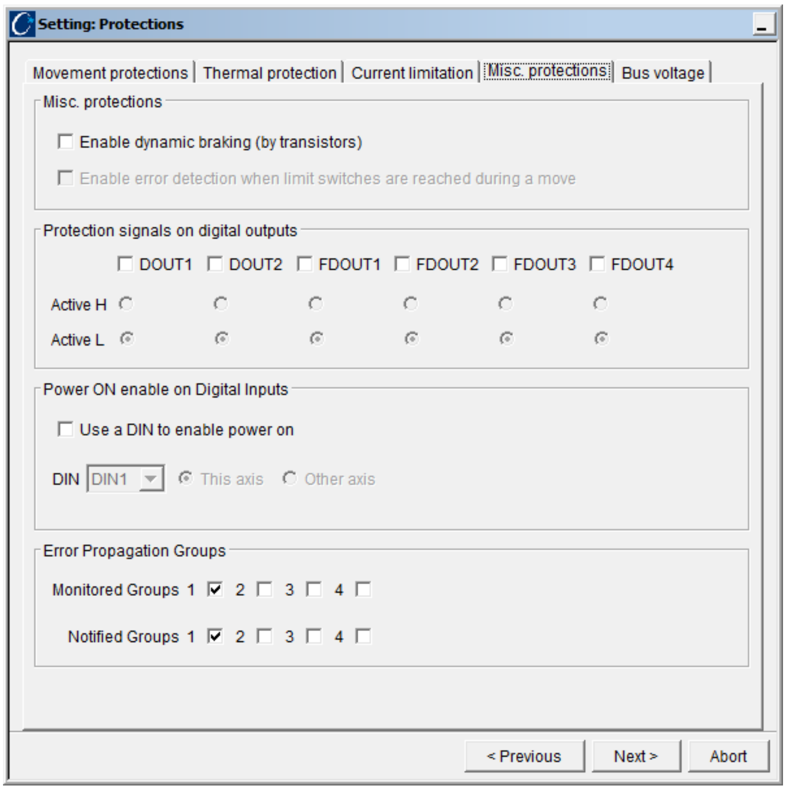
Overcurrent limit: 13.916 A

I²t rms level: 9.680 A²

I²t rms limit: 624.000 s·A²

Miscellaneous protections

- Misc. protections: enable dynamic breaking in case of error.
- Misc. protections: enable raising an error when the limit switches are reached during motion.
- Protection signals on digital outputs: set/reset digital outputs when an error occurs.
- Power ON enable on digital inputs: only allow axis power on if the digital input is set.
- Error propagation groups: configuration of the error propagation mechanism.



Misc. protections

☐ Enable dynamic braking (by transistors)

☐ Enable error detection when limit switches are reached during a move

Protection signals on digital outputs

	☐ DOUT1	☐ DOUT2	☐ FDOUT1	☐ FDOUT2	☐ FDOUT3	☐ FDOUT4
Active H	○	○	○	○	○	○
Active L	●	●	●	●	●	●

Power ON enable on Digital Inputs

☐ Use a DIN to enable power on

DIN DIN1 ● This axis ○ Other axis

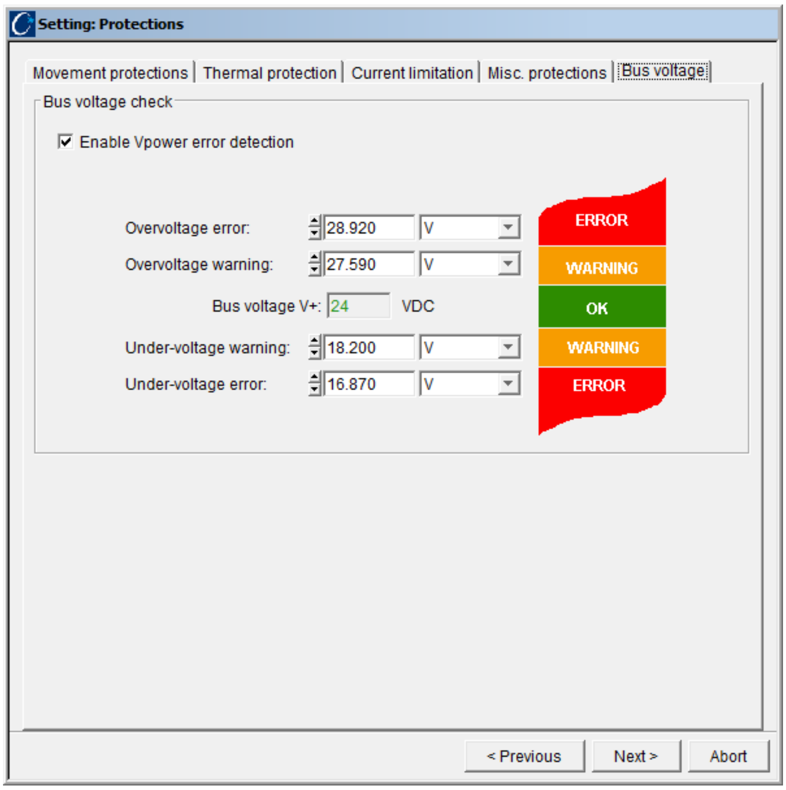
Error Propagation Groups

Monitored Groups 1 ☑ 2 ☐ 3 ☐ 4 ☐

Notified Groups 1 ☑ 2 ☐ 3 ☐ 4 ☐

Bus voltage

Enable error detection of the power input voltage by defining levels for overvoltage and under-voltage warning and error generation.



Bus voltage check

☑ Enable Vpower error detection

Overvoltage error: 28.920 V

Overvoltage warning: 27.590 V

Bus voltage V+: 24 VDC

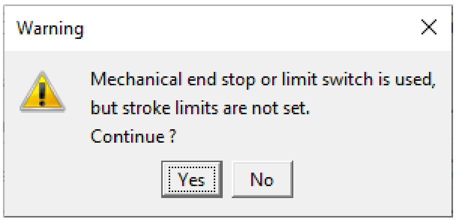
Under-voltage warning: 18.200 V

Under-voltage error: 16.870 V

IMPORTANT	Carefully read the *AccurET Modular Position Controller Operation & Software Manual* in order to set properly the protections of the application.

To proceed click on the **Next** button.

If mechanical end stops or limit switches are used in the application, but the stroke limits were not enabled in the sub-panel **Movement protections**, the following warning message pops-up.



Warning

Mechanical end stop or limit switch is used, but stroke limits are not set.
Continue ?

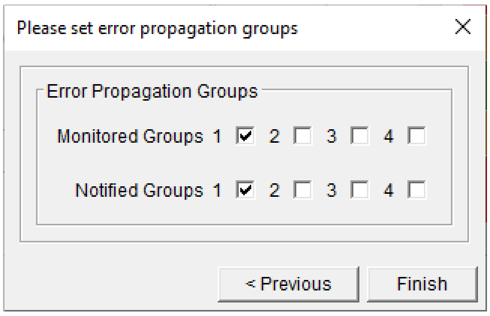
Click **Yes** to proceed or **No** to go back to the sub-panel **Movement protections** to configure the stroke limits.

4.1.10. Setting wizard: error propagation groups

The last information to configure is related to the ***AccurET***/***UltimET*** error propagation mechanism running through ***TransnET***.

The user can define the group (1 to 4) to which the axis belongs by selecting the **Monitored Groups** checkboxes. An axis can belong to more than one group.

In addition, the user can define the group in which the error must be published when an error occurs on the axis. An axis can publish the error to more than one group.



Please set error propagation groups

Error Propagation Groups

Monitored Groups 1 ☑ 2 ☐ 3 ☐ 4 ☐

Notified Groups 1 ☑ 2 ☐ 3 ☐ 4 ☐

NOTE	Refer to the *AccurET Modular Position Controller Operation & Software Manual* for further information about the error propagation mechanism on ***TransnET***.

To complete the Controller setting, click on the **Finish** button. Alternatively, clicking on the **Previous** button brings back the previous configuration panel related to protections. Once the setting is completed, the user is back to the main window of the *Setting* tool (**Edit main panel**), with the indication in the lower part that Controller is now set.

The controller is set

If necessary, the user can now revisit directly some of the configuration panels to verify the settings and modify. Below is the correspondence between the button to click and the configuration panel that opens.

Controller information → Setting wizard panel #1: general information
Information can be modified.

Application configuration → Setting wizard panel #3: motor environment
Configuration can be modified.

Motor configuration
Only informative, setting cannot be modified. A new setting is required to modify the motor settings.

Position feedback → Setting wizard panel #5: position feedback
Configuration can be modified.

Phasing → Setting wizard panel #6: phasing selection
Configuration can be modified.

Homing → Setting wizard panel #7: homing selection
Configuration can be modified.

Auto Setting → Setting wizard panel #8: auto setting
Configure and re-execute the auto-setting.

Protections → Setting wizard panel #9: protections
Configuration can be modified.

The other buttons also available on this **Edit main panel** are explained in corresponding Sections of this Manual.

I/O configuration → Refer to Chapter §9.

Regulation → Refer to Section §4.2.

4.2. Fine tuning

Once a basic setting has been completed, it is possible to fine tune the regulation parameters previously set by the auto tuning procedure.

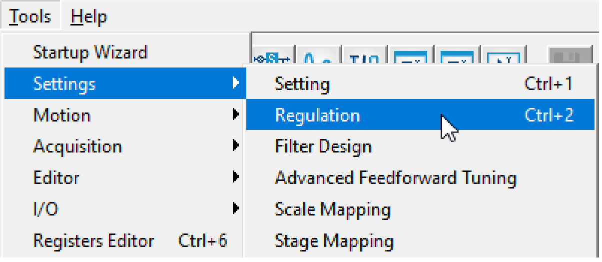
There are several different techniques for tuning a PID controller, but these can be basically classified under two categories: time domain and frequency domain techniques. ***ComET4***'s *Regulation* tool makes use of time domain techniques.

By analyzing the time domain response of the system to certain stimuli, the user can adjust the parameters of both the current and position loops and modify the parameters of each filter present in the regulation loops until obtaining the desired controller behavior.

There are several ways to launch the *Regulation* tool, such as:

1. On the **Toolbar Tools** group, click on the button .

2. Select the Menu option **Tools → Settings → Regulation**.

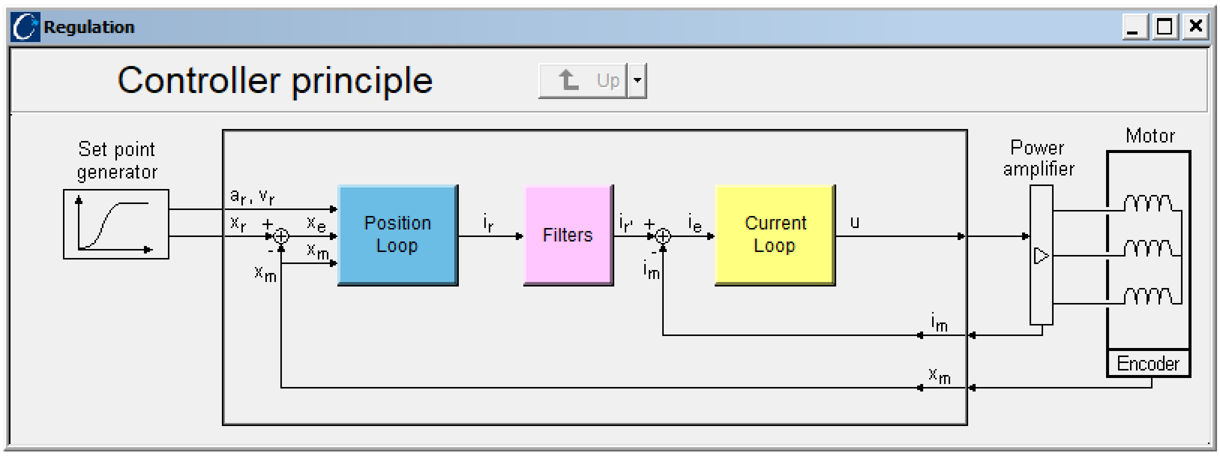


NOTE

Before executing the *Regulation* tool, please ensure that ***ComET4*** has a connection established with the target hardware.

The main window of the *Regulation* tool (**Controller principle**) contains the ***AccurET*** high-level control scheme, where three main blocks (control buttons) are clearly identified.

Current Loop	Current loop: PI controller
Position Loop	Position loop: PID controller
Filters	Filters: 5 advanced filters (+3 reserved for the force control mode)



The basic rules for tuning the Controller are:

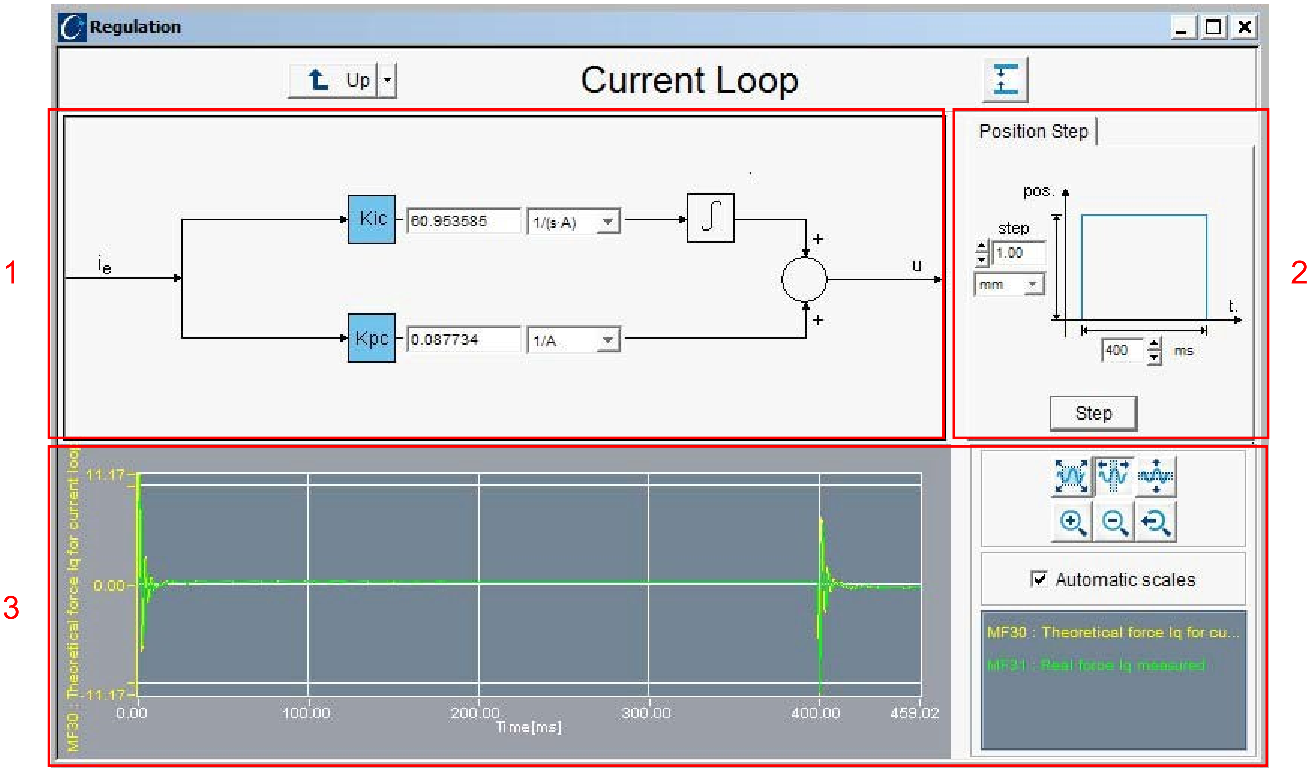
- First, fine tune the current loop to obtain the highest bandwidth possible;
- Then, fine tune the position loop;
- Adjust the filters; and
- Finally, re-tune the position loop.

4.2.1. Current loop

For fine tuning the current loop regulation parameters, click on the **Current Loop** button on the *Regulation* tool main window to display the **Current Loop** regulation window. This window is divided into three areas:

1. Current loop parameters (these can be edited by the user);

2. Settings of the stimuli function that can be applied to the system (**Position Step**);
3. Plot (visualization o the time domain system response to the stimuli applied).



Click on the **Step** button to execute a step movement of the axis with a given stroke and duration, which are configurable via the respective edit control boxes.

Based on the analysis of the time domain response of the theoretical current (`MF30`) and real current (`MF31`), adjust the current loop parameters `Kpc` (`KF80`) and `Kic` (`KF81`). Press again the **Step** button to view the effect of these changes on the system response.

This is an iterative process to be repeated until obtaining the desired current controller behavior.

NOTE	If the *Scope* tool is opened, the data acquisitions of the theoretical and real currents will not be displayed in the plot area of the **Current Loop** regulation window, but rather in the *Scope* tool directly (if it is properly configured to display these monitorings). Refer to the *AccurET Modular Position Controller Operation & Software Manual* for details on how to perform a basic tuning of the Controller's current loop.

The function of all button controls present on this **Current Loop** regulation window are detailed below.

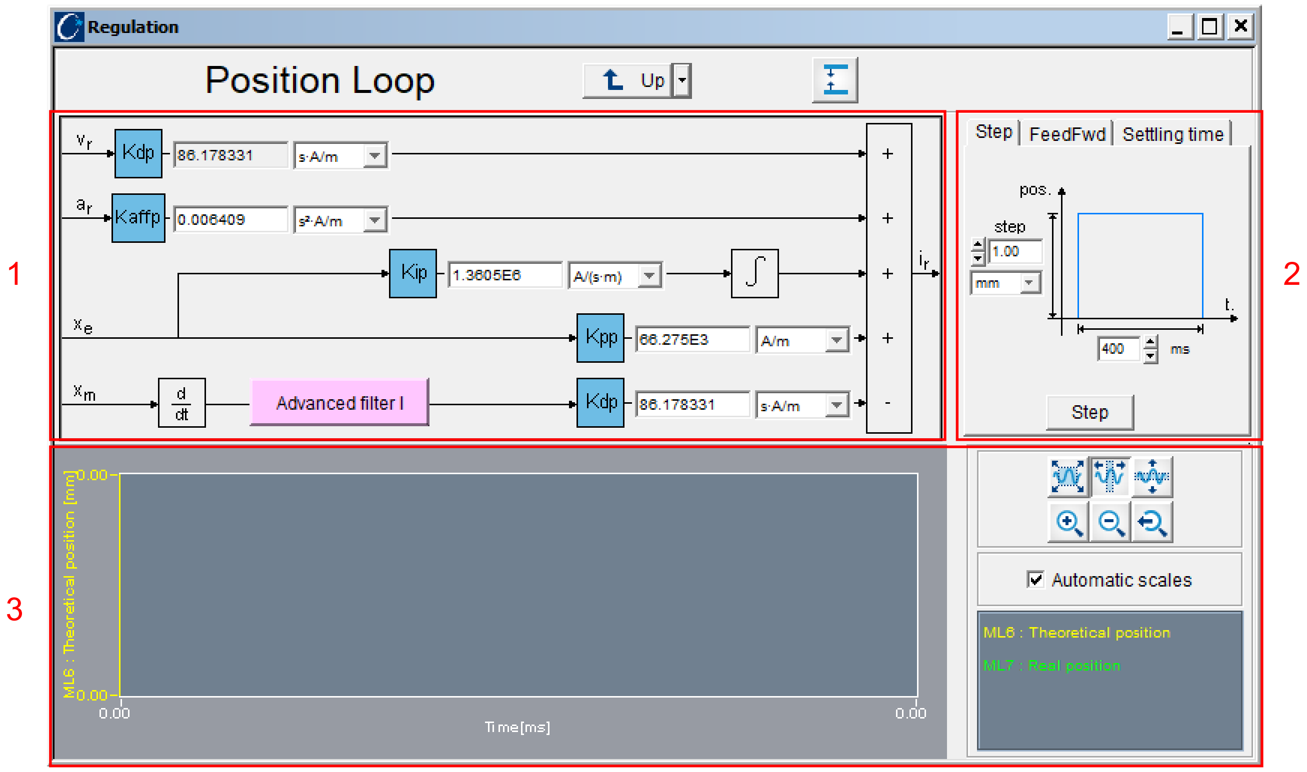
Up	Return to the *Regulation* tool main window (**Controller principle**) or change directly to the **Position Loop** window by selecting this option from the drop-down list.
	Hide/Unhide the plot area.
Step	Execute a step movement

	Zoom to rectangle.
	Zoom along the horizontal axis while keeping the vertical axis scale fixed.
	Zoom along the vertical axis while keeping the horizontal axis scale fixed.
	Zoom in with a fixed magnification ratio.
	Zoom out with a fixed demagnification ratio.
	Undo previous Zoom action.

4.2.2. Position loop

For fine tuning the position loop regulation parameters, click on the **Position Loop** button on the *Regulation* tool main window to display the **Position Loop** regulation window. This window is divided into three areas:

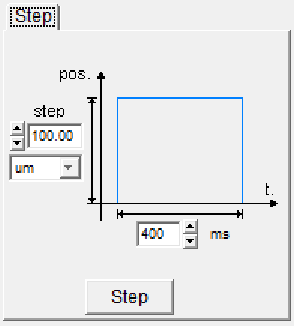
1. Position loop parameters (these can be edited by the user);
2. Settings of the stimuli functions that can be applied to the system (**Step**, **Feedforward** and **Settling time**);
3. Plot (visualization o the time domain system response to the stimuli applied).



Kdp 86.178331 s·A/m
Kaffp 0.006409 s²·A/m
Kip 1.3605E6 A/(s·m)
Kpp 66.275E3 A/m
Kdp 86.178331 s·A/m
step 1.00 mm
400 ms
☑ Automatic scales

There are three functions available on the three sub-panels:

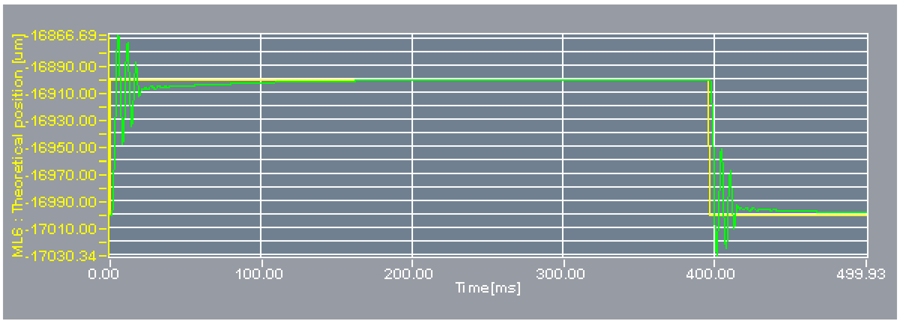
Step



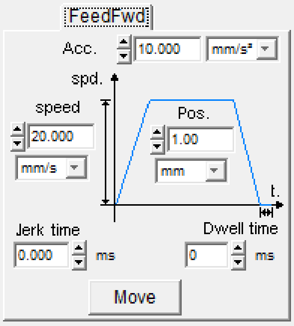
Click on the **Step** button to execute a step movement of the axis with a given stroke and duration, which are configurable via the respective edit control boxes.

Based on the analysis of the time domain response of the theoretical position (`ML6`) and real position (`ML7`), adjust the PID parameters `Kpp` (`KF1`), `Kip` (`KF4`) and `Kdp` (`KF2`). Press again the **Step** button to view the effect of these changes on the system response.

This is an iterative process to be repeated until obtaining the desired current controller behavior.



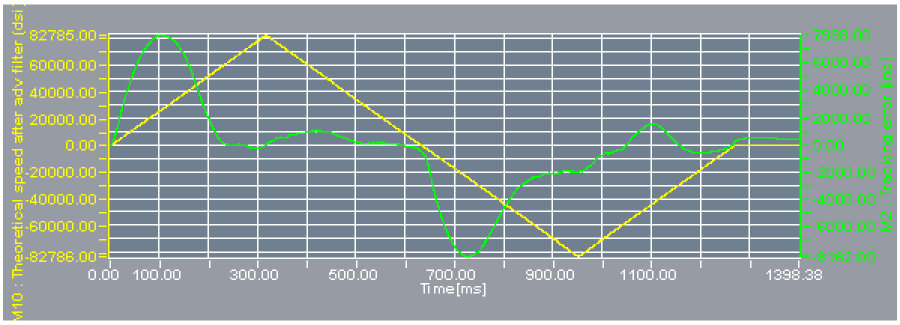
Feedforward



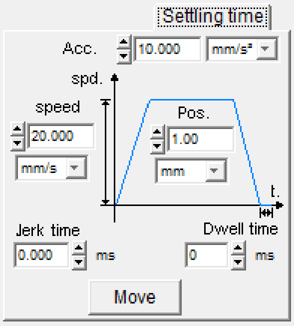
Click on the **Move** button to execute a movement of the axis with the given profile, which is configurable via the position, speed, acceleration, jerk time and dwell time edit control boxes.

Based on the analysis of the time domain response of the theoretical speed (`M10`) and tracking error (`M2`), adjust the feedforward parameter `Kaffp` (`KF21`). Press again the **Move** button to view the effect of this change on the system response.

This is an iterative process to be repeated until obtaining the desired current controller behavior.



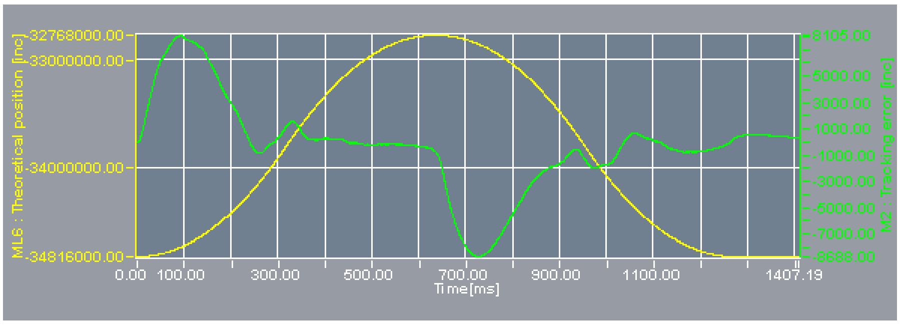
Settling time



Click on the **Move** button to execute a movement of the axis with the given profile, which is configurable via the position, speed, acceleration, jerk time and dwell time edit control boxes.

Based on the analysis of the time domain response of the theoretical position (`ML6`) and tracking error (`M2`), adjust the PID parameters `Kpp` (`KF1`), `Kip` (`KF4`) and `Kdp` (`KF2`) and feedforward parameter `Kaffp` (`KF21`). Press again the **Move** button to view the effect of these changes on the system response.

This is an iterative process to be repeated until obtaining the desired current controller behavior.



NOTE

If the *Scope* tool is opened, the data acquisitions of the theoretical and real positions, theoretical speed and tracking error will not be displayed in the plot area of the **Position Loop** regulation window, but rather in the *Scope* tool directly (if it is properly configured to display the corresponding monitorings).

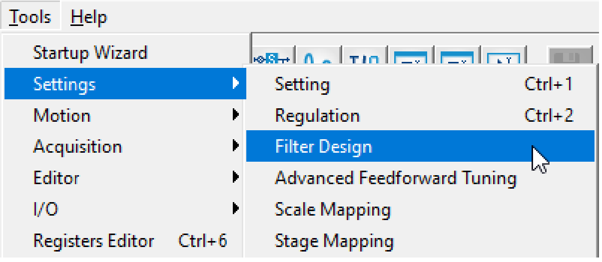
Refer to the *AccurET Modular Position Controller Operation & Software Manual* for details on how to perform a basic tuning of the Controller's position loop.

The function of all button controls present on this **Position Loop** regulation window are detailed below:

Up	Return to the *Regulation* tool main window (**Controller principle**) or change directly to the **Current Loop** window by selecting this option from the drop-down list.
	Hide/Unhide the plot area.
Advanced filter I	Launch the *Filter Design* tool.
Step	Execute a step movement.
Move	Execute a movement with the defined profile.
	Zoom to rectangle.
	Zoom along the horizontal axis while keeping the vertical axis scale fixed.
	Zoom along the vertical axis while keeping the horizontal axis scale fixed.
	Zoom in with a fixed magnification ratio.
	Zoom out with a fixed demagnification ratio.
	Undo previous Zoom action.

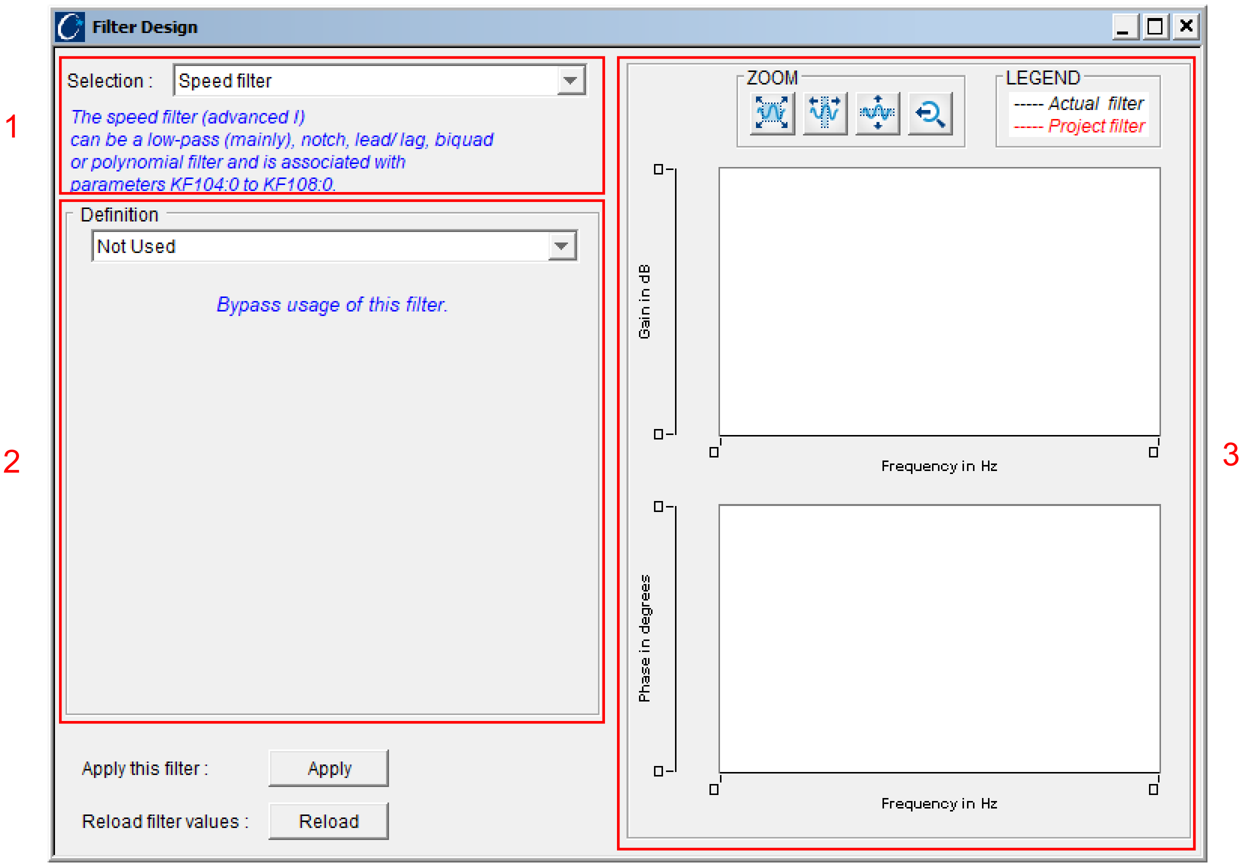
4.2.3. Filter design

From the *Regulation* tool it is also possible to configure the different filters of the Controller. Click on the **Filters** button on the main window to launch the *Filter Design* tool. Alternatively, this tool can be launched by selecting the Menu option **Tools → Settings → Filter Design**.



The *Filter Design* tool window is divided into three areas:

1. Filter selection;
2. Filter definition;
3. Plot of the filter's frequency response (gain and phase).



Selection : Speed filter

The speed filter (advanced I) can be a low-pass (mainly), notch, lead/ lag, biquad or polynomial filter and is associated with parameters KF104:0 to KF108:0.

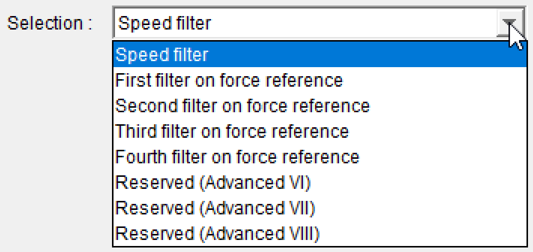
Definition: Not Used

Bypass usage of this filter.

Apply this filter :

Reload filter values :

Filter selection



Selection : Speed filter

- Speed filter
- First filter on force reference
- Second filter on force reference
- Third filter on force reference
- Fourth filter on force reference
- Reserved (Advanced VI)
- Reserved (Advanced VII)
- Reserved (Advanced VIII)

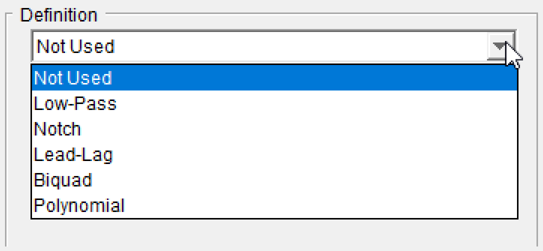
Up to 5 advanced filters can be set on the Controller:

- Advanced filter I → Speed filter
- Advanced filter II → First filter on force reference
- Advanced filter III → Second filter on force reference
- Advanced filter IV → Third filter on force reference
- Advanced filter V → Fourth filter on force reference

Parameters `KF104`, `KF105`, `KF106`, `KF107` and `KF108` are used to define these advanced filters. There are 5 depths, one for each filter.

The advanced filters VI, VII and VIII are reserved for the force control mode.

Filter definition



Definition

Not Used

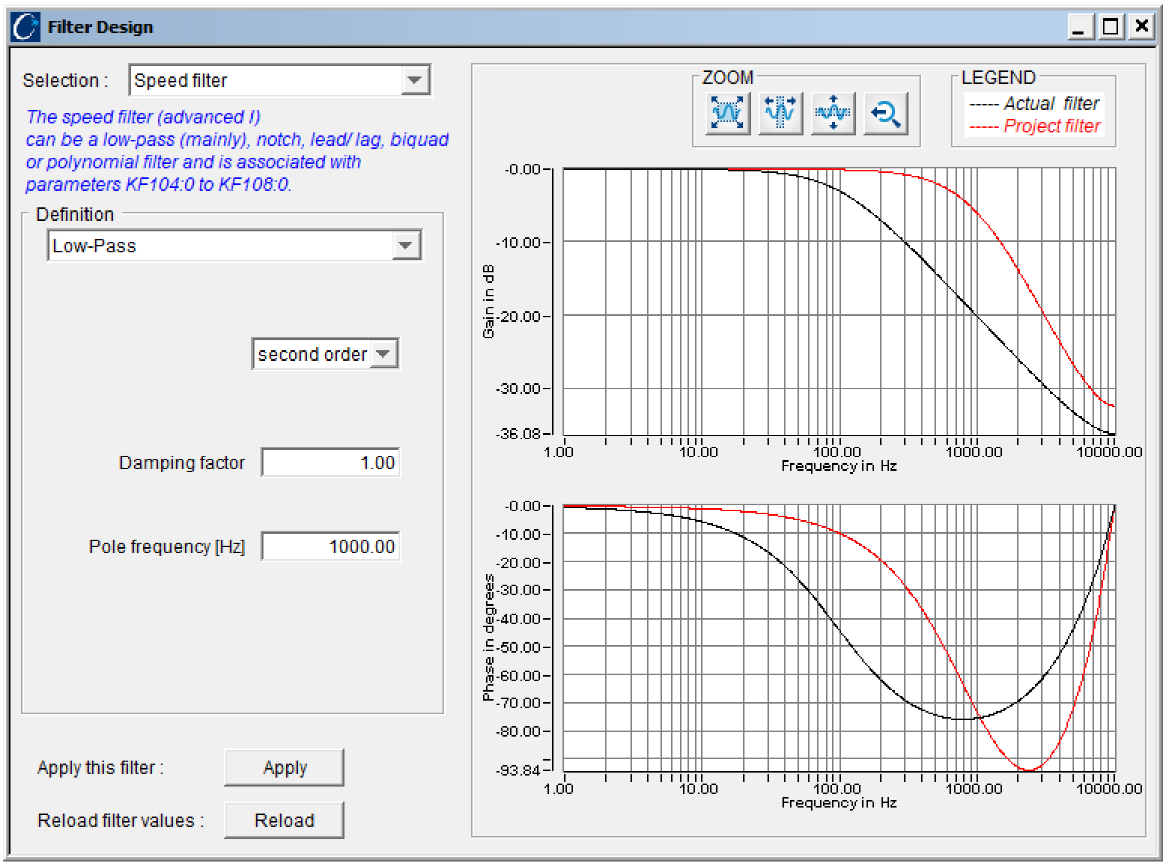
- Not Used
- Low-Pass
- Notch
- Lead-Lag
- Biquad
- Polynomial

The supported filter types are:

- Low-pass (first and second order);
- Notch;
- Lead-Lag (or Lag-Lead);
- Biquad;
- Polynomial.

NOTE Refer to the *AccurET Modular Position Controller Operation & Software Manual* for details about the Controller's regulator filters.

To set a filter, enter the values in the Definition area required by the selected filter and press the **Enter** key. The corresponding 'gain vs frequency' and 'phase vs frequency' curves are then displayed on the plot area.



Filter Design

Selection : Speed filter

The speed filter (advanced I) can be a low-pass (mainly), notch, lead/ lag, biquad or polynomial filter and is associated with parameters KF104:0 to KF108:0.

Definition: Low-Pass

second order

Damping factor: 1.00

Pole frequency [Hz]: 1000.00

Apply this filter : Apply

Reload filter values : Reload

The black curve is the **Actual filter** (filter whose parameters' values are currently set in the Controller) and the red one is the **Project filter** (filter corresponding to the entered values).

The function of the button controls present on the Plot area are detailed below:

	Zoom to rectangle.
	Zoom along the horizontal axis while keeping the vertical axis scale fixed.
	Zoom along the vertical axis while keeping the horizontal axis scale fixed.
	Undo previous Zoom action.

If the user clicks on the **Apply** button, the values of the selected filter's K parameters in the Controller will be updated with those just entered in the Definition area. This means that the **Actual filter** plots matches the **Project filter** plots.

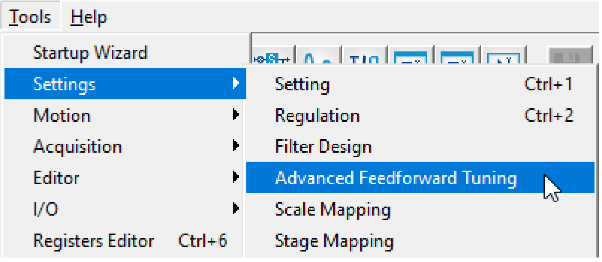
On the other hand, if the user clicks on the **Reload** button, the values in the Definition area will be overwritten by the Controller's actual values of the corresponding K parameters. This means that the **Project filter** plots matches the **Actual filter** plots.

4.2.4. Advanced feedforward tuning

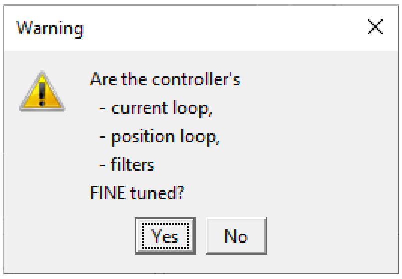
The *Advanced Feedforward Tuning* tool allows the user to fine tune the advanced feedforward parameters:

- Cogging compensation;
- Friction feedforward; and
- Acceleration feedforward.

To launch this tool select the Menu option **Tools → Settings → Advanced Feedforward Tuning**.



At tool startup, the following warning message pops up to remind the user that the tuning of the feedforward parameters should only be realized after having tuned properly the current loop, position loop and filters. Click on **Yes** to proceed or **No** to exit the tool.

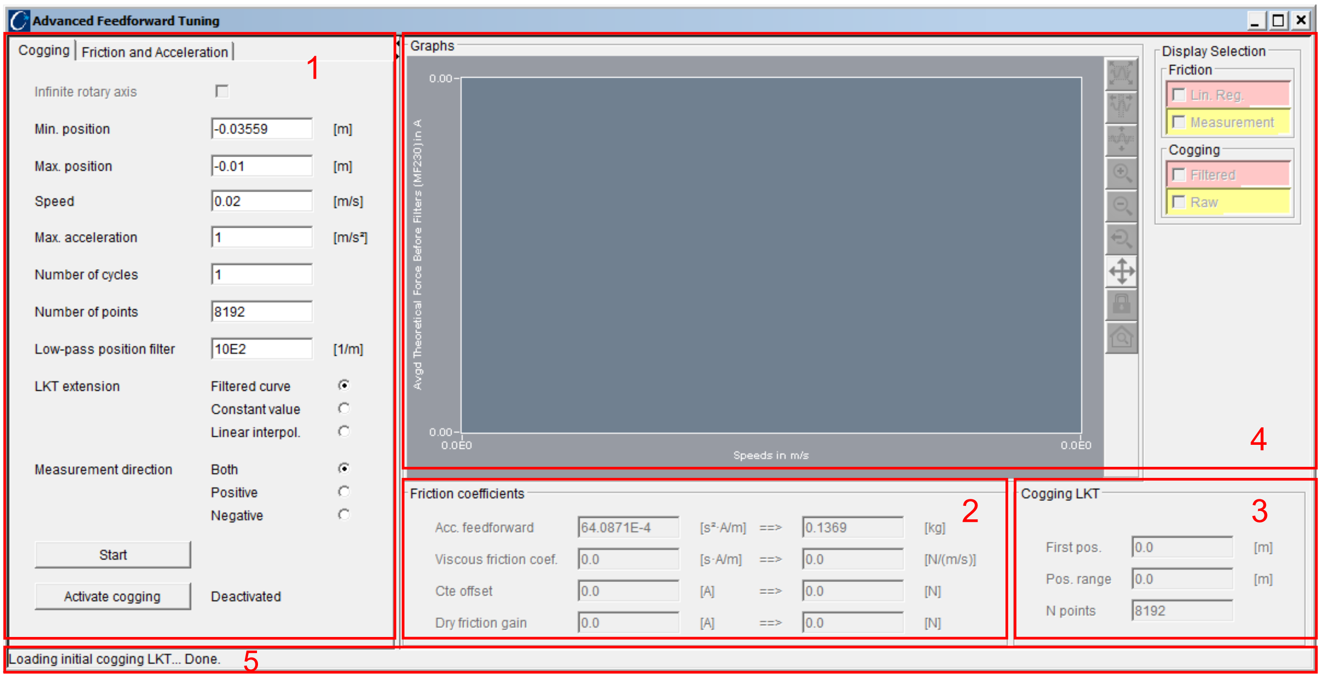


Are the controller's
- current loop,
- position loop,
- filters

FINE tuned?

The *Advanced Feedforward Tuning* tool window is divided into 5 areas:

1. Test conditions and other settings: composed of two tabs, one for the cogging and another for the friction and acceleration feedforward;
2. Computed friction and acceleration feedforward parameters;
3. Cogging look-up table configuration;
4. Plot of the measurements;
5. Status bar.



Infinite rotary axis ☐

Min. position -0.03559 [m]

Max. position -0.01 [m]

Speed 0.02 [m/s]

Max. acceleration 1 [m/s²]

Number of cycles 1

Number of points 8192

Low-pass position filter 10E2 [1/m]

LKT extension: Filtered curve ● Constant value ○ Linear interpol. ○

Measurement direction: Both ● Positive ○ Negative ○

Activate cogging: Deactivated

Friction coefficients

Acc. feedforward	64.0871E-4	[s²·A/m]	==>	0.1369	[kg]
Viscous friction coef.	0.0	[s·A/m]	==>	0.0	[N/(m/s)]
Cte offset	0.0	[A]	==>	0.0	[N]
Dry friction gain	0.0	[A]	==>	0.0	[N]

Cogging LKT

First pos.	0.0	[m]
Pos. range	0.0	[m]
N points	8192	

Loading initial cogging LKT... Done.

NOTE

In order to obtain a good tuning, start by tuning first the cogging parameters and only then the friction and acceleration feedforward parameters.

Furthermore, the cogging compensation should be active when tuning the friction and acceleration feedforward parameters.

Cogging

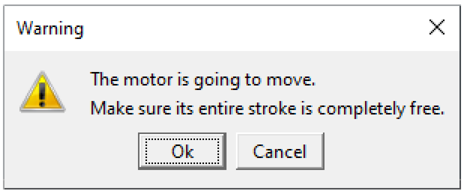
The cogging compensation table can compensate any position dependent force acting on the system (cogging, spring force, gravity, restoring force…). In order to acquire this table the following inputs should be provided (to tool already fills the different fields with proposed settings that the user can modify).

Infinite rotary axis ☐	In case of a rotary axis, indicate if it has an infinite rotary motion.
Min. position ▭ [m]	Minimum position of measurement. This position should be greater or equal to the minimum software position limit (`KL34`).

Max. position		[m]	Maximum position of measurement. This position should be smaller or equal to the maximum software position limit (`KL35`).
Speed		[m/s]	Speed at which the cogging compensation will be measured. It is recommended to measure the cogging compensation at low speed.
Max. acceleration		[m/s²]	Maximum acceleration of the motion executed for measuring the cogging compensation.
Number of cycles			A cycle is composed of a back-and-forth motion. If more than one cycle is used, the cogging compensation table will be an average between all cycles.
Number of points			The cogging compensation table can have up to 8192 points. The points used to store the cogging will be equally spaced between the minimum and maximum positions.
Low-pass position filter		[1/m]	Cut-off frequency of the low-pass filter used to filter the raw data. It can be modified after acquisition of the raw data.
LKT extension	Filtered curve Constant value Linear interpol.	○ ○ ○	The cogging compensation table is defined between the minimum and maximum positions (compensation zone). For a position smaller than the minimum or greater than maximum, the first or last point of the table is used. To measure correctly the cogging effect, the system must move at constant speed, which is not the case during motion acceleration and deceleration phases. If these motion phases occur within the compensation zone, the user can choose one of the following options: - **Filtered curve**: use anyway the filtered raw data; - **Constant value**: replace the raw data by a constant value (equal to the last point obtained at constant speed); - **Linear interpolation**: replace the raw data by a linear interpolation of the cogging compensation table. It should be noted that if the motion is at constant speed within the compensation zone, this option is disabled. The option selected by the user can also be modified after acquisition of the raw data.
Measurement direction	Both Positive Negative	○ ○ ○	The measurement is an average between positive and negative directions. However, in certain cases, the user might want to use only one direction.

NOTE The *Cogging Compensation* tool does not support the Gantry mode.

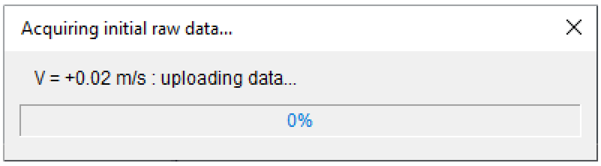
After having configured the settings above, click on the **Start** button to initiate the measurement procedure for determining the cogging compensation table. A message pops up to warn the user that the motor is about to move.


Warning

The motor is going to move.
Make sure its entire stroke is completely free.

WARNING	Always ensure that the proper safety precautions are taken when powering on a Controller and executing movements with a motion system.

If the safety conditions are assured, click on the **Ok** button to proceed with the measurement procedure. A progress dialog box appears to display the progress

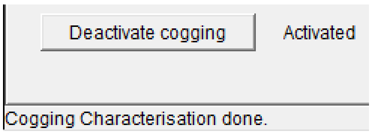


Acquiring initial raw data...

V = +0.02 m/s : uploading data...

0%

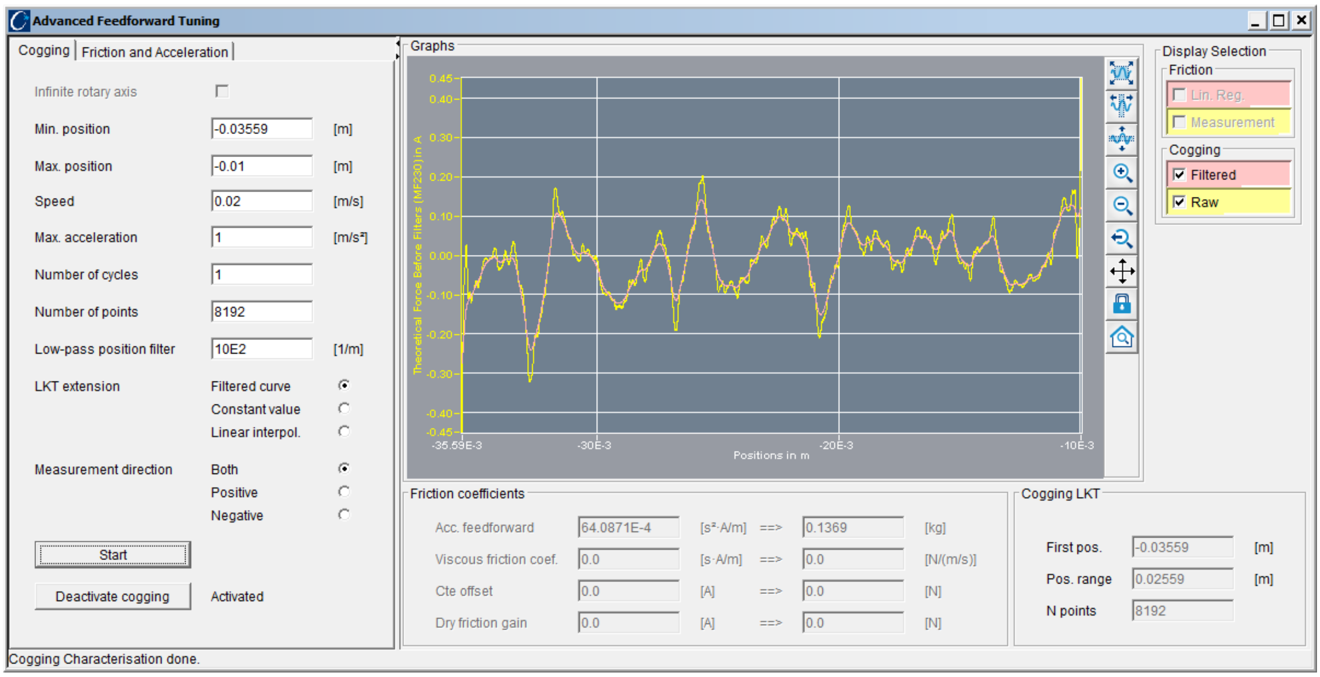
Once the procedure is completed, the progress dialog box closes and a message is displayed in the status bar informing that the procedure is completed. Furthermore, the cogging compensation is automatically activated at the end of a successful procedure.



Activated

Cogging Characterisation done.

The raw and filtered measurements of the theoretical current after the advanced filters (`MF230`) as a function of the motor's position are displayed in the plot area. The user can modify the cut-off frequency of the low-pass filter and visualize the effect. Also, the **Cogging LKT** information in area 3 is updated accordingly.



Infinite rotary axis ☐

Min. position -0.03559 [m]

Max. position -0.01 [m]

Speed 0.02 [m/s]

Max. acceleration 1 [m/s²]

Number of cycles 1

Number of points 8192

Low-pass position filter 10E2 [1/m]

LKT extension: ● Filtered curve ○ Constant value ○ Linear interpol.

Measurement direction: ● Both ○ Positive ○ Negative

Activated

Display Selection – Friction: ☐ Lin. Reg. ☐ Measurement; Cogging: ☑ Filtered ☑ Raw

Friction coefficients

Acc. feedforward	64.0871E-4	[s²·A/m]	==>	0.1369	[kg]
Viscous friction coef.	0.0	[s·A/m]	==>	0.0	[N/(m/s)]
Cte offset	0.0	[A]	==>	0.0	[N]
Dry friction gain	0.0	[A]	==>	0.0	[N]

Cogging LKT

First pos.	-0.03559	[m]
Pos. range	0.02559	[m]
N points	8192	

Cogging Characterisation done.

The function of the button controls present on the Plot area are detailed below:

⬚	Zoom to rectangle.
↔	Zoom along the horizontal axis while keeping the vertical axis scale fixed.
↕	Zoom along the vertical axis while keeping the horizontal axis scale fixed.
⊕	Zoom in with a fixed magnification ratio.
⊖	Zoom out with a fixed magnification ratio.
↶	Undo previous Zoom action.
✥	Pan.
🔒	Lock axis (this option is particularly useful to analyze the effect of the different options for the LKT extension; if the axis is locked, the user can switch between the options without the inconvenience of the plot being refreshed to the default view).
⌂	Restore original view.

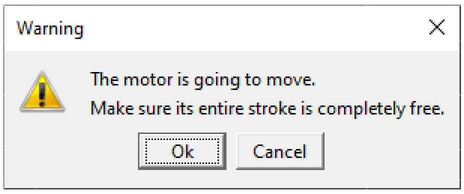
The next step consists of tuning the friction and acceleration feedforward parameters:

Friction and Acceleration feedfoward

To tune these feedforward parameters, the following inputs should be provided (to tool already fills the different fields with proposed settings that the user can modify).

Min. position	☐	[m]	Minimum position of measurement. This position should be greater or equal to the minimum software position limit (`KL34`).
Max. position	☐	[m]	Maximum position of measurement. This position should be smaller or equal to the maximum software position limit (`KL35`).
Min. speed for friction test	☐	[m/s]	Minimum speed at which the friction is measured.
Max. speed for friction test	☐	[m/s]	Maximum speed at which the friction is measured.
Max. speed for acc. test	☐	[m/s]	Maximum speed used for the acceleration feedforward parameter tuning.
Number of speeds	☐		Number of different speeds used between the minimum and maximum values.
Max. acceleration	☐	[m/s²]	Maximum acceleration used.
Jerk time	☐	[s]	Jerk time used on every motion.
Dry friction mode :	w/o hysteresis w/ hysteresis	○ ○	Possibility to use a friction model with or without hysteresis.
Threshold speed	☐	[m/s]	If the friction model with hysteresis is selected, the threshold speed can be adjusted.
Moving average	0.0 ▾	[s]	A moving average filter is used to filter the feedforward response to smooth the step at speed 0 or at threshold speed.
Use cogging compensation	☐		Select if the cogging compensation should be active (recommended) or not.

After having configured the settings above, click on the **Start** button to initiate the measurement procedure for determining the friction and acceleration feedforward parameters. A message pops up to warn the user that the motor is going to move.

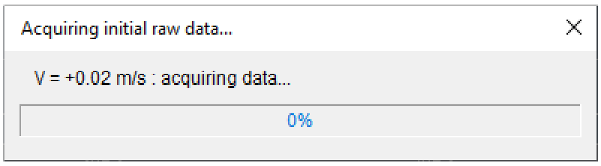


Warning

The motor is going to move.
Make sure its entire stroke is completely free.

WARNING	Always ensure that the proper safety precautions are taken when powering on a Controller and executing movements with a motion system.

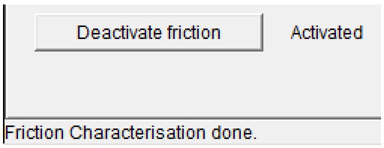
If the safety conditions are assured, click on the **Ok** button to proceed with the measurement procedure. A progress dialog box appears to display the progress.



Acquiring initial raw data...

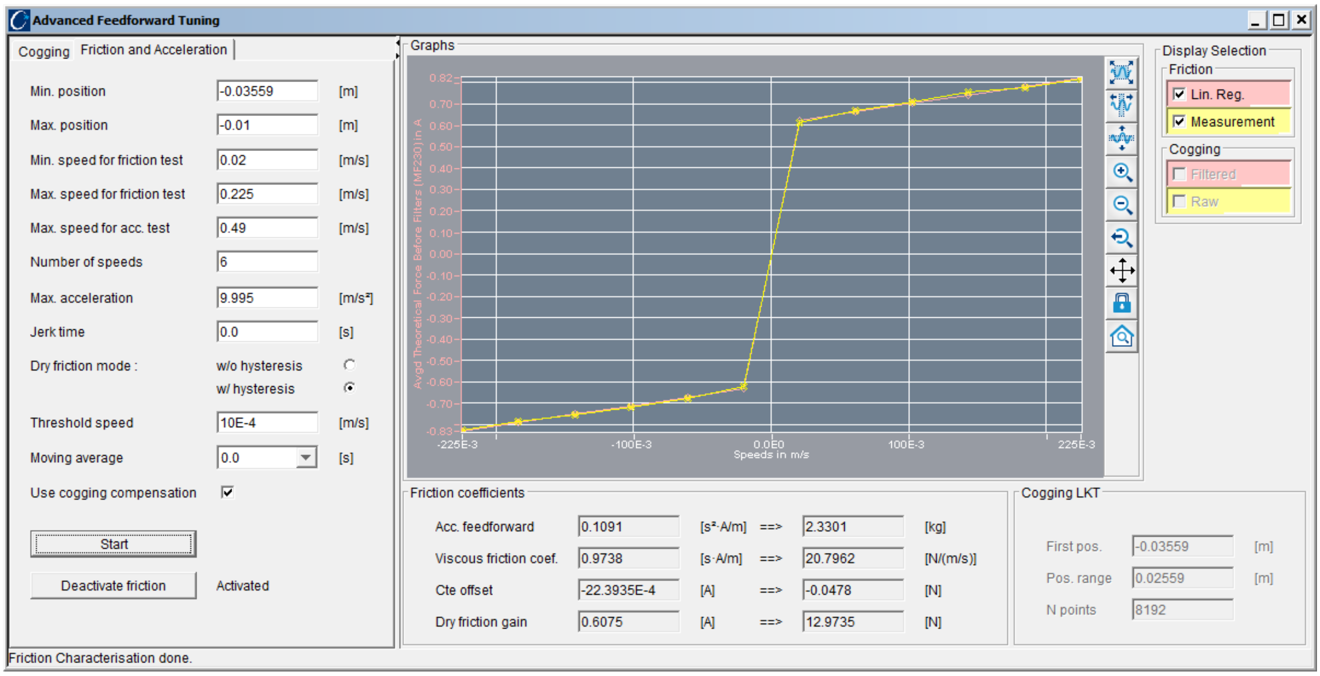
V = +0.02 m/s : acquiring data...

Once the procedure is completed, the progress dialog box closes and a message is displayed in the status bar to inform the user that the procedure is completed. Furthermore, the friction feedforward is automatically activated at the end of a successful procedure.



Friction Characterisation done.

The average of theoretical current after the advanced filters (`MF230`) as a function of the speed and a linear regression fit to this data are displayed in the plot area. Also, the **Friction coefficients** information in area 2 is updated accordingly.



Min. position -0.03559 [m]
Max. position -0.01 [m]
Min. speed for friction test 0.02 [m/s]
Max. speed for friction test 0.225 [m/s]
Max. speed for acc. test 0.49 [m/s]
Number of speeds 6
Max. acceleration 9.995 [m/s²]
Jerk time 0.0 [s]
Dry friction mode : w/o hysteresis ○ w/ hysteresis ●
Threshold speed 10E-4 [m/s]
Moving average 0.0 [s]
Use cogging compensation ☑
Activated

☑ Lin. Reg.
☑ Measurement
☐ Filtered
☐ Raw

Acc. feedforward 0.1091 [s²·A/m] ==> 2.3301 [kg]
Viscous friction coef. 0.9738 [s·A/m] ==> 20.7962 [N/(m/s)]
Cte offset -22.3935E-4 [A] ==> -0.0478 [N]
Dry friction gain 0.6075 [A] ==> 12.9735 [N]

First pos. -0.03559 [m]
Pos. range 0.02559 [m]
N points 8192

Friction Characterisation done.

Finally, the user must save the configuration to the Controller. For this, select the Menu **Controller → Save Configuration to Controller** or click on the **Save configuration to controller** toolbar button . On the **Save on Controller** dialog box that pops-up, select which axis to save, select the radio button control corresponding to the `SAV = 0` command for saving the complete configuration on the Controller and then click on the **Save** button.

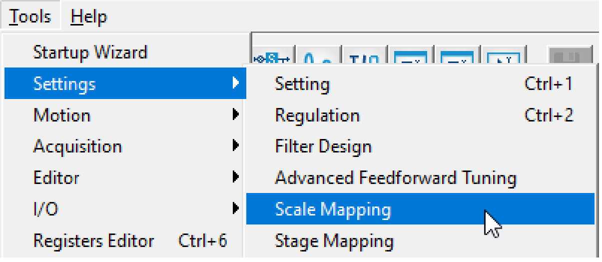
Alternatively, this command can also be typed in the *Terminal* tool. Refer to Section §10.3 for more information about saving a Controller's configuration.

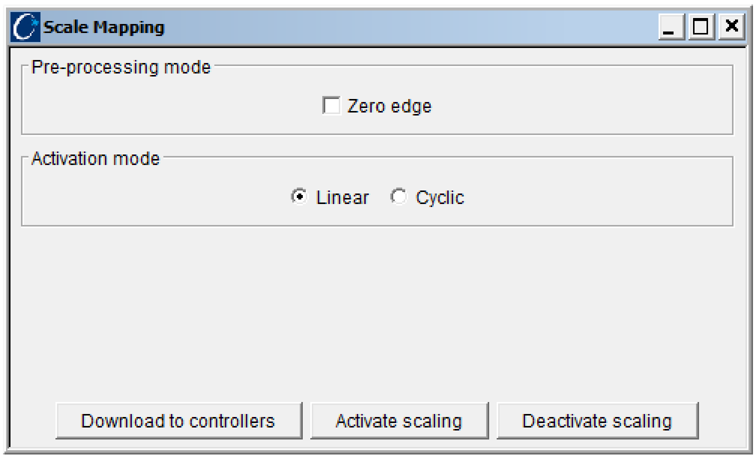
4.2.5. Scale mapping

Measurements of all linear and rotary encoders include errors with respect to the real position. The ***AccurET***'s scale error mapping feature can be used to compensate for the deterministic portion of such errors based on an error map provided by the user.

ComET4's *Scale Mapping* tool allows the user to configure the ***AccurET***'s scale error mapping feature, to download to the Controller the correction data and to activate/deactivate this feature.

This tool can be launched by selecting the Menu option **Tools → Settings → Scale Mapping**.





Scale Mapping

Pre-processing mode

☐ Zero edge

Activation mode

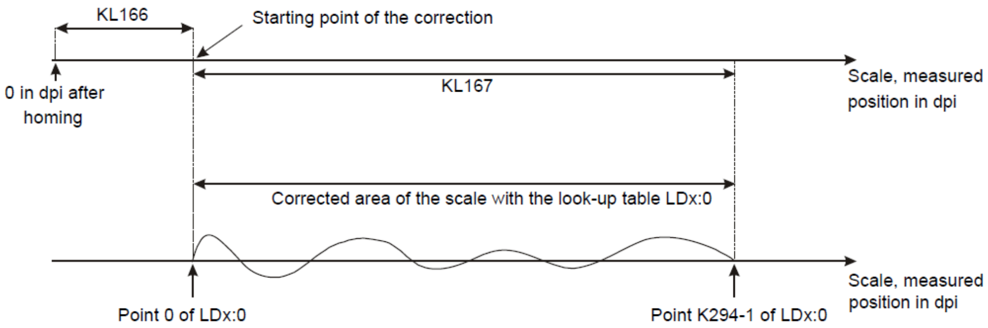
● Linear ○ Cyclic

Before describing how the *Scale Mapping* tool works, it is important to refresh some basic notions of the ***AccurET***'s scale error mapping feature.

The table below lists the important Controller registers associated to this feature:

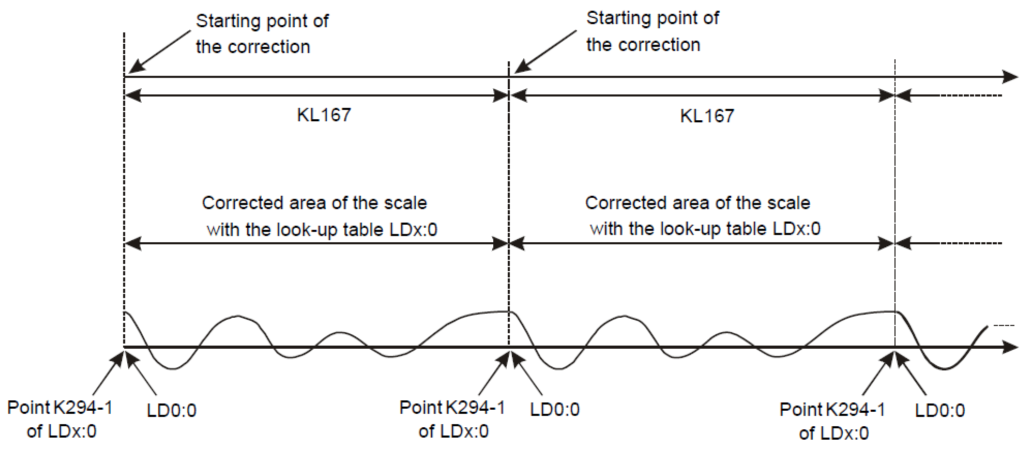
`K165`	Enable/Disable the scale error mapping feature: = 0 → scale correction disabled; = 1 → linear scale mapping mode activated; = 4 → cyclic (rotary) scale mapping mode activated.
`K294`	Number of points of the scale mapping correction.
`KL166`	Position where the scale correction starts. Must be zero when using the cyclic scale mapping mode (`K165 = 4`).
`KL167`	Length where the scale mapping correction is active.
`ML9`	Gives the scale correction value being applied.
`ML19`	Real position before scale correction.
`ML17`	Real position after scale correction (`ML17 = ML19 + ML9`). If the scale mapping feature is deactivated (`K165 = 0`), `ML17 = ML19`.
`LD0`	Look-up table containing the corrections to apply.

When using the linear scale mapping mode, the correction is only applied to the position zone defined by `KL166` and `KL167`. The correction for the first and last points of this zone must be zero.



NOTE When the position is out of the correction zone (defined by `KL166` and `KL167`), the applied correction is the last value of the table.

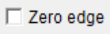
The cyclic scale mapping mode is suited for a rotary axis. When using this mode, parameter `KL166` must be set to zero and parameter `KL167` must be set equal to the distance in dpi corresponding to the value of `KL27` (maximum position range limit for a rotary movement; for an infinite rotary movement, it corresponds to the value of one turn). Whatever the distance to be covered, the same look-up table is applied again and again if the motor is moving.



NOTE Whatever the scaling mapping mode, the applied correction is rounded to the integer. Refer to the *AccurET Modular Position Controller Operation & Software Manual* for details about the Controller's scale error mapping feature.

When using the *Scale Mapping* tool, follow this recommended sequence of actions to properly configure the ***AccurET***'s scale error mapping feature:

1. Activate/Deactivate the pre-processing mode;
2. Select the activation mode;
3. Download the scale mapping file;
4. Activate the scale mapping feature;
5. Verify if the scale mapping feature is working as expected;
6. Save the configuration to the Controller.

Pre-processing mode	
 ☐ Zero edge	The user can select the zero-edge pre-processing mode. This basically ensures that the first and last scale corrections on the look-up table `LD0` will be zero as required by the linear scale mapping mode (alternatively, the user can ensure that the first and last corrections listed in the scale mapping file are zero and deactivate this feature). This option must be activated prior to the download of the scale mapping data to the Controller to have the desired effect. Indeed, it is only when downloading the scale mapping data to the Controller that ***ComET4*** checks if this option is activated or not.

	If activated, ***ComET4*** reads the scale corrections from the file and appends on-the-fly a zero before the first and after the last point when transferring the data to the Controller. Furthermore, ***ComET4*** adjusts parameter `K294` accordingly and consequently parameter `KL167`. E.g., if the scale mapping file indicates that there are 20 correction points, `K294` will be set to 22 to account for these two extra zeros added on-the-fly and, consequently, parameter `KL167` is increased by 2 times the step size. Be aware that enabling this option will indirectly affect where the first correction is applied. Indeed, the first correction will be applied at the origin defined in the scale mapping file (corresponding to `KL166`). If this option is activated, the correction that will be applied at this location corresponds to the zero added on-the-fly by ***ComET4*** and not to the first correction listed in the scale mapping file.

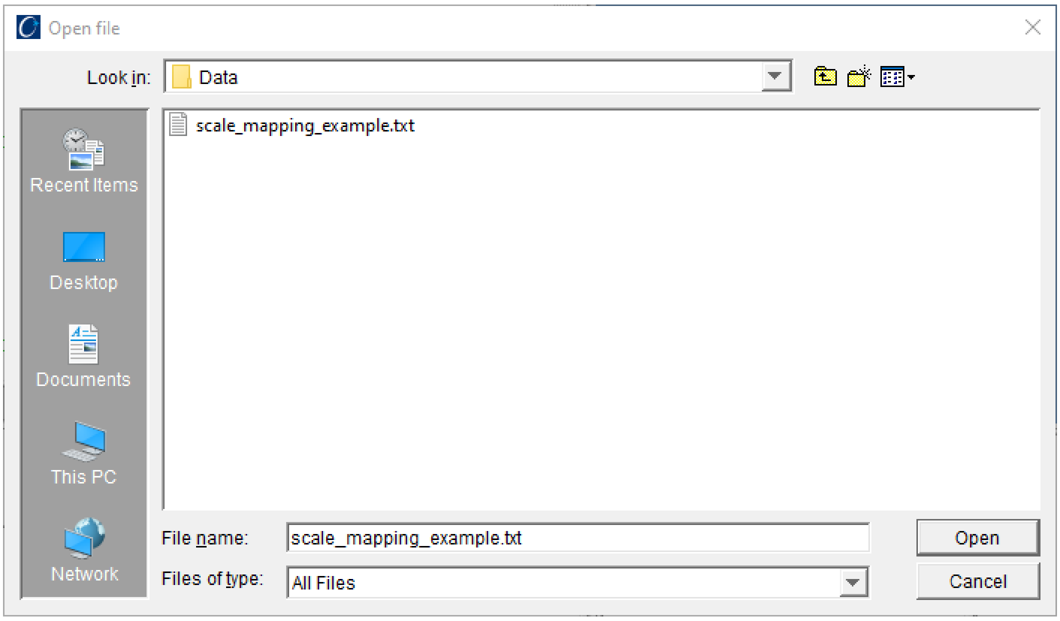
Activation mode	
● Linear ○ Cyclic	The user can select between using the linear or cyclic scale mapping modes. ***ComET4*** only checks which activation mode is selected at the instant the user clicks on the **Activate scaling** button. Parameter `K165` of the Controller is set accordingly: `K165 = 1` for the linear scale mapping mode; or `K165 = 4` for the cyclic scale mapping mode.

NOTE

ComET4 does not notify the user if the linear scale mapping mode has been selected, but the first and last scale mapping corrections are not zero as required. It is up to the user to ensure that such constraint is respected.

ComET4 does not notify the user if the cyclic scale mapping mode has been selected, but the origin of the mapping (`KL166`) is not set to zero as required. It is up to the user to ensure that such constraint is respected.

After having realized steps 1 and 2, the user must now download the scale mapping file to the Controller. Click on the **Download to controllers** button to select the scale mapping file and press on the **Open** button to initiate the download.



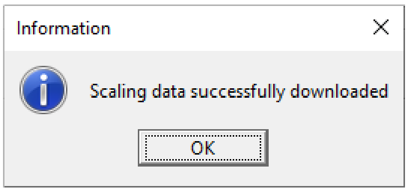
Look in: Data

scale_mapping_example.txt

File name: scale_mapping_example.txt

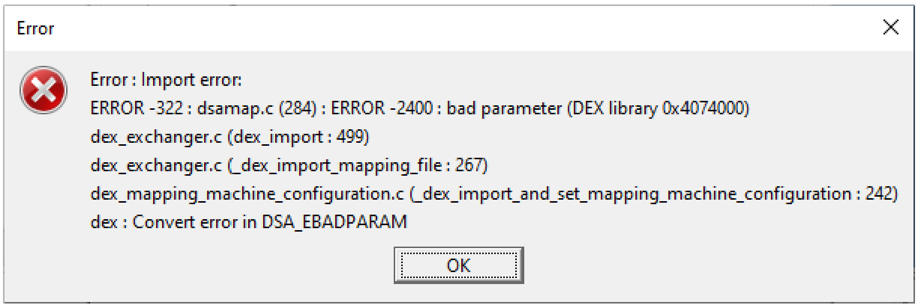
Files of type: All Files

If the download is completed successfully, the following dialog box pops-up:



Scaling data successfully downloaded

On the other hand, if there is a problem with the file format, the following error message pops-up:



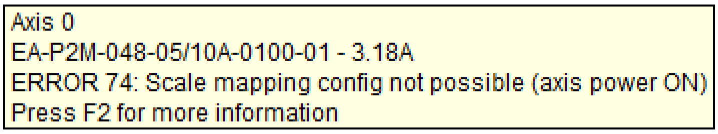
```
Error : Import error:
ERROR -322 : dsamap.c (284) : ERROR -2400 : bad parameter (DEX library 0x4074000)
dex_exchanger.c (dex_import : 499)
dex_exchanger.c (_dex_import_mapping_file : 267)
dex_mapping_machine_configuration.c (_dex_import_and_set_mapping_machine_configuration : 242)
dex : Convert error in DSA_EBADPARAM
```

NOTE

Depending on the root cause, other types of error messages might be displayed.
If required contact an ETEL representative for support on addressing the problem.

Although downloading a new scale mapping file to the Controller while this feature is activated does not raise any error, please follow the recommended steps and ensure that the scale mapping feature is deactivated before downloading a new file.

Downloading a new scale mapping file to the Controller while the axis is powered on will raise an error on the Controller.



```
Axis 0
EA-P2M-048-05/10A-0100-01 - 3.18A
ERROR 74: Scale mapping config not possible (axis power ON)
Press F2 for more information
```

An example of a scale mapping file is presented below.

```
[Header]

[[General info]]
Data type, Scale error mapping
Data format version, 1.00A
Software name, ComET4 Scale Mapping tool
Software version, 4.23A
Date, 01/01/2020
Time, 00:00:00
Operator, John Doe
Customer, My dearest customer
Project, Customer application
Description, X scale error mapping

[[Controller info]]
```

```
Controller name list, EA-P2M-048-05/10A-0000-01, EA-P2M-048-05/10A-0000-01
Controller firmware list, 3.19A, 3.19A
Controller address list, 0, 1
Controller SN, 12345678, 12345678
Controller status, 0x20290000, 0x20290000

[[Scale error mapping configuration]]
Mapping version, 1.01A
Machine type, METIS
Machine SN, 12345
Correction mode, positive
Axis, X, 0

[[[Configuration 1]]]
Corrected axis, X
Source axes, X
Source registers, ML19
Correction table, table 1
Origin, X, 0.1

[Data]

[[Info table 1]]
Step size, 1.0e-3
Table size, 20
Data unit factor, -9

[[Data table 1]]
-10.0,20.0,-10.0,20.0,20.0,-10.0,20.0,-10.0,20.0,20.0,-10.0,20.0,-10.0,20.0,20.0,-
10.0,20.0,-10.0,20.0,20.0

[End Of File]
```

NOTE

In the above example of a scale mapping file, the greyed text is not mandatory.
The file format must be respected, including the closing line `[End Of File]`.

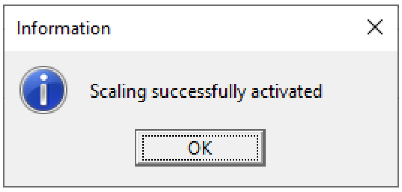
It is a plain text file hierarchically organized by sections:

- `[Header]`
  - `[[General info]]`
  - `[[Controller info]]`
  - `[[Scale error mapping configuration]]`
    - `[[[Configuration 1]]]`
- `[Data]`
  - `[[Info table 1]]`
  - `[[Data table 1]]`

All sections are mandatory and the file format must be respected (e.g. 1st level sections are embraced by single squared brackets, 2nd level sections are embraced by double squared brackets …). However, part of the information contained in some sections is not mandatory. In the example below, the information displayed with a grey font is facultative.

Header	
`General info`	Identify the data type and format. Remaining information is not mandatory.
`Controller info`	Non mandatory information related to the Controller (product type, firmware version…).
`Scale error mapping configuration`	Define the correction mode (positive or negative) and assign a virtual axis identifier to a real physical axis. This identifier is used in the remainder of the file to identify the concerned axis. Remaining information is not mandatory.
`Configuration 1`	Identify which axis is going to be corrected, which are the source axis and source register, the correction table and the origin of the correction (corresponds to `KL166`).
Data	
`Info table 1`	Define the step size (`KL167 = (K294 - 1)*step_size`), the table size (corresponds to `K294`) and a conversion factor to apply to the data table.
`Data table 1`	Comma separated list of corrections, as many values as indicated by the table size defined in `Info table 1`. When downloading this table to the Controller, for each correction it is applied the `Data unit factor` defined in `Info table 1`.

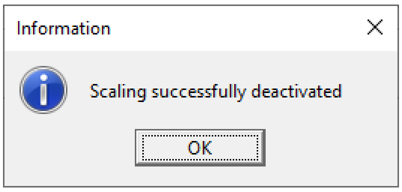
Once the scale mapping file has been successfully downloaded to the Controller, click on the **Activate scaling** button to activate the feature (Controller's parameter `K165` is set accordingly to the activation mode selected). If the activation is successful, the following message pops-up.



Scaling successfully activated

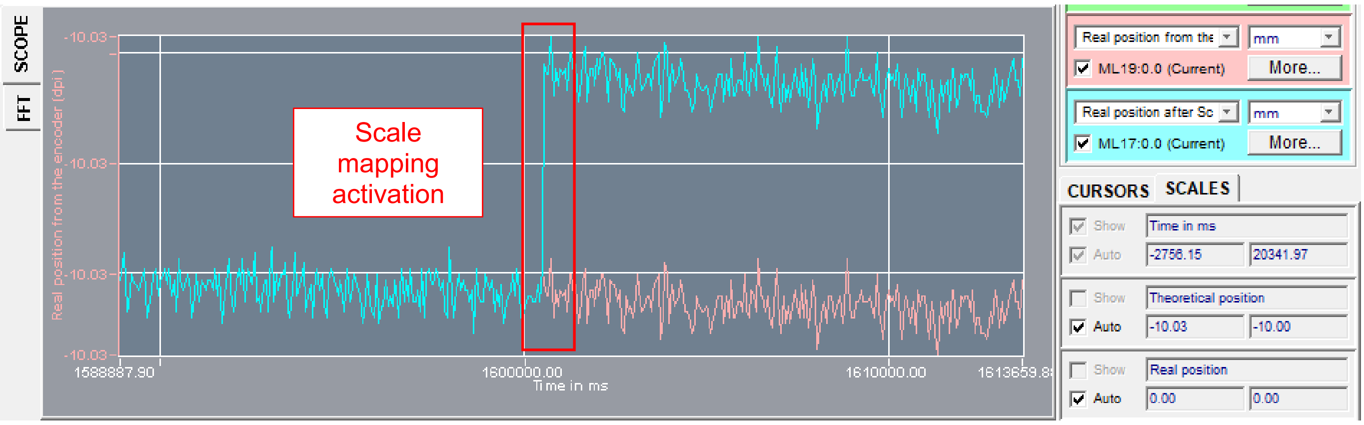
NOTE	Even if the scale mapping feature has been successfully activated (`K165 ≠ 0`), the corrections are only applied to the real position after a homing is done.

Clicking on the **Deactivate scaling** button will reset parameter `K165` to zero (`K165 = 0`).

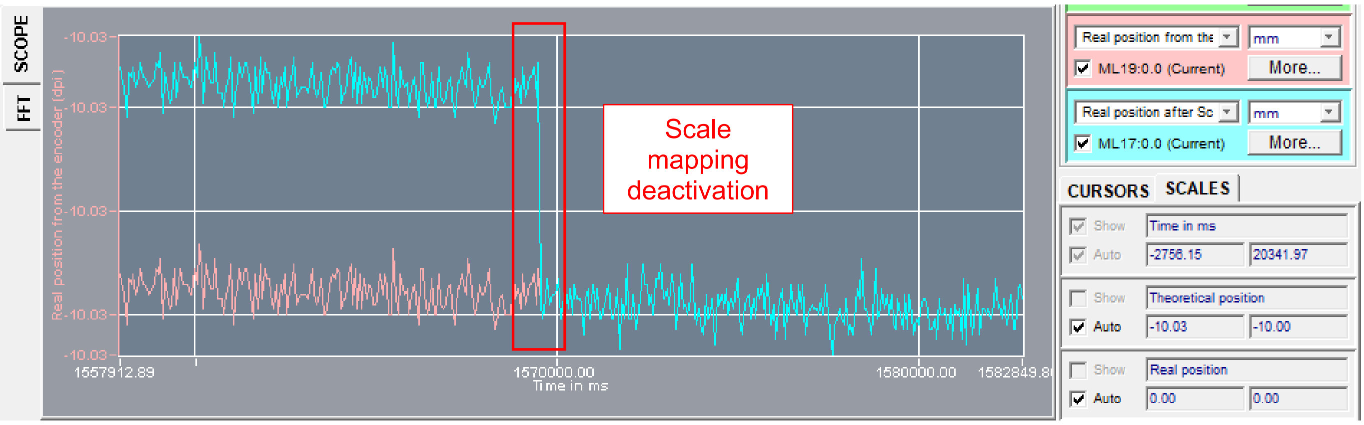


Scaling successfully deactivated

In order to verify if the scale mapping feature is working as expected, use the *Scope* tool to trace monitorings `ML19` and `ML17`. Position the axis at a location within the position zone where the scale corrections are applied (defined by `KL166` and `KL167`) and activate/deactivate the feature to check the effect on the real position after scale correction (`ML17`). Don't forget that a homing must have been done previously and ensure that the correction for the position where the axis is located is different from zero to be able to visually verify its effect.


Scale mapping activation

Real position from the ▾ mm ▾
☑ ML19:0.0 (Current) More...
Real position after Sc ▾ mm ▾
☑ ML17:0.0 (Current) More...
☑ Show Time in ms
☑ Auto -2756.15 20341.97
☐ Show Theoretical position
☑ Auto -10.03 -10.00
☐ Show Real position
☑ Auto 0.00 0.00


Scale mapping deactivation

Real position from the ▾ mm ▾
☑ ML19:0.0 (Current) More...
Real position after Sc ▾ mm ▾
☑ ML17:0.0 (Current) More...
☑ Show Time in ms
☑ Auto -2756.15 20341.97
☐ Show Theoretical position
☑ Auto -10.03 -10.00
☐ Show Real position
☑ Auto 0.00 0.00

In the above *Scope* tool screenshots it is possible to observe the effect of activating and deactivating the scale mapping feature. When the feature is activated, `ML17` becomes different from `ML19` by the scale correction for that location. Inversely, when the feature is deactivated, `ML17` and `ML19` have the same value.

NOTE	There are others ways of verifying if the scale mapping feature is working as expected. Refer to the *AccurET Modular Position Controller Operation & Software Manual* for details about the Controller's scale error mapping feature.

Finally, the user must save the configuration to the Controller. For this, select the Menu **Controller → Save Configuration to Controller** or click on the **Save configuration to controller** toolbar button 💾. On the **Save on Controller** dialog box that pops-up, select which axis to save, select the radio button control corresponding to the `SAV = 0` command for saving the complete configuration on the Controller (including the mapping registers) and then click on the **Save** button.

Alternatively, this command can also be typed in the *Terminal* tool. Refer to Section §10.3 for more information about saving a Controller's configuration.

4.2.6. Stage mapping

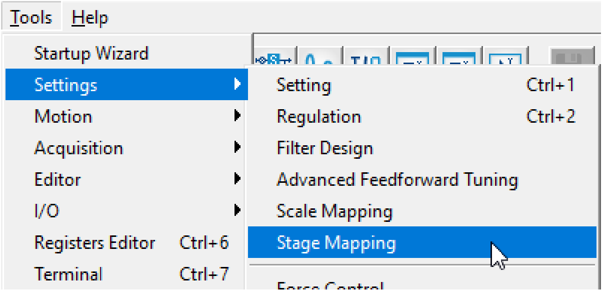
The ***AccurET***'s stage mapping feature allows the user to apply an error compensation to the concerned axes within a given operational area (2D) or volume (3D).

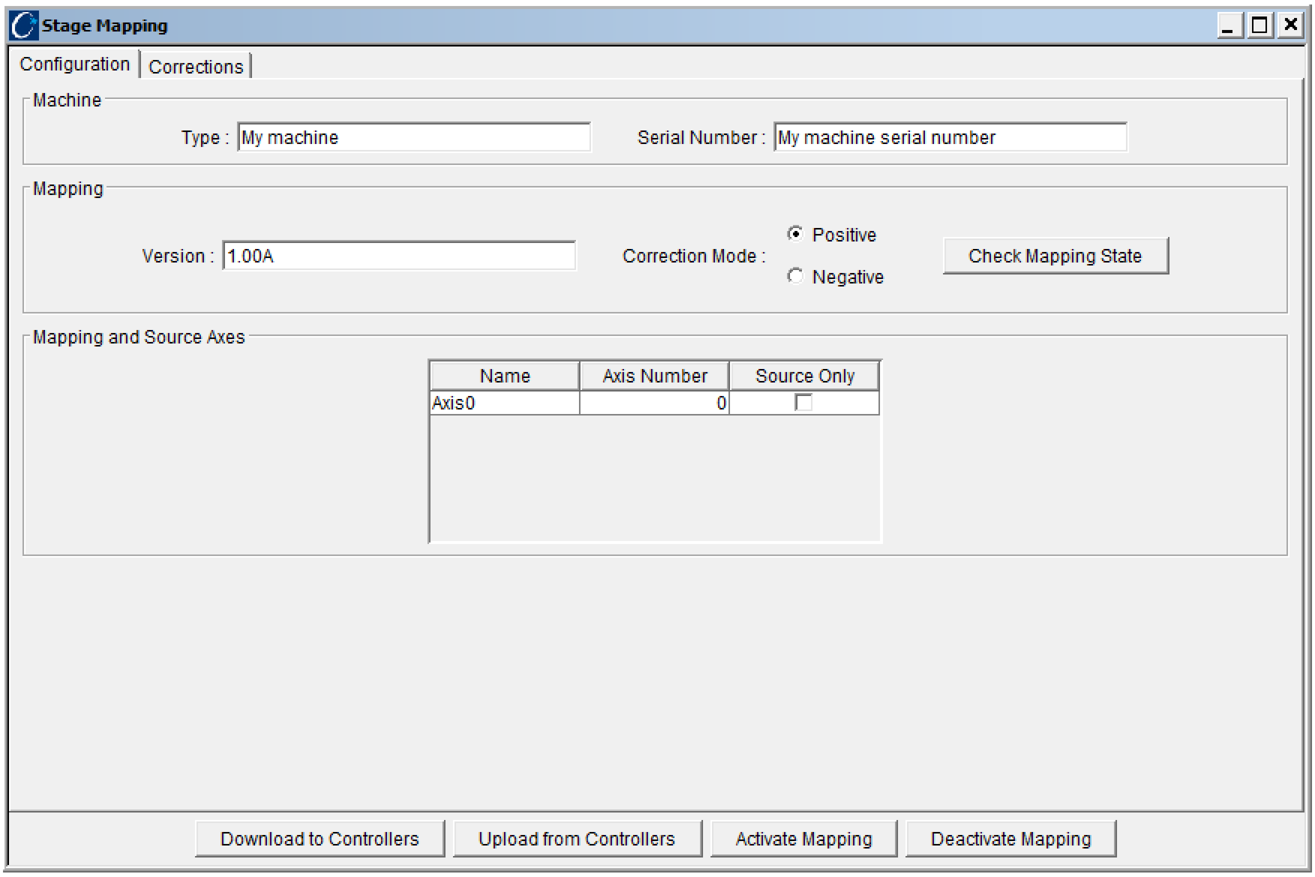
Each axis that has to apply the stage error compensation along its corresponding direction will contain a stage mapping table and the information to determine and apply the correction (e.g. origin of the coordinates of the mapped area, step size, number of steps…). The information about the position of the other axes is provided through ***TransnET***.

NOTE	The stage mapping feature requires the presence of an ***UltimET*** motion controller. This feature cannot be used with an individual ***AccurET*** position controller. Refer to the *AccurET Modular Position Controller Operation & Software Manual* for details about the Controller's stage mapping feature.

ComET4's *Stage Mapping* tool allows the user to download/upload to/from the Controllers the stage mapping data, to display the contents of a stage mapping file, to save the stage mapping data into a file, to modify the stage mapping data and to activate/deactivate this feature.

This tool can be launched by selecting the Menu option **Tools → Settings → Stage Mapping**:





Type : My machine

Serial Number : My machine serial number

Version : 1.00A

Correction Mode : ● Positive ○ Negative

Name	Axis Number	Source Only
Axis0	0	☐

Before describing how the *Stage Mapping* tool works, it is important to refresh some basic notions of the ***AccurET***'s stage mapping feature.

The table below lists the main Controller registers associated to this feature:

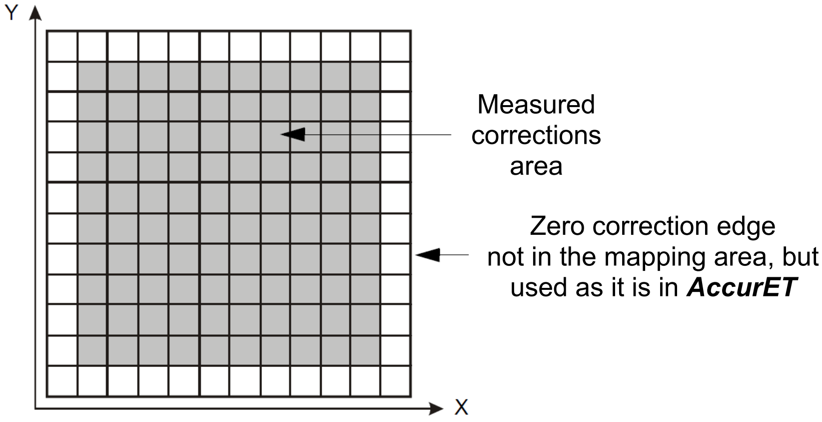
`K365`	Enable/Disable the stage mapping feature: = 0 → stage mapping disabled; = 1 → stage mapping enabled.
`M21`	Gives the stage mapping compensation value.
`ML17`	Real position after scale mapping and before stage mapping.
`ML1`	Real position after stage mapping.
`P`	Registers where the stage error mapping information is stored. There are 16352 `P` registers and each `P` register has 8 depths (0 to 7). Thus, a total of 130816 correction values can be stored for each axis.

The stage mapping feature can be used in many different mapping configurations, but here are a few examples:

Mapping configuration	Map dimension	Source axes	Corrected axes
3D stage error mapping	3D	X, Y, Z	X, Y, Z
X-Y-Theta 3D stage error mapping	3D	X, Y, Theta	X, Y
2.5D stage error mapping	2D	X, Y	X, Y, Z
2D stage error mapping	2D	X, Y	X, Y

NOTE	Other mapping configurations besides the standard examples presented above can be realized based on the same principle. Contact your ETEL representative for support on designing the stage mapping for your application.

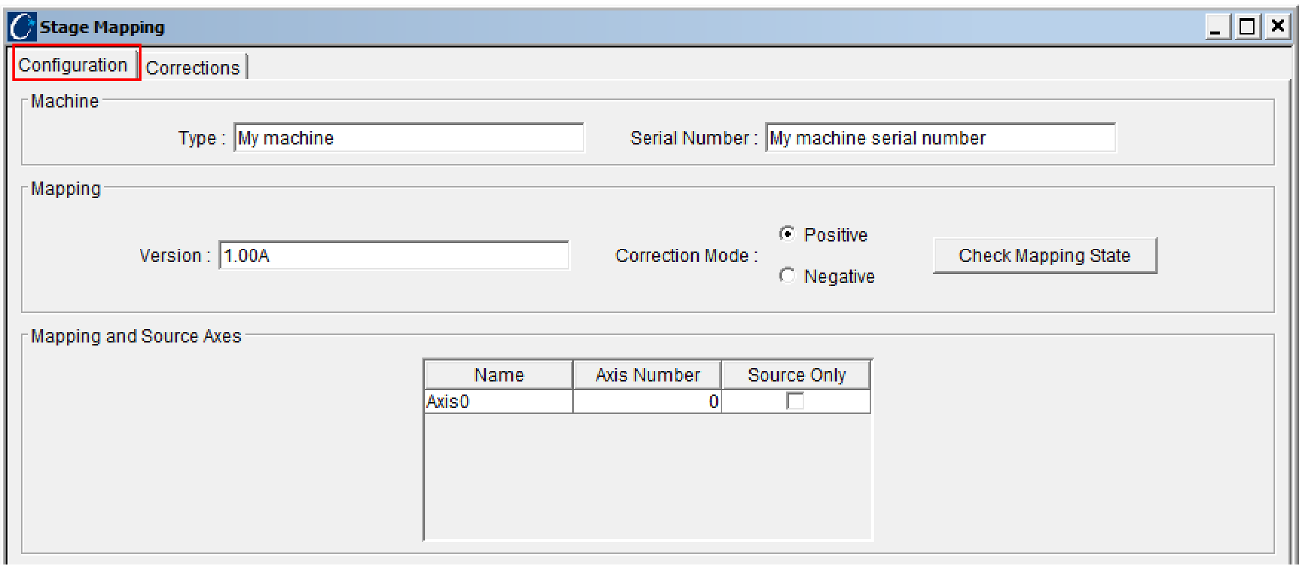
The stage error mapping configuration is measured and defined by the user. The border between mapped and non-mapped areas/volumes should be smoothed by the user to have no correction in the non-mapped part. By default, the Controller automatically add a zero-correction range all around the mapping area/volume to apply a transition between areas. This transition is done on a one step size in each dimension.



NOTE	The stage mapping is done on a set of coordinates. Between these coordinates, a linear interpolation is applied.

The *Stage Mapping* tool is composed of two main panels:

- **Configuration** panel, where the mapped and source axes are defined; and
- **Corrections** panel, where the map of corrections is defined.



Type : My machine

Serial Number : My machine serial number

Version : 1.00A

Correction Mode : ● Positive ○ Negative

Name	Axis Number	Source Only
Axis0	0	☐

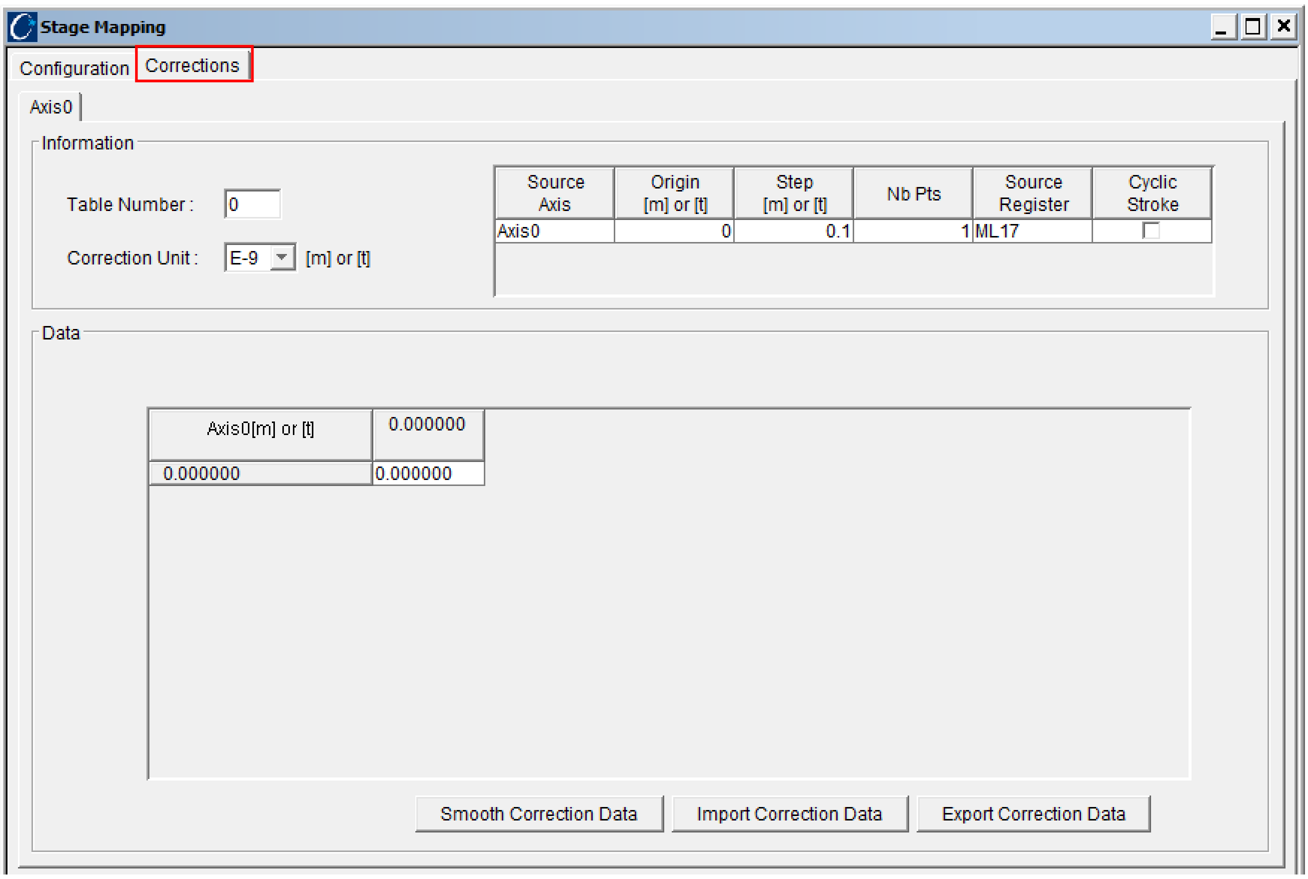


Table Number : 0

Correction Unit : E-9 [m] or [t]

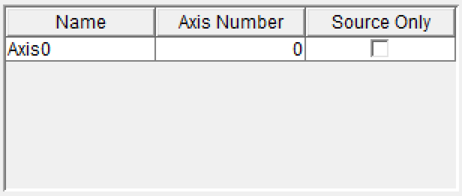
Source Axis	Origin [m] or [t]	Step [m] or [t]	Nb Pts	Source Register	Cyclic Stroke
Axis0	0	0.1	1	ML17	☐

Axis0[m] or [t]	0.000000
0.000000	0.000000

When using the *Stage Mapping* tool, follow this recommended sequence of actions to properly configure the ***AccurET***'s stage mapping feature:

1. Under the **Configuration** panel, identify the system to which the mapping data refers and define the mapped and source axes according to the mapping configuration (e.g. 2D, 2.5D or 3D);
2. Under the **Corrections** panel and according to the selected mapping configuration, define the mapping tables using this tool or reading the correction data from a file;
3. Configure the transition smoothing from mapped to non-mapped areas/volumes;
4. Download the stage mapping data to the Controllers;
5. Activate the stage mapping feature;
6. Verify if the stage mapping feature is working as expected;
7. Save the configuration to the Controller;
8. If necessary, save the stage mapping configuration and correction data to a file (e.g. for backup purposes). This file can be reloaded to the *Stage Mapping* tool if required.

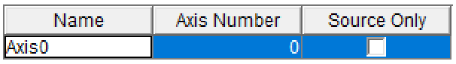
Configuration panel	
Type :	Input the type of machine (e.g. METIS, VULCANO2, CHARON2…).
Serial Number :	Input the machine's serial number.
Version :	Define the version of the mapping.
Correction Mode : ○ Positive ○ Negative	Define if the correction should be added or subtracted to `ML17`.



Name	Axis Number	Source Only
Axis0	0	☐

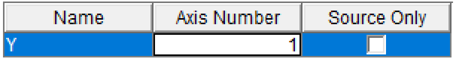
Define the mapped and source axes.

Double click on the axis **Name** edit control to rename an axis:



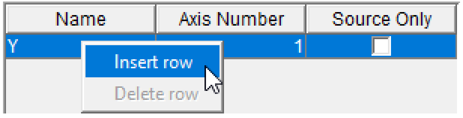
Name	Axis Number	Source Only
Axis0	0	☐

Double click on the **Axis Number** edit control to modify an axis number:



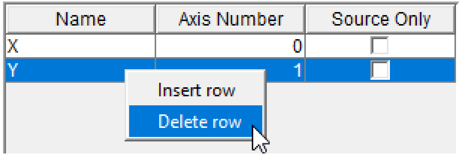
Name	Axis Number	Source Only
Y	1	☐

To add a new axis right-click on the table and select **Insert row**:



Name	Axis Number	Source Only
Y	1	☐

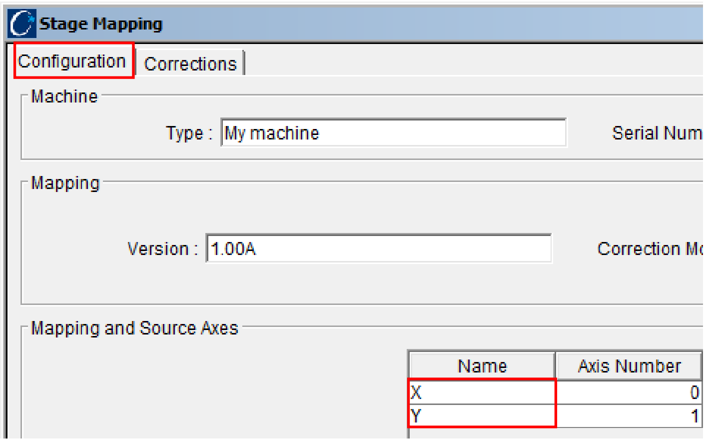
To delete an axis right-click on the table and select **Delete row**:



Name	Axis Number	Source Only
X	0	☐
Y	1	☐

Check the **Source only** checkbox control for the axes that are not to be mapped, but on which depends the mapping of another axes.

Under the **Corrections** panel, there are as many sub-panels as mapped axes defined in the **Configuration** panel (source axes only excluded). E.g., if the user has created the mapped axes **X** and **Y** in the **Configuration** panel, two sub-panels **X** and **Y** are available in the **Corrections** panel.



Type : My machine

Version : 1.00A

Name	Axis Number
X	0
Y	1

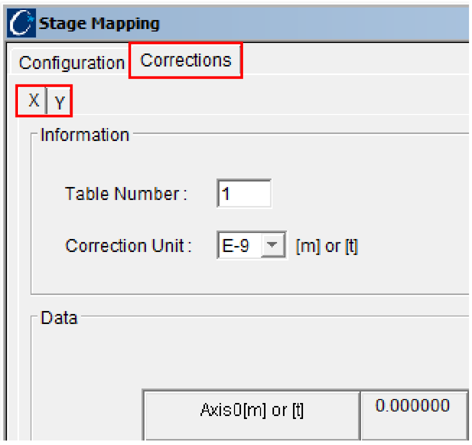


Table Number : 1

Correction Unit : E-9 [m] or [t]

Axis0[m] or [t]	0.000000

Therefore, for each one of the sub-panels under the **Corrections** panel (e.g. **X**, **Y**), the user must input the following information:

Corrections panel

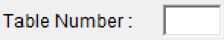
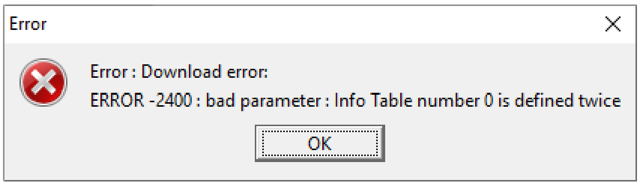
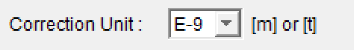


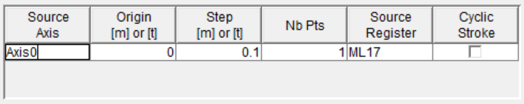
Table Number :

Unique identifier for this mapping table (starting from 0). If not, the following error is raised:



Error : Download error:
ERROR -2400 : bad parameter : Info Table number 0 is defined twice

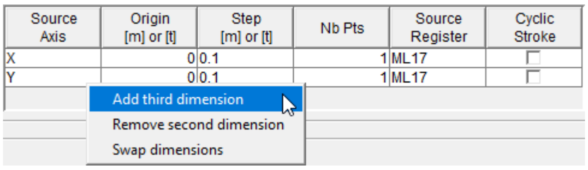
<table>
<tr>
<td>


Correction Unit : E-9 [m] or [t]
</td>
<td>Conversion factor to apply to the mapping data when downloading it to the Controllers.</td>
</tr>
<tr>
<td>


<table>
<tr><th>Source Axis</th><th>Origin [m] or [t]</th><th>Step [m] or [t]</th><th>Nb Pts</th><th>Source Register</th><th>Cyclic Stroke</th></tr>
<tr><td>Axis0</td><td>0</td><td>0.1</td><td>1</td><td>ML17</td><td>☐</td></tr>
</table>
</td>
<td>

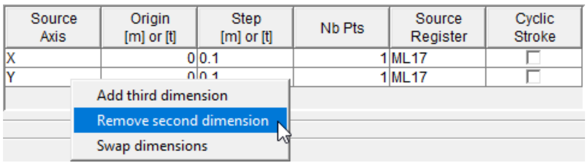
- Source axis for this mapping;
- Origin of the mapping along this axis;
- Step of the mapping along this axis;
- Number of mapping points;
- Source register (usually `ML17`, but can be another);
- If it is a cyclic axis (i.e. rotary axis) that repeats over one turn.

To add another dimension (i.e. source axis) to the mapping table right-click on the table and select **Add x dimension**:



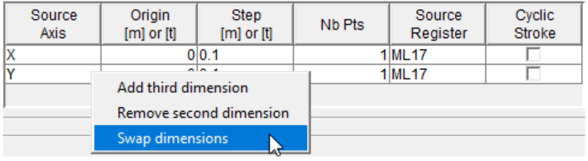
<table>
<tr><th>Source Axis</th><th>Origin [m] or [t]</th><th>Step [m] or [t]</th><th>Nb Pts</th><th>Source Register</th><th>Cyclic Stroke</th></tr>
<tr><td>X</td><td>0</td><td>0.1</td><td>1</td><td>ML17</td><td>☐</td></tr>
<tr><td>Y</td><td>0</td><td>0.1</td><td>1</td><td>ML17</td><td>☐</td></tr>
</table>

Similarly, to remove a dimension (i.e. source axis) from the mapping table right-click on the table and select **Remove x dimension**:



<table>
<tr><th>Source Axis</th><th>Origin [m] or [t]</th><th>Step [m] or [t]</th><th>Nb Pts</th><th>Source Register</th><th>Cyclic Stroke</th></tr>
<tr><td>X</td><td>0</td><td>0.1</td><td>1</td><td>ML17</td><td>☐</td></tr>
<tr><td>Y</td><td>0</td><td>0.1</td><td>1</td><td>ML17</td><td>☐</td></tr>
</table>

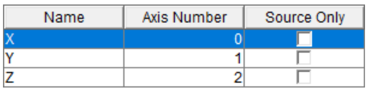
Finally, two dimensions (i.e. source axis) of the mapping table can be swapped by right-clicking on the table and selecting the **Swap dimensions** option:



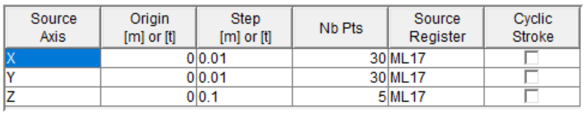
<table>
<tr><th>Source Axis</th><th>Origin [m] or [t]</th><th>Step [m] or [t]</th><th>Nb Pts</th><th>Source Register</th><th>Cyclic Stroke</th></tr>
<tr><td>X</td><td>0</td><td>0.1</td><td>1</td><td>ML17</td><td>☐</td></tr>
<tr><td>Y</td><td></td><td></td><td>1</td><td>ML17</td><td>☐</td></tr>
</table>

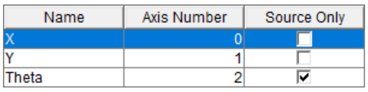
</td>
</tr>
</table>

So, here are examples of how the **Configuration** and **Corrections** panels should look like for the typical mapping configurations presented before (3D, 2.5D, 2D).

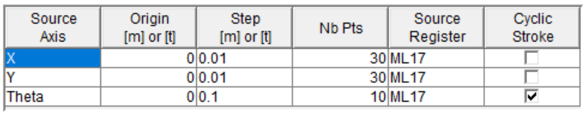
<table>
<tr><th>Mapping configuration</th><th>Configuration panel</th><th>Corrections panel</th></tr>
<tr>
<td>3D stage error mapping</td>
<td>


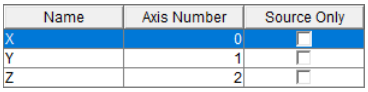
<table>
<tr><th>Name</th><th>Axis Number</th><th>Source Only</th></tr>
<tr><td>X</td><td>0</td><td>☐</td></tr>
<tr><td>Y</td><td>1</td><td>☐</td></tr>
<tr><td>Z</td><td>2</td><td>☐</td></tr>
</table>
</td>
<td>
For each of the **3** sub-panels: X, Y and Z



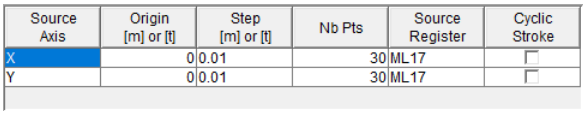
<table>
<tr><th>Source Axis</th><th>Origin [m] or [t]</th><th>Step [m] or [t]</th><th>Nb Pts</th><th>Source Register</th><th>Cyclic Stroke</th></tr>
<tr><td>X</td><td>0</td><td>0.01</td><td>30</td><td>ML17</td><td>☐</td></tr>
<tr><td>Y</td><td>0</td><td>0.01</td><td>30</td><td>ML17</td><td>☐</td></tr>
<tr><td>Z</td><td>0</td><td>0.1</td><td>5</td><td>ML17</td><td>☐</td></tr>
</table>
</td>
</tr>
<tr>
<td>X-Y-Theta
3D stage error mapping</td>
<td>


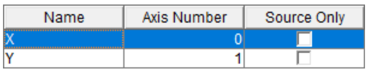
<table>
<tr><th>Name</th><th>Axis Number</th><th>Source Only</th></tr>
<tr><td>X</td><td>0</td><td>☐</td></tr>
<tr><td>Y</td><td>1</td><td>☐</td></tr>
<tr><td>Theta</td><td>2</td><td>☑</td></tr>
</table>
</td>
<td>
For each of the **2** sub-panels: X and Y



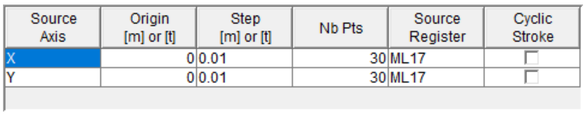
<table>
<tr><th>Source Axis</th><th>Origin [m] or [t]</th><th>Step [m] or [t]</th><th>Nb Pts</th><th>Source Register</th><th>Cyclic Stroke</th></tr>
<tr><td>X</td><td>0</td><td>0.01</td><td>30</td><td>ML17</td><td>☐</td></tr>
<tr><td>Y</td><td>0</td><td>0.01</td><td>30</td><td>ML17</td><td>☐</td></tr>
<tr><td>Theta</td><td>0</td><td>0.1</td><td>10</td><td>ML17</td><td>☑</td></tr>
</table>
</td>
</tr>
<tr>
<td>2.5D stage error mapping</td>
<td>


<table>
<tr><th>Name</th><th>Axis Number</th><th>Source Only</th></tr>
<tr><td>X</td><td>0</td><td>☐</td></tr>
<tr><td>Y</td><td>1</td><td>☐</td></tr>
<tr><td>Z</td><td>2</td><td>☐</td></tr>
</table>
</td>
<td>
For each of the **3** sub-panels: X, Y and Z



<table>
<tr><th>Source Axis</th><th>Origin [m] or [t]</th><th>Step [m] or [t]</th><th>Nb Pts</th><th>Source Register</th><th>Cyclic Stroke</th></tr>
<tr><td>X</td><td>0</td><td>0.01</td><td>30</td><td>ML17</td><td>☐</td></tr>
<tr><td>Y</td><td>0</td><td>0.01</td><td>30</td><td>ML17</td><td>☐</td></tr>
</table>
</td>
</tr>
<tr>
<td>2D stage error mapping</td>
<td>


<table>
<tr><th>Name</th><th>Axis Number</th><th>Source Only</th></tr>
<tr><td>X</td><td>0</td><td>☐</td></tr>
<tr><td>Y</td><td>1</td><td>☐</td></tr>
</table>
</td>
<td>
For each of the **2** sub-panels: X and Y



<table>
<tr><th>Source Axis</th><th>Origin [m] or [t]</th><th>Step [m] or [t]</th><th>Nb Pts</th><th>Source Register</th><th>Cyclic Stroke</th></tr>
<tr><td>X</td><td>0</td><td>0.01</td><td>30</td><td>ML17</td><td>☐</td></tr>
<tr><td>Y</td><td>0</td><td>0.01</td><td>30</td><td>ML17</td><td>☐</td></tr>
</table>
</td>
</tr>
</table>

For sake of simplicity, the following explanations refer to a 2D stage error mapping configuration with two source axis (**X** and **Y**) and two mapped axis (**X** and **Y**).

Once the **Configuration** and the **Corrections' X** and **Y** sub-panels have been set as described previously, including the origin, step and source register for every dimension, the user has two options for creating the correction data for each of the mapped axis **X** and **Y**:

1. Define the number of points for each dimension of the stage mapping (this will define the size of the 2D correction matrix) and input the correction values directly via the *Stage Mapping* tool;

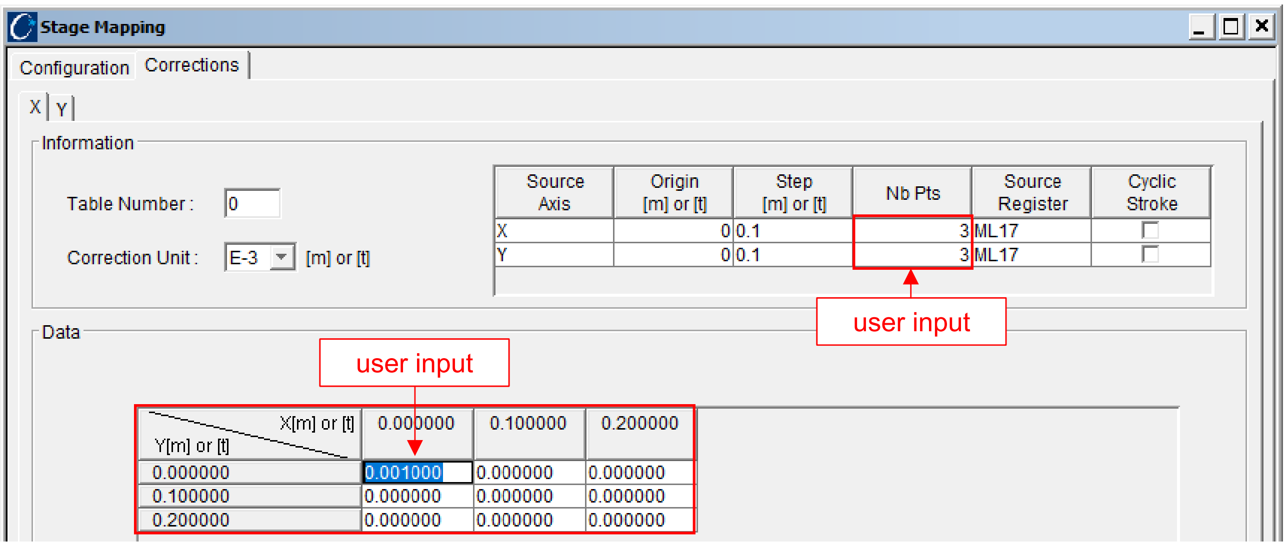


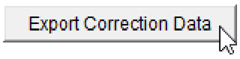
Table Number : 0

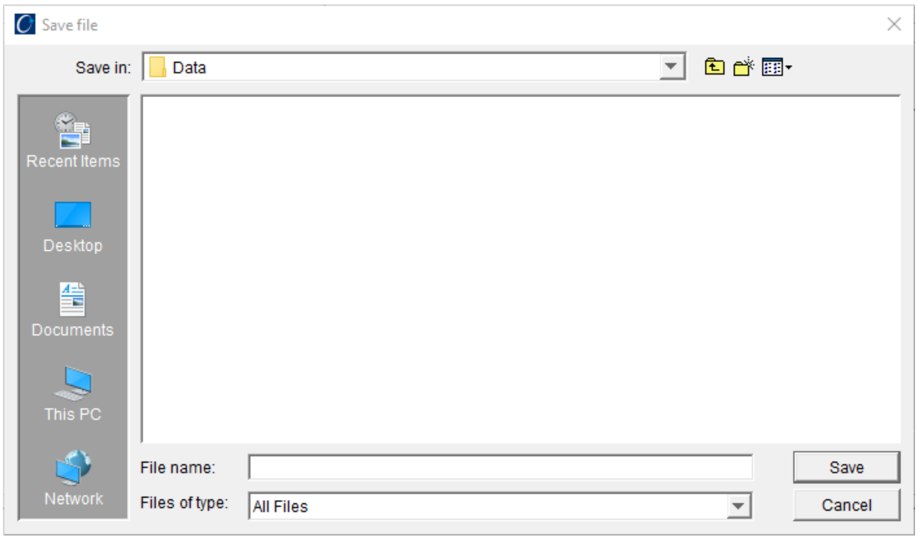
Correction Unit : E-3 [m] or [t]

Source Axis	Origin [m] or [t]	Step [m] or [t]	Nb Pts	Source Register	Cyclic Stroke
X	0	0.1	3	ML17	☐
Y	0	0.1	3	ML17	☐

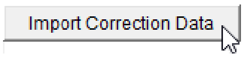
X[m] or [t] / Y[m] or [t]	0.000000	0.100000	0.200000
0.000000	0.001000	0.000000	0.000000
0.100000	0.000000	0.000000	0.000000
0.200000	0.000000	0.000000	0.000000

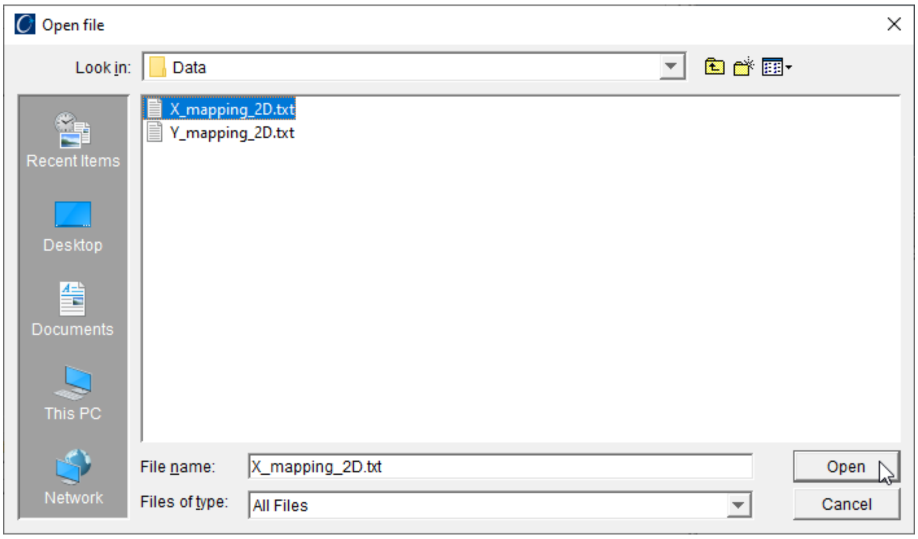
The user can always backup the stage mapping data to a file by clicking on the **Export Correction Data** button, entering the file name in the dialog box that pops-up and pressing the **Save** button.





2. Import the correction data from a file. After reading the file, and provided there is no issue with its format, the *Stage Mapping* tool will display the correction values and automatically set the number of points accordingly.





Look in: Data

X_mapping_2D.txt
Y_mapping_2D.txt

File name: X_mapping_2D.txt

Files of type: All Files

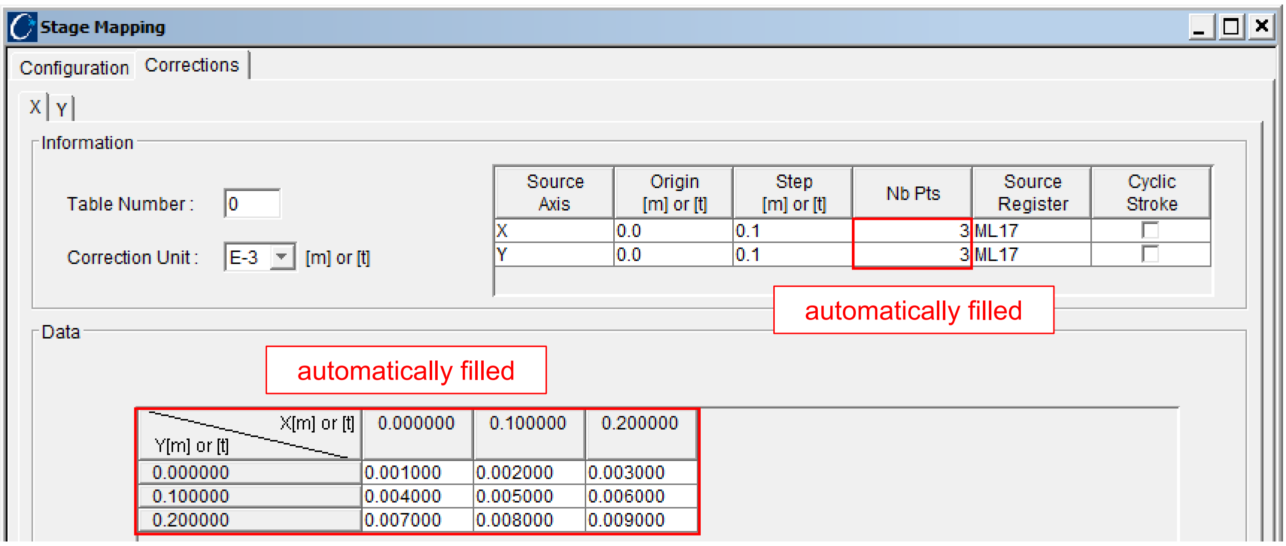


Table Number : 0

Correction Unit : E-3 [m] or [t]

Source Axis	Origin [m] or [t]	Step [m] or [t]	Nb Pts	Source Register	Cyclic Stroke
X	0.0	0.1	3	ML17	☐
Y	0.0	0.1	3	ML17	☐

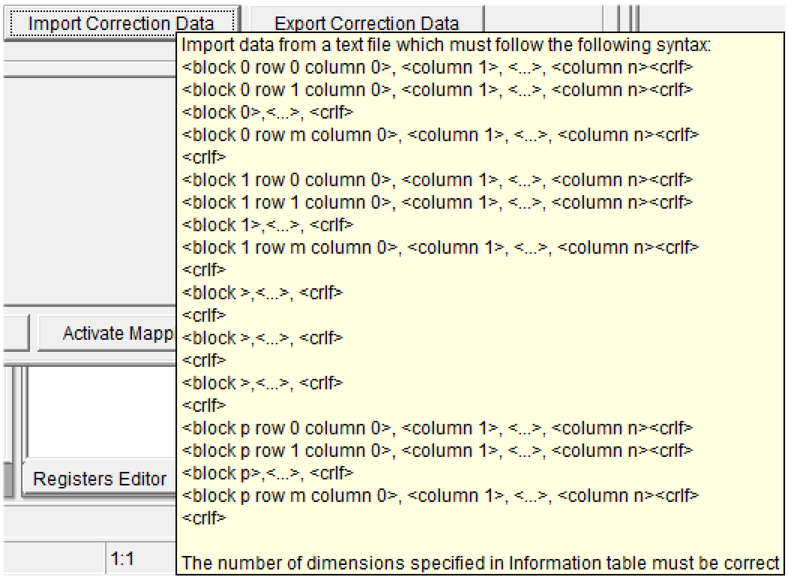
automatically filled

automatically filled

X[m] or [t] Y[m] or [t]	0.000000	0.100000	0.200000
0.000000	0.001000	0.002000	0.003000
0.100000	0.004000	0.005000	0.006000
0.200000	0.007000	0.008000	0.009000

NOTE	Be aware that when downloading the stage error mapping data to the Controllers, the **Correction Unit** factor selected on the corresponding drop-down list box will be applied. Bear this in mind when defining the correction values.

The correction data file is a plain text file with a given format. This format is explained in the tooltip that is displayed when hovering with the mouse over the **Import Correction Data** button.



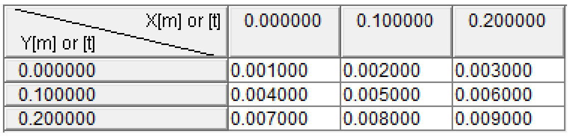
```
Import data from a text file which must follow the following syntax:
<block 0 row 0 column 0>, <column 1>, <...>, <column n><crlf>
<block 0 row 1 column 0>, <column 1>, <...>, <column n><crlf>
<block 0>,<...>, <crlf>
<block 0 row m column 0>, <column 1>, <...>, <column n><crlf>
<crlf>
<block 1 row 0 column 0>, <column 1>, <...>, <column n><crlf>
<block 1 row 1 column 0>, <column 1>, <...>, <column n><crlf>
<block 1>,<...>, <crlf>
<block 1 row m column 0>, <column 1>, <...>, <column n><crlf>
<crlf>
<block >,<...>, <crlf>
<crlf>
<block >,<...>, <crlf>
<crlf>
<block >,<...>, <crlf>
<crlf>
<block p row 0 column 0>, <column 1>, <...>, <column n><crlf>
<block p row 1 column 0>, <column 1>, <...>, <column n><crlf>
<block p>,<...>, <crlf>
<block p row m column 0>, <column 1>, <...>, <column n><crlf>
<crlf>

The number of dimensions specified in Information table must be correct
```

It is basically based on a comma-separated values (CSV) format, but with a small twist: empty lines make the separation between blocks of mapping data.

One block of mapping data is a 2D map, i.e. a two dimensional matrix of size `NxM`, where `N` represents the number of lines of the block and `M` the number of comma-separated values per line. The several blocks represent the third dimension for being able to define 3D maps.

For the example above, the file contains a single block (2D map) representing a 3x3 matrix (3 lines and 3 comma-separated values).

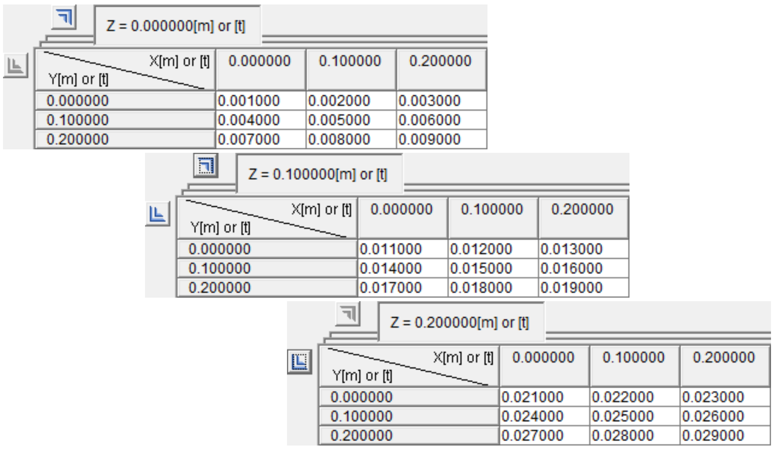
```
0.001,0.002,0.003
0.004,0.005,0.006
0.007,0.008,0.009
```



X[m] or [t] / Y[m] or [t]	0.000000	0.100000	0.200000
0.000000	0.001000	0.002000	0.003000
0.100000	0.004000	0.005000	0.006000
0.200000	0.007000	0.008000	0.009000

The following example below would represent a 3D map file, a matrix of 3x3x3 (3 lines and 3 comma-separated values per block and 3 blocks)

```
0.001,0.002,0.003
0.004,0.005,0.006
0.007,0.008,0.009

0.011,0.012,0.013
0.014,0.015,0.016
0.017,0.018,0.019

0.021,0.022,0.023
0.024,0.025,0.026
0.027,0.028,0.029
```



Z = 0.000000[m] or [t]

X[m] or [t] / Y[m] or [t]	0.000000	0.100000	0.200000
0.000000	0.001000	0.002000	0.003000
0.100000	0.004000	0.005000	0.006000
0.200000	0.007000	0.008000	0.009000

Z = 0.100000[m] or [t]

X[m] or [t] / Y[m] or [t]	0.000000	0.100000	0.200000
0.000000	0.011000	0.012000	0.013000
0.100000	0.014000	0.015000	0.016000
0.200000	0.017000	0.018000	0.019000

Z = 0.200000[m] or [t]

X[m] or [t] / Y[m] or [t]	0.000000	0.100000	0.200000
0.000000	0.021000	0.022000	0.023000
0.100000	0.024000	0.025000	0.026000
0.200000	0.027000	0.028000	0.029000

Be aware that the file with the correction data has no information whatsoever concerning the origin and step at which the corrections are applied. This information must be properly set in the **Corrections**' sub-panels.

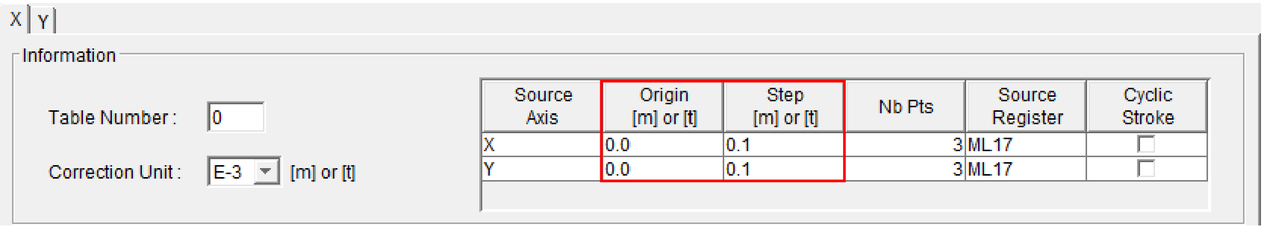
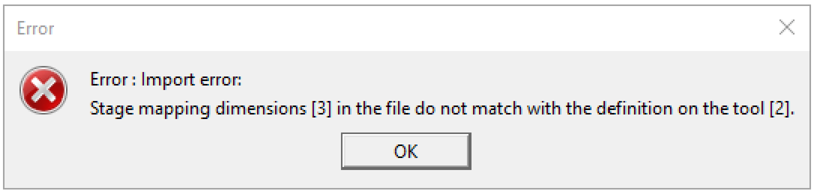


Table Number : 0

Correction Unit : E-3 [m] or [t]

Source Axis	Origin [m] or [t]	Step [m] or [t]	Nb Pts	Source Register	Cyclic Stroke
X	0.0	0.1	3	ML17	☐
Y	0.0	0.1	3	ML17	☐

If the file contents do not match the configuration set in the *Stage Mapping* tool, an error is generated when importing the data. E.g. in this case the user is trying to import a 3D map correction while the *Stage Mapping* tool has only two mapped axis defined:

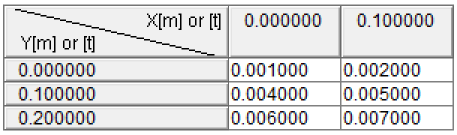


Error : Import error:
Stage mapping dimensions [3] in the file do not match with the definition on the tool [2].

Also, be very careful about any formatting mistakes included in the corrections data file. These are not flagged with an error by the *Stage Mapping* tool while importing the data, but still the outcome might give unexpected results.

In the example below, the user forgot to add in the first line the second comma and the third value (`,0.003`). The result after importing the file is still a 2D map file as expected, but the data related to one step for the `X` dimension is completely missing (the resulting matrix is 3x2, instead of the expected 3x3 matrix).

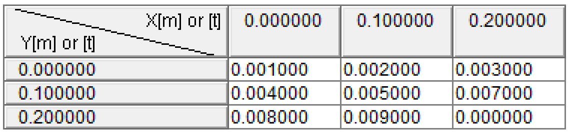
```
0.001,0.002,0.003
0.004,0.005,0.006
0.007,0.008,0.009
```



Y[m] or [t] \ X[m] or [t]	0.000000	0.100000
0.000000	0.001000	0.002000
0.100000	0.004000	0.005000
0.200000	0.006000	0.007000

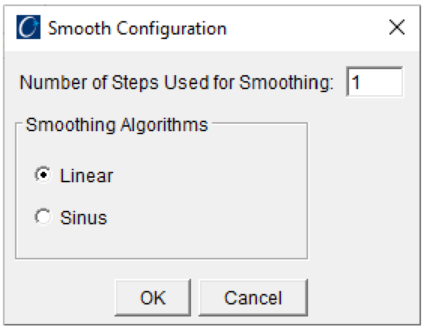
Here is another mistake similar to the previous one, but on the second line (`,0.006` is missing). In this case, the result is still a 3x3 matrix as expected, but the corrections are not assigned to the right locations and a zero correction is added to the last [**X**, **Y**] mapped location.

```
0.001,0.002,0.003
0.004,0.005,0.006
0.007,0.008,0.009
```



Y[m] or [t] \ X[m] or [t]	0.000000	0.100000	0.200000
0.000000	0.001000	0.002000	0.003000
0.100000	0.004000	0.005000	0.007000
0.200000	0.008000	0.009000	0.000000

Once error mapping data has been created for the concerned mapped axes, the user can next configure the transition smoothing from mapped to non-mapped areas/volumes by clicking on the **Smooth Correction Data** button. Configure how many steps to be used for the smoothing and select one of the two possible algorithms available: linear or sinusoidal smoothed transition.

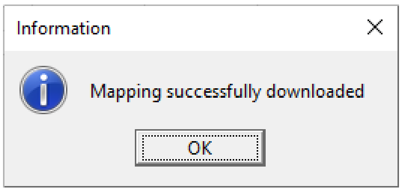

Smooth Configuration

Number of Steps Used for Smoothing: 1

Smoothing Algorithms

● Linear
○ Sinus

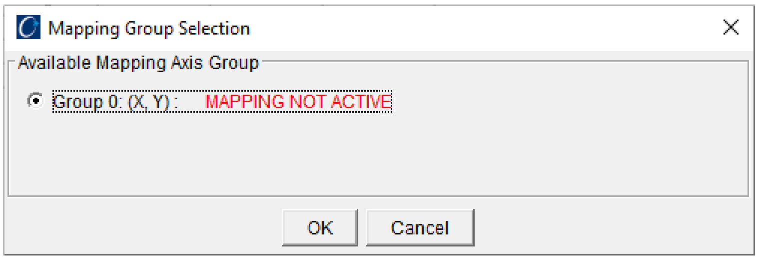
After having created the error mapping data for all the mapped axes (i.e. for all **Corrections**' sub-panels **X** and **Y**) and configured the transition smoothing, the stage mapping data is finally ready for being downloaded to the Controllers. Press the **Download to Controllers** button and if the download is successful, the following information message pops-up:


Information

Mapping successfully downloaded

NOTE	When downloading the stage mapping data, the Controllers will power off the motors which are powered on.

Next step consists on activating the stage mapping feature by clicking on the **Activate Mapping** button (Controllers' parameter `K365` will be set accordingly and all real-time value channels set accordingly to exchange the information over ***TransnET***). A dialog box appears for the user to select which mapping axis group to download:

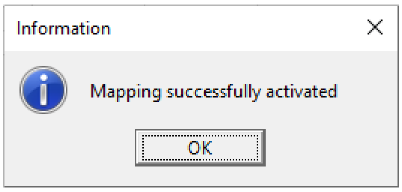

Mapping Group Selection

Available Mapping Axis Group

● Group 0: (X, Y) : MAPPING NOT ACTIVE

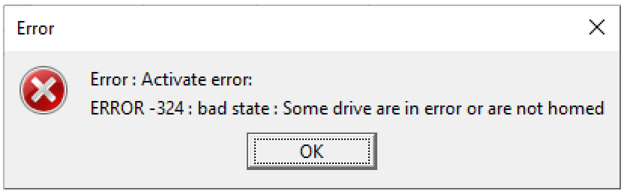
The concept of mapping axis group was not yet introduced. Basically, the *Stage Mapping* tool allows to create/manage multiple mapping axis groups. E.g. consider a dual-gantry system with **X1**/**Y1** axes for one gantry and **X2**/**Y2** axes for the other gantry. With the *Stage Mapping* tool, the user can create an error map for (**X1**,**Y1**) and another error map for (**X2**,**Y2**), which are managed as two separate mapping groups.

Select the mapping group and press the **OK** button to activate the stage mapping feature on the concerned Controllers. If the activation is successful, the following message pops-up:



Mapping successfully activated

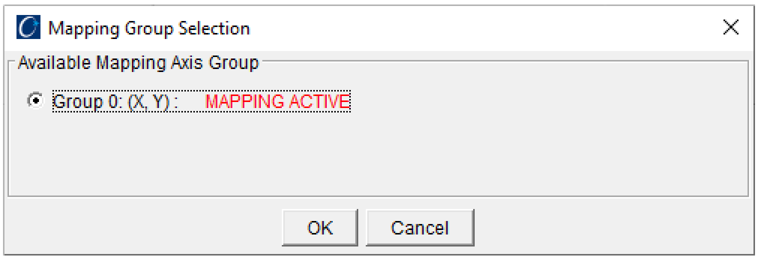
On the other hand, in case of an issue with the activation of the stage mapping feature, an error message pops-up to inform the user of the nature of the problem. E.g. the following message informs the user that one of the axis concerned by the mapping was in error or not homed (this was indeed the root cause) and for that reason the activation of the stage mapping feature failed.



Error : Activate error:
ERROR -324 : bad state : Some drive are in error or are not homed

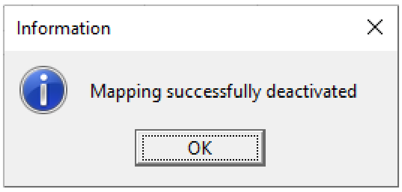
NOTE	Depending on the root cause, other types of error messages might be displayed. If required contact an ETEL representative for support on addressing the problem.

To deactivate the stage mapping feature, click on the **Deactivate Mapping** button, select the mapping axis group to deactivate from the dialog box and press the **OK** button.



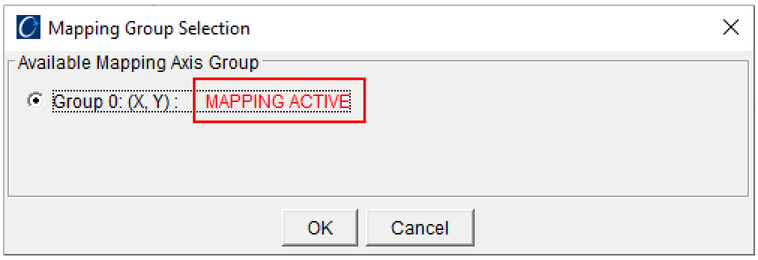
● Group 0: (X, Y) : MAPPING ACTIVE

Upon a successful deactivation, the following information message pops up and parameter `K365` of the concerned axes will be reset to zero (`K365 = 0`).

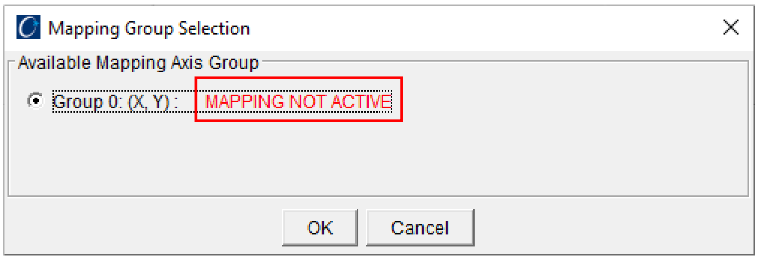


Mapping successfully deactivated

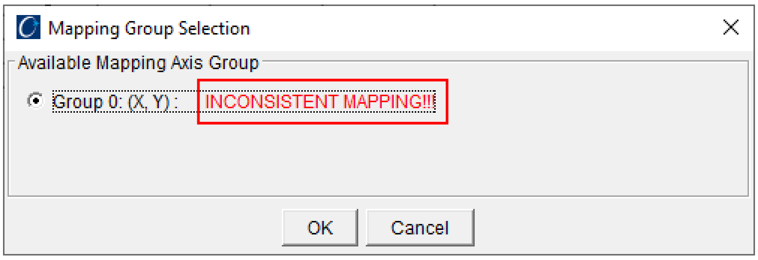
The user can inquire about the status of the stage mapping feature (activated or deactivated) by clicking on the **Check Mapping State** button on the **Configuration** panel. A message dialog box pops up with the status of the stage mapping feature. Click either **OK** or **Cancel** to close it.



● Group 0: (X, Y) : MAPPING ACTIVE



● Group 0: (X, Y) : MAPPING NOT ACTIVE



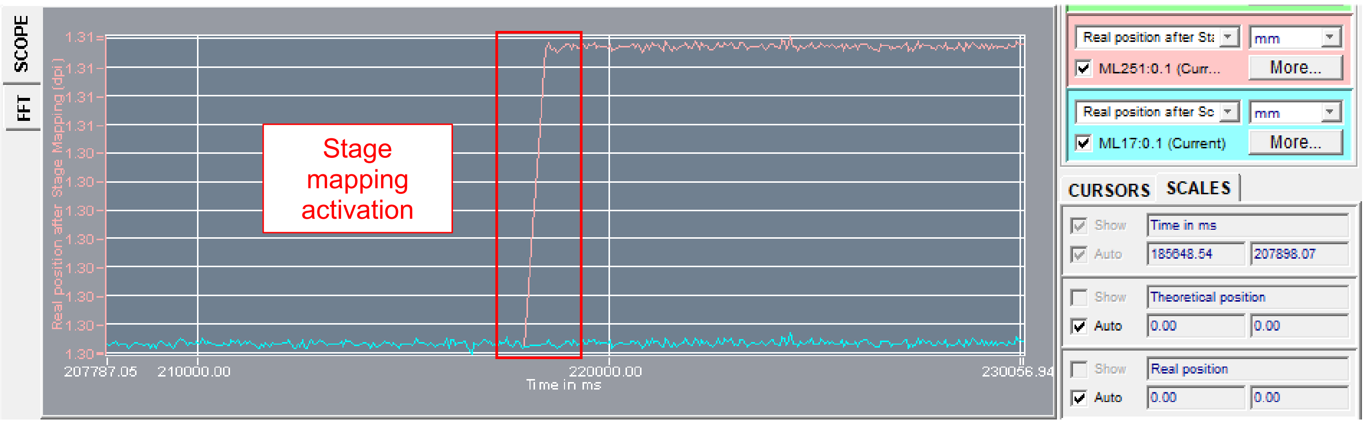
● Group 0: (X, Y) : INCONSISTENT MAPPING!!!

NOTE

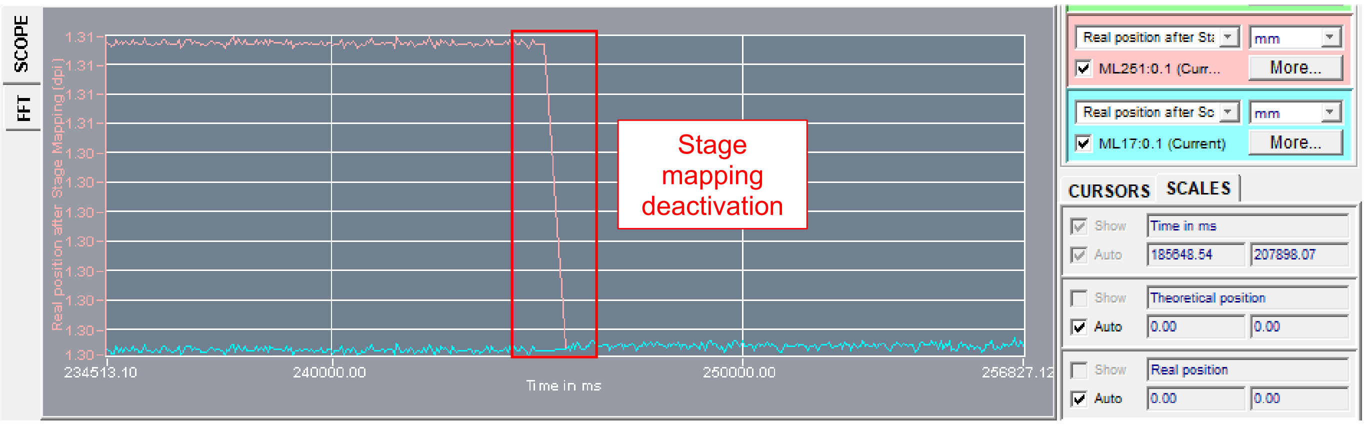
INCONSISTENT MAPPING means that all axes belonging to a same mapping group do not have the same mapping state (either all active or all inactive).

To recover from this state, deactivate the stage mapping feature on the concerned group and reactivate it again if this is the state it should be.

In order to verify if the stage mapping feature is working as expected, use the *Scope* tool to trace monitorings `ML17` and `ML1`. Position the axes at a location within the position area/volume where the stage corrections are applied and activate/deactivate the feature to check the effect on the real position after stage correction (`ML1`). Don't forget to ensure that the correction for the position where the axes are located is different from zero to be able to visually verify its effect.



Stage mapping activation



Stage mapping deactivation

In the above *Scope* tool screenshots it is possible to observe the effect of activating and deactivating the stage mapping feature. When the feature is activated, `ML1` becomes different from `ML17` by the stage correction for that location. Inversely, when the feature is deactivated, `ML1` and `ML17` have the same value.

NOTE	There are alternative ways of verifying that the stage mapping feature is working as expected. Refer to the *AccurET Modular Position Controller Operation & Software Manual* for details about the Controller's stage error mapping feature.

The next step consists on saving the configuration to the Controller. For this, select the Menu **Controller → Save Configuration to Controller** or click on the **Save configuration to controller** toolbar button . On the **Save on Controller** dialog box that pops-up, select which axis to save, select the radio button control corresponding to the `SAV = 0` command for saving the complete configuration on the Controller (including the mapping registers) and then click on the **Save** button.

Alternatively, this command can also be typed in the *Terminal* tool. Refer to Section §10.3 for more information about saving a Controller's configuration.

NOTE

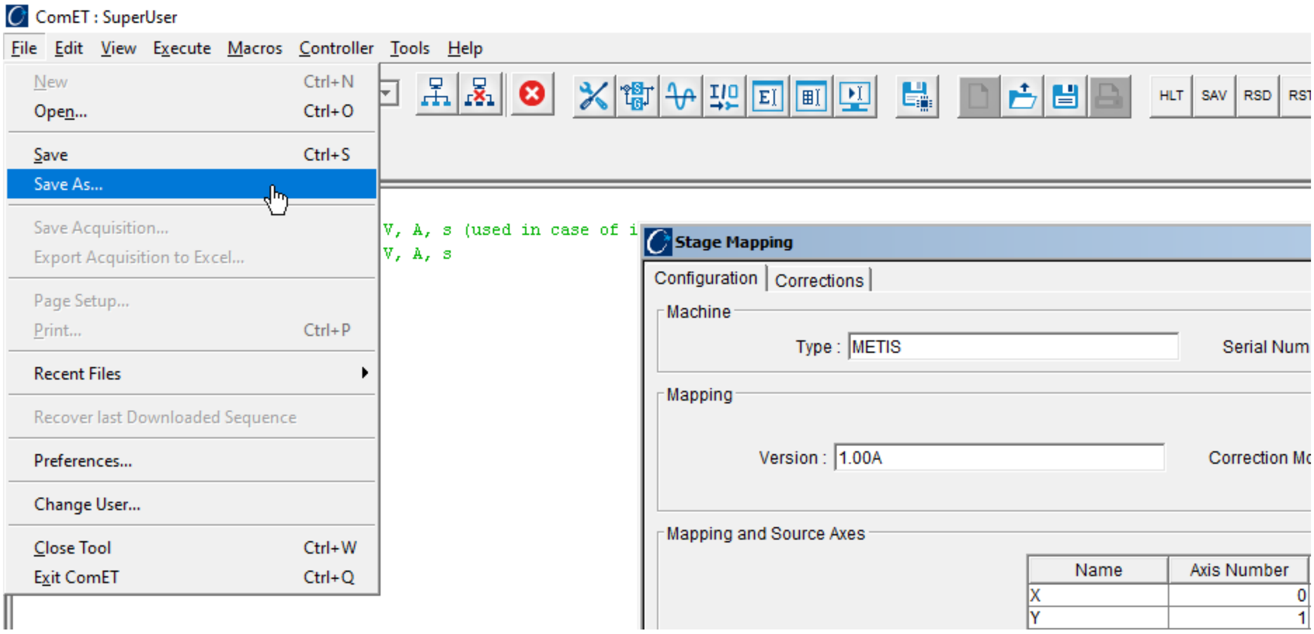
Be aware that saving the configuration to the Controller only guarantees that the stage mapping correction data is stored and, thus, available after rebooting the Controller(s).

However, all the configuration related to the exchange of information about the position of the axes over ***TransnET*** through Real-Time Values (RTVs) that is required for the *Stage Mapping* functionality is lost after rebooting the Controller(s).

This configuration needs to be reprogrammed by the user at each startup of his system either through his application based on EDI or a Sequence running on one of the Controllers.

Refer to the *AccurET Modular Position Controller Operation & Software Manual* for details about the Controller's stage error mapping feature or contact an ETEL representative for support.

The user can also save (backup) the stage mapping configuration and correction data to a file. Simply go to **File → Save As…**, type in the file name and click on the **Save** button.

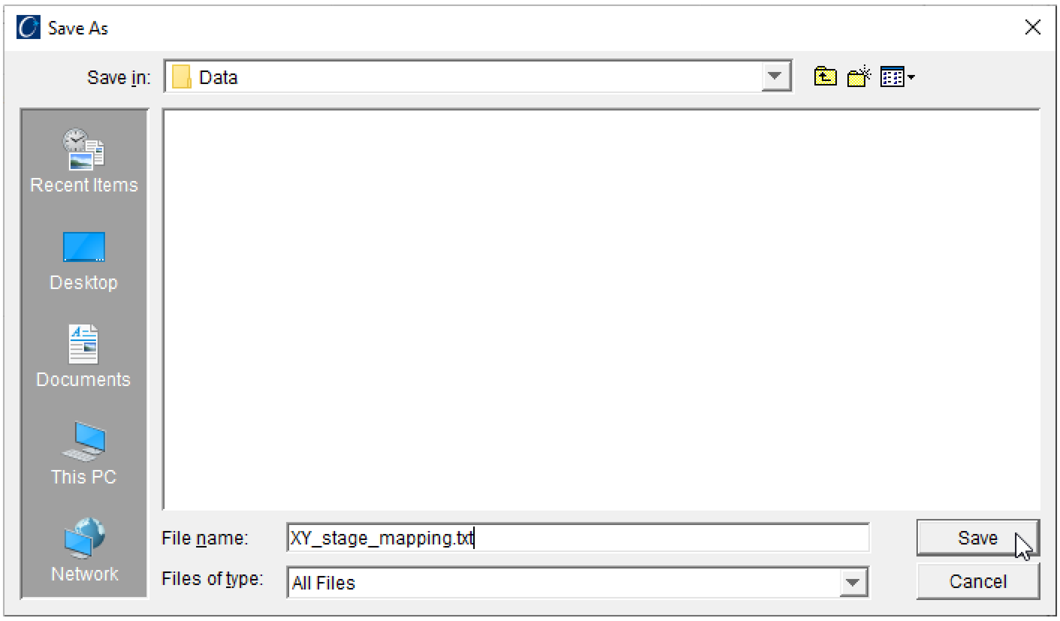


```
V, A, s (used in case of i
V, A, s
```

Type : METIS

Version : 1.00A

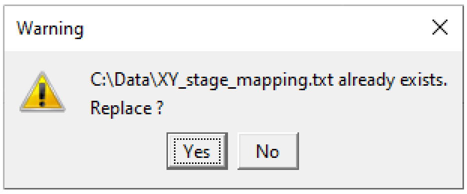
Name	Axis Number
X	0
Y	1



NOTE	Ensure that the *Stage Mapping* tool detains the interface focus before attempting to save the stage mapping file. Or else, it can happen that the option **Save As…** under the Menu **File** is disabled or, even more deceiving, it might be enabled in relation to another tool detaining the interface focus (e.g. the *Editor* tool).

TIP	Use the custom file extension *.emap for stage mapping files and associate it to the ***ComET4*** software, making it the default application for this type of file.

If the file already exists, a warning message pops-up allowing the user to confirm or not the overwriting. Click on the **Yes** button to overwrite or on the **No** button to cancel the operation of saving the stage mapping data.



C:\Data\XY_stage_mapping.txt already exists.
Replace ?

The format of the stage mapping file is very similar to the scale mapping file format (refer to Section §4.2.5). An example of a 2D stage mapping file is presented below.

```
[Header]
[[General info]]
Data type, Stage error mapping
Data format version, 1.00A
Software name, ComET Stage mapping tool
Software version,4.23A
Date, 01/01/2020
Time, 00:00:00
```

```
Operator, John Doe
Customer, My dearest customer
Project, Customer application
Description, XY stage mapping

[[Controller info]]
Controller name list, EA-P2M-048-05/10A-0100-01
Controller firmware list, 3.18A
Controller address list, 1, 0
Controller SN, 40930067, 0
Controller type list, 0, 0
Controller status, 0x0, 0x0

[[Stage error mapping configuration]]
Mapping version, 1.00A
Machine type, METIS
Machine SN, 12345678
Correction mode, positive
Axis, X, 0
Axis, Y, 1

[[[Configuration 0]]]
Corrected axis, X
Correction dimensions, 2
Source axes, X, Y
Source registers, ML17, ML17
Correction table, table 0
Origin, X, 0.000000
Origin, Y, 0.000000

[[[Configuration 1]]]
Corrected axis, Y
Correction dimensions, 2
Source axes, X, Y
Source registers, ML17, ML17
Correction table, table 1
Origin, X, 0.000000
Origin, Y, 0.000000

[Data]
[[Info table 0]]
Step size, 1.000000e-01, 1.000000e-01
Table size, 3, 3
Data unit factor, -3

[[Data table 0]]
0.001000, 0.002000, 0.003000
0.004000, 0.005000, 0.006000
0.007000, 0.008000, 0.009000

[[Info table 1]]
Step size, 1.000000e-01, 1.000000e-01
Table size, 3, 3
Data unit factor, -3

[[Data table 1]]
0.001000, 0.002000, 0.003000
0.004000, 0.005000, 0.006000
0.007000, 0.008000, 0.009000

[End Of File]
```

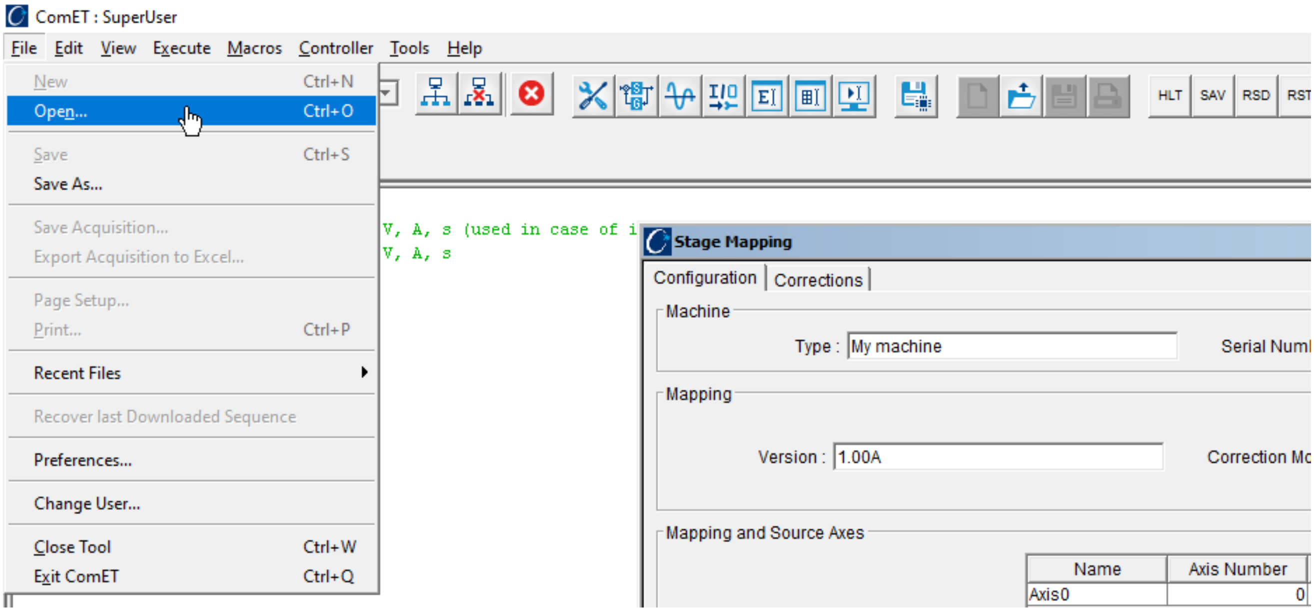
NOTE	The stage mapping file can be edited with any text editor, but the format must not be modified, including the closing line `[End Of File]`.

It is also a plain text file hierarchically organized by sections:

- `[Header]`
    - `[[General info]]`
    - `[[Controller info]]`
    - `[[Stage error mapping configuration]]`
        - `[[[Configuration 0]]]`
        - `[[[Configuration 1]]]`
- `[Data]`
    - `[[Info table 0]]`
    - `[[Data table 0]]`
    - `[[Info table 1]]`
    - `[[Data table 1]]`

Header	
`General info`	Contains information about the data type and data format version of the stage mapping file, which ***ComET4*** tool and version was used to generate the file and the time and date of file generation. The remaining information about the operator, customer, project and description are left empty and can be edited by the user as will using a text editor of his choice.
`Controller info`	Contains information related to the Controller(s) (product type, firmware version…).
`Stage error mapping configuration`	Contains information about the mapping version, the machine type and serial number. It also includes information about the correction mode to apply (positive or negative) and the correspondence between virtual axes to a real physical axes identifiers. These identifiers are used in the remainder of the file to identify the concerned axes and improve the file's readability.
`Configuration 0 / 1`	Identifies the corrected axes, the correction dimensions (2 for 2D, 3 for 3D), the source axes and source registers, the correction table and the origin of the correction.
Data	
`Info table 0 / 1`	Contains information about the step size, the table size and the conversion factor to be applied to the data table. There are two tables for 2D maps and three tables for 3D maps.
`Data table 0 / 1`	Table of corrections, with as many lines and comma separated values as indicated by the table size in `Info table 0 / 1`. There are two tables for 2D maps and three tables for 3D maps. In addition, for 3D tables, there is an empty line separating the blocks of data relative to the third dimension (just as the format of the correction data file presented before). When downloading this table to the Controller, for each correction it is applied the `Data unit factor` defined in `Info table 0 / 1`.

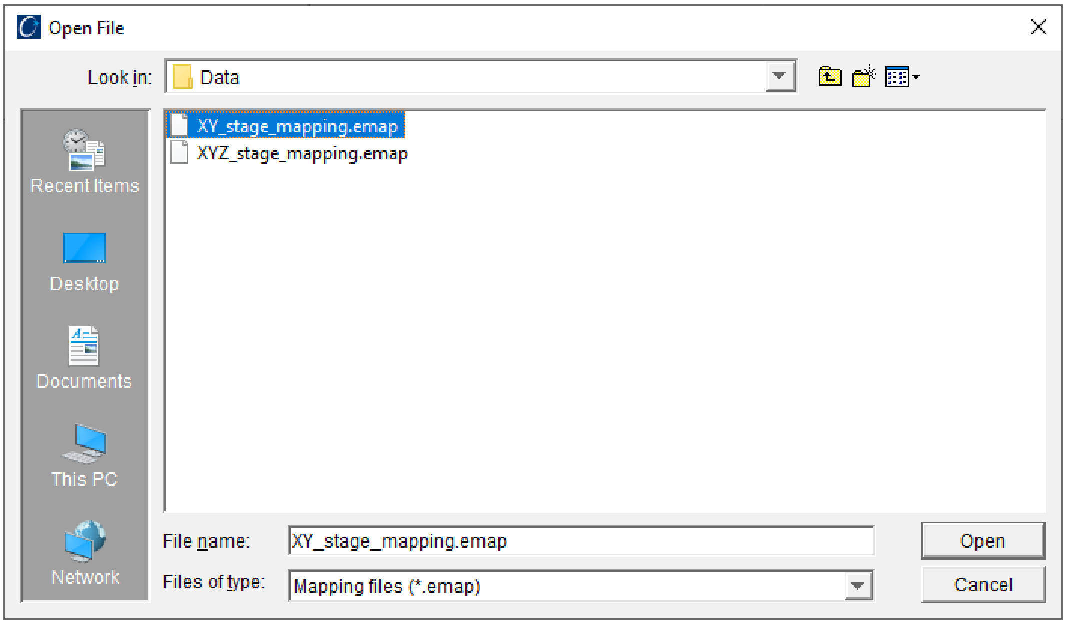
An existing stage mapping file can also be opened with the *Stage Mapping* tool. Simply go to **File → Open…**, select the file to open and click on the **Open** button.



Type : My machine

Version : 1.00A

Name	Axis Number
Axis0	0



Look in: Data

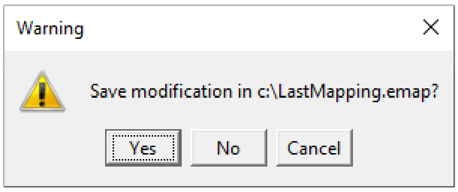
File name: XY_stage_mapping.emap

Files of type: Mapping files (*.emap)

NOTE

Ensure that the *Stage Mapping* tool detains the interface focus before attempting to open the stage mapping file. Or else, it can happen that the option **Open...** under the Menu **File** is disabled or, even more deceiving, it might be enabled in relation to another tool detaining the interface focus (e.g. the *Editor* tool).

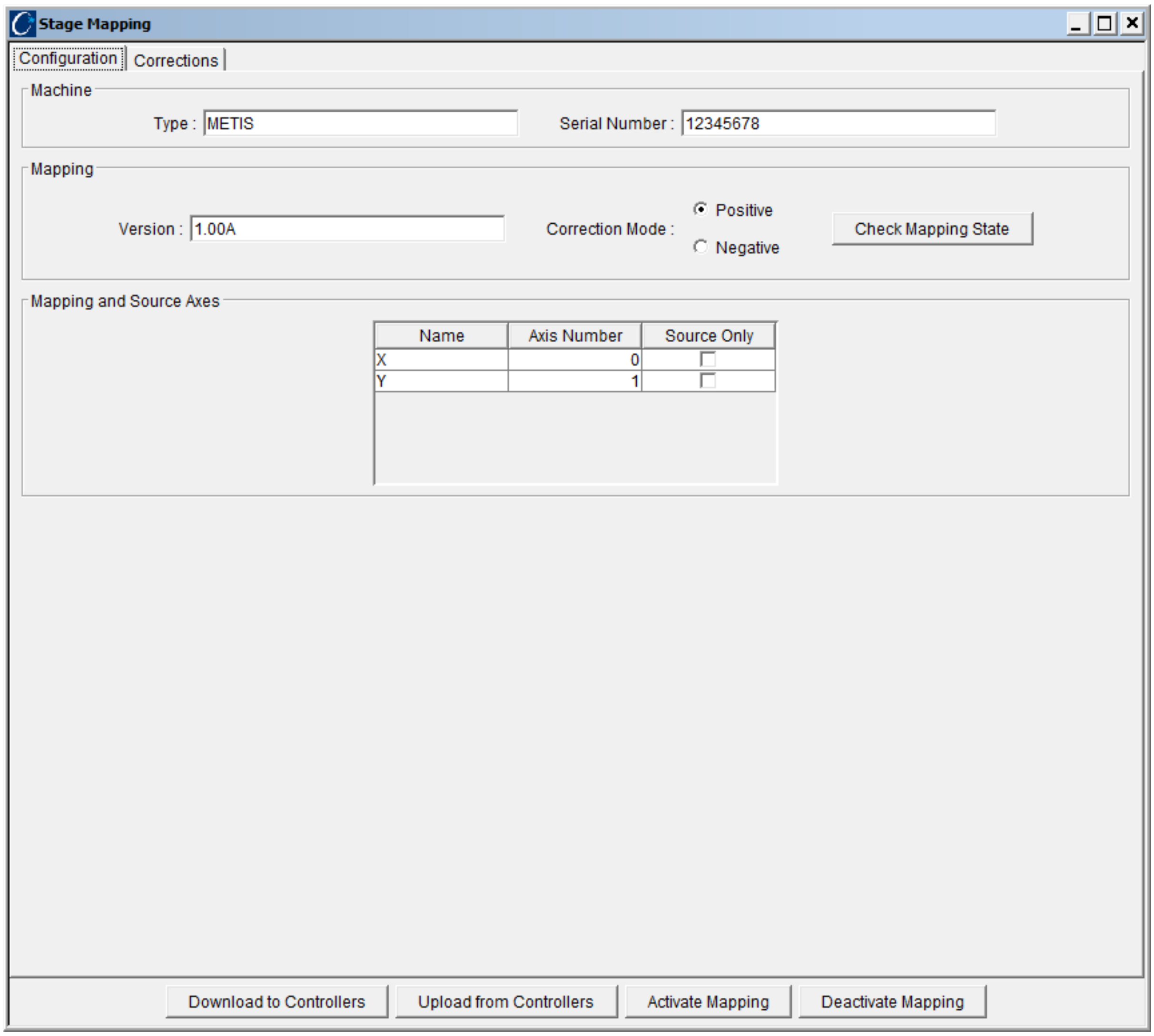
If the current stage mapping data being edited by the *Stage Mapping* tool has been modified and not yet saved, a warning message pops-up allowing the user to decide the right action to take. Click on the **Yes** button to save the existing configuration before loading the new one, or on the **No** button to proceed with the loading without saving the existing configuration or on the **Cancel** button to simply abort the whole operation.



Warning

Save modification in c:\LastMapping.emap?

Once loaded to the *Stage Mapping* tool, the mapping configuration and correction data can be modified if required or simply downloaded to the Controllers and the stage mapping feature activated as explained previously.



Stage Mapping

Machine

Type : METIS

Serial Number : 12345678

Mapping

Version : 1.00A

Correction Mode : ● Positive ○ Negative

Mapping and Source Axes

Name	Axis Number	Source Only
X	0	☐
Y	1	☐

5. Setting of other control modes

The ***AccurET*** position controller can be configured to operate in other control modes besides the standard position control of an axis. The other control modes available are:

- Force control;
- QuiET; and
- ZxT.

The following Sections introduce the tools available in ***ComET4*** for commissioning these less conventional control modes available in the ***AccurET*** position controller.

NOTE	The QuiET and ZxT control modes are not supported by the ***ACCURET+*** position controllers.

5.1. Force Control

The force control mode addresses those applications requiring the execution of motion in a position controlled way with a seamless transition to force control mode in the final stage of the movement to accurately control an applied contact force.

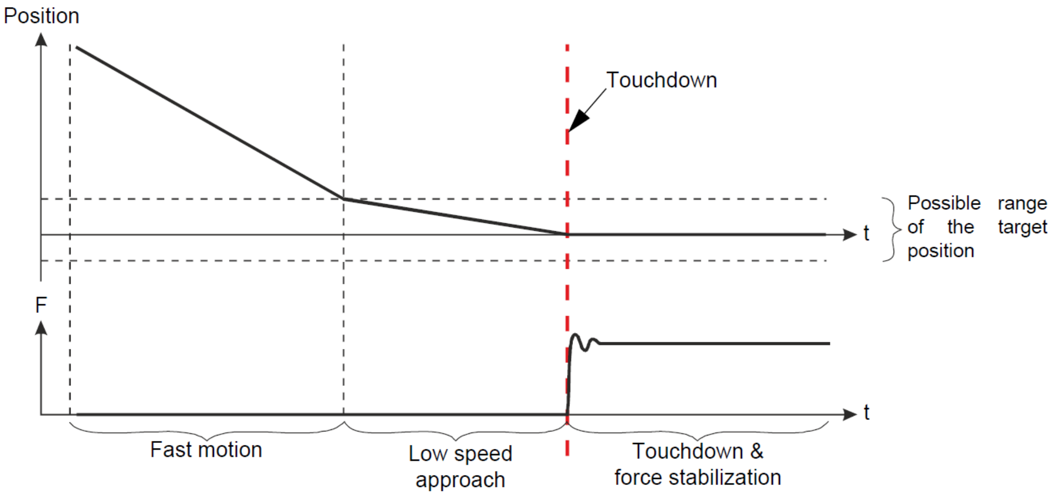
NOTE	The single axis force control mode available in the ***AccurET*** position controller is not suited to control actuators where several axes affect the contact force (e.g. dual-axis actuator with a short and long stroke axis). Refer the *AccurET Modular Position Controller Operation & Software Manual* for details about the Controller's force control mode.

The ***AccurET's*** force control feature offers various modes of operation targeting different types of applications.

5.1.1. Force control action

A force control action is made of three distinct phases:

1. **Fast Motion**
   The axis is moved at high dynamics using a standard position controller. This brings the tooltip at a predefined position and with a predefined residual constant speed. This residual speed is used as approach speed in the next phase.
2. **Low Speed Approach**
   The axis moves at a low constant speed. The touchdown detection is activated during this phase.
3. **Force Control**
   As soon as touchdown (contact) is detected, the Controller is switched to force control mode. The force reference is tracked until force control is ended.



5.1.2. Force control modes

The ***AccurET's*** force control modes of operation use different control schemes during the low speed approach phase and during the force control phase. There are three main modes of operation designated as **Mode 0, 1** and **2**.

Mode	Low speed approach	Force control (after touchdown)
0	PID position controller tracking a position ramp	Control loop build around the position control loop
1	PID position controller tracking a position ramp	Control loop build around the current control loop
2	P speed controller with constant speed reference	Open loop control of the current control loop reference

5.1.2.1. Choosing the right mode of operation

The three available force control modes offer different performance tradeoffs. The choice of the mode of operation therefore depends on the type of axis and application.

- **Mode 0** can be seen as a multi-purpose mode of operation. It is robust with most types of axes and works with all choices of estimator settings (i.e. sensorless, sensor-based, with/without spring compensation). The downside is that it reaches a lower bandwidth compared to the other modes, leading to a slower force settling time.
- **Mode 1** has the same scope of application as **Mode 0**. However, it can achieve higher bandwidths at the cost of a somewhat reduced robustness.
- **Mode 2** has the fastest force settling time, but it is limited to low friction (or frictionless) axes without pre-constraint spring. It works without estimator in the loop and is limited to sensorless applications. Wire bonding heads are typical applications for this mode of operation.

NOTE	In sensorless applications (**Mode 0/1** with sensorless estimator and **Mode 2**), the accuracy of the applied force after settling depends on the accuracy of the motor constant Kt. It is also influenced by axis friction.

5.1.2.2. *Low speed approach phase*

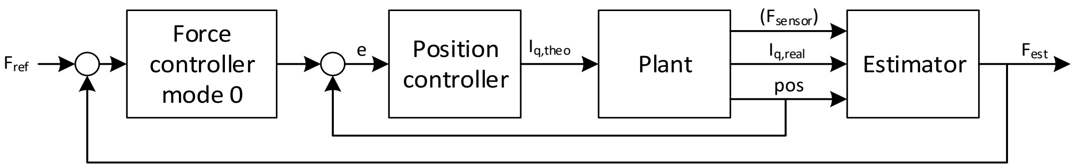
The control strategy for the low speed approach varies according to the selected force control mode. In **Modes 0** and **1**, the approach is performed with the axis position controller, the reference of which is computed from the output of an integrator (position ramp). Refer to the *AccurET Modular Position Controller Operation & Software Manual* for details on setting up the appropriate gains manually. The *Force Control Tool* allows setting these by simply specifying the desired approach speed.

In **Mode 2**, the control strategy during approach is different. The speed is stabilized by a simple proportional speed controller with gain *D* (the same gain value as used during force control, see Section §5.1.2.3.

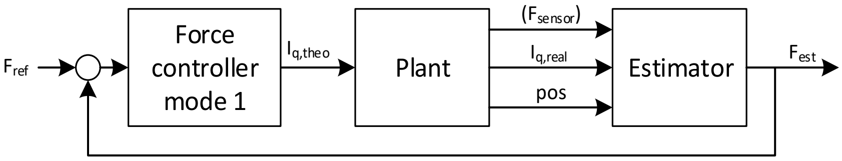
While stability during the low speed approach is guaranteed by a proper position control loop design in **Modes 0** and **1**; in **Mode 2**, stability must be ensured when tuning the force controller. This is part of the *Force Control Tool's* commissioning tasks.

5.1.2.3. *Force control phase*

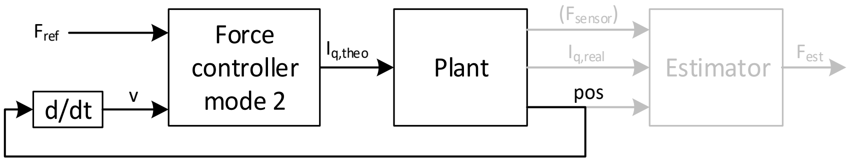
In **Mode 0**, the force controller acts on the axis position reference and is fed back via a force estimator.

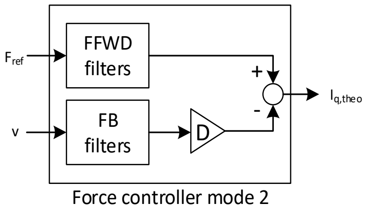


In **Mode 1**, the force controller acts on the axis current references and is fed back via a force estimator.



In **Mode 2**, the force controller applies a current reference directly derived from the (filtered) force reference. The feedback loop only features stabilization via damping (D gain and filtering). The force estimator is not in the feedback loop.





5.1.2.4. Touchdown detection

The switching between the *low speed approach phase* and the *force control phase* is triggered by the touchdown detection. Two types are available:

1. Detection on estimated force level. This is the recommended detection type for most applications using **Modes 0** and **1**;
2. Detection on measured speed level. In **Modes 0** and **1**, the threshold speed is specified as an absolute speed value. In **Mode 2** the threshold is specified relative to the chosen approach speed in percent [%]. This is the recommended detection type in **Mode 2**.

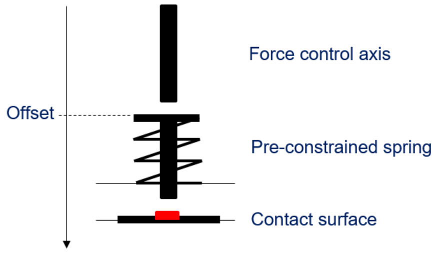
5.1.2.5. Force estimator

The ***AccurET*** features a force estimation algorithm. The output of the force estimator has multiple purposes:

1. Feedback value for the force control loops in **Modes 0** and **1**;
2. Force value reading for touchdown detection (mainly in **Modes 0** and **1**);
3. Force values reading for assessing settling with respect to specification windows (**Modes 0**, **1** and **2**).

The force estimator has three main modes of operation:

1. Using a force sensor. If the sensor is moving with the axis, acceleration effects can be compensated for;
2. Sensorless operation. In this mode, the force is estimated based on motor current (using the Kt motor constant), speed, acceleration, etc. are used to compensate for dynamic effects;
3. Sensorless operation with spring-compensation. This mode is identical to the above one with additional position-based compensation for use cases featuring a pre-constrained spring. Use this mode if the axis is preloaded with a spring and the spring force is not a component of the force to be applied to the contact surface.

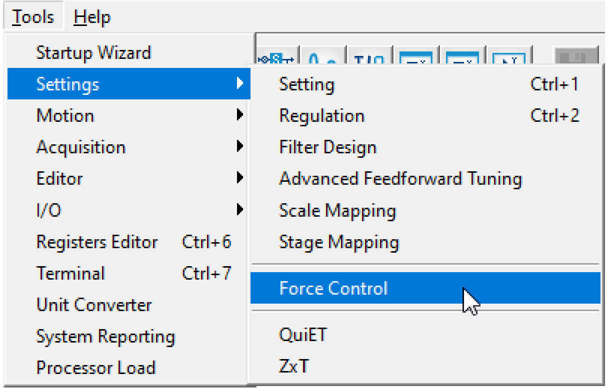


5.1.3. Force Control Tool

The *Force Control* tool allows the user to configure the force control mode on one of the axis of an ***AccurET*** position controller. This tool is one of ***ComET4***'s so-called external tools consisting of a MATLAB-based standalone application.

NOTE	The *Force Control* tool requires the prior installation of the MATLAB Compiler Runtime (MCR) version 2019b, which can be downloaded from: http://www.mathworks.com/products/compiler/mcr/. This tool will take several seconds to initialize while the MCR is being loaded into memory. MATLAB® is a numerical computing environment and proprietary programming language developed by The MathWorks Inc.

The *Force Control* tool can be started by selecting the Menu option **Tools → Settings → Force Control**:

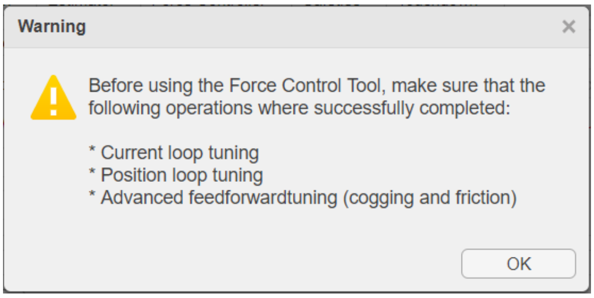


Or by executing the file ForceControlTool.exe that can be found under:

"C:\Program Files (x86)\ETEL SA\ComET-4.xxY\external-tools\ForceControlTool\".

NOTE	The *Force Control* tool can only be executed on a 64-bit Windows Operating System. Furthermore, the tool can only be used together with an ***AccurET*** position controller running firmware 3.10A or above. For the force control **Mode 2** the firmware version must be 3.19B or above.

At startup of the *Force Control* tool, a warning message informs the user of the conditions to be fulfilled to ensure optimal operation. Click on the **OK** button to proceed.



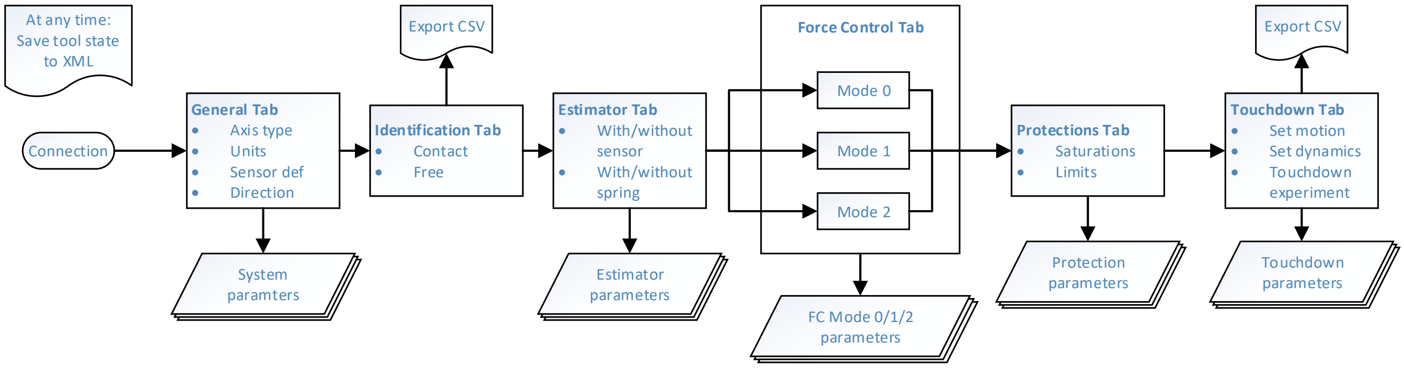
Before using the Force Control Tool, make sure that the following operations where successfully completed:

* Current loop tuning
* Position loop tuning
* Advanced feedforwardtuning (cogging and friction)

5.1.4. General Workflow

The *Force Control* tool is divided in six main tabs, each corresponding to a specific step in the workflow for tuning a force control axis:

1. **General**: set axis type, units to be used in the tool, sensor type if available and force contact direction.
2. **Identification**: contact identification and free identification (when axis not in contact). When using a sensor, a measurement of the Kt motor constant is also performed during contact identification.
3. **Estimator**: tune the force estimator (with sensor or sensorless).
4. **Force Controller**: tune force controller for operation **Mode 0**, **1** or **2**.
5. **Protections**: set axis protection parameters to prevent damages.
6. **Touchdown**: run touchdown experiments in operation **Modes 0**, **1** or **2** to assess tuning performances.



At any time, the current tool state can be saved to (**File → Save to XML**) or loaded from an XML file (**File → Load from XML**). The XML file will retain the following information:

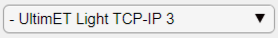
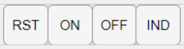
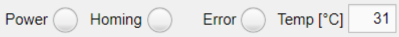
1. Identification measurements;
2. Tuning gains and drive registers relevant for force control features (called parameter sets in the tool);
3. Time traces of last touchdown experiment.

NOTE	Loading an XML file will overwrite all information in the tool with the content of the file.

In addition to the XML format, identification and time-domain experiment results can be saved individually to CSV format. The time-domain data is compatible with the ***ComET4*** scope.

5.1.5. Connection

Before interacting with a force control axis, the user needs to establish the communication. This is done via the dedicated panel always visible on the top of the tool's interface.

Connection bar	
	Selects the type of connection. Local connections are available by default (***UltimET*** and USB). Additional remote connections are listed. If ***ComET4*** is connected to an axis upon starting the tool, the connection will be shared and labelled **Auto connection**.
	Connect / Disconnect to a remote IP address.
	Choose force control axis once a connection type is chosen and established.
	Basic axis commands: • **RST** reset axis; • **ON** power on; • **OFF** power off; • **IND** perform a homing.
	Current axis status.

NOTE The *Force Control* tool is a MATLAB-based standalone application. Therefore, the connection to the drive axis is independent from the ***ComET4*** application instance.

5.1.6. Parameter sets instances

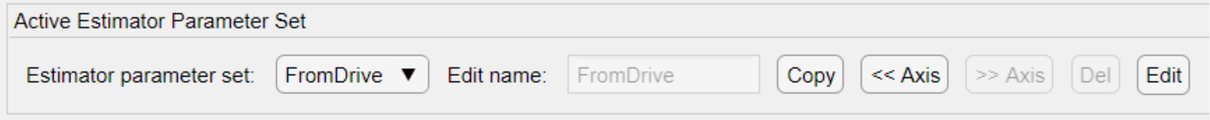
The force control features in the ***AccurET*** position controller are configured via numerous registers. To clarify and ease the tuning process, registers related to force control operations have been split in non-overlapping parameter sets, each corresponding to separate sub-functionalities. Each tuning tab in the tool (except for the Identification tab) is dedicated to the tuning of one of the parameter sets. Detailed parameter sets content is given in Section §5.1.15.

Furthermore, for each parameter set, multiple instances can be created. This allows experimenting with different tuning settings and easily switch between these. It is important to note the following behavior:

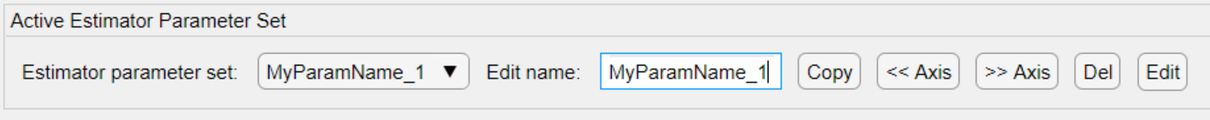
- The different instances of a given parameter set are identified with a user-editable name.
- The first instance of each set has the name **FromDrive** and cannot be edited. This parameter set is systematically loaded with the Controller's register content upon *each connection* and *each axis selection*.
- To create a new instance, an existing parameter set is selected and then copied (duplicated). The copied set can then be edited or used as basis for further tuning.
- The *active parameter set instance* is the instance whose name is currently selected. This is the set used by the tool for tuning and for executing touchdown tests.

- The tuning results are stored in the corresponding active parameter sets, but they are not saved nor written to the Controller. Active parameter sets can be written to the Controller individually from the corresponding tab or all at once from the menu **Controller → Active parameters → Write all to axis**.
- When an experiment is carried out (touchdown), the axis parameters are backed-up, all active parameter sets are written to the Controller, the experiment is performed and then the backed-up parameters are restored to the Controller.
- All active parameter sets can be read at once from the Controller with **Controller → Active parameters → Read all from axis**.
- All active parameter sets can be written at once to the Controller with **Controller → Active parameters → Write all to axis**. Note that the values are written to the Controller registers, but not saved (no `SAV` command is issued).

The following depicts the access panel for the **Active Estimator Parameter Set** in the **Estimator** tab, showing either the **FromDrive** instance as active or a user editable instance named **MyParamName_1**.



Estimator parameter set: FromDrive ▼ Edit name: FromDrive



Estimator parameter set: MyParamName_1 ▼ Edit name: MyParamName_1

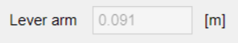
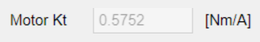
Active parameter selection	
Estimator parameter set: MyParamName_1 ▼	Select active parameter set from the list of available parameters. The list contains the **FromDrive** instance followed by all user-created instances. The values from the active set are used throughout the tool (either tuned or used for experiments).
Edit name: MyParamName_1	Edit the name of the currently selected parameter set. The name of the **FromDrive** parameter set cannot be edited.
Copy	Duplicate the active parameter set. The name is initialized with a unique variant of the duplicated set name and can be edited afterwards.
<< Axis	Overwrite the active parameter set with the Controller (axis) register values.
>> Axis	Write active parameter set content to corresponding Controller (axis) register values.
Del	Delete active parameter set. The first set **FromDrive** cannot be deleted.
Edit	Edit parameters manually. Opens a popup window with an editable parameters. Note that this button is not available for all parameter sets.

5.1.7. General tab

The **General** tab groups the settings of some basic tool-wide parameters.

5.1.7.1. Active System Parameter Set panel

This parameter set contain only two properties related to force control applications:

Active System Parameter Set panel	
 Lever arm 0.091 [m]	Sets the lever arm length for rotary actuators. Set this field to 1 [m] if using a linear actuator. If a value different from 1 [m] is used with a linear axis, a warning message is displayed.
 Motor Kt 0.5752 [Nm/A]	Motor force constant in [N/A] for linear axes and [Nm/A] for rotary axes. When using a force sensor, the value is measured during identification and can be copied here.

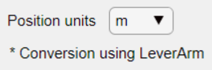
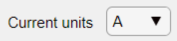
The **System Parameter Set** also contains other Controller register values that are not editable from the tool (refer to Section §5.1.15). These are not related to force control, but directly influence the force control behavior and performance.

NOTE

If system parameters (position loop PID gains, advanced filters 1-4, current loop PI gains) are modified outside the tool after the tool was connected to a controller, the system parameter sets (also the **FromDrive** set) in the tool will not correspond to the drive values anymore. Use the << Axis button to read the controller values and load them into the active set.

5.1.7.2. Displayed Units panel

Units used for displaying position and current values throughout the tool user interface can be selected here:

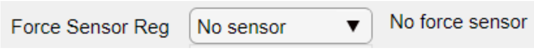
Displayed Units	
 Position units m ▼ * Conversion using LeverArm	Units for positions displayed in the tool. When choosing a linear position unit with a rotary axis, the **Lever arm** value is used as a conversion factor.
 Current units A ▼	Current units used throughout the tool. **Motor Kt** and **Lever arm** are used for converting between current values in Ampere and force or torque values.

Whenever a value is displayed in units requiring a conversion factor dependent on some parameter value, the unit name is shown with an "*" appended to it. This should attract the user's attention to the fact that the displayed value will change if for example the Lever arm or Motor Kt values are modified.

The unit name will be displayed in red if the conversion is problematic (e.g. Lever arm set to zero).

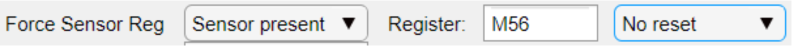
5.1.7.3. Force Sensor panel

In a sensorless application, select **No sensor**:



Force Sensor Reg: No sensor ▼ No force sensor

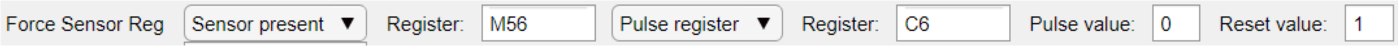
To define a sensor, select **Sensor present** and enter the register corresponding to the sensor signal.



Force Sensor Reg: Sensor present ▼ Register: M56 No reset ▼

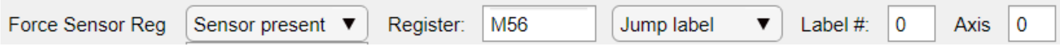
Some sensors need to be reset before every measurement. Two options are available:

1. Sending a short pulse to a chosen register. In the example below, a pulse is sent to register `C6` by setting it to 0 for some milliseconds, and resetting it to 1 afterwards. This example assumes that the register `C6` is normally set to 1.



Force Sensor Reg: Sensor present ▼ Register: M56 Pulse register ▼ Register: C6 Pulse value: 0 Reset value: 1

2. Launch a Sequence. The user is then responsible for writing an appropriate Sequence and downloading it to the Controller. In the example below, the sensor is reset by calling the Sequence function `func0` on axis 0.



Force Sensor Reg: Sensor present ▼ Register: M56 Jump label ▼ Label #: 0 Axis 0

Finally, the sensor gain needs to be specified in the corresponding edit field.

5.1.7.4. Force Axis Direction panel

The user needs to specify if the contact is reached by a positive or negative motion.

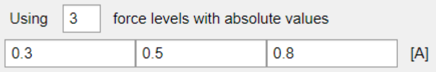
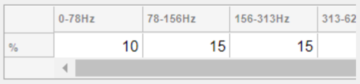
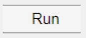
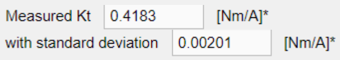
5.1.8. Identification tab

Identification results are required for any force controller tuning. Two types of identifications are available:

1. **Contact Identification:** run a frequency domain identification of the contact behavior. Multiple identifications can be run with different average contact force exerted. This allows tuning of a more robust controller. It is recommended to run identifications with force levels covering the range of force levels used by the application. At least one contact identification is required to tune any of the **Modes 0**, **1** and **2**.
2. **Free Identification:** run a frequency domain identification of the axis away of the contact. Only one identification result can be stored. Free identification is only required for tuning force control in **Mode 2** to ensure stability during approach.

Note that the **Identification** tab is the only tab in the tool not related to a parameter set. Indeed, it only allows performing measurements.

5.1.8.1. Contact Identification Settings panel

Contact Identification	
 Rest Position 0.003 [m] << Axis pos	The **Rest Position** defines the position to which the axis returns once identification is completed and where the sensor is reset (if configured to do so). The **<< Axis pos** button can be used to set the edit field value to current axis position. Note that it is advisable to enter a position value not too distant from the contact position to avoid unnecessarily large impacts (contact is established by increasing the current slowly, not with the force control algorithm).
 Using 3 force levels with absolute values 0.3 0.5 0.8 [A]	Specify the number of contact identifications to run. For each run, an average force offset to be applied must be specified. These values must all be strictly positive (irrespective of the contact direction specified in the **General** tab).
 0-78Hz 78-156Hz 156-313Hz 313-62 % 10 15 15	The identification noise is split into 8 different frequency bands. The amplitude of the noise in each band can be specified as a percentage of the force offset defined above. The default values are usually good enough, but inspection of the coherence function may reveal that the level needs to be adjusted for better measurement quality (especially at low frequencies). Refer to Section §5.1.8.4 for more details.
 Run	The **Run** button starts the contact identification(s). Note that it is advisable to start from a position near to the contact.
 Measured Kt 0.4183 [Nm/A]* with standard deviation 0.00201 [Nm/A]*	Once the identification has been completed, a measured motor Kt constant is displayed. If more than one identification was run, a standard deviation is also given. If the standard deviation is not much smaller than the value itself, the measured Kt should not be used and one should rely on the datasheet Kt value.

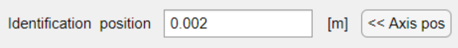
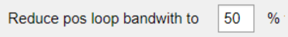
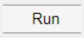
If the estimated standard deviation of the Kt measurement is much smaller than the measurement value itself, the Kt value can be copied to the corresponding edit field in the **General** tab. Note however that doing so will change any value dependent on Kt (i.e. units involving Kt in the conversion).

The estimated transfer functions are plotted in the **Results** panel (see Section §5.1.8.3).

5.1.8.2. Free Identification Settings panel

Running a free identification (with the axis *not in contact*) is only required for tuning the force controller in **Mode 2**. In addition, it also allows inspection of the position loop and current loop transfer functions (this can be useful in assessing the quality of the axis tuning prior to the tuning of the force control functionality).

NOTE	The identification method used for the 'Free Identification' is a 3-points closed-loop identification. This is different from the standard method in ***ComET4***. In this method, the axis is excited with an identification noise signal while the controller is in active closed loop with constant reference position. For best performances, the PID gains are typically reduced so as to lower the control bandwidth during identification.

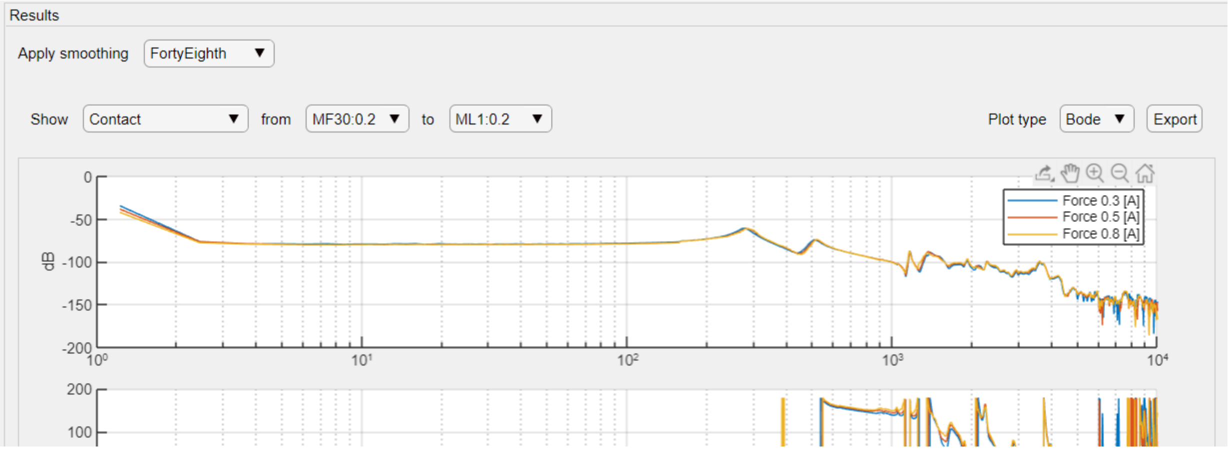
Free Identification	
 Identification position 0.002 [m] << Axis pos	The identification position defines the position around which the identification is performed The **<< Axis pos** button can be used to set the edit field value to current axis position.
 Limit noise level to 1 [A]	The identification noise level setting algorithm will not go above this value.
 Reduce pos loop bandwith to 50 %	Reduce PID gains so as to reduce the controller bandwidth during identification. On a frictionless axis, a value as low as 30% may be used.
 Run	The **Run** button starts the free identification.

The estimated transfer functions are plotted in the **Results** panel (see Section §5.1.8.3).

5.1.8.3. Results panel

The **Results** panel shows both contact and free identification measurements. A drop-down menu allows to apply some *smoothing* on the transfer function estimates. It is recommended to apply some smoothing (usually **FortyEigth** or **TwentyFourth** of octave) as this helps with the subsequent tuning algorithm convergence.

The available transfer functions to display (if measured) are **Contact**, **Contact coherence** and **Free**. For each chosen transfer function, the input-output pair of the displayed data can be chosen as well. At this stage, it is important to check the **Contact coherence** plot to ensure that the measurement is of sufficient quality, see Section §5.1.8.4.



Results

Apply smoothing FortyEighth

Show Contact from MF30:0.2 to ML1:0.2 Plot type Bode Export

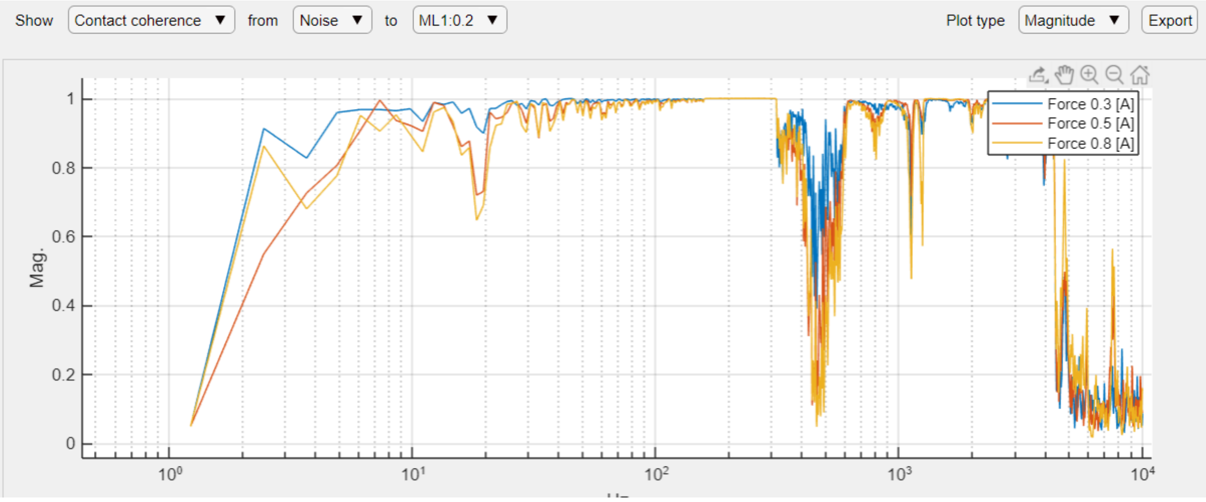
5.1.8.4. Reading the Coherence function estimate

A good force control tuning can be obtained only if the measured transfer functions are of sufficient quality. It turns out that measuring the transfer function of a system in contact can be tricky. The main challenge is to find a good ratio between the applied force offset and the amplitude of the added excitation signal. In most cases, the default ratios set in **Contact Identification settings** panel are good enough (see Section §5.1.8.1). However in some cases, the relative amplitude may have to be adjusted in one or some of the frequency bands. The reason for a bad identification quality may be because of either of two reasons:

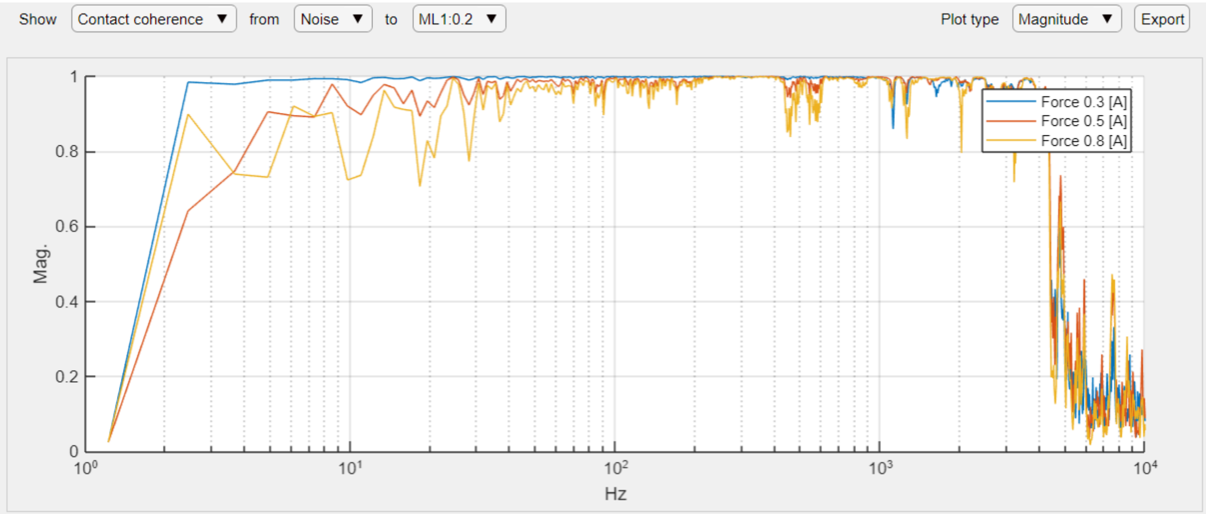
- Too high excitation level leading to contact loss at the toolpoint (this usually produces an audible vibration sound); or
- Too low excitation level leading to a poor signal-to-noise ratio.

The **Contact coherence** plot is useful for assessing the quality of the identification in a given frequency band. Whenever the plotted value is high (close to 1), the identification is of good quality. Whenever the value is lower than about 0.8 over a certain frequency band, the excitation level around these frequencies should be readjusted, either by increasing or decreasing the level.

The following plot shows an example of poor coherence in the range 300Hz-600Hz.


Show Contact coherence ▼ from Noise ▼ to ML1:0.2 ▼ Plot type Magnitude ▼ Export

On the other hand, this next plot gives an example of good coherence on a large frequency range (coherence is always poor at very low and very high frequencies). Note that it may not always be possible to obtain a coherence as consistently high as depicted in this plot.


Show Contact coherence ▼ from Noise ▼ to ML1:0.2 ▼ Plot type Magnitude ▼ Export

5.1.9. Estimator tab

The **Estimator** tab is used to tune the force estimator according to the use case. As such, it tunes values in the **Active Estimator Parameter Set** (refer to Sections §5.1.6 and §5.1.15 for details about parameter sets).

The purpose of the estimator algorithm is described in Section §5.1.2.5. Tuning the estimator is mandatory for force control **Modes 0** and **1**. In **Mode 2**, the estimator is also of use for validation and for settling window assessment. It is recommended to always tune the estimator, even if only **Mode 2** operation is foreseen.

NOTE

The estimator tuning algorithm assumes that the Cogging table and the Advanced Feedforward where properly tuned before. A good cogging compensation table is of paramount importance for the estimator tuning and performance. See Section §4.2.4 for more information on tuning Cogging tables and Advanced Feedforwards.

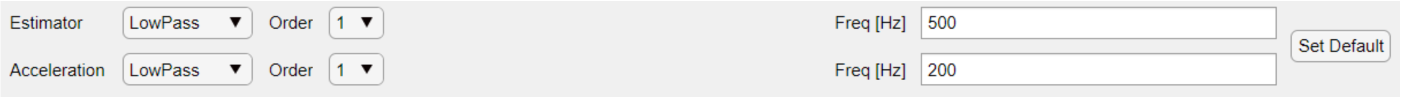
The tuning of the estimator has a large influence on the behavior of the force controller in **Modes 0** and **1**. It must always be tuned first. If the estimator parameters are modified, the force controllers for **Modes 0** and **1** must be re-tuned. On the other hand, **Mode 2** stability is independent of the estimator tuning.

5.1.9.1. Active Estimator Parameter Set panel

The active set selector for the estimator parameters features an **Edit** button. Clicking it opens a popup window with a table of all parameters (except for the filter settings). This may be useful for advanced users. However, the tuning algorithm should be able to cope with most situations.

5.1.9.2. Estimator Filters panel

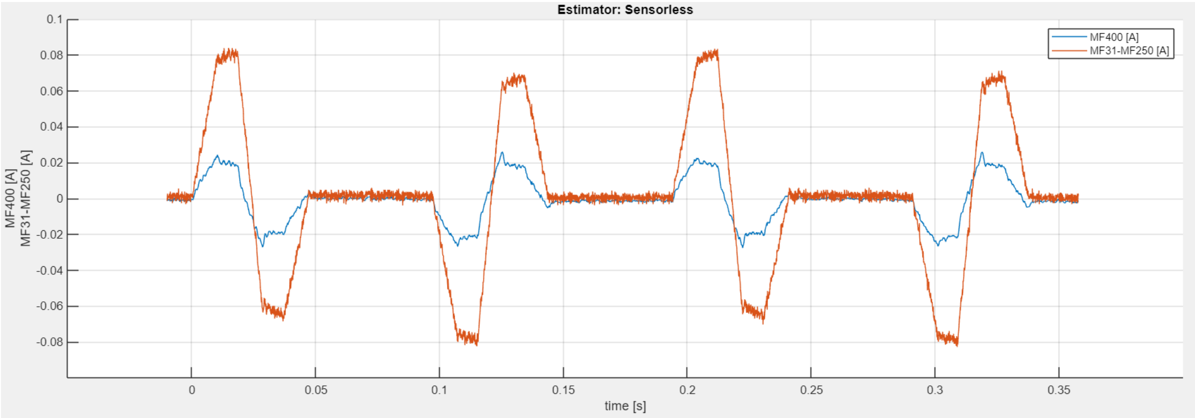
The estimator features two filters, one on the estimator output and one acting only on the measured acceleration component. Clicking the **Set Default** button gives two filters featuring a good compromise between bandwidth and noise rejection for most applications. These filters must be set manually before tuning.

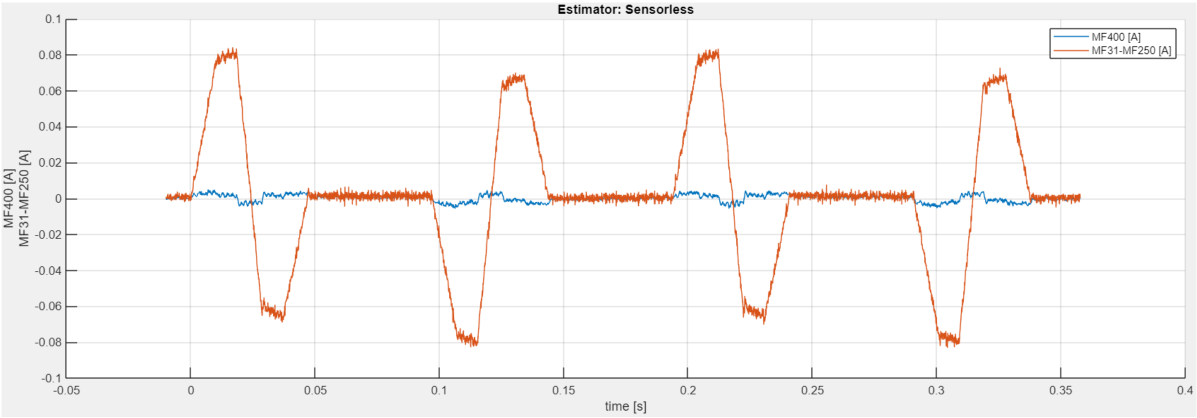


Estimator LowPass ▼ Order 1 ▼ Freq [Hz] 500
Acceleration LowPass ▼ Order 1 ▼ Freq [Hz] 200

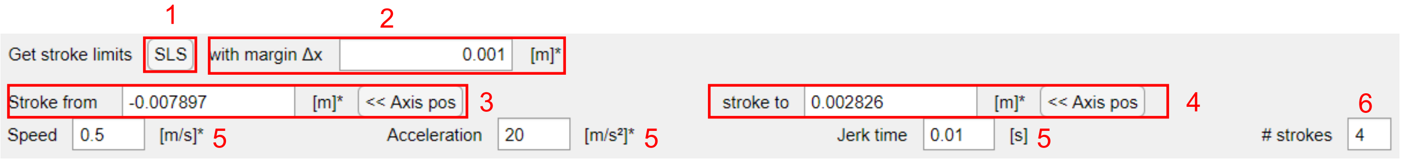
5.1.9.3. Tuning panel

The tuning of the estimator is done based on time-domain experimental data. A series of high dynamics motions without contact is executed (near or around the contact region if possible). The estimator coefficients are then tuned according to one of the three proposed use-cases and in a way such that the output of the estimator is as close to zero as possible during all motion phases. Indeed, since there is no contact, there should be no estimated contact force. The next two plots show examples of tuning results in a sensorless application. The tuning is good if the estimator output (expressed in Ampere) is small compared to the actuator current. In Section §5.1.9.9 there is an example of an estimator tuned with a poor cogging table, leading to very poor performances.





The tuning of either of the three use-cases is split in three sub-tabs. The sub-tabs contain various setting controls. Among other things, they all feature settings for the tuning- and test-motions definition:



Get stroke limits SLS with margin Δx 0.001 [m]*

Stroke from -0.007897 [m]*

stroke to 0.002826 [m]*

Speed 0.5 [m/s]*

Acceleration 20 [m/s²]*

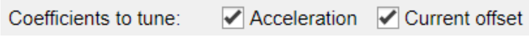
Jerk time 0.01 [s]

strokes 4

Motion definition	
[1] Stroke Limit Search	Issues an `SLS` command. The axis slowly moves back and forth and detects end-stops or contact in either direction. The extreme positions are the used as motion stroke limits.
[2] Δx margin (≥ 0)	The motion stroke as defined by the `SLS` command is reduced on either ends by the amount `Δx`.
[3] Stroke start position	Position at which the motion will start. The **<< Axis pos** button gets the current axis position.
[4] Stroke end position	Position at which the motion will end. The **<< Axis pos** button gets the current axis position.
[5] Motion dynamics	Maximum speed, maximum acceleration and jerk time to use.
[6] Number of test strokes	Tune and test with that many 1-way motion strokes.

5.1.9.4. Tuning with Sensor tab

This tunes an estimator using a force sensor. In this use case, acceleration compensation and force offset are tuned. Checkboxes allow to choose whether a given coefficient should be tuned or forced to zero. Acceleration compensation is useful if the sensor is mounted on the axis mobile part. If the sensor does not move, the acceleration coefficient should not be tuned (uncheck the **Acceleration** checkbox).



Coefficients to tune: ☑ Acceleration ☑ Current offset

Press the **Tune** button to start the tuning process. Then, press the **Test** button to repeat the experiment with the tuned coefficients and evaluate the tuning result in the **Results** panel as explained in Section §5.1.9.3.

5.1.9.5. Tuning Sensorless tab

This tunes a sensorless estimator. Force is estimated based on acceleration, speed, and feedforward signals.

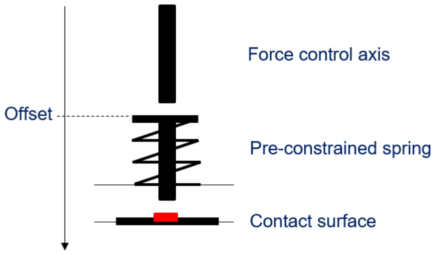
Coefficients to tune: ☑ Acceleration ☑ Speed ☐ Dry friction ☑ Current offset

In most cases, it is recommended to tune an estimator using all coefficients except the **Dry friction** one.

Press the **Tune** button to start the tuning process. Then, press the **Test** button to repeat the experiment with the tuned coefficients and evaluate the tuning result in the **Results** panel as explained in Section §5.1.9.3.

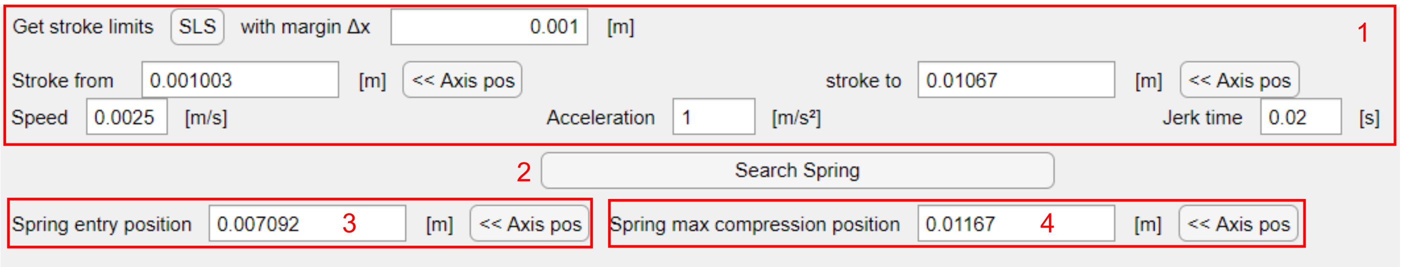
5.1.9.6. Tuning Sensorless with Spring tab

This use case is intended for applications featuring an axis pushing against a pre-constrained spring. The shaft associated with the spring in turn enters in contact with the surface on which the controlled force must be applied. The tuning of this use case is split in two parts: 1) determine the spring entry point and range; and 2) tune the estimator within the spring range.



NOTE	Compensating for a spring force with the estimator is only supported with force control **Modes 0** and **1**. To use **Mode 2** with a spring, the spring force must be compensated for using the cogging table (not recommended).

5.1.9.7. Spring search sub-tab



Get stroke limits with margin Δx 0.001 [m]

Stroke from 0.001003 [m]

stroke to 0.01067 [m]

Speed 0.0025 [m/s]

Acceleration 1 [m/s²]

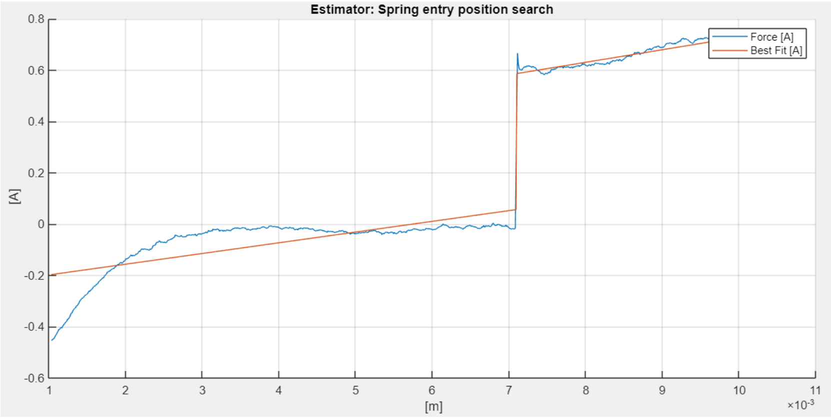
Jerk time 0.02 [s]

Spring entry position 0.007092 [m]

Spring max compression position 0.01167 [m]

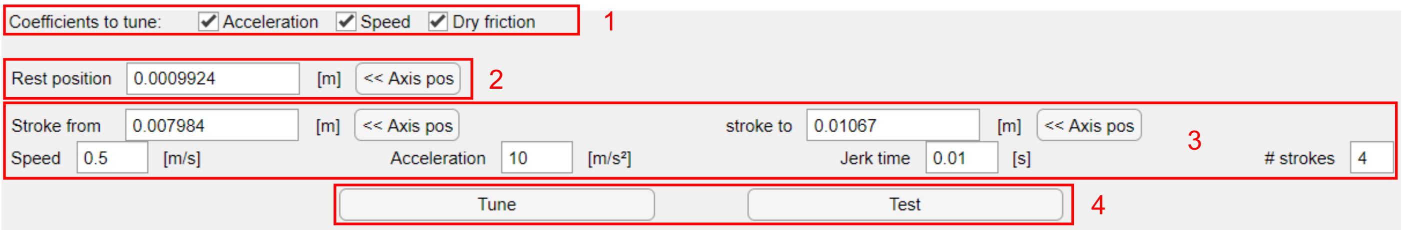
Spring search setting	
[1] Search stroke motion settings	This determines the motion stroke to use for spring detection. The settings are similar to the ones described in Section §5.1.9.3. Note, however, that the motion dynamics should be low (stroke should complete within 1-3 seconds).
[2] Search Spring	This starts the spring entry point search. When complete, data is displayed in the **Results** panel
[3] Entry position	Detected start of the spring range. The value can also be entered manually. The **<< Axis pos** button gets the current axis position.
[4] Max compression	Position of maximum compression of the spring. The value is determined from the result of the `SLS` motion result. The value can also be entered manually. The **<< Axis pos** button gets the current axis position.

The next plot shows a spring search result example. In this case the spring entry point was detected at 7.1 mm.



5.1.9.8. Tune inside spring range sub-tab

Once the spring range is detected or manually specified (see Section §5.1.9.7), the estimator can be tuned within the spring range. The motion stroke and rest position are defined automatically from the results of the spring range search experiment, but may also be entered/overwritten manually.



Coefficients to tune: ☑ Acceleration ☑ Speed ☑ Dry friction

Rest position 0.0009924 [m]

Stroke from 0.007984 [m]

stroke to 0.01067 [m]

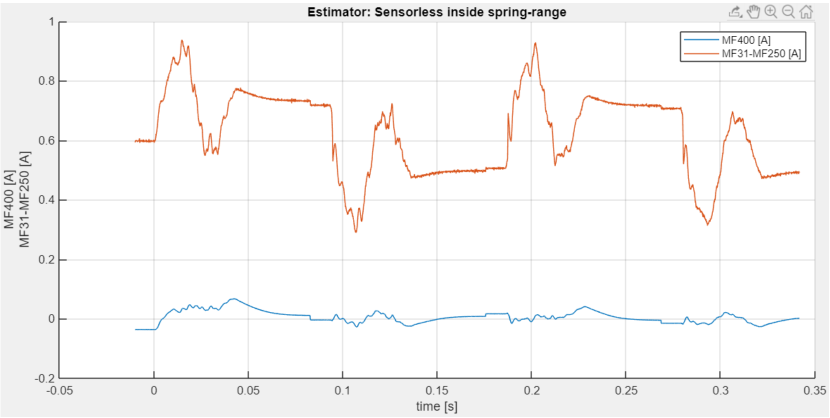
Speed 0.5 [m/s]

Acceleration 10 [m/s²]

Jerk time 0.01 [s]

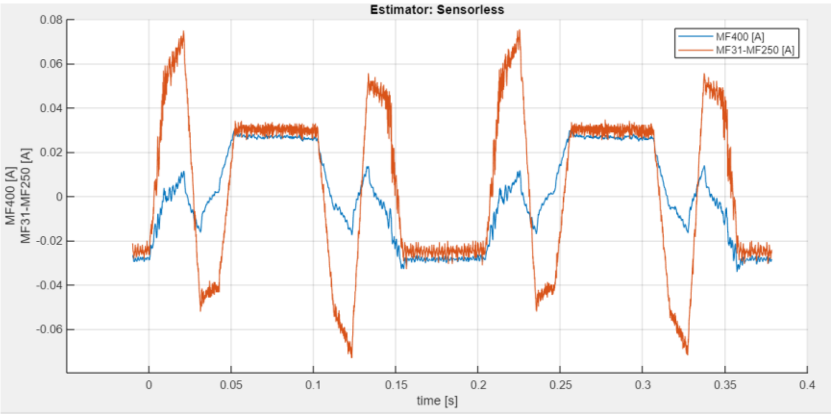
strokes 4

Spring range tuning	
[1] Coefficients to tune	Choose what estimator coefficients should be used/tuned. A spring assembly often has significant dry friction so that tuning the corresponding coefficient may be advisable.
[2] Rest position	The axis will go to this position after experiment. It is recommend to set a position outside the spring range to avoid continuous forces. The value is set automatically and may be overwritten manually.
[3] Motion definition	This determines the motion stroke to use for tuning. The settings are similar to the ones described in Section §5.1.9.3. The **Stroke from** and **stroke to** values are filled automatically, but may be set manually as well.
[4] Tune / Test	Start tuning and test tuned coefficients. The next plot shows an example of a properly tuned estimator with spring (inside the spring range).



5.1.9.9. Troubleshooting

Cogging. Before tuning the estimator, it is essential to make sure that the axis cogging is properly compensated for (select in ***ComET4*** the option **Tools→Settings→Advanced Feedforwards Tuning**). To stress the importance of this point, the next plot gives an example of the best tuning obtainable without proper cogging table (the axis used in the example features a simple voice-coil; expect even worse figures on other types of axes).



5.1.10. Force Controller / Mode 0 tab

The **Force Controller / Mode 0** tab is used to tune the force controller for operation in **Mode 0**. As such, it tunes values in the **Active Mode 0 Parameter Set** (refer to Sections §5.1.6 and §5.1.15 for details about parameter sets).

5.1.10.1. Active Force Control Mode 0 Parameter Set panel

This panel selects which instance of the **Mode 0** parameter sets is the active one (displayed and tuned).

5.1.10.2. Tuning panel

The **Tuning** panel is used to tune the controller based on a modulus margin criterion. The auto-tuner tries to tune a PI controller maximizing the bandwidth while satisfying a user-settable modulus margin. A full PID tuner may also be tuned manually, checking the **Results** panel and the Nyquist plot for assessing performance.

Target Modulus Margin 0.5

KDF:1 0

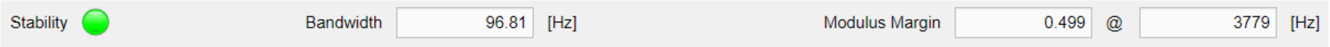
KPF:1 2.681e-05

KIF:1 0.1595

Force controller tuning – Mode 0	
[1] Target Modulus Margin	Modulus margin that the auto-tuner should ensure while maximizing bandwidth.
[2] Tune & Update	Start auto-tuning and updates the **Results** and **Responses** panels' data.
[3] Controller gains	Force controller gains computed by the auto-tuner. Gains may be manually edited as well. Note that the auto-tuner produces a PI controller.
[4] Update, Auto Update	Updates the **Results** and **Responses** panels' data. If the **Auto Update** checkbox is selected, data will be updated every time a gain parameter is edited.

5.1.10.3. *Results panel*

The **Results** panel displays numerical tuning performance results:

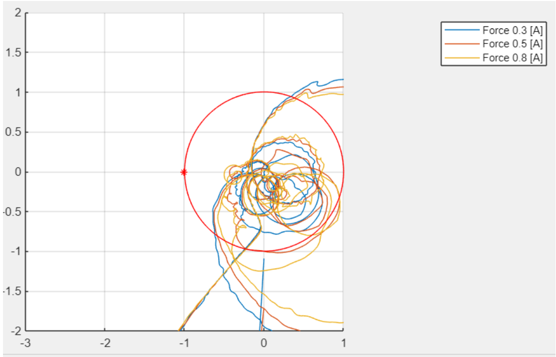


Stability 🟢 Bandwidth 96.81 [Hz] Modulus Margin 0.499 @ 3779 [Hz]

Tuning Results	
Stability	Stability indicator: • Green: indicates stability; • Red: indicates an unstable control loop; • Grey: undefined / no data available.
Bandwidth	Achieved controller bandwidth.
Modulus Margin	Achieved Modulus Margin and frequency at which the modulus margin is the smallest.

5.1.10.4. *Response panel*

The **Response** panel shows the open or closed loop response of the tuned system. By default, the Nyquist plot of the open-loop system is displayed. The transfer function may be exported to a CSV file. The next plot shows a successfully tuned system.



5.1.11. **Force Controller / Mode 1 tab**

The **Force Controller / Mode 1** tab is used to tune the force controller for operation in **Mode 1**. As such, it tunes values in the **Active Mode 1 Parameter Set** (refer to Sections §5.1.6 and §5.1.15 for details about parameter sets).

5.1.11.1. *Active Force Control Mode 1 Parameter Set panel*

This panel selects which instance of the **Mode 1** parameter sets is the active one (displayed and tuned).

5.1.11.2. *Tuning panel*

The **Tuning** panel is used to tune the controller based on a modulus margin criterion. The auto-tuner tries to tune a PI controller maximizing the bandwidth while satisfying a user-settable modulus margin. A full PID tuner may also be tuned manually, checking the **Results** panel and the Nyquist plot for assessing performance.

Target Modulus Margin 0.5

KDFC:1 0

KPFC:1 0.0004298

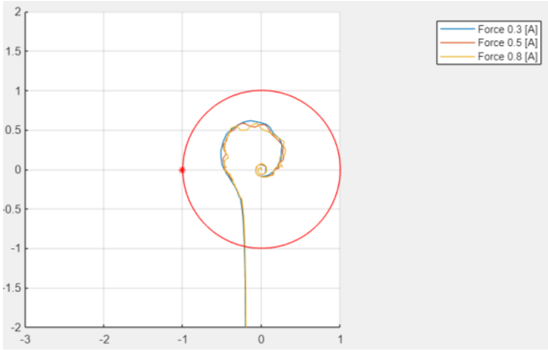
KIFC:1 389.7

Force controller tuning – Mode 1	
[1] Target Modulus Margin	Modulus margin that the auto-tuner should ensure while maximizing bandwidth.
[2] Tune & Update	Starts auto-tuning and updates the **Results** and **Responses** panels' data.
[3] Controller gains	Force controller gains computed by the auto-tuner. Gains may be manually edited as well. Note that the auto-tuner produces a PI controller.
[4] Update, Auto Update	Updates the **Results** and **Responses** panels' data. If the **Auto Update** checkbox is selected, data will be updated every time a gain parameter is edited.

NOTE

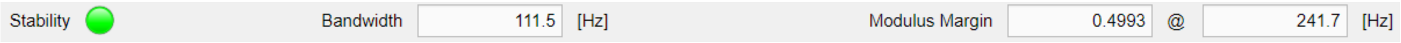
The performances achieved by the auto-tuner strongly depends on the settings of the estimator. Reducing/increasing the low-pass estimator filters cutoff frequencies may change tuning results substantially.

The following plots depict an example where reducing the cutoff frequency of the estimator acceleration filter increases the obtained controller bandwidth (on the left, a **Mode 1** controller with low bandwidth of 60Hz and, on the right, a higher bandwidth of 110Hz). Estimator filters influence controller performances substantially. Sometimes, adding some derivative gain `KDFC:1` also improves bandwidth slightly. Note that the auto-tuner only produces PI controllers. Full PID controllers must be tuned manually.



5.1.11.3. Results panel

The **Results** panel displays numerical tuning performance results:



Stability ●

Bandwidth 111.5 [Hz]

Modulus Margin 0.4993 @ 241.7 [Hz]

Tuning Results	
Stability	Stability indicator: • Green: indicates stability; • Red: indicates an unstable control loop; • Grey: undefined / no data available.
Bandwidth	Achieved controller bandwidth.
Modulus Margin	Achieved Modulus Margin and frequency at which the modulus margin is the smallest.

5.1.11.4. Response panel

The **Response** panel shows the open or closed loop response of the tuned system. By default, the Nyquist plot of the open-loop system is displayed. The transfer function may be exported to a CSV file. The next plot shows a successfully tuned system.

5.1.12. **Force Controller / Mode 2 tab**

The **Force Controller / Mode 2** tab is used to tune the force controller for operation in **Mode 2**. As such, it tunes values in the **Active Mode 2 Parameter Set** (refer to Sections §5.1.6 and §5.1.15 for details about parameter sets).

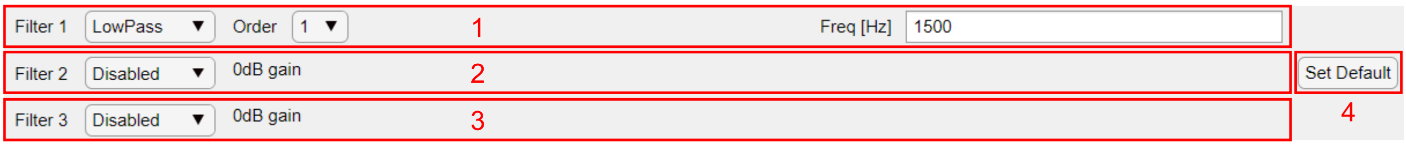
There are three different components to tune for the force control **Mode 2**:

1. **Feedback filters**: there are three feedback filters in the controller feedback loop. They can be used to fine tune the controller's behavior. In most cases, using just one low-pass filter (default option) will give good results. Any tuning should be attempted first with the default setting proposed by the tool.
2. Feedback **Speed Gain**: the auto-tuner only tunes this gain, based on the preset feedback filters.
3. **Feedforward Filters**: these filters have no influence on the stability of the feedback loop, therefore, they should be set to their default values for the initial tuning. The feedforward filters are then set based on experiments made in the **Touchdown** tab: if an oscillation is observed in the measured or estimated force plot, a filter is placed at the approximate observed frequency.

5.1.12.1. Active Force Control Mode 2 Parameter Set panel

This panel selects which instance of the **Mode 2** parameter sets is the active one (displayed and tuned).

5.1.12.2. Feedback Filters panel


Filter 1 LowPass Order 1 Freq [Hz] 1500
Filter 2 Disabled 0dB gain
Filter 3 Disabled 0dB gain

Feedback Filters	
[1-3] Filter 1-3	Settings for each of the three series-connected feedback filters. Initial setting should first be done with one low-pass filter.
[4] Set Default	Set default filters 1 through 3. (**LowPass** and two **Disabled** filters. **Disabled** means unity gain).

5.1.12.3. Tuning panel

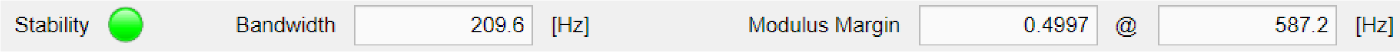
The **Tuning** panel is used to tune the controller based on a modulus margin criterion. The auto-tuner tries to tune a single gain **Speed Gain**. The **Results** panel displays the resulting stability information and the **Responses** panel displays the Nyquist plot for assessing performance. The gain can be tuned manually as well.


Target Modulus Margin 0.5
Speed Gain 2.954
☐ Auto Update

Force controller tuning – Mode 2	
[1] Target Modulus Margin	Modulus margin that the auto-tuner should ensure while maximizing bandwidth.
[2] Tune & Update	Starts auto-tuning and updates the **Results** and **Responses** panels' data.
[3] Controller gain	Force controller gain computed by the auto-tuner. Gain may be manually edited as well.
[4] Update, Auto Update	Updates the **Results** and **Responses** panels' data. If the **Auto Update** checkbox is selected, data will be updated every time the gain parameter or any filter is edited.

5.1.12.4. Results panel

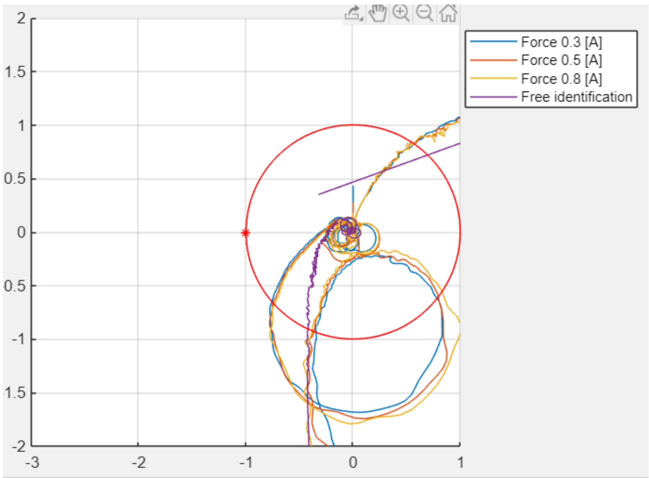
The **Results** panel displays numerical tuning performance results:


Stability ●
Bandwidth 209.6 [Hz]
Modulus Margin 0.4997 @ 587.2 [Hz]

Tuning Results	
Stability	Stability indicator. The stability is assessed both for the low-speed approach phase and for the force control phase simultaneously: • Green: indicates stability; • Red: indicates an unstable control loop; • Grey: undefined / no data available.
Bandwidth	Achieved controller bandwidth. The bandwidth is indicated for the approach phase. In force control **Mode 2**, bandwidth during contact is not defined.
Modulus Margin	Achieved **Modulus Margin** and frequency at which the modulus margin is the smallest. The value is the worst case value between approach phase and contact phase.

5.1.12.5. Responses panel

The **Responses** panel shows the open or closed loop response of the tuned system. By default, the Nyquist plot of the open-loop system is displayed. The transfer function may be exported to a CSV file. The next plot shows a successfully tuned system.

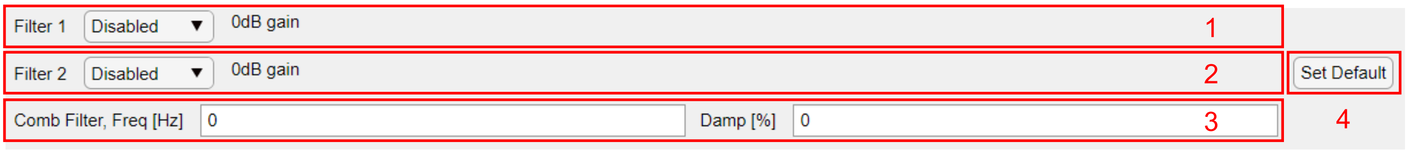


In **Mode 2**, two sets of frequency responses are displayed on the same plot:

1. Contact responses, this is similar to the other two control modes; and
2. Free response, in **Mode 2** control stability needs to be ensured during the approach phase as well.

5.1.12.6. Feedforward panel

As explained in Section §5.1.12, the **Feedforward Filters** should first be set to default until a stable controller with good bandwidth is found.


Filter 1 Disabled ▼ 0dB gain

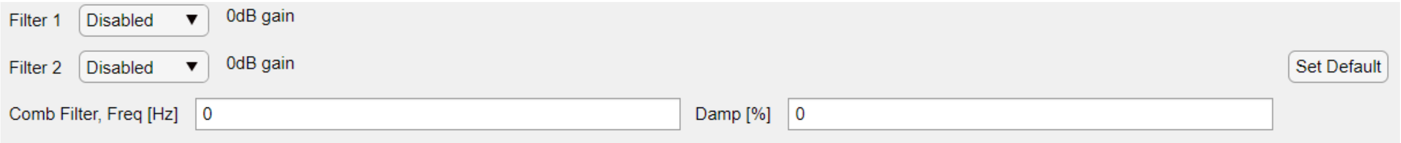
Filter 2 Disabled ▼ 0dB gain

Comb Filter, Freq [Hz] 0 Damp [%] 0

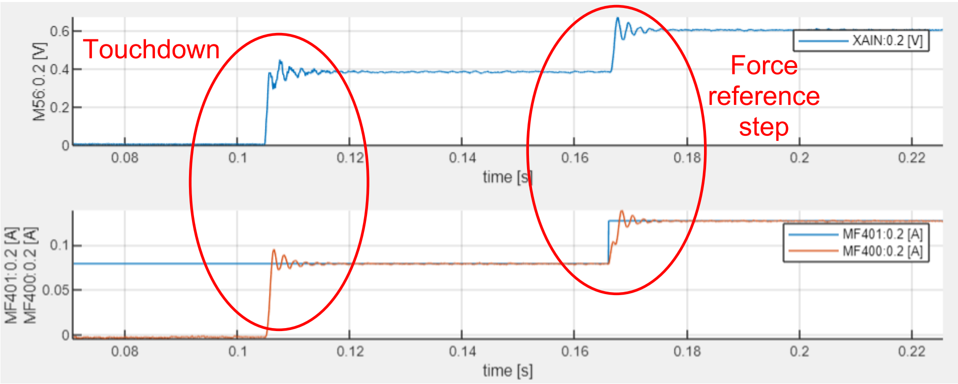
Feedforward Filters	
[1-2] 2nd order feedforward filters	Feedforward filters on force reference.
[3] Feedforward comb filter	Feedforward filter on force reference. Effective for suppressing oscillations. Enter frequency of observed oscillation. To choose the **Damp** value: If the oscillation has little damping (lasting for many periods) use the maximum value of 50%. If the oscillation presents a higher damping enter a lower value. The value can be determined more precisely by estimating the relative amplitude of two consecutive periods. The value to enter should be half of this ratio (in percentage). Note that only discrete frequency values can be entered. The user-entered value will be rounded to the closest available value.
[4] Set Default	Set all feedforward filters to default (disabled, i.e. unit gain).

With the feedback (filters and speed gain) tuned so as to get the highest possible bandwidth with specified modulus margin, a touchdown experiment is carried out (do not forget to set appropriate protection settings first, refer to Section §5.1.13 for more information). It is recommended to use at least two force levels, so as to acquire a touchdown and at least one force transition.

A result example is given below. From either the force sensor acquisition (if available) or from the estimated force acquisition (`MF400`), one may check if any problematic oscillation is present. If so, a **Feedforward Filter** can be selected.

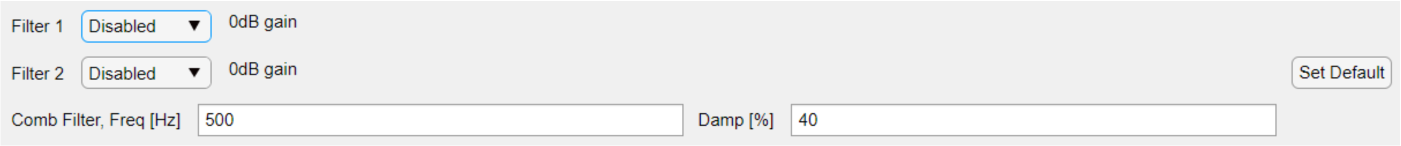


Filter 1 Disabled ▼ 0dB gain
Filter 2 Disabled ▼ 0dB gain
Comb Filter, Freq [Hz] 0
Damp [%] 0



The next plot shows the effectiveness of a **Comb filter** to reject oscillations during a force transitions. One should expect feedforward filters to be very effective on force reference transitions, less so on touchdown (as made clear by the example). **Filter 1** and **2** may additionally be used:

- Notch filters: reject any other frequency;
- Low-pass filter: may reduce noise (noise excited by reference changes, not noise from the feedback loop).

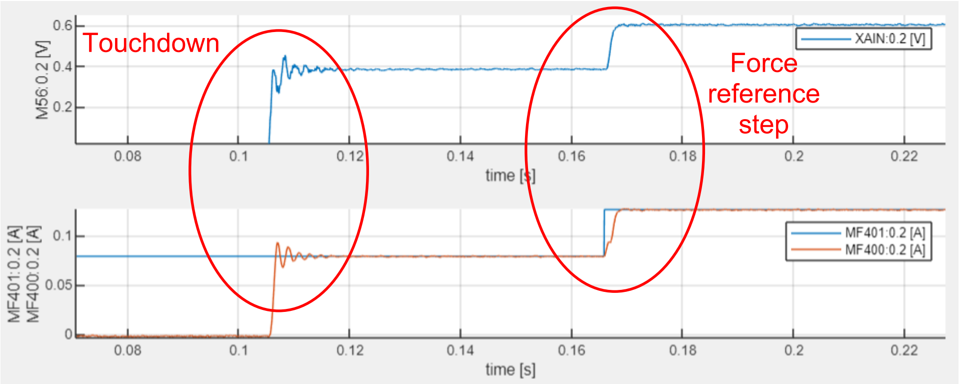


Filter 1 Disabled 0dB gain

Filter 2 Disabled 0dB gain

Comb Filter, Freq [Hz] 500

Damp [%] 40



NOTE	When trying to reject more than one oscillation, always use the **Comb filter** on the lowest frequency component. It is usually more effective than notch filters, but its frequency resolution is better at lower frequencies.

5.1.13. **Protections tab**

The **Protections** tab groups all axis-protection settings for all force control **Modes 0**, **1** and **2**.

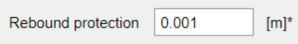
NOTE	It is essential to properly set the protection features before attempting any touchdown.

5.1.13.1. Active Protections Parameter Set panel

This panel selects which instance of the protections parameter sets is the active one (displayed and tuned).

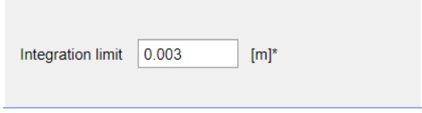
5.1.13.2. Protections Mode 0, 1 & 2

These settings are common to all Modes **0**, **1** and **2**.

Protections Mode 0/1/2	
 Output saturation 1.5 [A]	Saturation value of the output of the force controller (this does not saturate the current reference during position control).
 Rebound protection 0.001 [m]*	Max rebound distance after touchdown detection. If a rebound larger than this value is detected, the axis falls in error.

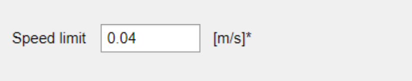
5.1.13.1. Protections Mode 0 & 1

These settings affect only force control **Modes 0** and **1**:

Protections Mode 0/1 only	
 Integration limit 0.003 [m]*	If this position is exceeded during low-speed approach in **Modes 0** or **1**, the axis falls in error. The position is relative to the low-speed approach starting position. The entered value should be positive irrespective of the defined axis direction.

5.1.13.2. Protections Mode 2 only

These settings affect only force control **Mode 2**:

Protections Mode 2 only	
 Speed limit 0.04 [m/s]*	If at any time during low-speed approach or during force-control phase, the measured speed exceeds this value, the axis falls in error.

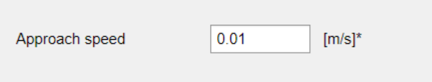
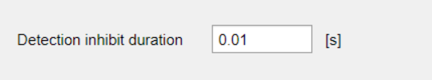
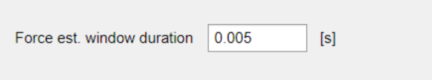
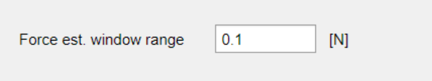
5.1.14. **Touchdown tab**

5.1.14.1. Active Touchdown Parameter Set panel

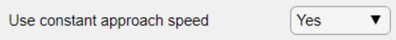
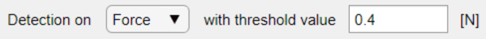
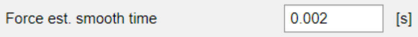
This panel selects which instance of the touchdown parameter sets is the active one (displayed, tuned and used).

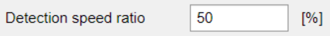
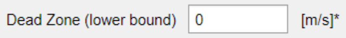
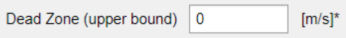
5.1.14.2. Force Control Mode 0/1/2 panel

This tab groups settings that depend on the chosen force control mode. The parameters in the left column are common to all modes. Those in the right column are different if **Mode 0** or **1** is selected or if **Mode 2** is selected

Force control Mode 0/1/2 (common to all modes, left column)	
 Approach speed 0.01 [m/s]*	Speed of the low-speed approach.
 Detection inhibit duration 0.01 [s]	After starting the low-speed approach, ignore any touchdown detection for that amount of time.
 Force est. window duration 0.005 [s]	For a force level to be detected as reached-and-stabilized, the estimated force must remain within the window range (next setting) for that amount of time.
 Force est. window range 0.1 [N]	Window range definition $[F_{ref} - \text{value}, F_{ref} + \text{value}]$

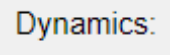
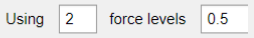
NOTE	The force window settings are used in all Modes and are based on the estimator output. This is why it is important to tune the force estimator also in **Mode 2**. If the force window range is set to a too small value, estimated force noise may prevent the *in-window* criterion ever to be satisfied, leading to waiting time-up. In that case, the axis remains in contact for some time and the error "… WTF timed out" pops up. In such case, increase the **Force est. window range** value.

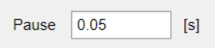
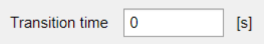
Force control Mode 0/1 (common to modes 0 and 1, right column)	
 Use constant approach speed Yes ▼	If **Yes** is selected, the force feedback is disabled during slow-speed approach, resulting in a constant approach speed (recommended setting is **Yes**).
 Detection on Force ▼ with threshold value 0.4 [N]	Touchdown detection on estimated **Force** (recommended) or **Speed**. The numerical value is the threshold value to use (always positive).
 Force est. smooth time 0.002 [s]	If a non-zero T_{smooth} value is given, the estimated force is multiplied by a ramp $r(t) = \max(0, \min(1, \frac{t}{T_{smooth}}))$ in the feedback loop. This can be used in case of estimation overshoot at the beginning of force control.

Force control Mode 2 (particular to mode 2, right column)	
 Detection speed ratio 50 [%]	In force control **Mode 2**, touchdown detection is based on the measured speed. The value is specified relative to low-speed-approach speed. A value of 50% works in most cases. After initial tuning, the value may be increased (earlier detection). Note that higher values increase the risk of false detection during approach.
 Dead Zone (lower bound) 0 [m/s]*	The force control **Mode 2** includes a **Dead Zone** nonlinearity in the feedback loop. This allows to effectively prevent damping at very low speeds (i.e. when in contact). Non-zero value are useful only in situations where the contact surface has a low rigidity and where the **Speed Gain** could slow down force transitions (due to motions while in contact). In most situation, zero is the recommended value.
 Dead Zone (upper bound) 0 [m/s]*	Upper bound of the **Dead Zone** (see above). In most situation, zero is the recommended value.

5.1.14.3. Motion & Force Reference panel

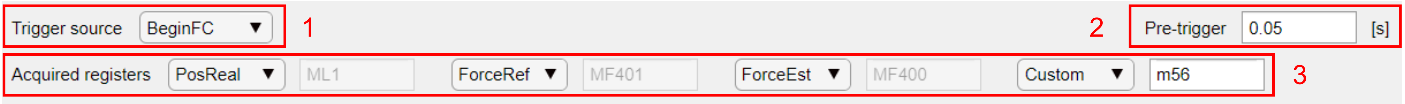
This tab groups settings for the approach motion and for the force levels to go through while in contact.

Motion & Force Reference	
 Dynamics:	Speed, acceleration and jerk time of the initial motion (performed in position control and before the beginning of the low-speed approach phase).
 Motion start position = -0.005861 [m]* << Axis pos	Initial motion start position. The **<<Axis pos** button takes the actual axis position as value.
 FC Start pos = 0.002795 [m]* << Axis pos	End of the initial motion and start position of the low-speed approach phase. This position should be close, but not equal to the contact surface position. The **<<Axis pos** button takes the actual axis position as value.
 Using 2 force levels 0.5	Number and values of the force reference levels to go through.

 Pause 0.05 [s]	Pause between each force levels (approximate value).
 Transition time 0 [s]	The force reference can be stepped or ramped between specified levels. Set 0s for steps.

5.1.14.4. Acquisition panel

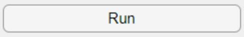
This tab allows to specify which registers should be acquired during touchdown experiments. Up to four different simultaneous traces can be acquired.



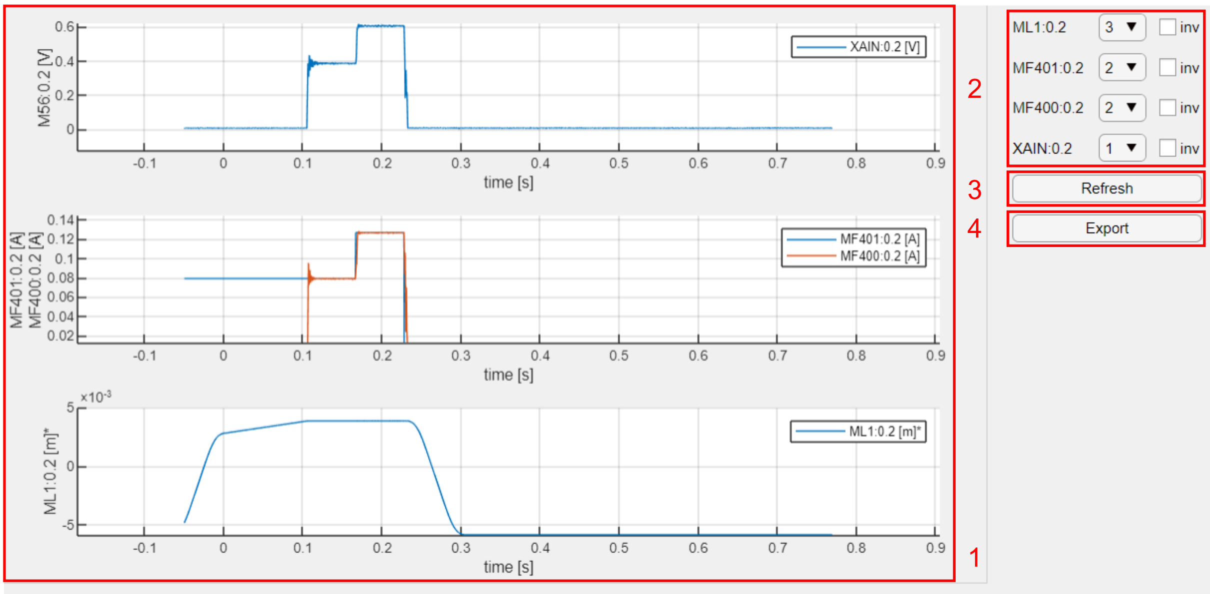
Trigger source BeginFC

Pre-trigger 0.05 [s]

Acquired registers PosReal ML1 ForceRef MF401 ForceEst MF400 Custom m56

Motion & Force Reference	
[1] Trigger Source	Event type for starting acquisition: - **BeginMove** trigger is at the start of the initial position-controlled motion; - **BeginFC** trigger is at the beginning of the low-speed approach phase; - **Touchdown** trigger is at the touchdown detection instant.
[2] Pre-trigger	Time shift between trigger and start of acquisition. If positive, the first acquired point is before the trigger event.
[3] Acquired registers	Define registers to be acquired: - **None**, for no register; - **Custom**, to specify a custom register name, e.g. `ML6`; - <Name>, select one of the predefined register names. If all registers are set to **None**, no acquisition is started. An acquisition can be configured and started from ***ComET*** instead.
 Run	Starts the experiment and acquisition (if at least one register was configured).

5.1.14.5. Results panel



ML1:0.2 3 ☐ inv

MF401:0.2 2 ☐ inv

MF400:0.2 2 ☐ inv

XAIN:0.2 1 ☐ inv

Results	
[1] Plots	Plots of all acquired registers' traces.
[2] Axes selection	For each acquisition, the axis number in which the plot should be displayed can be selected. The trace can be inverted as well (sign change).
[3] Refresh plots and units	Refresh the plots. Takes units selected in the **General** tab into account.
[4] Export to CVS (ComET4)	Export traces to a CSV text data file. The exported file is compatible with the ***ComET4*** *Viewer Tool* (**Tool→Acquisition→Viewer**).

5.1.14.6. Troubleshooting

It is recommended to adopt the following approach during tuning:

1. Make sure to produce identification data of sufficient quality, refer to Section §5.1.8.4.
2. Make sure to properly tune the estimator, even for **Mode 2**, refer to Section §5.1.9 (this implies a good cogging compensation).
3. Start with "lower than specified" values first, i.e.:
   a. Start with low **Approach speed**;
   b. Start with low motion **Dynamics** (low speed, low acceleration, large jerk time, e.g. 10-20ms);
   c. Start with long low-speed approach phase: set the **FC start pos** sufficiently off the contact surface position;
   d. **Detection inhibit duration**: start with a non-zero value, but make sure that the duration multiplied with the approach speed corresponds to a distance shorter than about half the approach distance;
   e. Start with a large **Force est. window duration** (values as high as twice the force levels).
   f. Detection threshold:
      i. **Mode 0/1**: start with half the first force level;
      ii. **Mode 2**: start with 50%.

Once a working setting (good bandwidth, etc.) is achieved, the values listed above can be tightened one by one.

When a satisfactory setting is obtained, all active parameters can be downloaded to the Controller via the menu entry **Controller→ActiveParameters→Write all to axis**.

NOTE	The active parameters are downloaded to the Controller, but not saved (i.e. the `SAV` command not issued).

Results	
Problem	**Possible issues and solutions**
Axis in error and RST button ineffective	Your axis may be on an error propagation group or the error cannot be reset with the `RST` command. Connect via ***ComET4*** and type `RST=123` in the *Terminal* tool.
Axis goes unstable	• Check force controller stability (tab **Force Control**); • Check current and position loop; • Try with a more conservative controller by increasing the modulus margin or decreasing gains manually; • Check if identification data used for tuning is of sufficient quality (refer to Section §5.1.8.4); • Check if the chosen mode is the best suited for the type of axis (refer to Section §5.1.2.1); • Try reducing the **Approach Speed** (panel Force control **Mode 0/1/2**); • Try to move the **FC Start pos** value further away from the contact surface; • Check if the used force levels are within or close to the range of forces used during identification.
Large force overshoot at touchdown or tracking error	• Make sure the **FC Start pos** is above the contact surface with sufficient margin for the low speed approach phase. Try increasing the margin by adjusting **FC Start pos**; • Try reducing the **Approach speed**; • Try reducing the motion **Dynamics** (lower speed/acceleration, larger jerk time); • Try reducing the **Detection inhibit duration**.
Modes 0/1/2 Contact established, axis stays in contact for some time, followed by error *"… Executing WTF command timed out"*	The **W**ait **T**ill **F**orce command timed-out before the in-window criterion was satisfied. • Was the estimator tuned correctly? • Try increasing the **Force est. window range** (refer to Section §5.1.14.2). This value may be set larger than the targeted force, effectively deactivating the window wait (thus relying only on the **Pause** value); • Try reducing the **Force est. window** if larger than 1s (refer to Section §5.1.14.2). Another reason (**Mode 0/1**) can be due to a too small Integration limit setting: • Go to tab **Protection** and increase the **Integration limit** value.
Early touchdown detection	• **Mode 0/1** with detection on force: check that the estimator is properly tuned. Try reducing the motion acceleration and/or increasing the motion jerk time; • **Mode 2**: try reducing the **Detection speed** ratio; • **Mode 0/1/2**: try increasing the **Detect inhibit duration**.
Modes 0/1/2 Touchdown fails with error *"… M64.x = 89, Bad setting for the Force Control loop"*	This error is triggered by the **Rebound protection** setting. Go to the protection tab and: • Increase the **Rebound protection** value; • If the error persist, deactivate the protection by setting the value to 0.
Mode 2 Touchdown fails with error *"… The velocity is greater than K31"*	The **Approach speed** (refer to Section §5.1.14.2) is too close to the **Speed limit** (**Protections** tab). Got to the **Protections** tab and increase the speed limit value.

5.1.15. Parameter sets content

For reference, the data content of each type of parameter set edited and tuned by the *Force Control Tool* is depicted below.

Estimator Parameters
- Acc Filter (KF104:5-108:5)
- Out filter (KF104:6-108:6)
- Current Offset (KF302)
- Acc gain (KF301)
- Spd gain (KF303)
- Dry friction (KF304)
- Sens. Offset (KF309)
- Sens. Gain (KF310)
- Sensor def (K311:0-3)
- Current gain (K316)
- Cogging gain (K317)
- Spring Offset (K373)
- Spring Stiff. (KF373)
- Spring max compression (K374)
- Spring damping (KF374)

FC Mode 0 Parameters
- KDF1 (KF318:1)
- KPF1 (KF305:1)
- KIF1 (KF306:1)

FC Mode 1 Parameters
- KDFC1 (KF314:1)
- KPFC1 (KF312:1)
- KIFC1 (KF313:1)

FC Mode 2 Parameters
- FB Filters (KF114-118, depth 0-2)
- FFWD Filters (KF114-118, depth 3-4)
- Comb filter settings (K291:4, K292:4)
- Speed gain *D* (KF315)

System Parameters
- Speed Filter (KF104:0-108:0)
- Adv Filters (KF104.108, depth 1-4)
- Kdp (KF2)
- Kpp (KF1)
- Kip (KF4)
- Kpc (KF80)
- Kpc (KF81)
- LeverArm (KF308)
- Kt (KF300)

Touchdown Parameters
- FC config bits (K302)
- Dead zone (K19:5, K19:6)
- TD detect inhibit duration (K193)
- Detect. Force threshold (KF299)
- Detect. Spd threshold mode 0/1 (K19:4)
- Detect. Spd threshold ration mode 2 (KF321)
- Detect. Delay (K191)
- Force estimation smooth time (K192)
- Force window duration (K190)
- Force window range (KF191)
- KDF:0 Approach derivative gain (always 0) (KF318:0)
- KPF:0 Approach proportional gain (always 0) (KF305:0)
- KIF:0 Approach integral gain (KF306:0)

Protection Parameters
- Out. Saturation (KF6:1)
- Rebound prot. (KL314)
- Speed Limit (K31:1)
- Pos integration limit (K307)

5.2. QuiET

The *QuiET* tool allows the user to verify and, if needed, perform adjustments to the settings of the ***QuiET*** active isolation system. The ***QuiET*** system serves two main purposes:

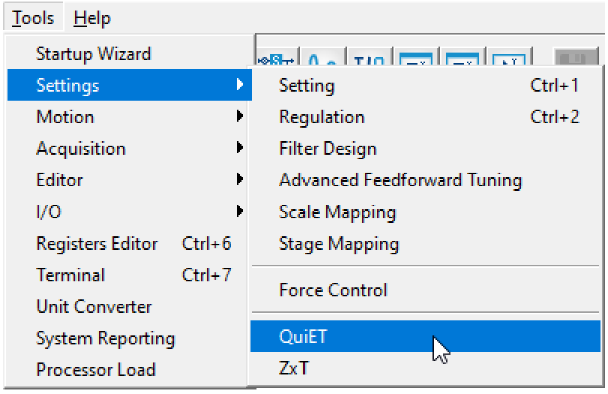
- Filter out the vibrations coming from the floor impacting the performance of the motion system mounted on top of it (i.e. vibration isolation capability); and
- Cancel the driving forces generated by the motion system movements (i.e. drive force cancellation capability).

NOTE	The QuiET control mode is not supported by the ***ACCURET+*** position controllers.

The *QuiET* tool is one of ***ComET4***'s so-called external tools consisting of a MATLAB-based standalone application.

NOTE	The *QuiET* tool requires the prior installation of the MATLAB Compiler Runtime (MCR) version 2019b, which can be downloaded from: http://www.mathworks.com/products/compiler/mcr/. This tool will take several seconds to initialize while the MCR is being loaded into memory. MATLAB® is a numerical computing environment and proprietary programming language developed by The MathWorks Inc. As a standalone MATLAB-based application external to ***ComET4***, the *QuiET* tool only communicates with QuiET controllers. It is not aware of the status of any other Controllers on the communication bus.

This tool can be launched from within ***ComET4*** by selecting the Menu option **Tools → Settings → QuiET**:

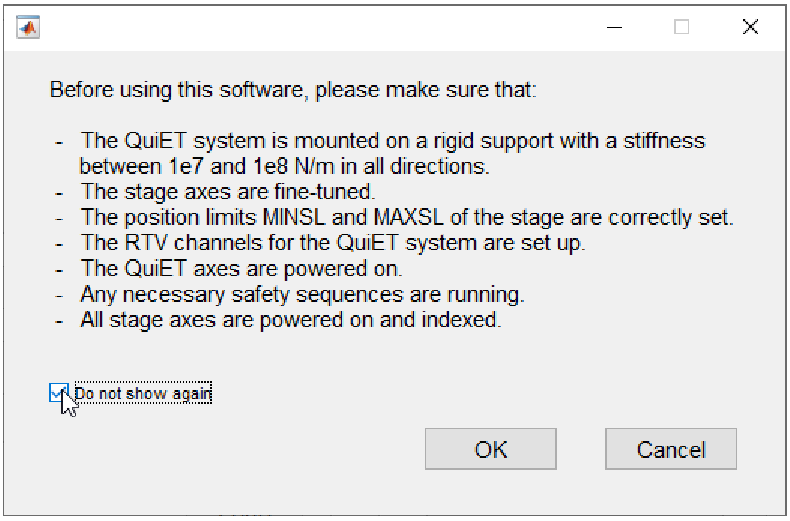


or executing the file QuiETTool.exe that can be found under:

"C:\Program Files (x86)\ETEL SA\ComET-4.xxY\external-tools\QuiETTool\".

NOTE	The *QuiET* tool can only be executed on a 64-bit Windows Operating System.

At startup, a warning message informs the user of the conditions to be fulfilled to ensure optimal and safe operation of the system. Click on the **OK** button to proceed.


Before using this software, please make sure that:

- The QuiET system is mounted on a rigid support with a stiffness between 1e7 and 1e8 N/m in all directions.
- The stage axes are fine-tuned.
- The position limits MINSL and MAXSL of the stage are correctly set.
- The RTV channels for the QuiET system are set up.
- The QuiET axes are powered on.
- Any necessary safety sequences are running.
- All stage axes are powered on and indexed.

☑ Do not show again

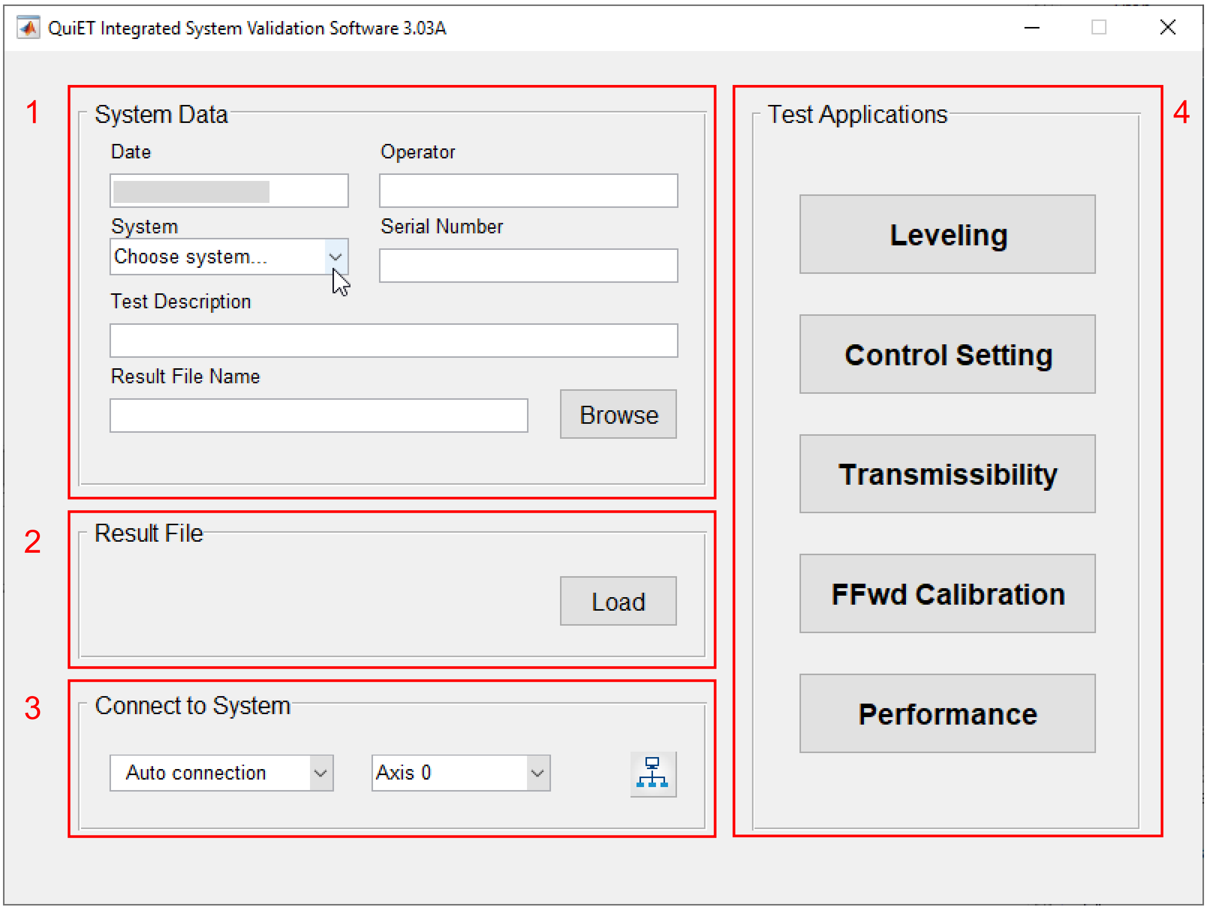
The main window is divided in 4 areas:

1. **System Data**;
2. **Result file**;
3. **Connect to System**; and
4. **Test Applications**.

In the **System Data** area, the user can select a system from the **System** drop-down list and choose the location where to store the test results file by clicking on the **Browse** button. The user must add the name of the operator conducting the tests and the system’s serial number (though not mandatory, a description of the test is recommended).

NOTE	The results are stored as a MATLAB native file. Therefore, it is recommended to use the default `*.mat` file extension.

Alternatively, the user can load test results for analysis by clicking on the **Load** button in the **Result file** area.



Usually, the connection with the Controllers is established automatically when the *QuiET* tool is launched from within ***ComET4***. The drop-down list in the **Connect to System** area lists the different connection types available and the button 🖧 allows the user to establish a connection to a TCP/IP host, just like in ***ComET4***. Select the Controller's axis from the second drop-down list.

In the **Test Applications** area, the user can access several tools for adjusting and verifying the settings of a ***QuiET*** active isolation system.

5.2.1. Leveling

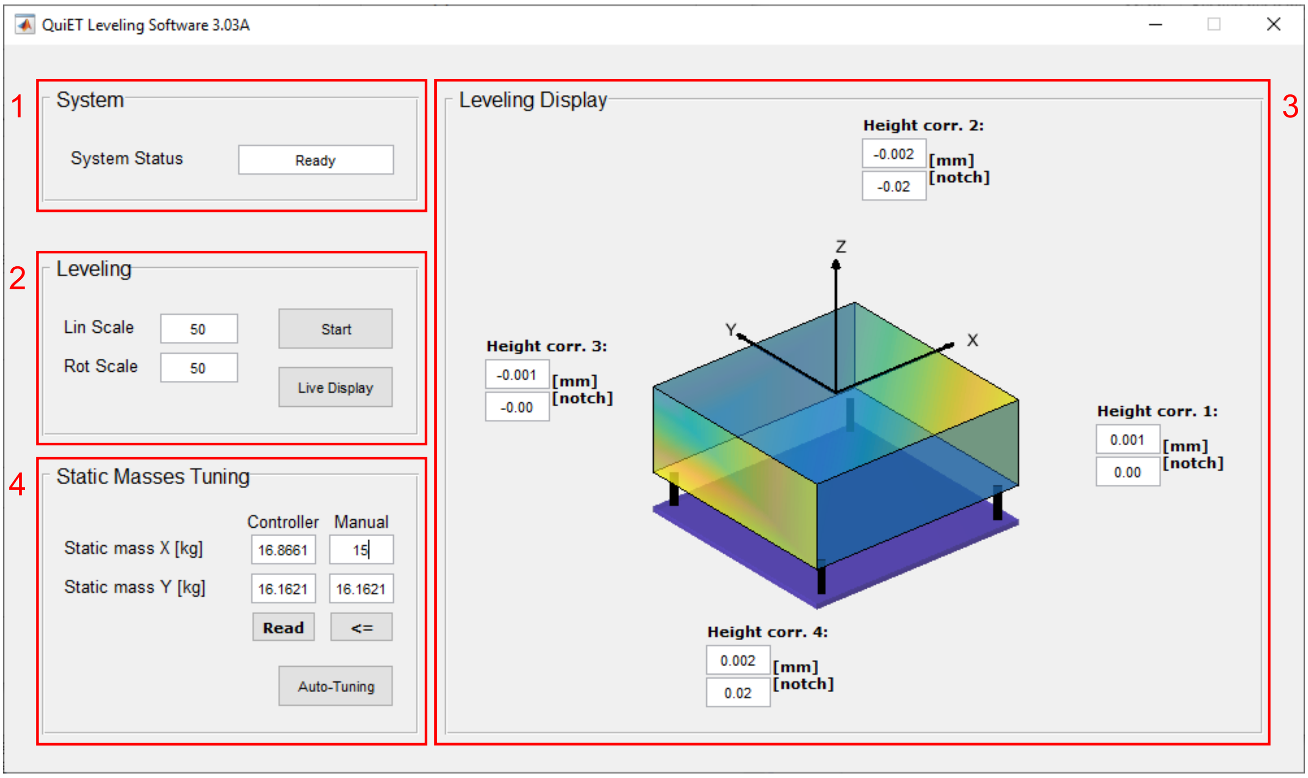
Clicking on the **Leveling** button in the **Test Applications** area opens the *Leveling* tool. This tool allows the user to adjust the leveling of the granite and set the system's X and Y static masses.

The *Leveling* tool window is divided in 4 areas:

1. **System**;
2. **Leveling**;
3. **Leveling Display**; and
4. **Static Masses Tuning**.

In the **System** area, the tool provides an indication of the status of the system (e.g. is the system ready, in error, connection not established…).

The controls in the **Leveling** and **Leveling Display** areas are required for leveling the granite. The controls in the **Static Mases Tuning** area are used for setting (and tuning) the system's X and Y static masses.



QuiET Leveling Software 3.03A

System Status: Ready

Lin Scale: 50

Rot Scale: 50

	Controller	Manual
Static mass X [kg]	16.8661	15
Static mass Y [kg]	16.1621	16.1621

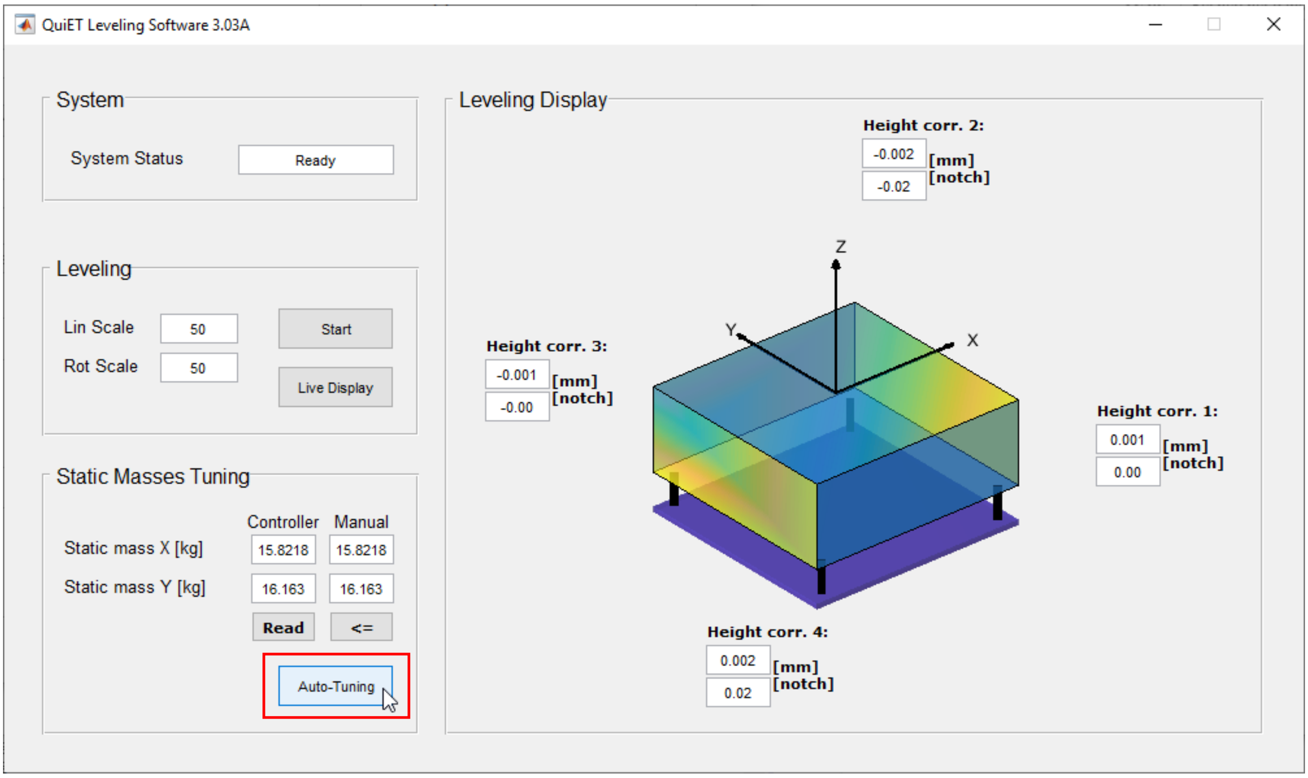
	[mm]	[notch]
Height corr. 1:	0.001	0.00
Height corr. 2:	-0.002	-0.02
Height corr. 3:	-0.001	-0.00
Height corr. 4:	0.002	0.02

The first step consists in leveling the granite according to the following procedure:

1. Make sure the brackets are in position below the feet and lock the blocking devices. This will ensure that the granite is parallel to the system's frame.
2. Click the **Start** button.
3. Once the virtual representation of the granite is displayed in the **Leveling Display** area, click on the **Live Display** button to get a live feed visualization of the granite's movements. The **Lin Scale** and **Rot Scale** edit controls allow the user to adjust the magnification factor between the movement of the "real" granite and its "virtual" representation on the tool. The goal is to make the very small movements of the granite visually perceptible to the user in the **Leveling Display**.
4. Unscrew the screws of the blocking devices and remove the brackets. The granite is free to position itself at equilibrium and the sensors will measure the leveling angle errors.
5. Check for the height corrections to apply in the **Leveling Display** area. Start with the isolator with the largest absolute error and apply the proposed number of turns at the pre-loading screw (refer to the ***QuiET*** integration manual for further information). Only adjust one isolator at a time. Once one isolator is adjusted, check on the **Leveling Display** area again for the new proposition and adjust the isolator with the largest absolute error. This operation should be executed iteratively until the required leveling (parallelism) is obtained. This value is reported in the system's specifications. If not explicitly provided, use the reference value of 20 µm for the maximum height error.

Once the leveling is completed, the user must set the parameters related to the system's X and Y static masses. The Controller's current configuration can be obtained by clicking on the **Read** button. If these need to be adjusted, the user can manually input the new parameters in the **Manual** edit controls placed to the right of the **Controller** edit controls and re-configure the Controller parameters by clicking on the **<=** button.

If X and Y static masses of the system are not known, click on the **Auto-Tuning** button to initiate an automatic procedure for determining these parameters. At any moment the user can abort the procedure by clicking on the **Stop test** button.



QuiET Leveling Software 3.03A

System

System Status: Ready

Leveling

Lin Scale: 50

Rot Scale: 50

Static Masses Tuning

	Controller	Manual
Static mass X [kg]	15.8218	15.8218
Static mass Y [kg]	16.163	16.163

Leveling Display

Height corr. 2: -0.002 [mm], -0.02 [notch]

Height corr. 3: -0.001 [mm], -0.00 [notch]

Height corr. 1: 0.001 [mm], 0.00 [notch]

Height corr. 4: 0.002 [mm], 0.02 [notch]

WARNING	The auto-tuning algorithm will execute a series of controlled movements with the system's axes. Always ensure that the proper safety precautions are taken when powering on a Controller and executing movements with a motion system.

If completed successfully, the results of the auto-tuning algorithm are written to the Controller's configuration and are displayed in the **Manual** and **Controller** edit controls.

Once all settings are completed, close the tool by clicking on the × button located on the top right corner.

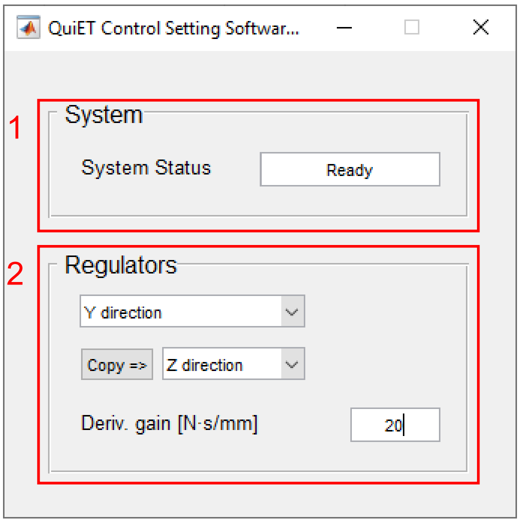
NOTE	The user must save the configuration to the Controller after using this tool. Refer to section §10.3 for more information about saving a Controller's configuration.

5.2.2. Control setting

Clicking on the **Control Setting** button in the **Test Applications** area opens the *Control Setting* tool. This tool allows the user to adjust the derivative gain of the PID regulators.

The *Control Setting* tool window is divided in 2 areas:

1. **System**; and
2. **Regulators**.



System Status: Ready

Y direction

Z direction

Deriv. gain [N·s/mm]: 20

In the **System** area, the tool provides an indication of the status of the system (e.g. is the system ready, in error, connection not established…).

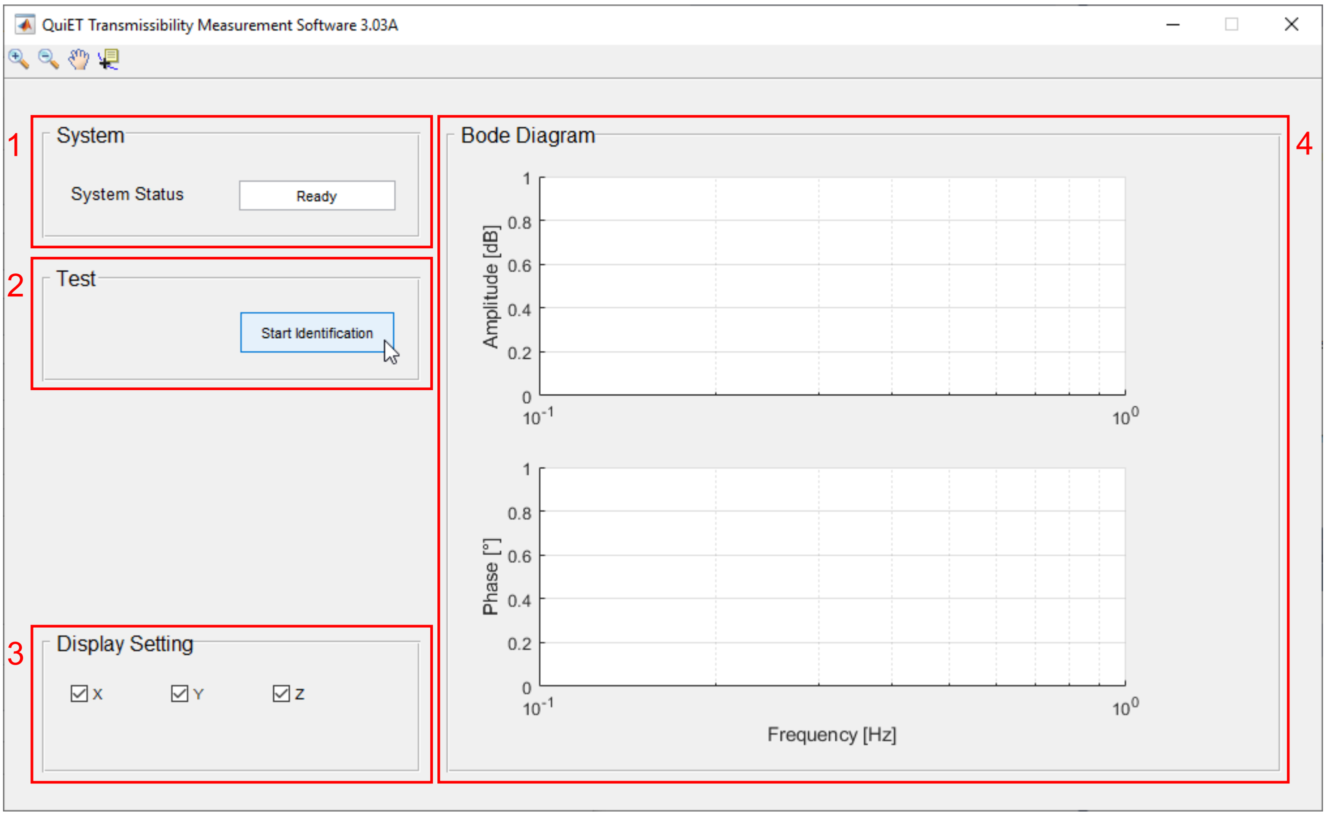
In the **Regulators** area, the user can modify the derivative gain of the PID regulator controlling the direction selected in the first drop-down list. With the **Copy =>** button the new derivative gain can also be applied to the PID regulator controlling another direction, corresponding to the selection in the second drop-down list.

5.2.3. Transmissibility

Clicking on the **Transmissibility** button in the **Test Applications** area opens the *Transmissibility Measurement* tool. This tool allows the user to realize an identification of the transmissibility of the ***QuiET*** system. The transmissibility is the ratio between the vibrations of the granite mounted on the ***QuiET*** system and the floor vibrations, being an indication of the performance its vibration isolation capability.

The *Transmissibility* tool window is divided in 4 areas:

1. **System**;
2. **Test**;
3. **Display Setting**; and
4. **Bode Diagram**.



System Status: Ready

☑ X ☑ Y ☑ Z

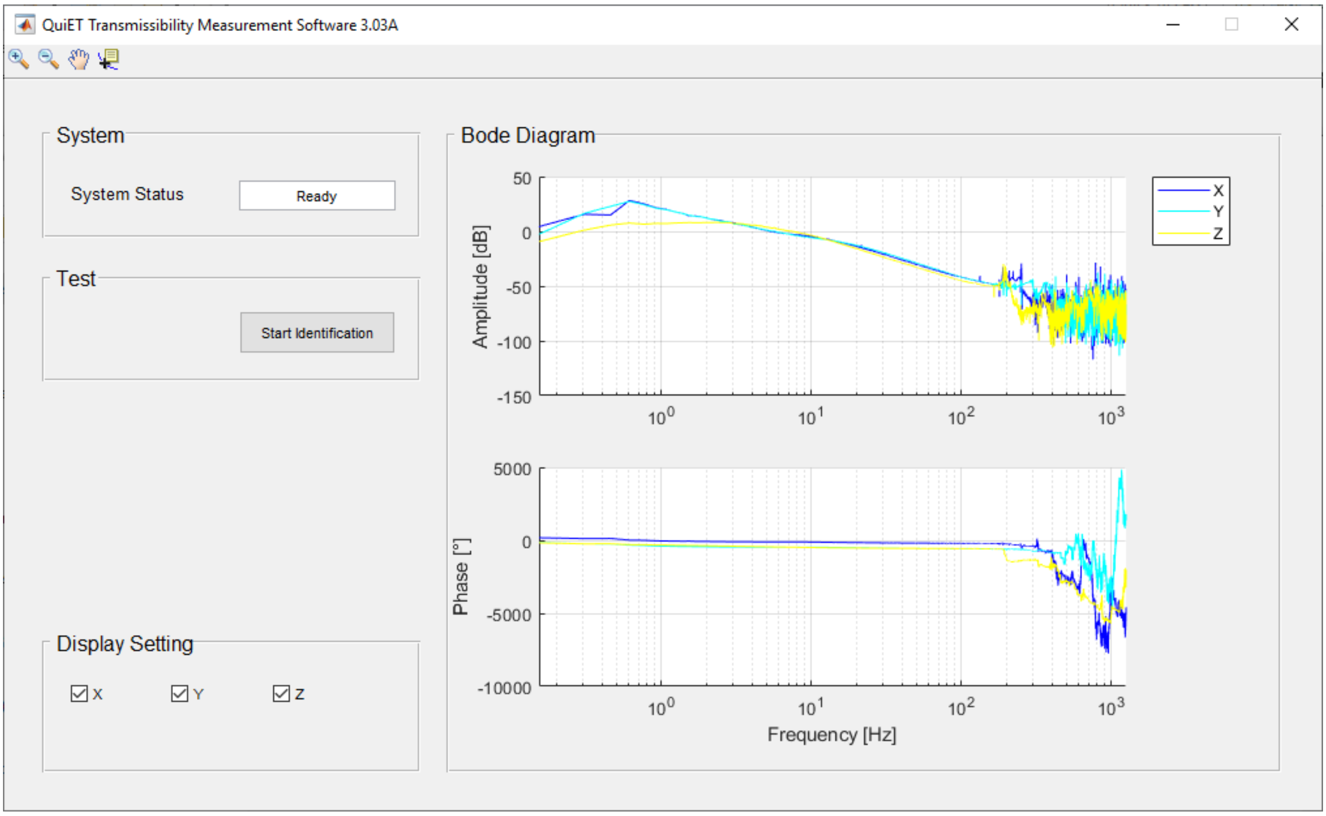
In the **System** area, the tool provides an indication of the status of the system (e.g. is the system ready, in error, connection not established…).

Click on the **Start Identification** button in the **Test** area to initiate an identification of the transmissibility transfer function. At any moment the user can abort the procedure by clicking on the **Stop Identification** button.

The transmissibility's amplitude and phase are displayed in the **Bode Diagram** area. The user can interact with the plots using the tools located at the toolbar:

🔍+	Zoom in.
🔍−	Zoom out.
✋	Pan.
⌖	Cursor.

The user can choose which transmissibility curves to display using the checkboxes in the **Display Setting** area.



5.2.4. Feedforward calibration

Clicking on the **FFwd Calibration** button in the **Test Applications** area opens the *Feedforward Tuning* tool. This tool allows the user to adjust the ***QuiET*** feedforward parameters.

The tool window is divided in 2 areas:

1. **System**; and
2. **Setting**.

In the **System** area, the tool provides an indication of the status of the system (e.g. is the system ready, in error, connection not established…).

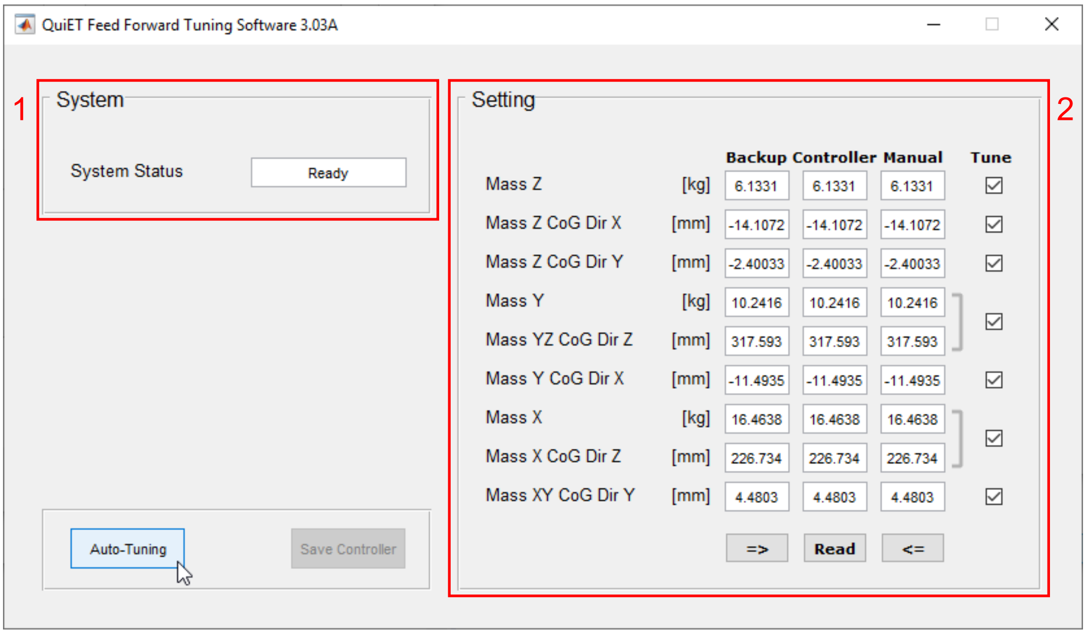
In the **Setting** area the user can find the feedforward parameters to adjust organized in three sets:

- **Backup**: set of parameters the user should keep as reference, i.e. not to be modified;
- **Controller**: set of parameters currently active in the Controller;
- **Manual**: set of parameters the user can modify.

Click on the **Read** button to upload the Controller active parameters and display them under the **Controller** column. Using the **=>** button, the user downloads the **Backup** set of parameters to the Controller. Likewise, with the **<=** button, the user downloads the **Manual** set of parameters to the Controller.

The user can initiate an automatic tuning of the feedforward parameters clicking on the **Auto-Tuning** button. At any moment the user can abort the procedure by clicking on the **Stop Test** button.

The automatic procedure will tune all the feedforward parameters the user has selected for tuning using the **Tune** checkboxes located to the right of the parameters' set. Certain parameters are tuned jointly being indicated by the **]** bracket sign located to their right:



System Status: Ready

		Backup	Controller	Manual	Tune
Mass Z	[kg]	6.1331	6.1331	6.1331	☑
Mass Z CoG Dir X	[mm]	-14.1072	-14.1072	-14.1072	☑
Mass Z CoG Dir Y	[mm]	-2.40033	-2.40033	-2.40033	☑
Mass Y	[kg]	10.2416	10.2416	10.2416	☑
Mass YZ CoG Dir Z	[mm]	317.593	317.593	317.593	
Mass Y CoG Dir X	[mm]	-11.4935	-11.4935	-11.4935	☑
Mass X	[kg]	16.4638	16.4638	16.4638	☑
Mass X CoG Dir Z	[mm]	226.734	226.734	226.734	
Mass XY CoG Dir Y	[mm]	4.4803	4.4803	4.4803	☑

WARNING

The auto-tuning algorithm will execute a series of controlled movements with the system's axes. Always ensure that the proper safety precautions are taken when powering on a Controller and executing movements with a motion system.

Finally, once the user is satisfied with the performance of the ***QuiET*** system, the Controller parameters can be saved by clicking on the button **Save Controller**.

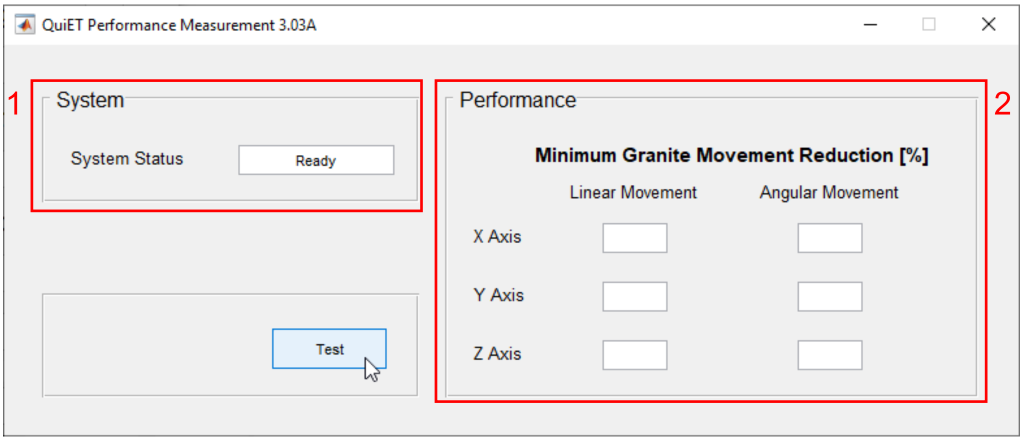
5.2.5. Performance

The last tool available in the **Test Applications** area is the *Performance Measurement* tool. Click on the **Performance** button to launch it.

This tool allows the user to verify the level of efficiency of the ***QuiET*** system in cancelling the motion system born movements. In other words, it gives an indication of the performance of its drive force cancellation capability.

The tool window is divided in 2 areas:

1. **System**; and
2. **Performance**.



System

System Status: Ready

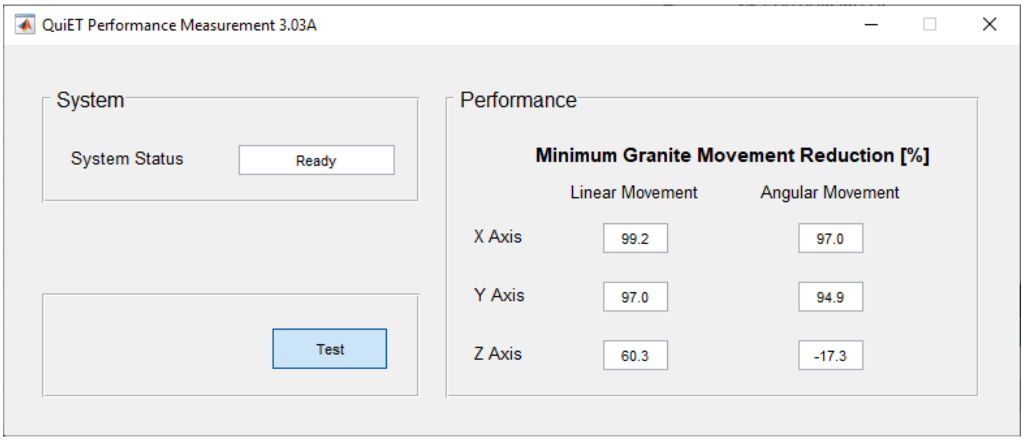
Performance

Minimum Granite Movement Reduction [%]

	Linear Movement	Angular Movement
X Axis		
Y Axis		
Z Axis		

In the **System** area, the tool provides an indication of the status of the system (e.g. is the system ready, in error, connection not established…).

Click on the **Test** button to initiate the test procedure. Once completed, the performance levels are displayed in the **Performance** area.



System

System Status: Ready

Performance

Minimum Granite Movement Reduction [%]

	Linear Movement	Angular Movement
X Axis	99.2	97.0
Y Axis	97.0	94.9
Z Axis	60.3	-17.3

WARNING	The test procedure will execute a series of controlled movements with the system's axes. Always ensure that the proper safety precautions are taken when powering on a Controller and executing movements with a motion system.

5.3. ZxT

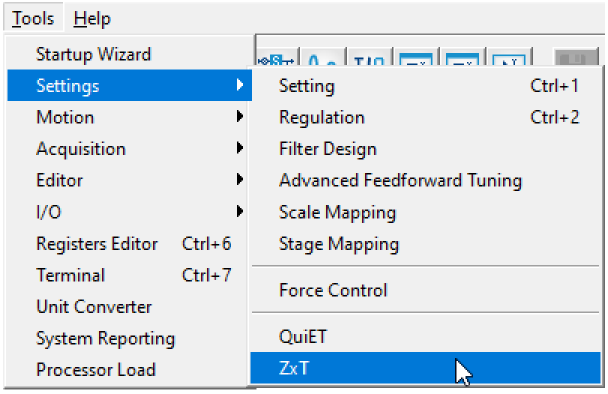
The *ZxT* tool allows the user to automatically set the encoder offsets, determine the tip/tilt limit strokes and perform a position loop identification of a module controlled by the ZxT firmware, such as the ***Z3TH*** or ***Z3TM***.

NOTE	The ZxT control mode is not supported by the ***ACCURET+*** position controllers.

The *ZxT* tool is one of ***ComET4***'s so-called external tools consisting of a MATLAB-based standalone application.

NOTE	The *ZxT* tool requires the prior installation of the MATLAB Compiler Runtime (MCR) version 2019b, which can be downloaded from: http://www.mathworks.com/products/compiler/mcr/. This tool will take several seconds to initialize while the MCR is being loaded into memory. MATLAB® is a numerical computing environment and proprietary programming language developed by The MathWorks Inc. As a standalone MATLAB-based application external to ***ComET4***, the *ZxT* tool only communicates with ZxT controllers. It is not aware of the status of any other Controllers on the communication bus, except when tuning the feedforward parameters in the **Feedforward Tuning** panel.

This tool can be launched from within ***ComET4*** by selecting the Menu option **Tools → Settings → ZxT**:

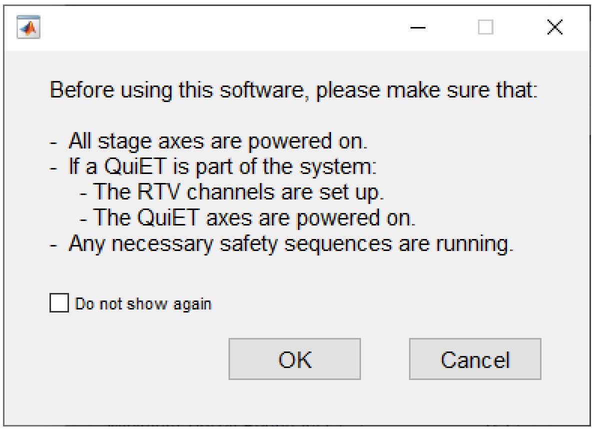


or executing the file ZxTTool.exe that can be found under:

"C:\Program Files (x86)\ETEL SA\ComET-4.xxY\external-tools\ZxTTool\".

NOTE	The *ZxT* tool can only be executed on a 64-bit Windows Operating System.

At startup, a warning message informs the user of the conditions to be fulfilled to ensure optimal and safe operation of the system. Click on the **OK** button to proceed.



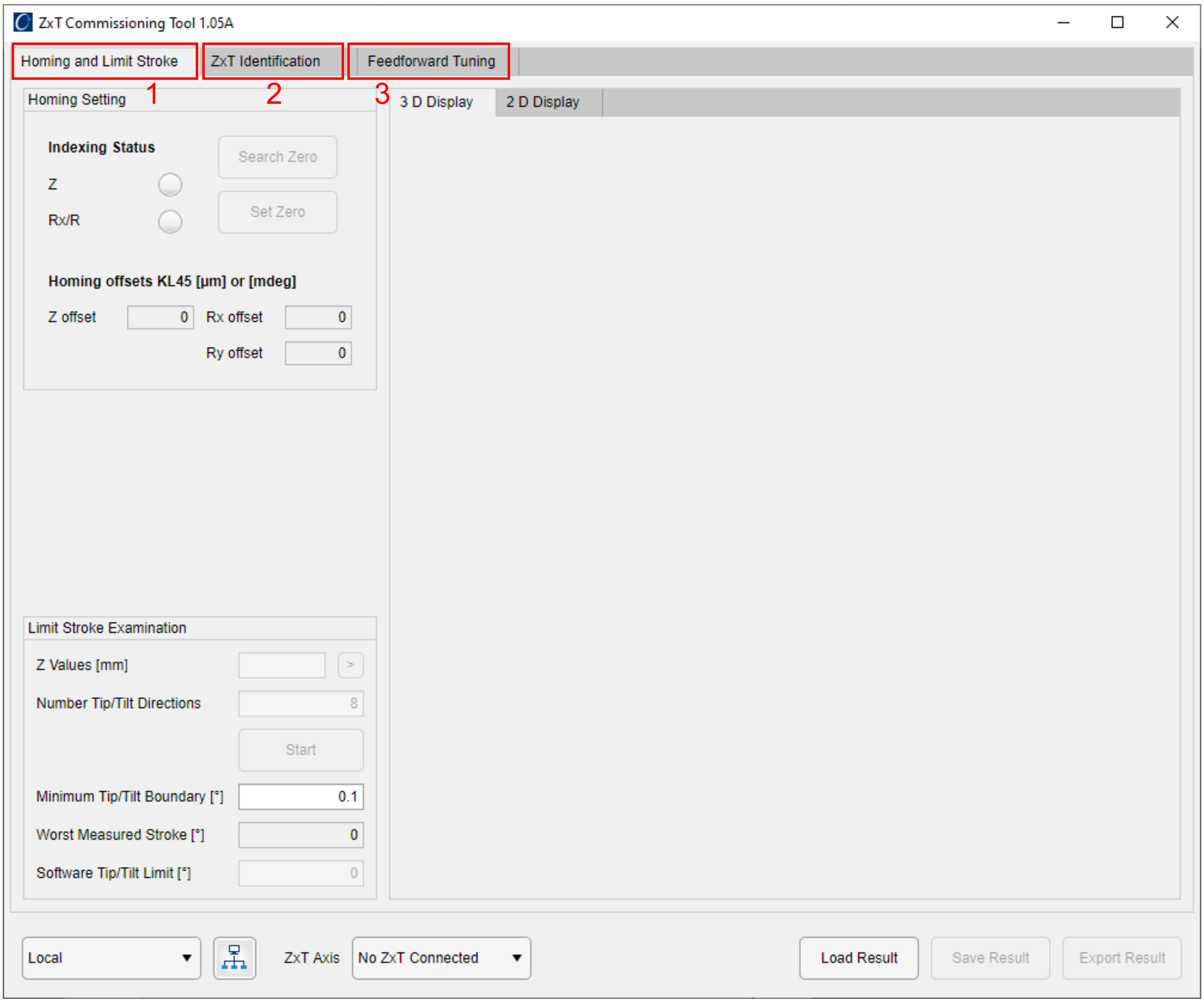
Before using this software, please make sure that:

- All stage axes are powered on.
- If a QuiET is part of the system:
  - The RTV channels are set up.
  - The QuiET axes are powered on.
- Any necessary safety sequences are running.

☐ Do not show again

The *ZxT* tool is divided in three main panels:

1. **Homing and Limit Stroke**;
2. **ZxT Identification**;
3. **Feedforward Tuning**.



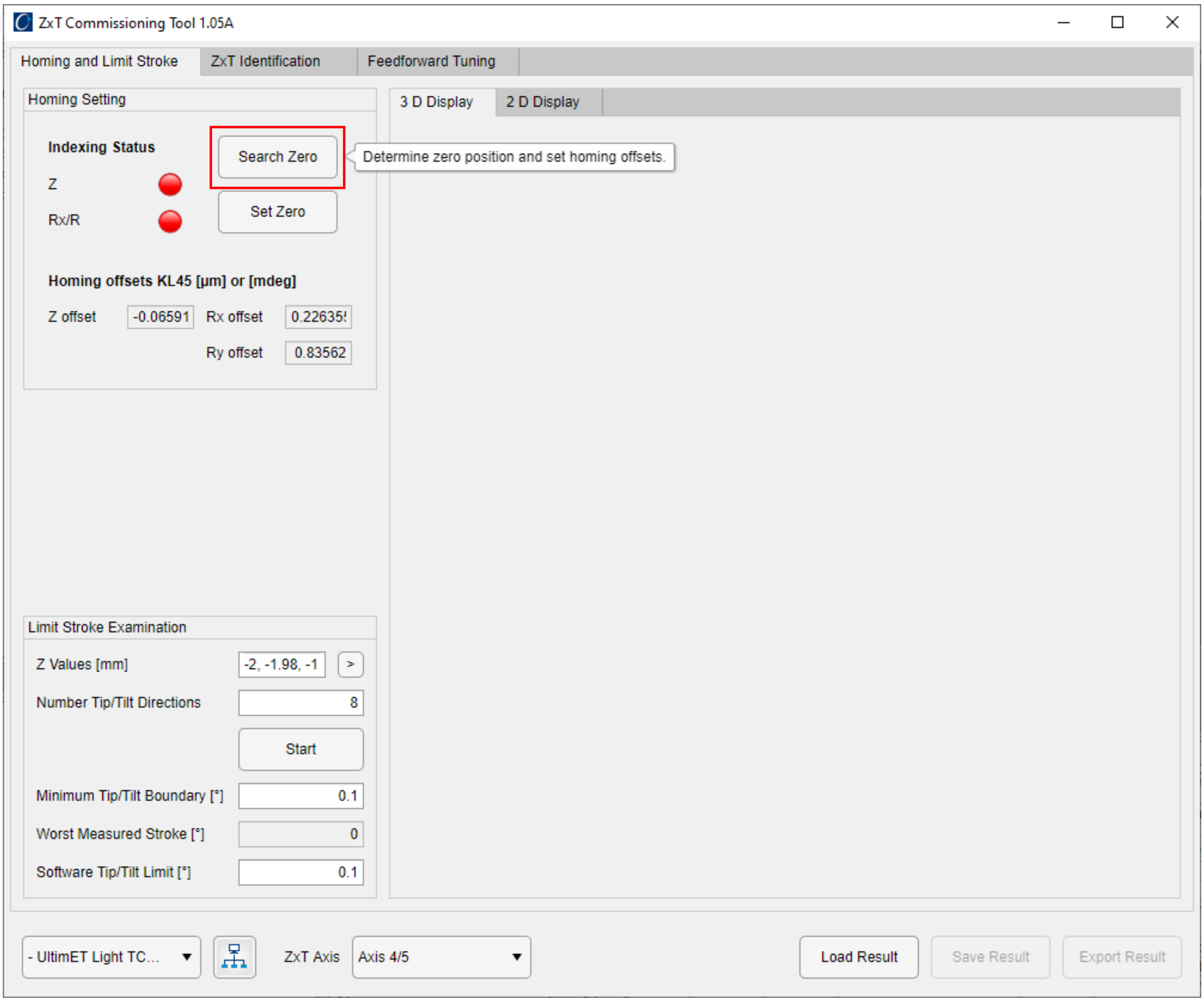
Usually, the connection with a ZxT controller is established automatically when the *ZxT* tool is executed from within ***ComET4***. The drop-down lis🖧n the lower part of the tool's window lists the different connection types available and the button allows the user to establish a connection to a TCP/IP host, just like in ***ComET4***. The Controller(s) running a ZxT firmware are automatically detected and their axis numbers are displayed in the **ZxT Axis** drop-down list.

5.3.1. Homing and Limit Stroke

In this panel the user can automatically set the encoder offsets and to determine the tip/tilt limit strokes.

5.3.1.1. Setting factory encoder offsets

When commissioning a ***ZxT*** module, the factory encoder offsets must be adjusted to set the zero position of the Z and tip/tilt axes at the center of their respective mechanical strokes. The factory encoder offsets can be determined automatically by clicking on the **Search Zero** button. The tool will then determine the zero position of the ***ZxT*** module and set the offsets accordingly.



Determine zero position and set homing offsets.

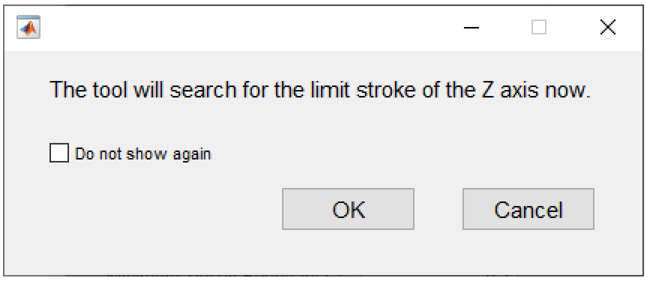
Homing offsets KL45 [µm] or [mdeg]

Z offset -0.06591
Rx offset 0.22635!
Ry offset 0.83562

Z Values [mm] -2, -1.98, -1
Number Tip/Tilt Directions 8
Minimum Tip/Tilt Boundary [°] 0.1
Worst Measured Stroke [°] 0
Software Tip/Tilt Limit [°] 0.1

- UltimET Light TC...
ZxT Axis Axis 4/5

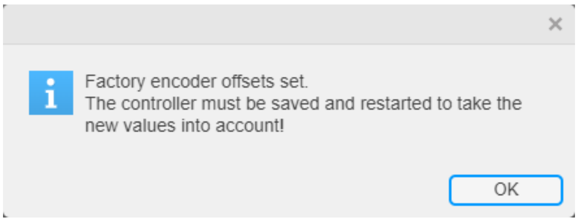
After clicking on the **Search Zero** button, the following information message pops-up. Click on the **OK** button to proceed. To prevent this message from appearing again, select the **Do not show again** checkbox.



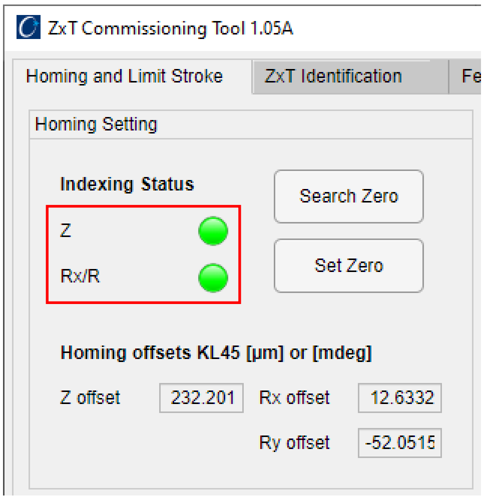
The tool will search for the limit stroke of the Z axis now.

☐ Do not show again

Once the process is completed the following dialog box is displayed and the **Indexing Status** traffic lights switch to green. The new factory encoder offsets corresponding to parameters `K480` depths 0, 1, 2 and 3 are also presented.



Factory encoder offsets set.
The controller must be saved and restarted to take the new values into account!



Z offset 232.201
Rx offset 12.6332
Ry offset -52.0515

The user must save the Controller parameters and reboot it, so that the new Controller parameters are taken into account. Refer to Section §10.3 for information on how to save a Controller's configuration. Alternatively, the user can set the factory encoder offsets such that the current Z-tip/tilt position becomes the zero position of the ***ZxT*** module by clicking on the **Set Zero** button.

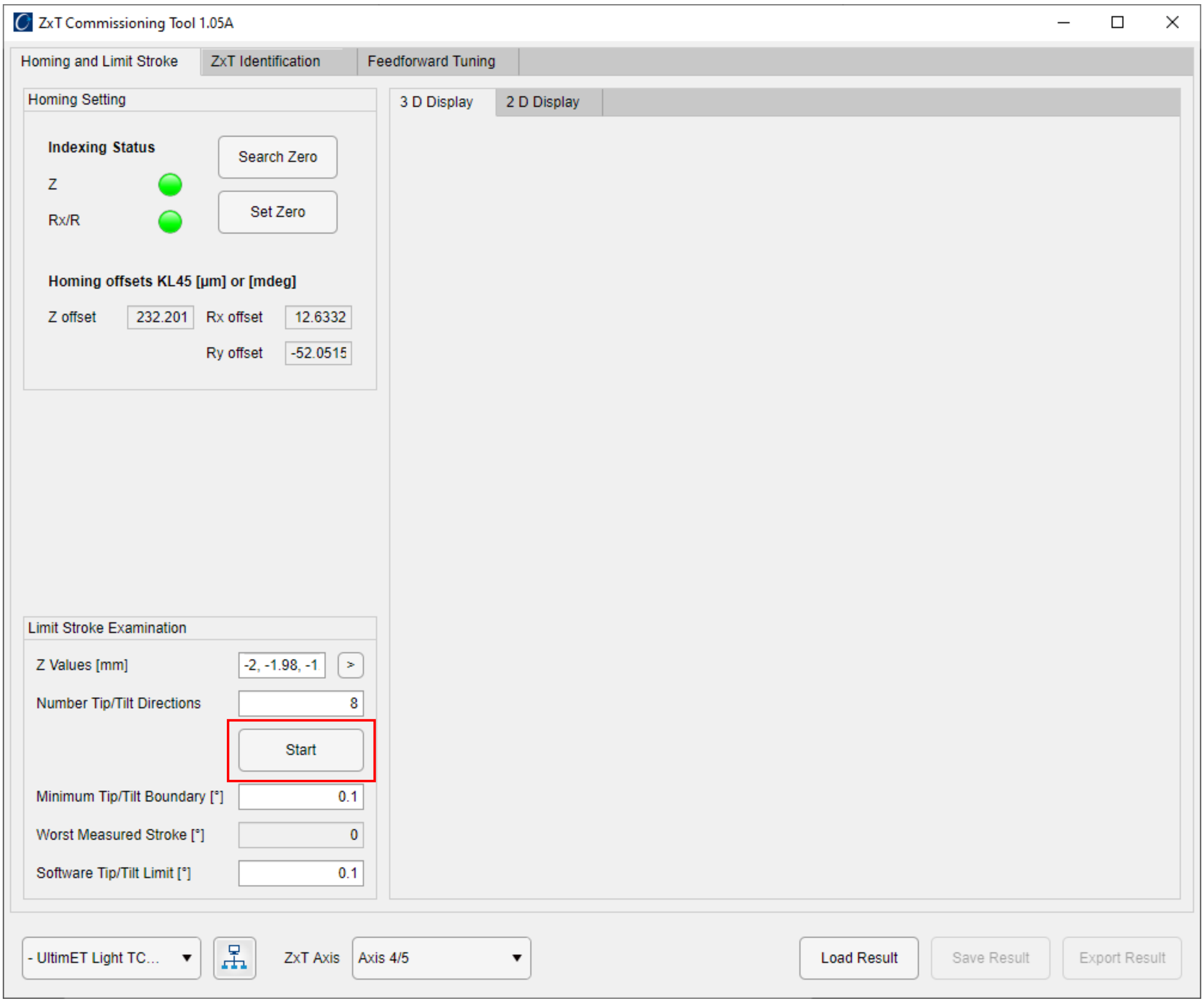
NOTE	It is highly recommended to use the **Search Zero** button to automatically find the factory encoder offsets. If the application requires the zero position of the Z axis to be located elsewhere than the center of the Z stroke, the user can use the homing offset `KL45` to adjust it (refer to the *AccurET Modular Position Controller Operation & Software Manual* for further information). Only set `KL45` after adjusting the factory encoder offsets, as modifying these also affects the zero position set by `KL45`. The **Set Zero** button should only be used when it is required to align the ***ZxT*** module's zero position with a specific hardware location. It should not be used to set the zero position close to the limits of the Z stroke instead of using `KL45`. The reason for this is that the tip/tilt strokes at the limits of the Z stroke are often not symmetrical and, consequently the center of the Z stroke might be inaccurately computed.

5.3.1.2. Limit stroke examination

The *ZxT* tool allows the user to examine the tip/tilt (Rx and Ry) strokes for different Z positions and tip/tilt directions.

Before initiating the test, define the Z positions as a list of values separated by commas in the **Z Values** edit control and define how many tip/tilt directions in the **Number Tip/Tilt Directions** edit control (e.g. 8 directions means that the tip/tilt axis will change direction by steps of 45 degrees).

To start the verification, click on the **Start** button.

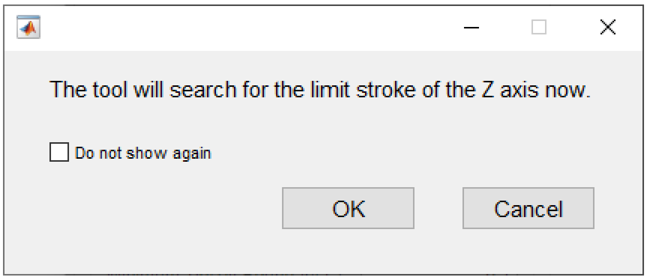


Z offset 232.201
Rx offset 12.6332
Ry offset -52.0515

Z Values [mm] -2, -1.98, -1
Number Tip/Tilt Directions 8
Minimum Tip/Tilt Boundary [°] 0.1
Worst Measured Stroke [°] 0
Software Tip/Tilt Limit [°] 0.1

- UltimET Light TC...
ZxT Axis Axis 4/5

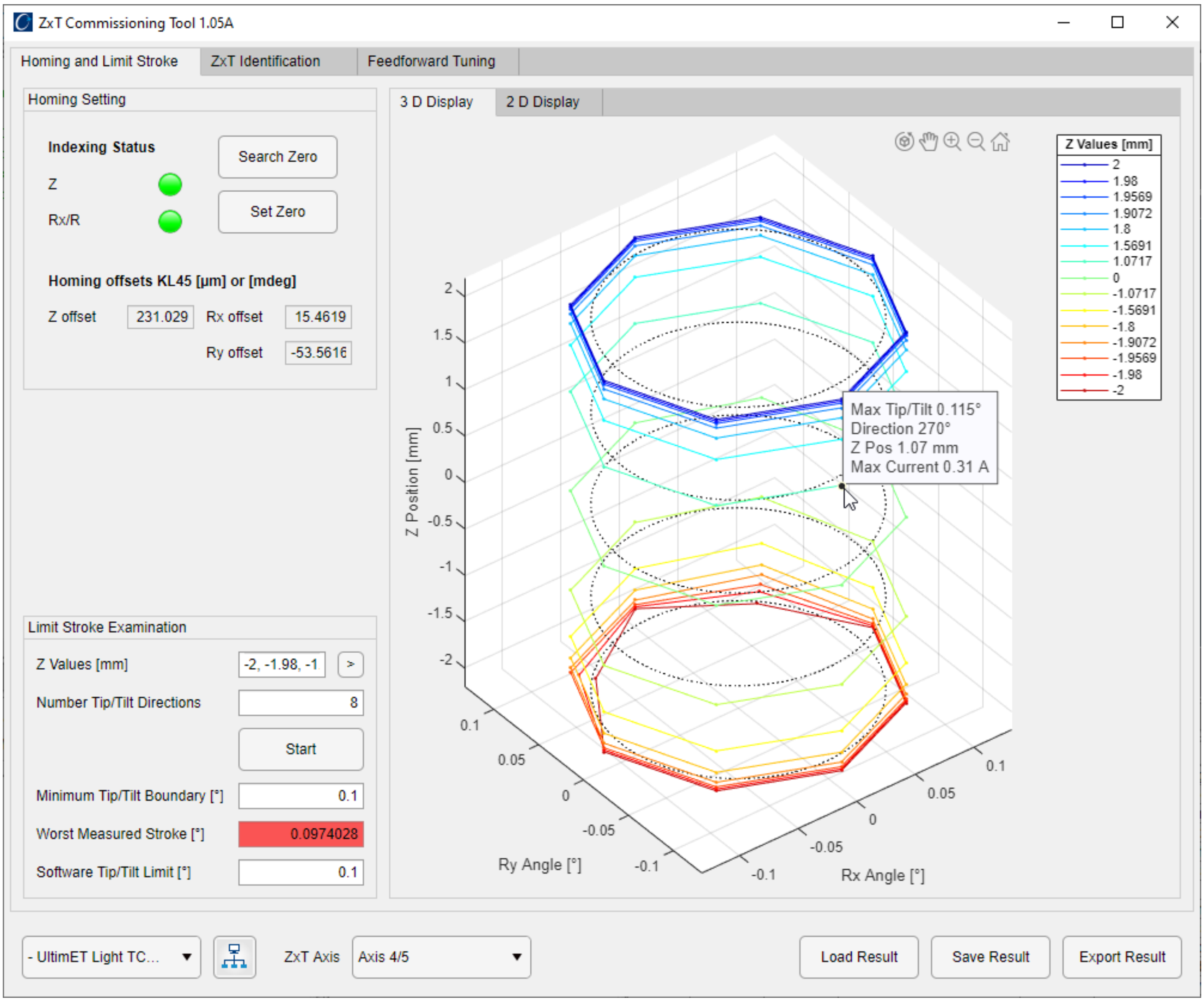
The following information message pops-up. Click on the **OK** button to proceed. To prevent this dialog box from appearing again, select the **Do not show again** checkbox.



The tool will search for the limit stroke of the Z axis now.

☐ Do not show again

Once the test verification is completed the results are displayed as 3D or 2D plots.



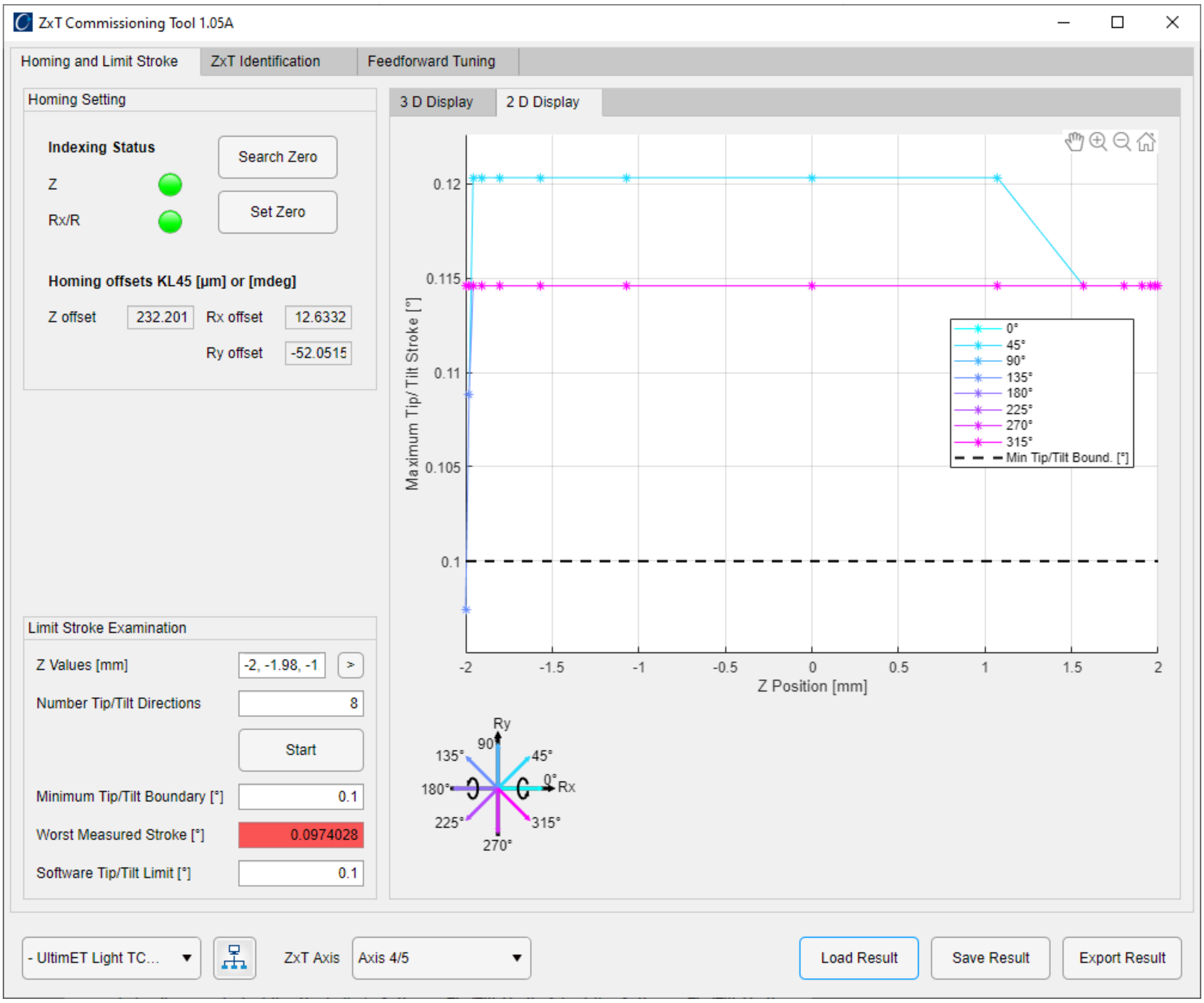
ZxT Commissioning Tool 1.05A

Z offset: 231.029
Rx offset: 15.4619
Ry offset: -53.5616

Z Values [mm]: -2, -1.98, -1
Number Tip/Tilt Directions: 8
Minimum Tip/Tilt Boundary [°]: 0.1
Worst Measured Stroke [°]: 0.0974028
Software Tip/Tilt Limit [°]: 0.1

Max Tip/Tilt 0.115°
Direction 270°
Z Pos 1.07 mm
Max Current 0.31 A

- UltimET Light TC...
ZxT Axis: Axis 4/5



Z offset 232.201
Rx offset 12.6332
Ry offset -52.0515

Z Values [mm] -2, -1.98, -1
Number Tip/Tilt Directions 8
Minimum Tip/Tilt Boundary [°] 0.1
Worst Measured Stroke [°] 0.0974028
Software Tip/Tilt Limit [°] 0.1

- UltimET Light TC...
ZxT Axis Axis 4/5

The user can interact with the plots using the tools that appear when hovering with the mouse over the plot:

⊕	Zoom in.
⊖	Zoom out.
✋	Pan.
⟳	3D rotation.
⌂	Return to original view.

The results can be saved to a file by clicking on the **Save Result** button. Alternatively, the user can load results from a previously saved test for analysis using the **Load Result** button.

The **Software Tip/Tilt Limit** (corresponding to MAXSL) set in the Controller is displayed and can be modified. The **Minimum Tip/Tilt Boundary** represented by the dotted circles displayed in the 3D plot helps the user to find the Controller's **Software Tip/Tilt Limit**. Adjust the **Software Tip/Tilt Limit** value in such a way that all maximum stroke measurements are displayed on the exterior of the dotted circles.

In the above example, the **Worst Measured Stroke** is 0.097 degrees obtained at the tip/tilt direction of 270 degrees and Z position of 1.07 mm. This value is below the **Minimum Tip/Tilt Boundary** of 0.1 degrees; in other words, this stroke is on the interior of the dotted circles. Therefore, the Controller's **Software Tip/Tilt Limit** cannot be set to 0.1 degrees, but to a value lower than the **Worst Measured Stroke**.

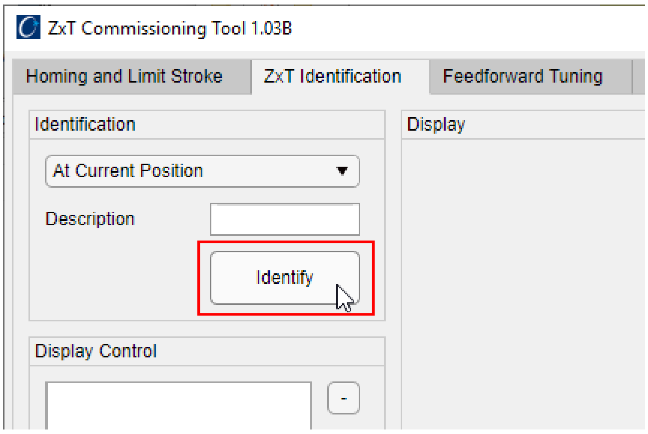
NOTE	The ZxT control loops needs to be well tuned for the algorithm to work correctly.

5.3.2. **ZxT identification**

In this panel the user can perform an identification of the position loop of a ***ZxT*** module or simulate its behavior based on identification data previously collected.

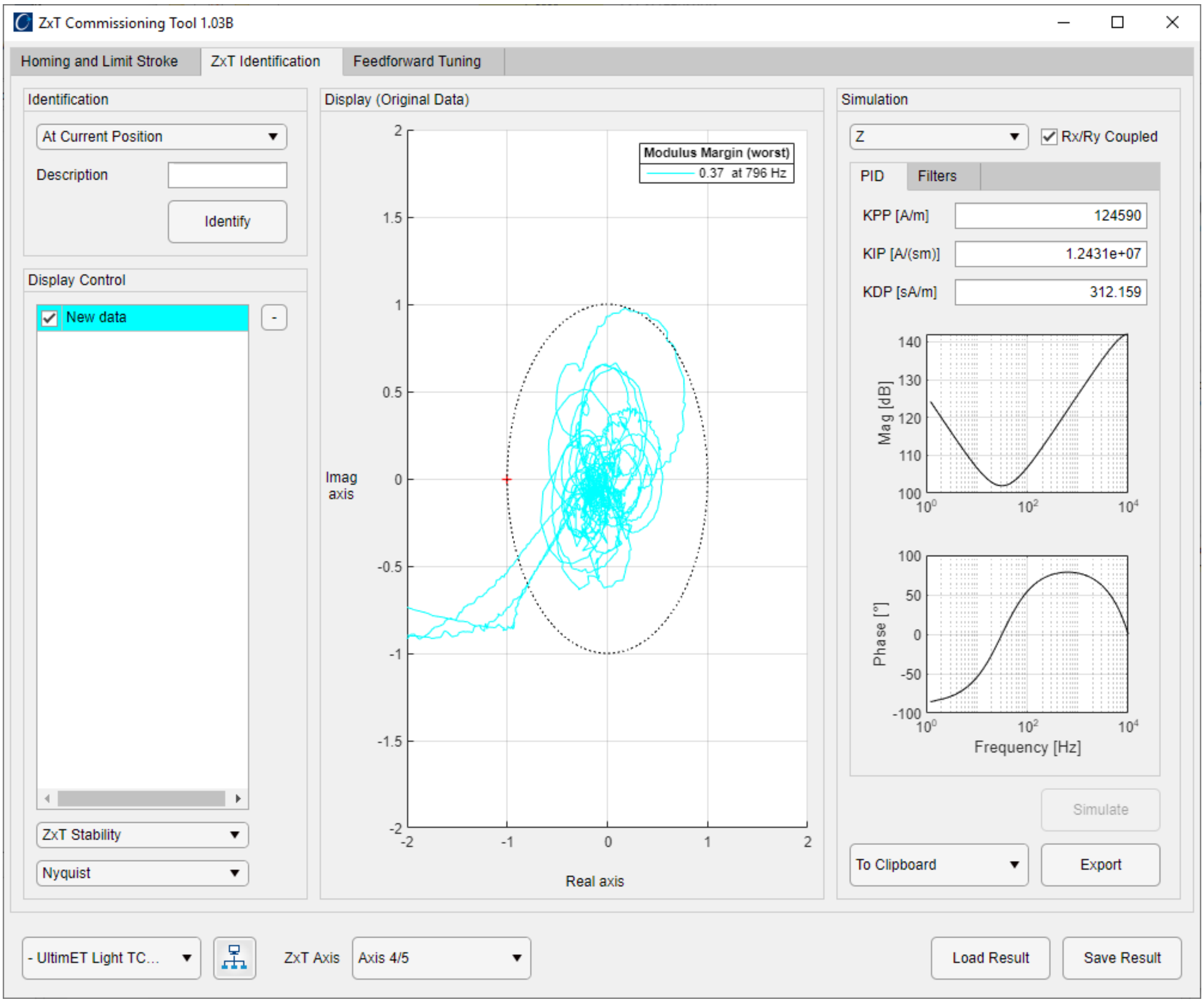
5.3.2.1. Identification

To perform an identification of the position loop at the current position click on the **Identify** button.

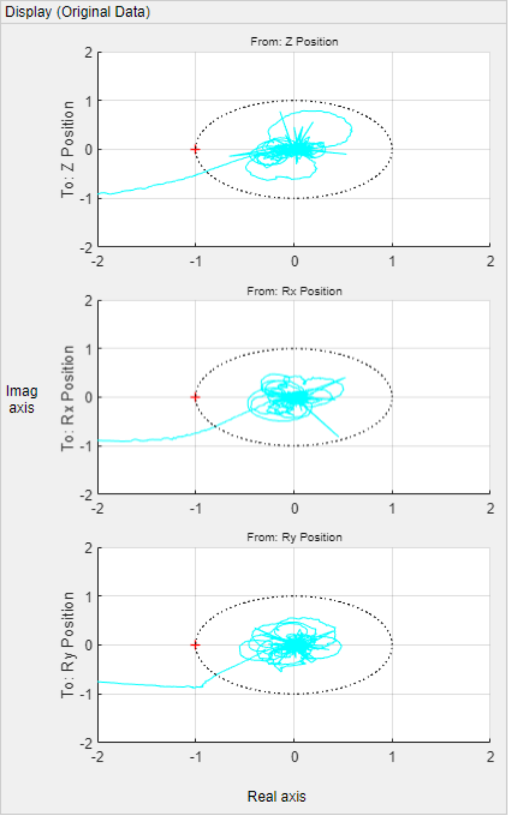


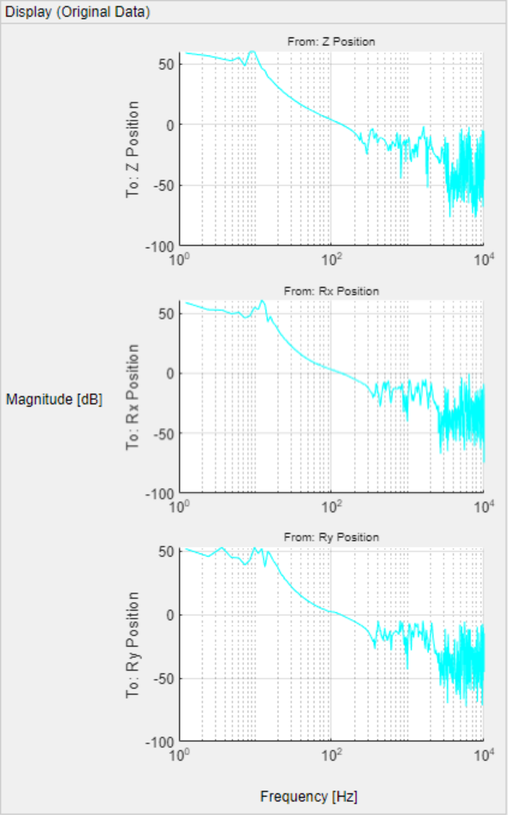
Once the identification is completed, the results are added to the data list in the **Display Control** area and displayed in the **Display** area. It is possible to display multiple identification results for comparison purposes. Just select from the data list which identification results are to be presented.

For a better understanding of the different results, a description can be added in the **Description** edit control prior to initiating the identification. Alternately, an identification result can be renamed at any time from the data list. To remove an identification result, select it from the data list and click on the ⊟ button.

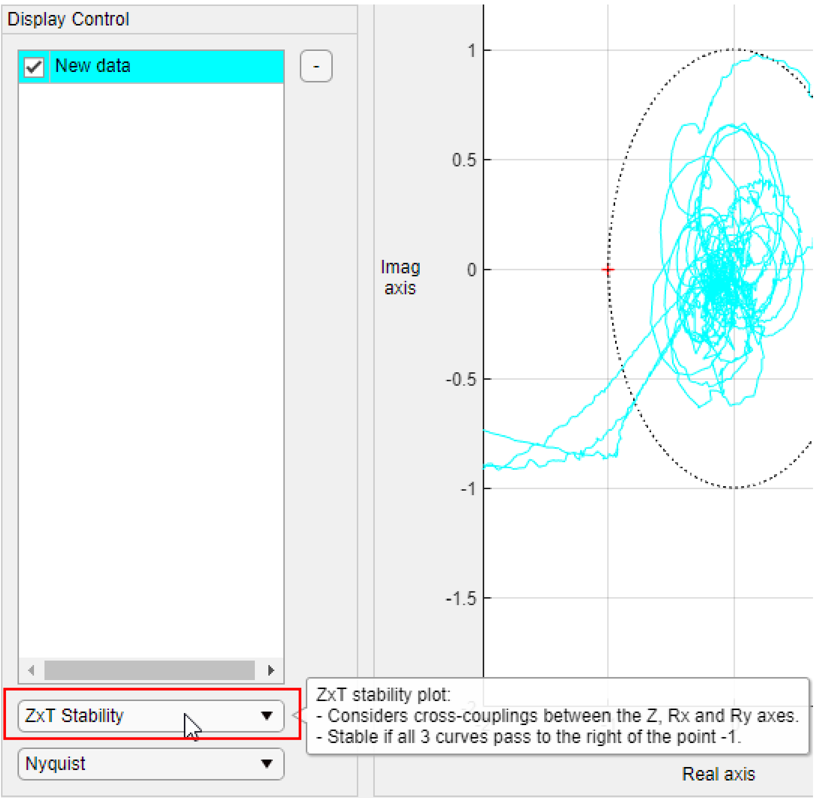


Like ***ComET4's*** *Identification* tool, different types of transfer functions and diagrams can be selected for display using the drop-down list controls located below the data list.





To determine the stability of the ***ZxT*** module’s position loop select the **ZxT Stability** option. The loop is stable if all 3 curves pass to the right of the critical point (-1; 0).



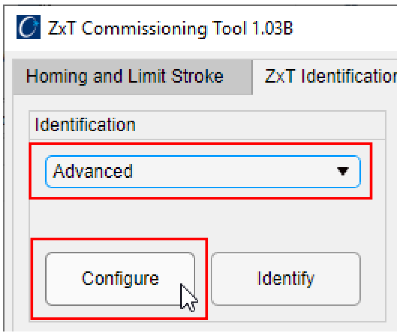
ZxT stability plot:
- Considers cross-couplings between the Z, Rx and Ry axes.
- Stable if all 3 curves pass to the right of the point -1.

The user can interact with the plots using the tools that appear when hovering with the mouse over the plot:

⊕	Zoom in.
⊖	Zoom out.
✋	Pan.
⟳	3D rotation.
⌂	Return to original view.

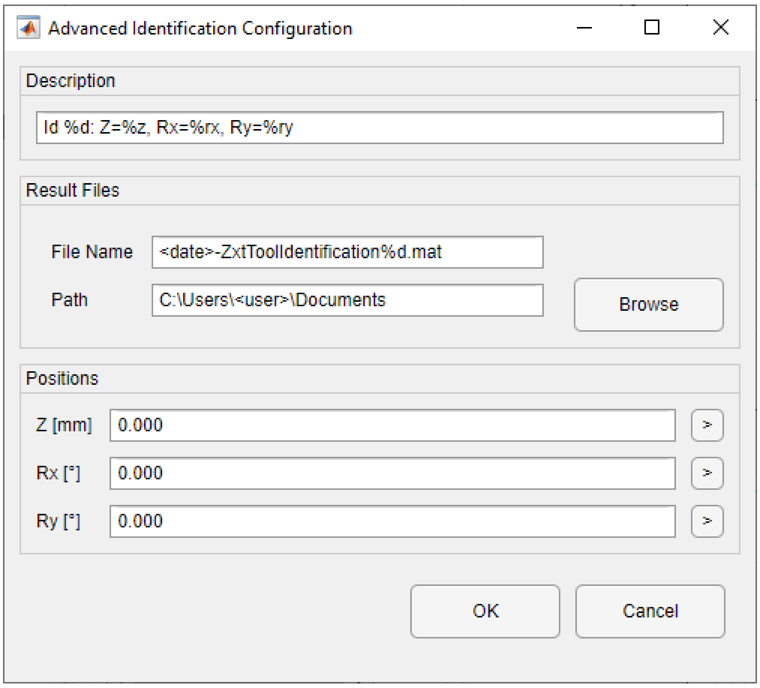
The identification results can be saved to a file by clicking on the **Save Result** button. Alternatively, the user can load results from a previously saved identification for analysis using the **Load Result** button.

It is also possible to start a series of identifications at different positions of the Z, Rx and Ry axes. For this, select the **Advanced** option in the left topmost drop-down list and click on **Configure** to input the specifications.


ZxT Commissioning Tool 1.03B

Identification: Advanced

The following dialog box will open:


Advanced Identification Configuration

Description: Id %d: Z=%z, Rx=%rx, Ry=%ry

Result Files

File Name: <date>-ZxtToolIdentification%d.mat

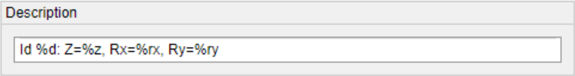
Path: C:\Users\<user>\Documents

Positions

Z [mm]: 0.000

Rx [°]: 0.000

Ry [°]: 0.000

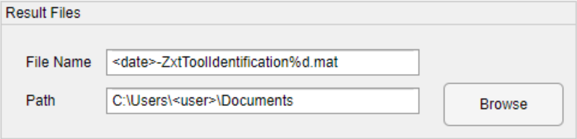


Id %d: Z=%z, Rx=%rx, Ry=%ry

A different description for each identification can be generated by using placeholders. For example, assume that two identifications have to be performed: one at Z = 0 mm and a second at Z=1 mm, and the results in the data table have to appear with the descriptions:

- Identification 1: At Z=0 mm;
- Identification 2: At Z=1 mm.

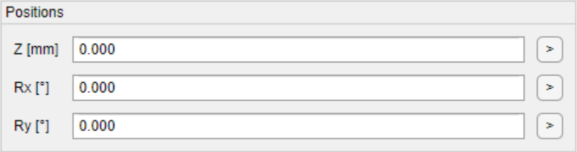
For that enter ***Identification %d: At Z=%z mm*** in the description field. The placeholder ***%d*** stands for the consecutive number of the identification. With the placeholders ***%z***, ***%rx*** and ***%ry***, you can insert the Z, Rx and Ry position into the description.



File Name <date>-ZxtToolIdentification%d.mat

Path C:\Users\<user>\Documents

To avoid saving each result manually after the identification, file names can be generated similarly to the description. The data will then be saved during identification. Click on the **Browse** button to select the path.



Z [mm] 0.000

Rx [°] 0.000

Ry [°] 0.000

There are two ways of specifying the Z, Rx or Ry positions:

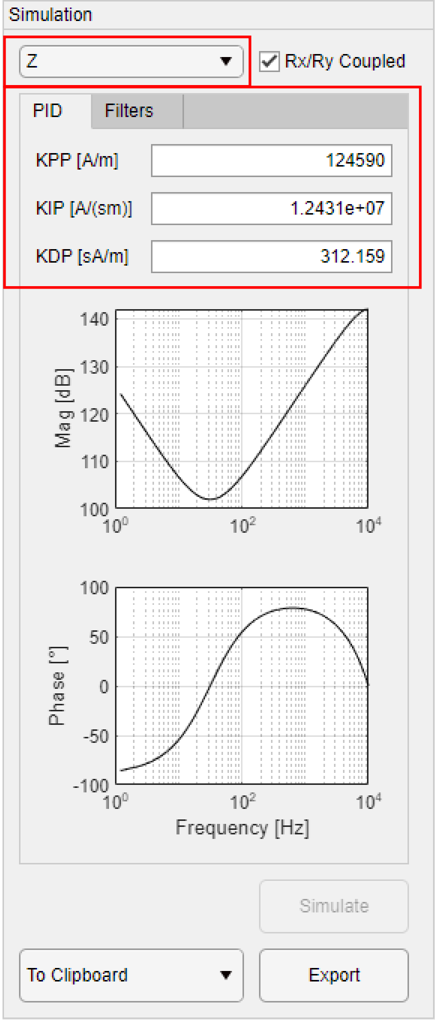
- A comma to separate the list of numbers;
- By specifying the start position, the step between positions and the final position, separated by colons. Thus, ***-0.1:0.05:0.1*** is equivalent to ***-0.1, -0.05, 0.0, 0.05, 0.1***.

The **>** buttons to the right of the position edit controls open a separate window for editing. The tool will perform an identification for each possible combination of Z, Rx and Ry positions.

5.3.2.2. Simulation

The *ZxT* tool also allows the user to simulate the behavior of the position loop based on identification data previously collected.

In the upper part of the **Simulation** area, select which axis to simulate from the drop-down list (Z, Rx or Ry) and configure the PID and filters parameters in the corresponding **PID** and **Filters** panels. The user can select if Rx and Ry should have common parameters by checking the **Rx/Ry Coupled** checkbox.

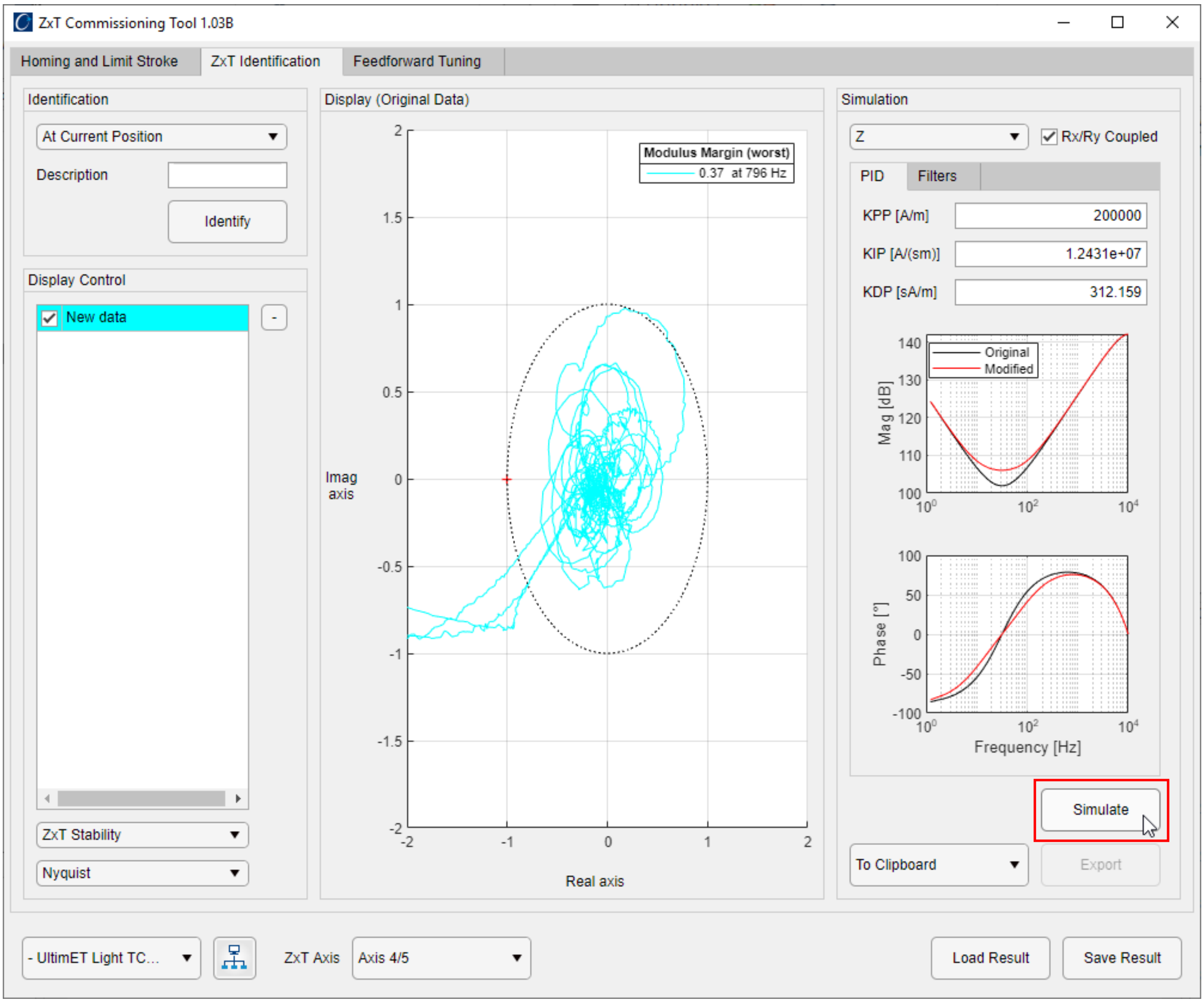


KPP [A/m] 124590

KIP [A/(sm)] 1.2431e+07

KDP [sA/m] 312.159

The Bode diagrams below then show the previous (**black** line) and modified (**red** line) transfer function for PID controller (equivalently for the filters). Upon clicking on the **Simulate** button, the diagram shown in the **Display** area is recalculated with the new parameters.



At Current Position

☑ New data

ZxT Stability

Nyquist

Z

☑ Rx/Ry Coupled

KPP [A/m] 200000

KIP [A/(sm)] 1.2431e+07

KDP [sA/m] 312.159

To Clipboard

ZxT Axis: Axis 4/5

The simulated Controller settings can be copied to the **Clipboard** in a format that can be directly pasted into ***ComET4***'s *Terminal* tool for configuring the Controller. Alternatively, if a connection is established, click on the **Export** button to download the configuration directly to the ***AccurET*** controller.

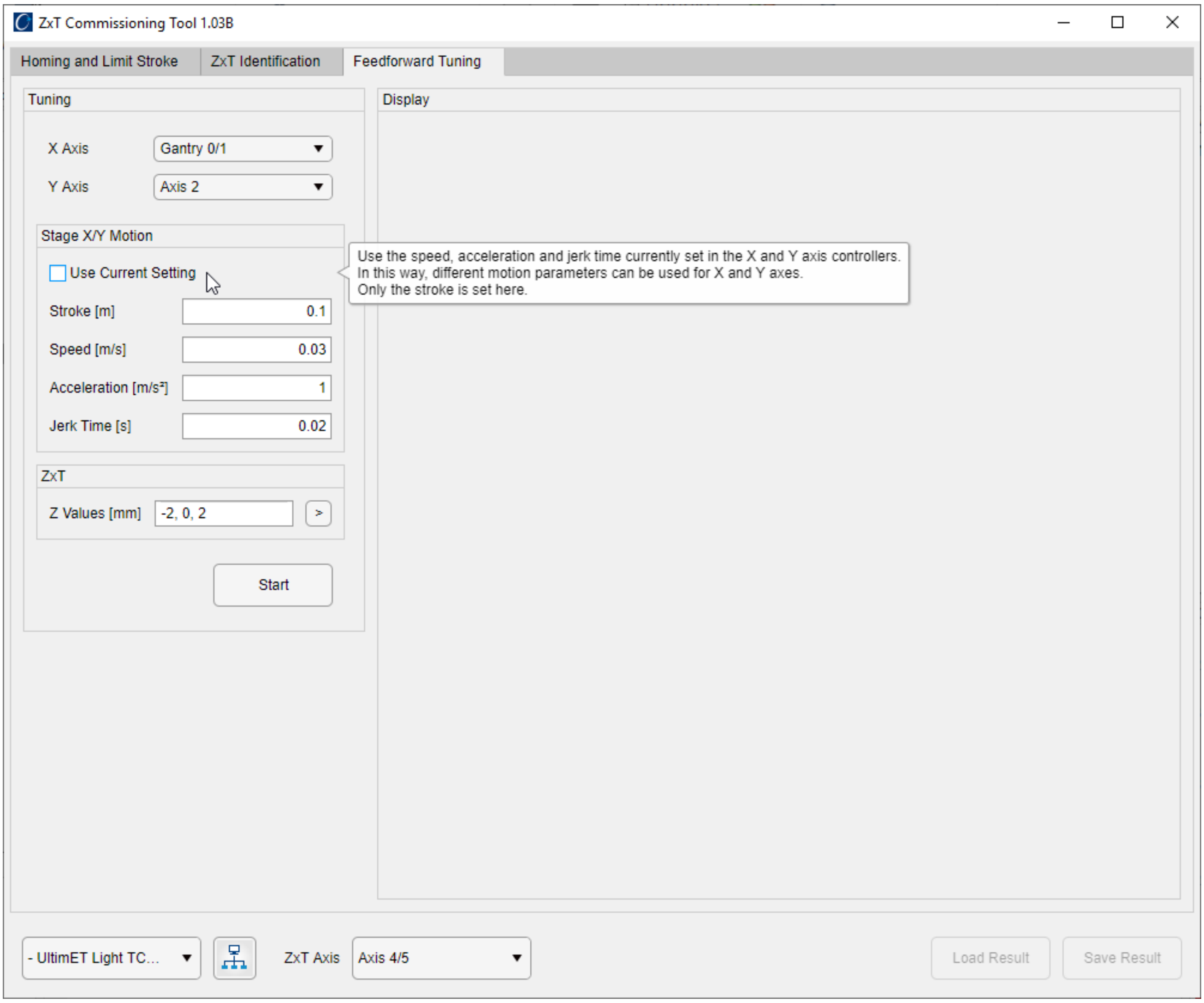
The user must save the Controller parameters and reboot it, so that the new Controller parameters are taken into account. Refer to Section §10.3 for information on how to save a Controller's configuration.

NOTE	A simulation result cannot be saved. Clicking on the **Save Result** button will only save the original identification data without the controller modifications.

5.3.3. Feedforward tuning

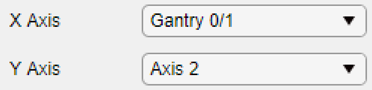
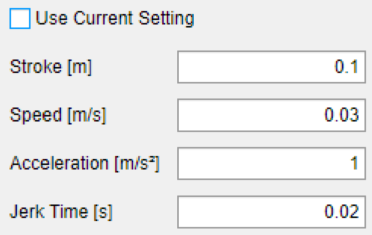
In this panel the user can tune the feedforward parameters to compensate for the effects of the X and Y movements of the motion system on top of which is mounted the ***ZxT*** module.

The user sets the tuning conditions in the **Tuning** area.

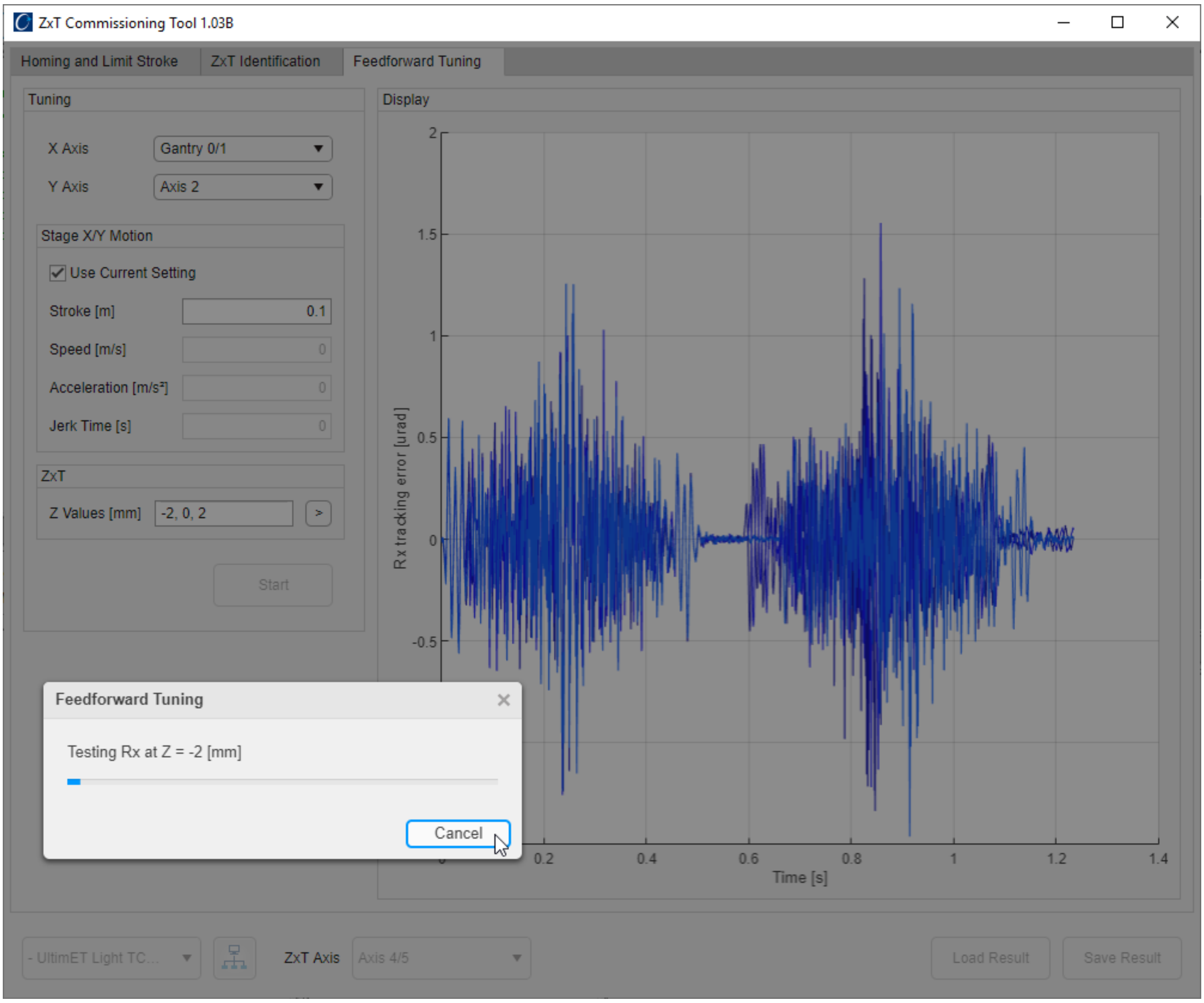


X Axis: Gantry 0/1
Y Axis: Axis 2
☐ Use Current Setting
Stroke [m]: 0.1
Speed [m/s]: 0.03
Acceleration [m/s²]: 1
Jerk Time [s]: 0.02
Z Values [mm]: -2, 0, 2
- UltimET Light TC…
ZxT Axis: Axis 4/5

Use the speed, acceleration and jerk time currently set in the X and Y axis controllers.
In this way, different motion parameters can be used for X and Y axes.
Only the stroke is set here.

 X Axis: Gantry 0/1 Y Axis: Axis 2	Select which Controllers are driving the X and Y axes.
 ☐ Use Current Setting Stroke [m]: 0.1 Speed [m/s]: 0.03 Acceleration [m/s²]: 1 Jerk Time [s]: 0.02	Configure the X and Y axes motion profiles. The stroke for the tuning motion is common for X and Y axes and is measured with respect to the current axes' position. Uncheck the **Use Current Setting** checkbox to set a common speed, acceleration and jerk time for both X and Y axes. Alternatively, check this checkbox if different speed, acceleration and jerks settings are required (use the axis' current settings).
 Z Values [mm]: -2, 0, 2	As the feedforward compensation is Z position dependent, specify different Z positions. There are two ways of specifying the Z positions: - A comma to separate the list of numbers; - By specifying the start position, the step between positions and the final position, separated by colons. Thus, **-0.1:0.05:0.1** is equivalent to **-0.1, -0.05, 0.0, 0.05, 0.1**. The **>** button to the right of the **Z Values** edit control open a separate window for editing.

Click on the **Start** button to initiate the tuning of the feedforward parameters. During the tuning, the **Display** area shows the tracking error of the axis which is currently being tuned (Rx or Ry), adding new colored curves for every iteration.



ZxT Commissioning Tool 1.03B

Tuning

X Axis: Gantry 0/1

Y Axis: Axis 2

Stage X/Y Motion

☑ Use Current Setting

Stroke [m]: 0.1

Speed [m/s]: 0

Acceleration [m/s²]: 0

Jerk Time [s]: 0

ZxT

Z Values [mm]: -2, 0, 2

Feedforward Tuning

Testing Rx at Z = -2 [mm]

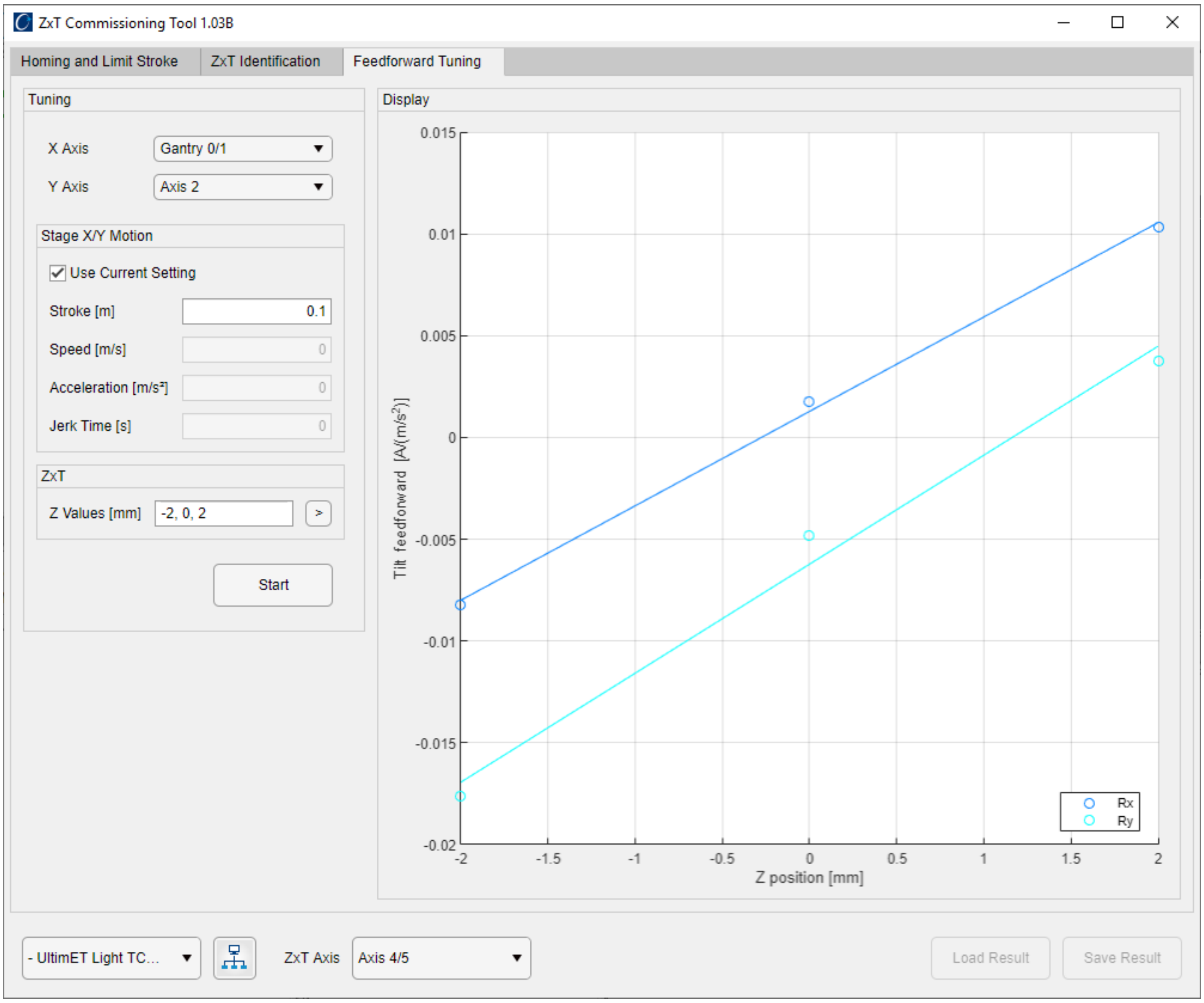
ZxT Axis: Axis 4/5

The user can abort at any time the tuning procedure by clicking on the **Cancel** button.

When the tuning is finished, the resulting feedforward values are displayed for each Z position, with the corresponding best-fit line. Based on this fit, the calculated mass and offset for Rx and Ry axes (respectively registers `CF490` and `KL250` in depths 0 and 1) are downloaded to the Controller.

The user must save the Controller parameters and reboot it, so that the new Controller parameters are taken into account. Refer to Section §10.3 for information on how to save a Controller's configuration.

NOTE	The results of the feedforward tuning cannot be saved.



X Axis: Gantry 0/1

Y Axis: Axis 2

☑ Use Current Setting

Stroke [m]: 0.1

Speed [m/s]: 0

Acceleration [m/s²]: 0

Jerk Time [s]: 0

Z Values [mm]: -2, 0, 2

- UltimET Light TC...

ZxT Axis: Axis 4/5

5.3.4. Stage Mapping

To enable the stage mapping on the Rx and Ry axes, use the *Stage Mapping* tool (refer to Section §4.2.6) as follows:

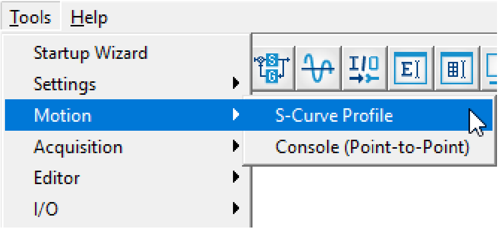
- Select the Rx axis by setting `K495 = 0` using the *Terminal*;
- Define the mapped and source axes under the **Configuration** panel.
- Define and fill the mapping correction table for the Rx axis under the **Corrections** panel;
- Click on the **Download to Controllers** button;
- Save the configuration to the Controller;
- Click on the **Activate Mapping** button;
- Switch to the Ry axis by setting `K495 = 1` using the *Terminal*;
- Define and fill the mapping correction table for the Ry axis under the **Corrections** panel;
- Click on the **Download to Controllers** button;
- Save the configuration to the Controller;
- Click on the **Activate Mapping** button.

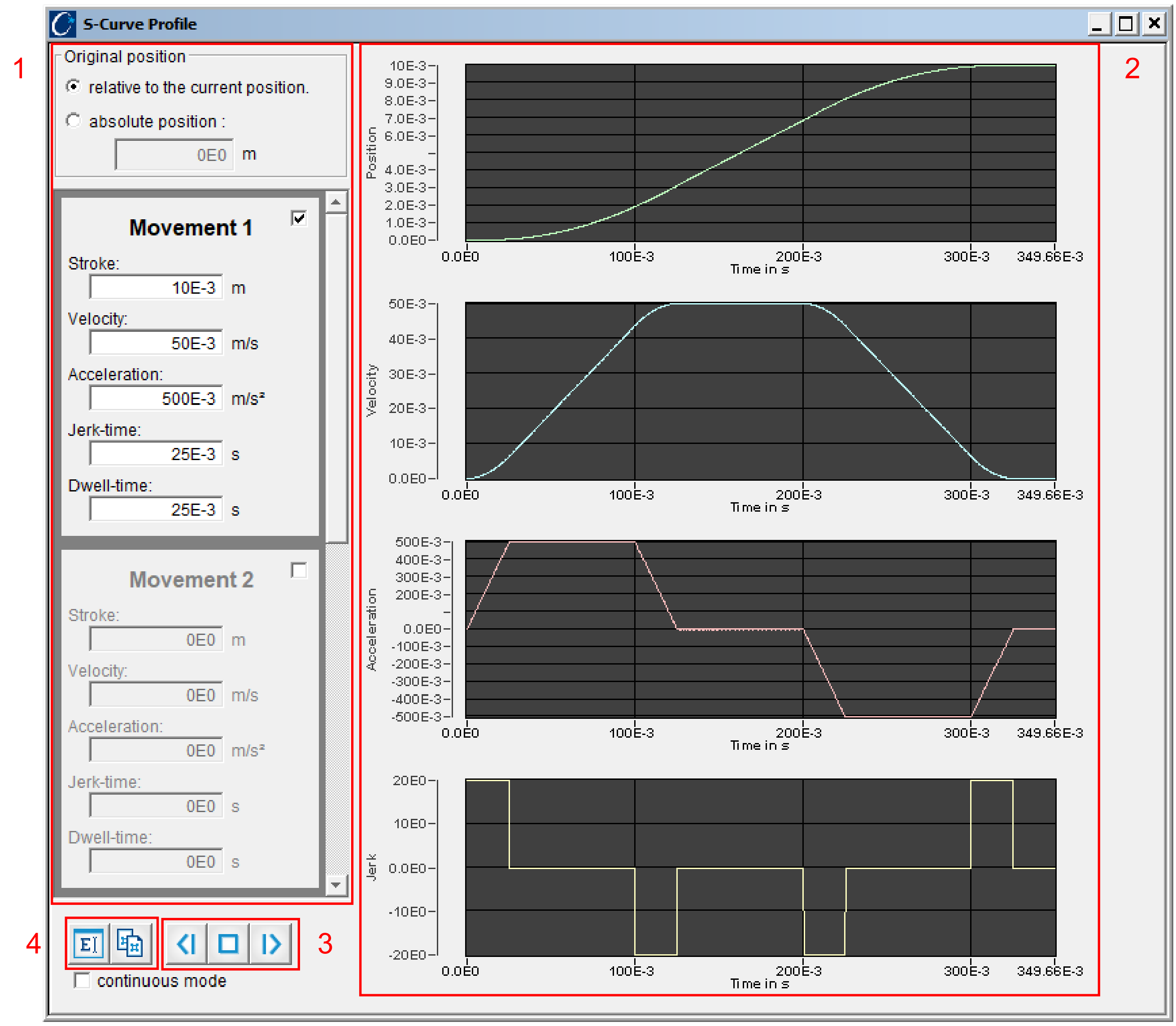
6. Motion

6.1. S-curve profile

The *S-Curve Profile* tool allows the user to easily define motion profiles and generate the corresponding Sequence C-like code to be executed by a Controller.

This tool can be launched by selecting the Menu option **Tools → Motion → S-Curve Profile**:





Original position
● relative to the current position.
○ absolute position : 0E0 m

Movement 1 ☑
Stroke: 10E-3 m
Velocity: 50E-3 m/s
Acceleration: 500E-3 m/s²
Jerk-time: 25E-3 s
Dwell-time: 25E-3 s

Movement 2 ☐
Stroke: 0E0 m
Velocity: 0E0 m/s
Acceleration: 0E0 m/s²
Jerk-time: 0E0 s
Dwell-time: 0E0 s

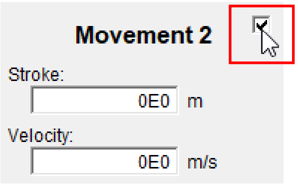
☐ continuous mode

NOTE	The *S-Curve Profile* tool only allows to define motion profiles of a single axis (i.e. in a single dimension).

The *S-Curve Profile* tool window is divided into 4 areas:

1. Definition of the motion profile(s);
2. Visualization of the motion profile(s);
3. Motion testing;
4. Sequence code generation.

In the first area, the user defines the specifications of the motion profile(s) to be executed. Up to four profiles can be defined and concatenated. By default only **Movement 1** is enabled, but the remaining movements can be enabled by clicking on the check box control on the top right side.

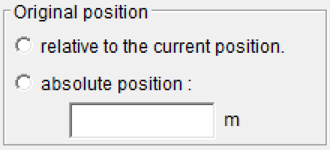
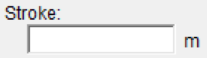
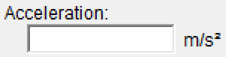
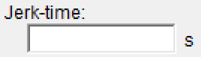
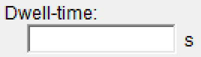


Movement 2 ☑

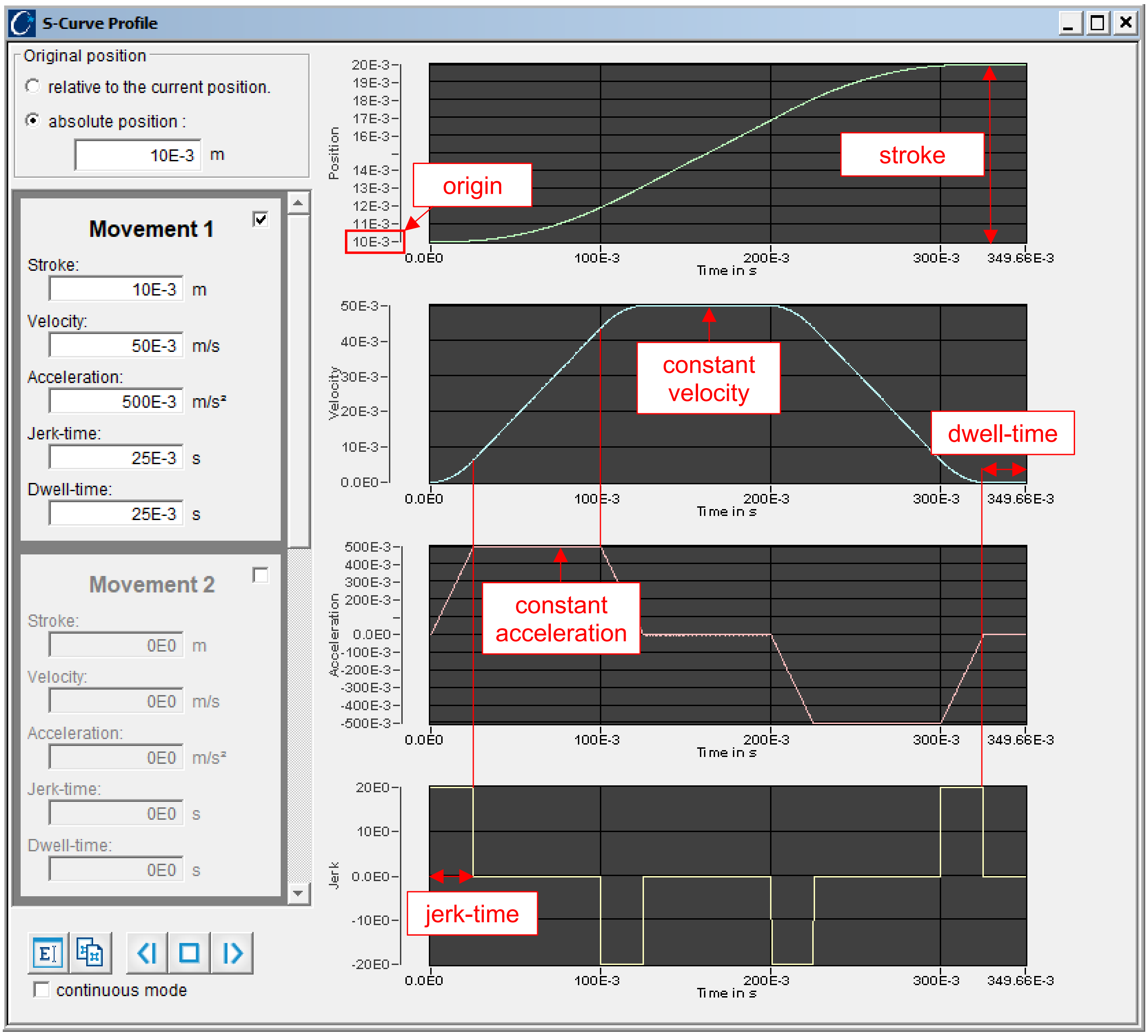
Stroke: 0E0 m

Velocity: 0E0 m/s

Here is what the user must set to configure the motion profile:

Definition of the motion profile(s)	
 Original position ○ relative to the current position. ○ absolute position : m	Starting position. It can be relative to the current position of the axis, i.e. the current position is the starting point. Or, it can be relative to some position the user defines in the corresponding edit box control.
 Stroke: m	Stroke corresponds to the relative distance to be travelled for this motion profile.
 Velocity: m/s	Velocity. Depending on the profile definition, this value might not actually be reached during the movement.
 Acceleration: m/s²	Acceleration. The same value is applied for the deceleration phase. Depending on the profile definition, this value might not actually be reached during the movement.
 Jerk-time: s	Jerk, expressed in time (seconds). Depending on the profile definition, this value might not actually be reached during the movement.
 Dwell-time: s	Dwell-time is the duration of the static motion at the end of the profile before the next one initiates.

In the second area, the user can visualize the evolution over time of the motion profiles specifications that were defined. Here is what these specifications represent on these plots.



S-Curve Profile

Original position

○ relative to the current position.

● absolute position : 10E-3 m

Movement 1 ☑

Stroke: 10E-3 m

Velocity: 50E-3 m/s

Acceleration: 500E-3 m/s²

Jerk-time: 25E-3 s

Dwell-time: 25E-3 s

Movement 2 ☐

Stroke: 0E0 m

Velocity: 0E0 m/s

Acceleration: 0E0 m/s²

Jerk-time: 0E0 s

Dwell-time: 0E0 s

☐ continuous mode

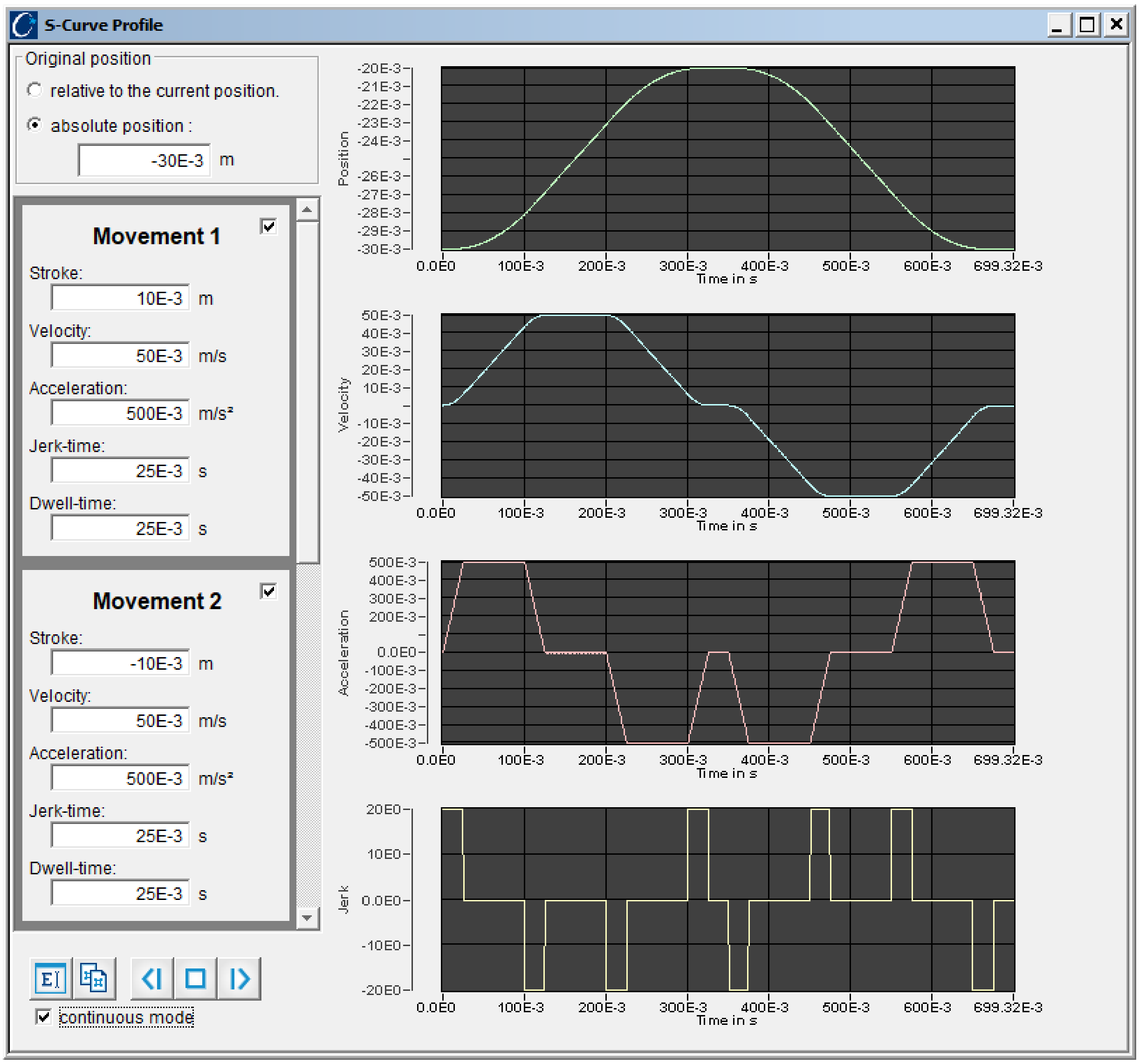
Once the motion has been defined, the user can verify its execution using the following buttons:

◁	Execute the motion profile of the axis in the backward direction.
□	Stop the execution of the motion profile.
▷	Execute the motion profile of the axis in a forward direction.
☐ continuous mode	Repeat continuously the motion profile.

NOTE	Ensure that the axis is powered on before making a movement.

WARNING	Always ensure that the proper safety precautions are taken when powering on a Controller and executing movements with a motion system.

Take the example of the following motion profile composed of two movements defined to travel in one direction and inverse direction to bring back the axis to the starting point.


S-Curve Profile

Original position

○ relative to the current position.

● absolute position : -30E-3 m

Movement 1 ☑

Stroke: 10E-3 m

Velocity: 50E-3 m/s

Acceleration: 500E-3 m/s²

Jerk-time: 25E-3 s

Dwell-time: 25E-3 s

Movement 2 ☑

Stroke: -10E-3 m

Velocity: 50E-3 m/s

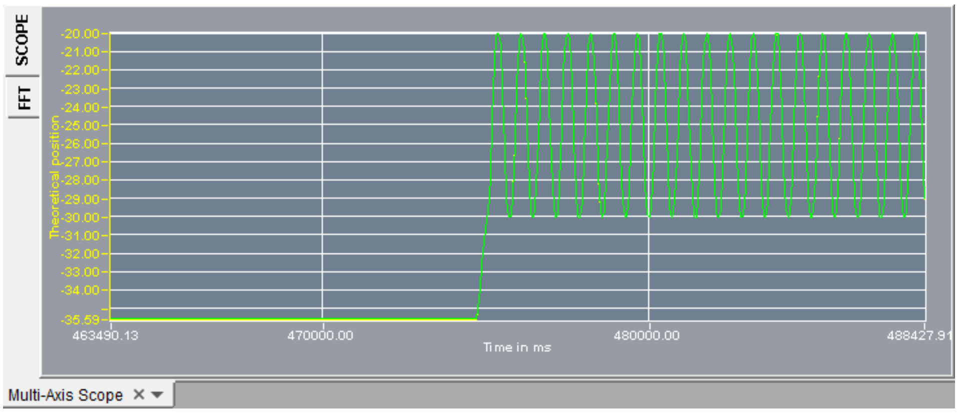
Acceleration: 500E-3 m/s²

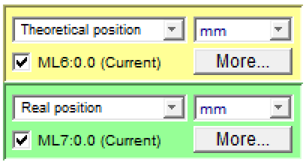
Jerk-time: 25E-3 s

Dwell-time: 25E-3 s

☑ continuous mode

Configure the *Scope* tool to display the theoretical and real positions (`ML6` and `ML7`, respectively) on **Roll** mode. Then, select the **continuous mode** check box on the *S-Curve Profile* tool, click on the button ▷ to execute the motion profile on the forward direction and analyze the signals on the *Scope*.



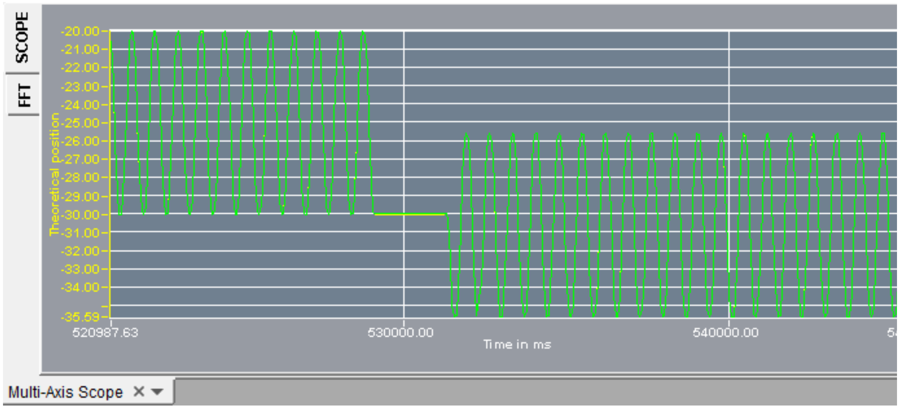

Theoretical position – mm

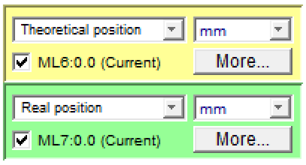
☑ ML6:0.0 (Current) More...

Real position – mm

☑ ML7:0.0 (Current) More...

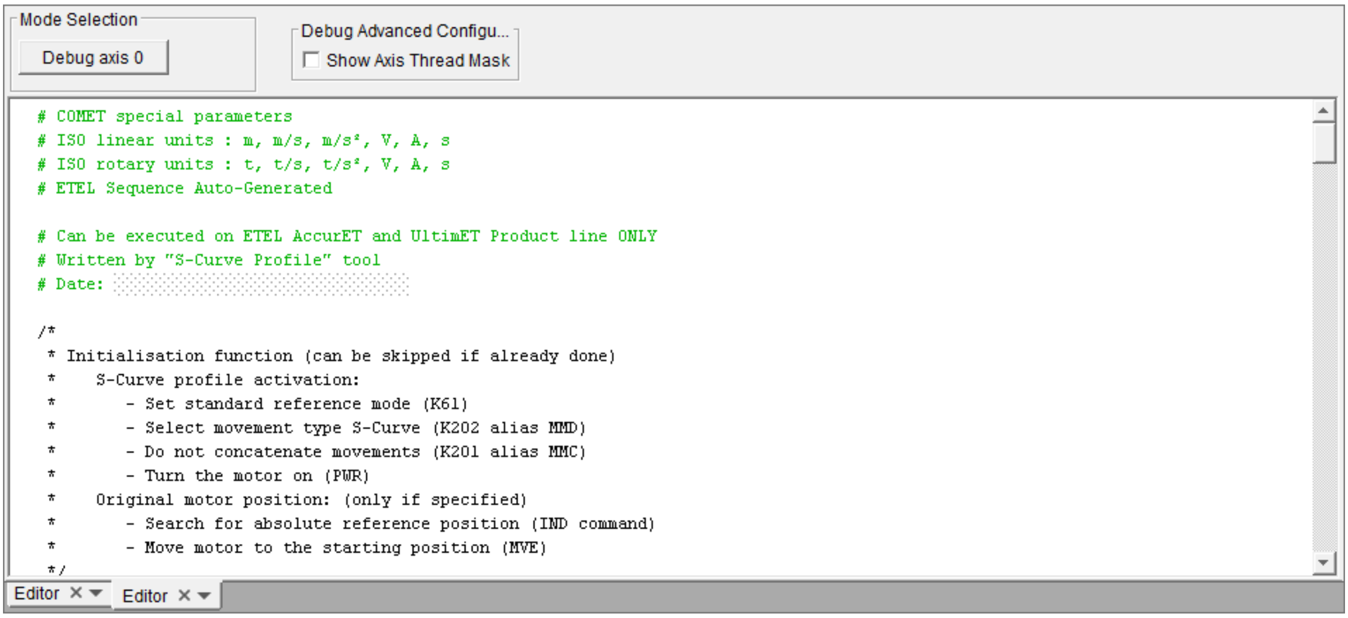
Click on the ⏴ to execute the motion profile on the backward direction.





After having verified that the defined motion profile performs as expected, the user can generate the corresponding Sequence C-like code to be executed by a Controller. For that, use one of the buttons:

EI	Opens a new *Editor* window with the Sequence code corresponding to the defined motion profile.
	Copies onto the **Clipboard** the Sequence code corresponding to the defined motion profile. The user can then paste this code to whatever editor of his choice.



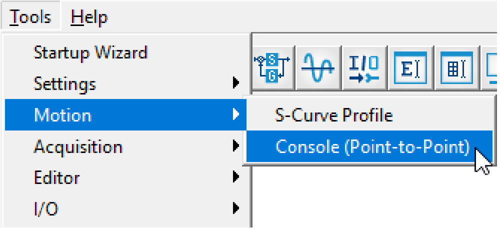
```
# COMET special parameters
# ISO linear units : m, m/s, m/s², V, A, s
# ISO rotary units : t, t/s, t/s², V, A, s
# ETEL Sequence Auto-Generated

# Can be executed on ETEL AccurET and UltimET Product line ONLY
# Written by "S-Curve Profile" tool
# Date: [redacted]

/*
 * Initialisation function (can be skipped if already done)
 *    S-Curve profile activation:
 *       - Set standard reference mode (K61)
 *       - Select movement type S-Curve (K202 alias MMD)
 *       - Do not concatenate movements (K201 alias MMC)
 *       - Turn the motor on (PWR)
 *    Original motor position: (only if specified)
 *       - Search for absolute reference position (IND command)
 *       - Move motor to the starting position (MVE)
 */
```

6.2. Console tool (Point-to-Point motion)

The *Console* tool allows the user to perform simple point-to-point movements. It provides a similar functionality to what the user can already find in the *Startup Wizard* tool (panel #5) or on the **Toolbar Motion** group. However, the *Console* tool also allows the user to set the speed and acceleration for the motion, to store the positions for replay and to manage several axis from the same interface.

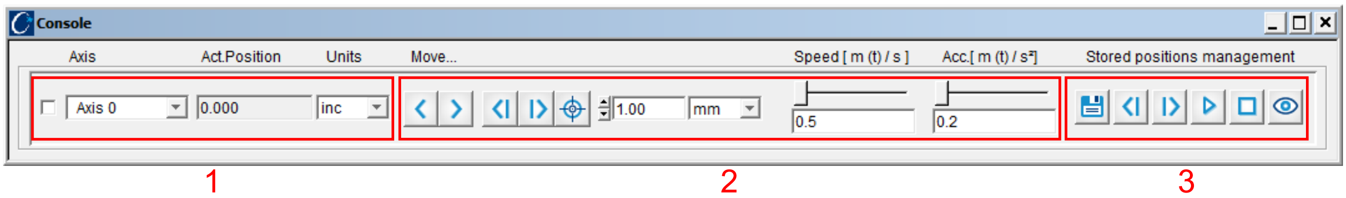
NOTE	Refer to Section §2.4.5 for more information about panel #5 of the *Startup Wizard* tool. Refer to Section §2.2.10 for more information about the **Toolbar Motion** group.

The *Console* tool can be launched by selecting the Menu option **Tools → Motion → Console (Point-to-Point)**:

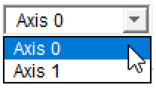
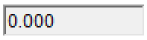
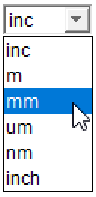


The *Console* tool window is divided into 3 areas:

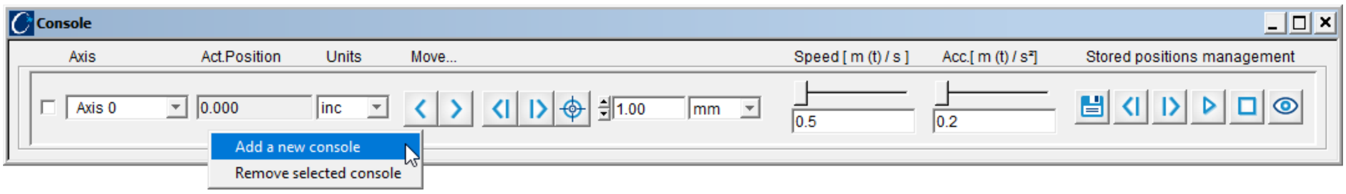
1. Current position of the selected axis;
2. Motion definition, namely, motion stroke or target position, speed and acceleration;
3. Management of stored positions.



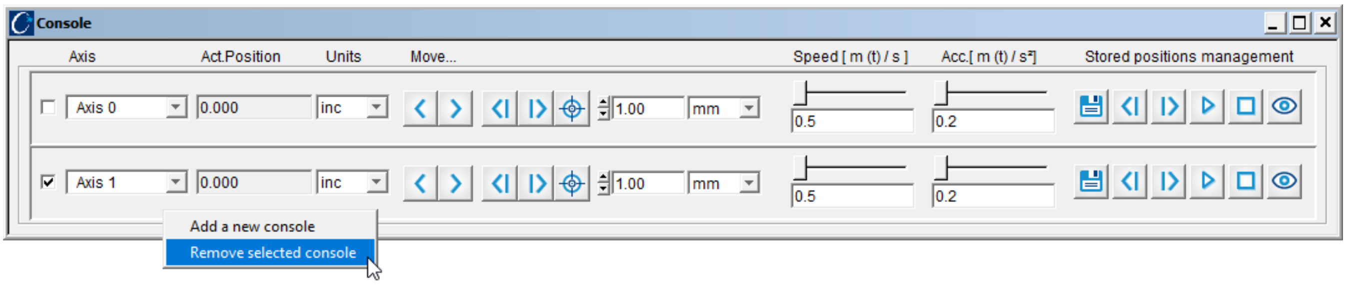
Here is an explanation of the controls that can be found in the first area of the *Console* tool:

Current position of the selected axis	
	Select one of the axes from the drop-down list with the available axes.
	Current position of the selected axis.
	Select the units used to display the current position of the selected axis.

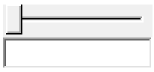
Additional axes can be added to the *Console* tool. Simply select the option **Add a new console** from the contextual menu that pops-up when right-clicking on the tool's window.



Similarly, an axis (or multiple axes) can be removed from the *Console* tool. First, select which axis (or axes) to remove using the checkbox controls on the left of the axis identifier and then select the option **Remove selected console** from the contextual menu that pops-up when right-clicking on the tool's window.



Here is an explanation of the controls that can be found in the second area of the *Console* tool:

Motion definition	
<	Execute a jog movement of the axis in the backward direction.
>	Execute a jog movement of the axis in the forward direction.
<|	Execute a relative movement of the axis in the backward direction. Distance to move is defined on the relative position control.
|>	Execute a relative movement of the axis in the forward direction. Distance to move is defined on the relative position control.
⌖	Execute an absolute movement of the axis to the position defined on the target position control.
	Dual-purpose control: - Relative position control: distance to move for relative movements; or - Target position control: target position for an absolute movement. Select the units accordingly.
	Set the speed and acceleration of the motion using the slider or edit controls.

NOTE	Ensure that the axis or axes are powered on before making a movement.

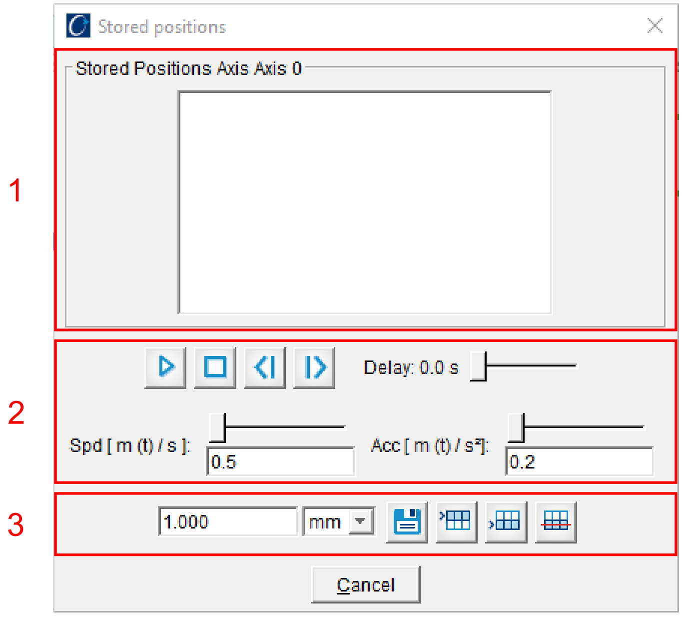
WARNING	Always ensure that the proper safety precautions are taken when powering on a Controller and executing movements with a motion system.

Here is an explanation of the controls that can be found in the third area of the *Console* tool:

Management of stored positions	
💾	Save the current position to the list of stored positions.
◁|	Execute a movement to previous position in the list of stored positions.
|▷	Execute a movement to next position in the list of stored positions.
▷	Move sequentially and continuously to all positions in the list of stored positions.
☐	Stop the axis movement.
👁	View (and edit) the list of stored positions.

The user can view and edit the list of stored positions by clicking on the button 👁 to display the **Stored positions** dialog box. This dialog box is divided in three distinct areas:

1. List of all stored positions;
2. Motion execution controls;
3. Editing controls.



Delay: 0.0 s

Spd [m (t) / s]: 0.5

Acc [m (t) / s^2]: 0.2

1.000 mm

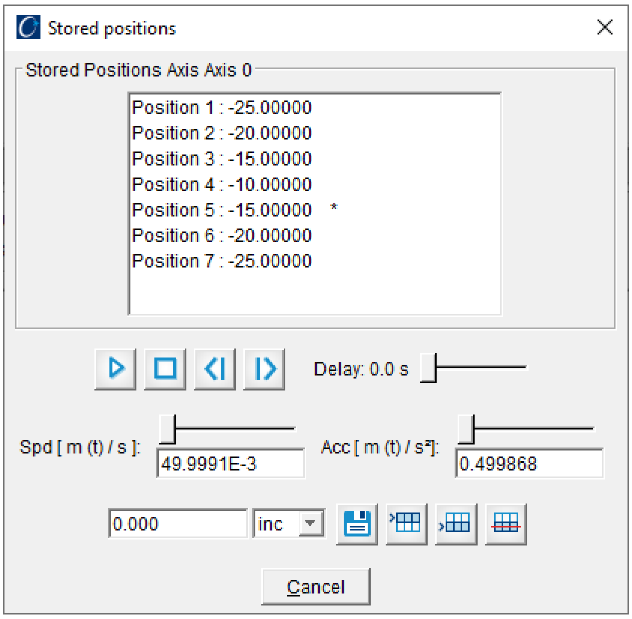
The list of all stored positions is displayed in the first area. The user can select any entry from this list and use the controls in the third area to edit its value, delete the entry from the list or add new entries to the list.

The controls in the second area are related to motion execution according to the list of stored positions and have the same functionality as described previously. Only the **Delay** slider control has not yet been introduced. It allows the user to define a waiting time before execution of the movement to the next target position.

The editing controls in the third area are described below:

Edit controls	
▭ mm ▾	Input a position value and select the corresponding units.
💾	Modify the selected entry in the list of stored positions with the value entered in the previous control.
›▦	Add a new position to the list of stored positions just before (above) the selected entry. This always creates a new entry with a zero position value. Use the modify control 💾 to modify the value.
›▦	Add a new position to the list of stored positions just after (below) the selected entry. This always creates a new entry with a zero position value. Use the modify control 💾 to modify the value.
▦	Delete the selected entry from the list of stored positions.

Take the example of the following list of stored positions that correspond to a movement in one direction and then backwards to the starting point.



Position 1 : -25.00000
Position 2 : -20.00000
Position 3 : -15.00000
Position 4 : -10.00000
Position 5 : -15.00000 *
Position 6 : -20.00000
Position 7 : -25.00000

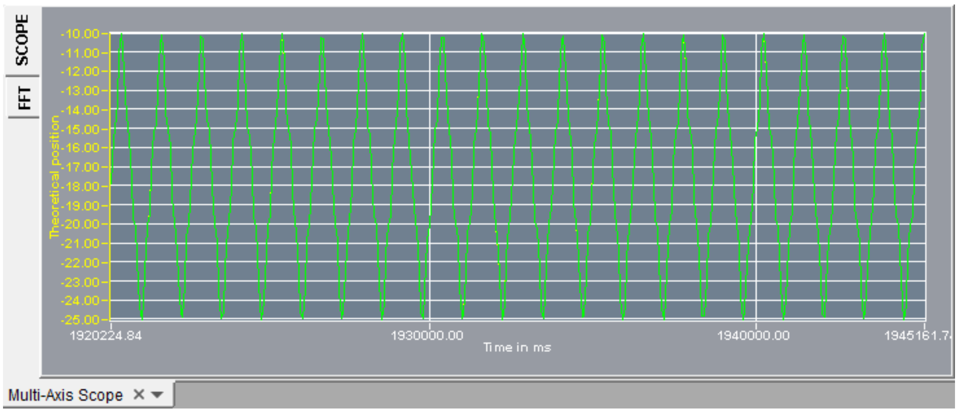
Delay: 0.0 s

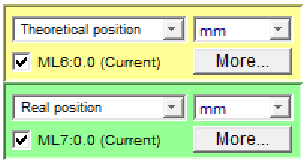
Spd [m (t) / s]: 49.9991E-3

Acc [m (t) / s²]: 0.499868

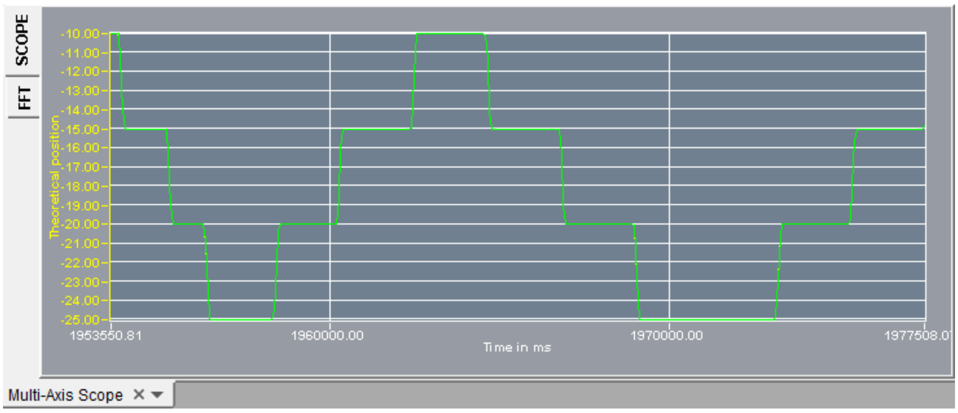
0.000 inc

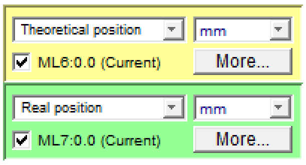
Configure the *Scope* tool to display the theoretical and real positions (`ML6` and `ML7`, respectively) on **Roll** mode. Then, click on the button ▷ to move sequentially (and continuously) to all positions in the list of stored positions and analyze the signals on the *Scope*. This is the result for a zero delay in between movements.



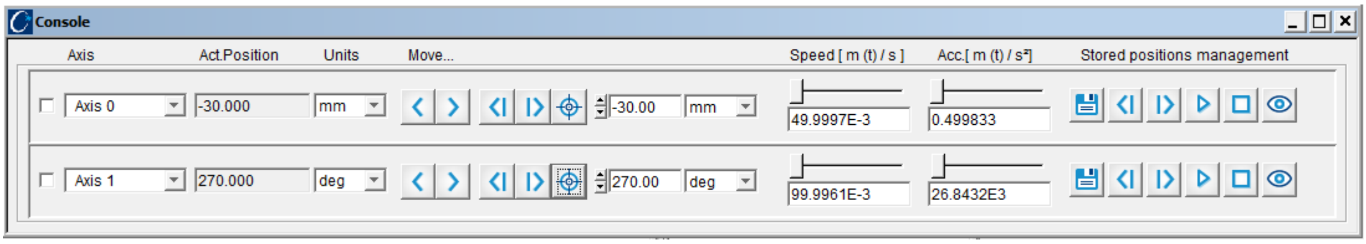

Theoretical position | mm
☑ ML6:0.0 (Current)
Real position | mm
☑ ML7:0.0 (Current)

This is now the result with a 2s delay in between movements.



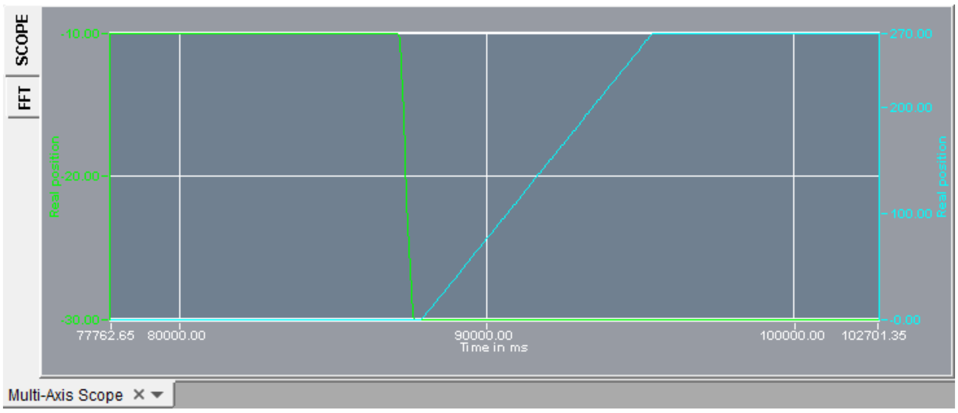

Theoretical position | mm
☑ ML6:0.0 (Current)
Real position | mm
☑ ML7:0.0 (Current)

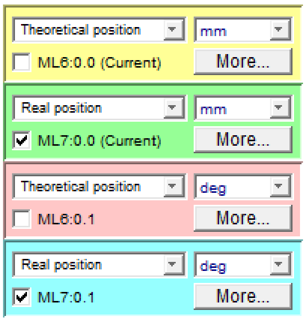
Finally, as presented before, the user can add several axes to the *Console* tool and control their movement. Here is an example with two axes, one linear and another rotary.



	Axis	Act.Position	Units	Move...		Speed [m (t) / s]	Acc.[m (t) / s²]	Stored positions management
☐	Axis 0	-30.000	mm	-30.00	mm	49.9997E-3	0.499833	
☐	Axis 1	270.000	deg	270.00	deg	99.9961E-3	26.8432E3	

The user has started the first movement of the linear axis from its current position at -10mm up to the target position at -30mm. A second movement of rotary axis is also realized from 0 degrees up to 270 degrees. This is how it looks like on the *Scope* tool.




Theoretical position — mm
☐ ML6:0.0 (Current) — More...

Real position — mm
☑ ML7:0.0 (Current) — More...

Theoretical position — deg
☐ ML6:0.1 — More...

Real position — deg
☑ ML7:0.1 — More...

7. Monitoring & Diagnostics

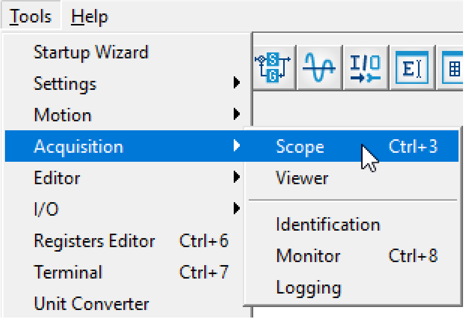
7.1. Scope

The *Scope* tool is one of the most versatile and suitable tools available in ***ComET4*** for monitoring and troubleshooting an application.

There are several ways to launch the *Scope* tool, such as:

1. On the **Toolbar Tools** group, click on the button .

2. Select the Menu option **Tools → Acquisition → Scope**.



The *Scope* tool main window is divided in 5 areas:

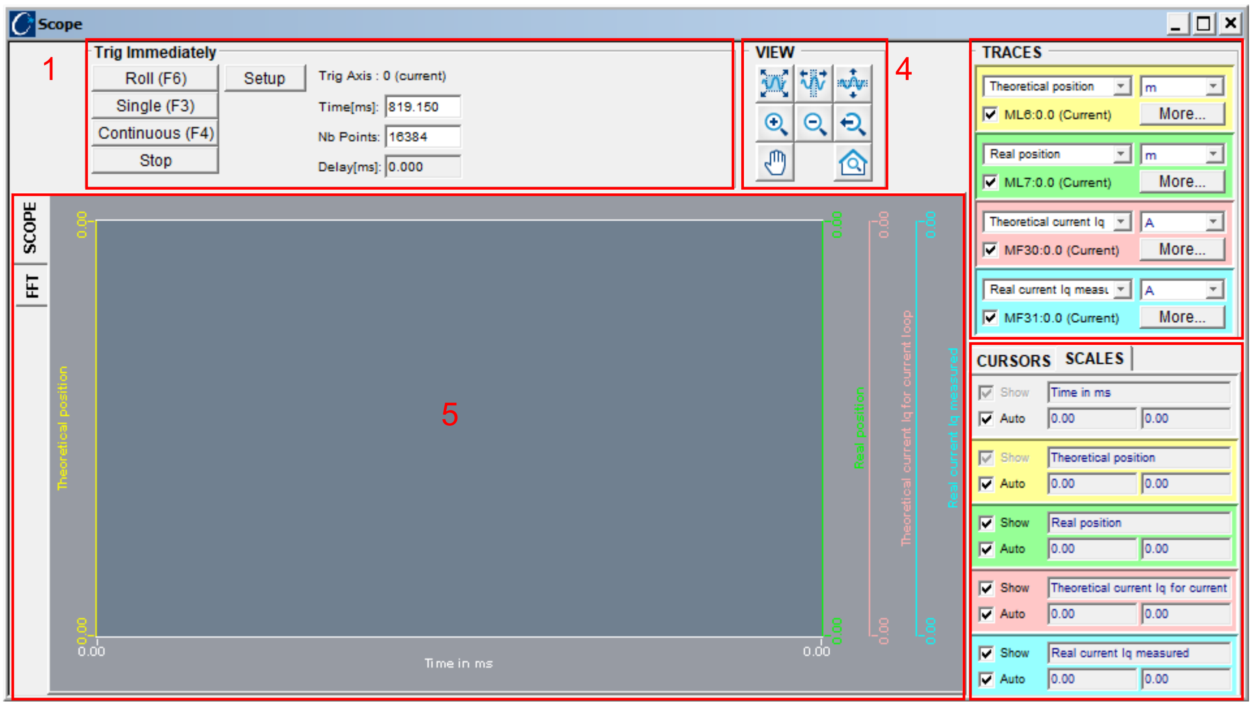
1. **Trigger** panel;
2. **Trace** panel;
3. **Scale/Cursor** panel;
4. **Zoom** panel;
5. **View**: Scope and FFT.

NOTE

A **Trace** is an advanced register type (`T` register) which allows the acquisition of the Controller's basic register types `K`, `M`, `X` and `C` versus time.

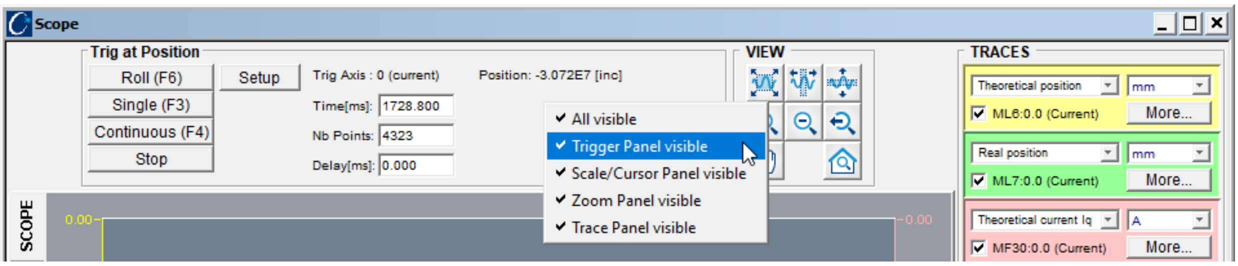
A trace contains the values of the selected register, sampled at the frequency set by the user and with the acquisition starting from the moment the trigger conditions, also set by the user, are valid.

Refer to the *AccurET Modular Position Controller Operation & Software Manual* and the *UltimET Light/ADVANCED Motion Controllers User's Manuals* for more information about register types.



Trig Axis : 0 (current)
Time[ms]: 819.150
Nb Points: 16384
Delay[ms]: 0.000

The user can customize the layout of this main window. All areas except the **View** can be hidden to free screen real estate for the plots. Right-click on the *Scope*'s tool window to bring up a contextual menu and select which panels to show/hide.



Trig Axis : 0 (current)
Position: -3.072E7 [inc]
Time[ms]: 1728.800
Nb Points: 4323
Delay[ms]: 0.000

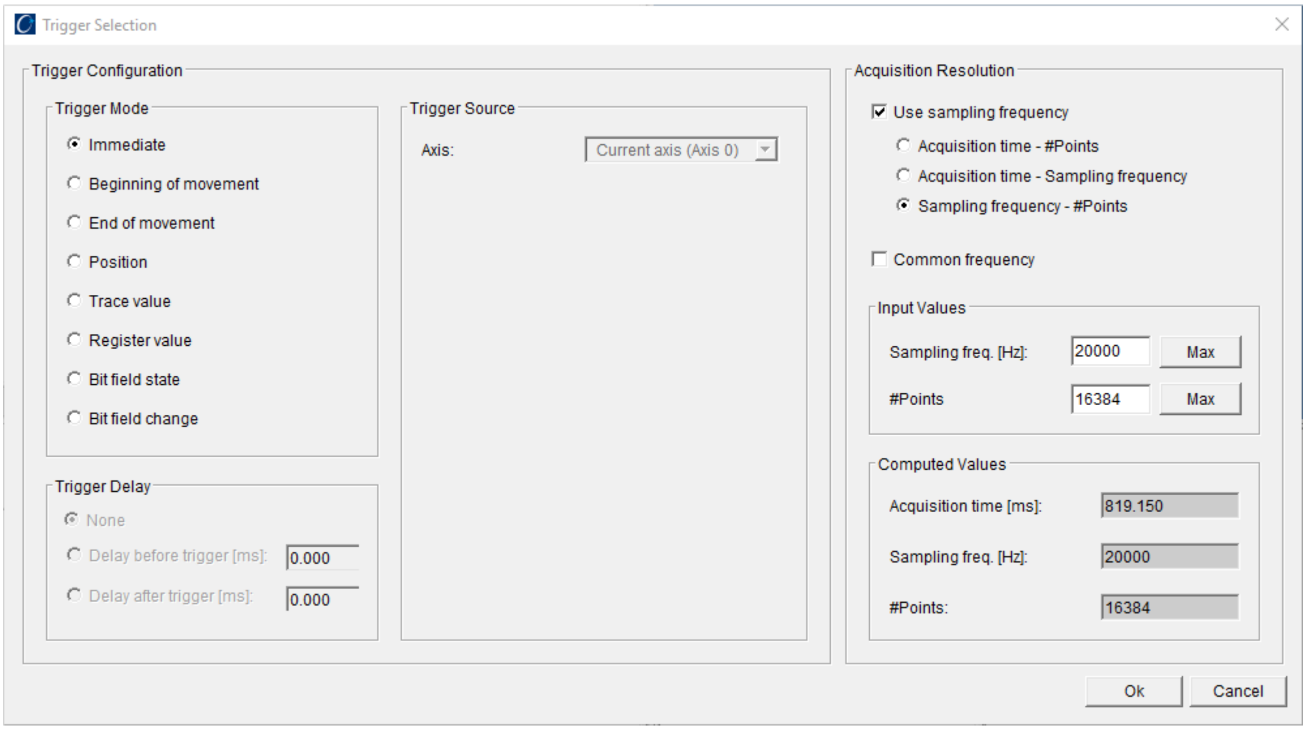
7.1.1. Trigger panel

The *Scope* tool supports the following acquisition modes:

Single (F3)	Perform a single acquisition. The trace is acquired when the trigger is fired. The trigger is not re-armed automatically (single shot). The trace is uploaded from the Controller and displayed in the **View** area replacing the previous view. To configure the trigger conditions click on the **Setup** button.
Continuous (F4)	Perform an acquisition every time the trigger is fired. Once fired, the trace is uploaded from the Controller and displayed in the **View** area replacing the previous view. The trigger is automatically re-armed after each acquisition. To configure the trigger conditions click on the **Setup** button. To stop this acquisition mode simply click on the same button to toggle off the mode or press the **Stop** button.
Roll (F6)	Perform acquisitions continuously independently of the trigger conditions. The trace is uploaded from the Controller and displayed in the **View** area appended to the already existing data. To stop this acquisition mode simply click on the same button to toggle off the mode or press the **Stop** button.

Click on the **Setup** button to configure the acquisition settings:

- Trigger mode, delay and source; and
- Acquisition resolution.



Trigger Selection

Trigger Configuration

Trigger Mode
- ● Immediate
- ○ Beginning of movement
- ○ End of movement
- ○ Position
- ○ Trace value
- ○ Register value
- ○ Bit field state
- ○ Bit field change

Trigger Delay
- ● None
- ○ Delay before trigger [ms]: 0.000
- ○ Delay after trigger [ms]: 0.000

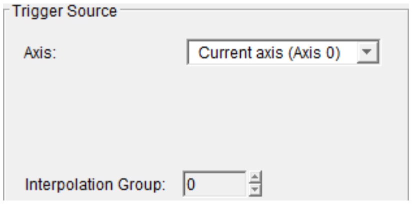
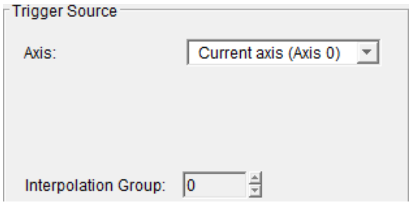
Trigger Source
Axis: Current axis (Axis 0)

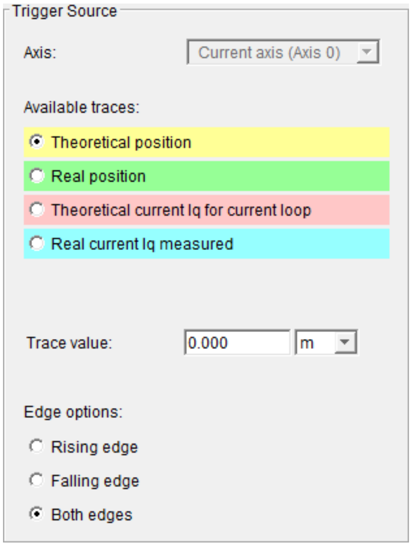
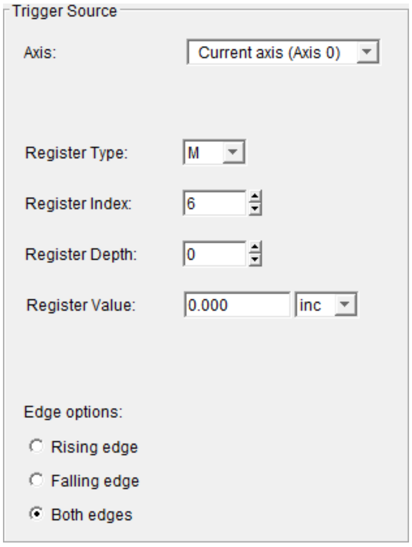
Acquisition Resolution
- ☑ Use sampling frequency
  - ○ Acquisition time - #Points
  - ○ Acquisition time - Sampling frequency
  - ● Sampling frequency - #Points
- ☐ Common frequency

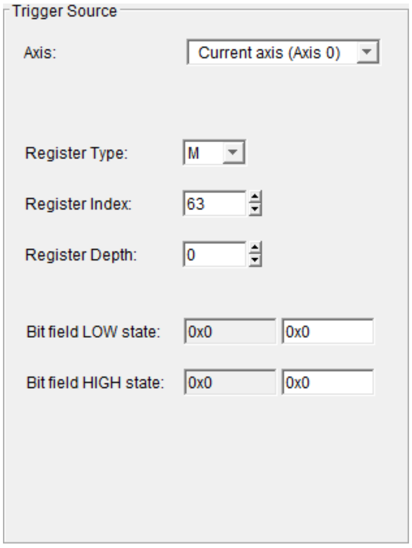
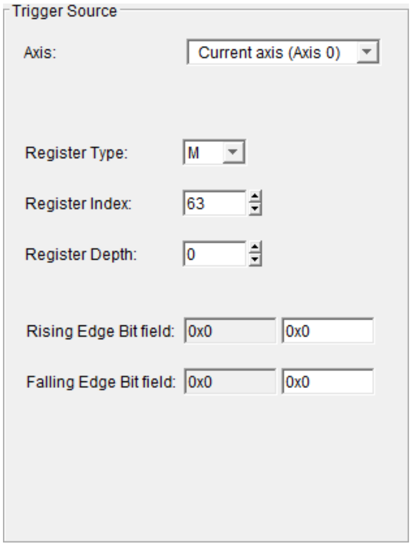
Input Values
Sampling freq. [Hz]: 20000 Max
#Points 16384 Max

Computed Values
Acquisition time [ms]: 819.150
Sampling freq. [Hz]: 20000
#Points: 16384

These are the options available for the **Trigger Mode** and **Trigger Source**:

Trigger Mode	**Trigger Source**	
○ Immediate	Trigger is fired immediately.	
○ Beginning of movement	Trigger is fired once the movement begins on the selected axis or interpolation group (if any). The detection of the movement is based on the toggling of the `isMoving` bit (Bit #4 in `M60` and bit #20 in `M63`) in the Controller.	 Trigger Source Axis: Current axis (Axis 0) Interpolation Group: 0
○ End of movement	Trigger is fired once the movement ends on the selected axis or interpolation group (if any). The detection of the movement is based on the toggling of the `isMoving` bit (Bit #4 in `M60` and bit #20 in `M63`) in the Controller.	 Trigger Source Axis: Current axis (Axis 0) Interpolation Group: 0

Trigger Mode		Trigger Source
○ Position	Trigger is fired once the selected axis reaches the pre-defined position. The user can also define if the trigger should be fired on: - Rising edge: position is reached with a movement direction corresponding to increasing values of position; - Falling edge: position is reached with a movement direction corresponding to decreasing values of position; or - Both: position is reached from whatever direction.	 Trigger Source Axis: Current axis (Axis 0) Position: 0.000 inc Edge options: ○ Rising edge ○ Falling edge ● Both edges
○ Trace value	Trigger is fired once the selected trace reaches the pre-defined value. The user can also define if the trigger should be fired on: - Rising edge: value is reached coming from smaller values, i.e. trace values are increasing when the pre-defined value is reached; - Falling edge: value is reached coming from bigger values, i.e. trace values are decreasing when the pre-defined value is reached; or - Both: value is reached from whatever direction.	 Trigger Source Axis: Current axis (Axis 0) Available traces: ● Theoretical position ○ Real position ○ Theoretical current Iq for current loop ○ Real current Iq measured Trace value: 0.000 m Edge options: ○ Rising edge ○ Falling edge ● Both edges
○ Register value	Trigger is fired once the selected register reaches the pre-defined value. The user can also define if the trigger should be fired on: - Rising edge: value is reached coming from smaller values, i.e. register values are increasing when the pre-defined value is reached; - Falling edge: value is reached coming from bigger values, i.e. register values are decreasing when the pre-defined value is reached; or - Both: value is reached from whatever direction.	 Trigger Source Axis: Current axis (Axis 0) Register Type: M Register Index: 6 Register Depth: 0 Register Value: 0.000 inc Edge options: ○ Rising edge ○ Falling edge ● Both edges

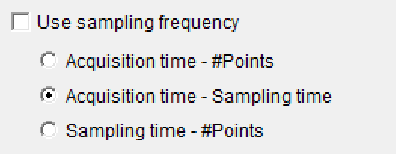
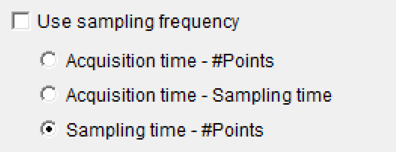
Trigger Mode		**Trigger Source**
○ Bit field state	Trigger is fired when the bits of the selected register corresponding to the LOW and HIGH state bit masks are set accordingly. Take the following example with register `M63`, where one would like to trigger when: - Bit #26 (controller in error) is "0", i.e. axis is not in error; and - Bit #20 (`isMoving` bit) is "1", i.e. axis is moving. To achieve this behavior: - **Bit field LOW state** must be set to `0x04000000`, corresponding to the mask for Bit #26. - **Bit field HIGH state** must be set to `0x00100000`, corresponding to the mask for Bit #20.	 Trigger Source Axis: Current axis (Axis 0) Register Type: M Register Index: 63 Register Depth: 0 Bit field LOW state: 0x0 0x0 Bit field HIGH state: 0x0 0x0
○ Bit field change	Trigger is fired when the bits of the selected register corresponding to either Rising Edge or Falling Edge state bit masks are toggled accordingly. Take the following example with register `M63`, where one would like to trigger when: - Bit #20 (`isMoving` bit) is set to "1", i.e. start of motion detected; and - Bit #20 is set to "0", i.e. end of motion detected. To achieve this behavior: - **Rising Edge Bit field** must be set to `0x00100000`, corresponding to the mask for Bit #20. - **Falling Edge Bit field** must be set to `0x00100000`, corresponding to the mask for Bit #20.	 Trigger Source Axis: Current axis (Axis 0) Register Type: M Register Index: 63 Register Depth: 0 Rising Edge Bit field: 0x0 0x0 Falling Edge Bit field: 0x0 0x0

These are the options available for the **Trigger Delay**:

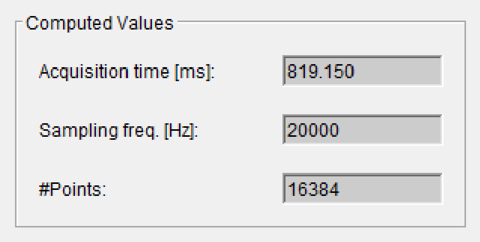
Trigger Delay	
○ None	Controller starts recording at the exact moment the trigger is fired.
○ Delay before trigger [ms]: 0.000	Controller records the x milliseconds prior to the trigger being fired.
○ Delay after trigger [ms]: 0.000	Controller starts recording x milliseconds after the trigger is fired.

Regarding the **Acquisition Resolution**, the user has multiple options to input the information:

Acquisition Resolution	
☐ Use sampling frequency ● Acquisition time - #Points ○ Acquisition time - Sampling time ○ Sampling time - #Points	Input the acquisition time and number of acquisition points. The *Scope* tool will determine the sampling frequency that best fits these settings.

 ☐ Use sampling frequency ○ Acquisition time - #Points ● Acquisition time - Sampling time ○ Sampling time - #Points	Input the acquisition time and sampling time (or sampling frequency if the **Use sampling frequency** checkbox is selected). The *Scope* tool will determine the number of acquisition points that best fits these settings.
 ☐ Use sampling frequency ○ Acquisition time - #Points ○ Acquisition time - Sampling time ● Sampling time - #Points	Input the sampling time (or sampling frequency if the **Use sampling frequency** checkbox is selected) and number of acquisition points. The *Scope* tool will calculate the corresponding acquisition time for such settings.

The **Computed Values** group control displays the values actually set for the acquisition resolution accounting for the limits of the Controller. In other words, the user input for defining the acquisition resolution is not always feasible because the Controller has a limited sampling frequency (which depends on the Controller model) and a limited number of acquisition points (16384):



Computed Values

Acquisition time [ms]: 819.150

Sampling freq. [Hz]: 20000

#Points: 16384

Furthermore, not all registers are sampled at the same frequency in the Controllers. E.g., in the ***AccurET*** position controller, some registers are updated at the PLTI rate, while others are updated at the slower MLTI rate. Also, ***UltimET*** motion controllers have a different sampling rate from the ***AccurETs***. So, when monitoring simultaneously with the *Scope* tool registers with different sampling rates, it might be more convenient to use a common sampling rate. If this is the case, select the **Common frequency** checkbox to acquire all traces using the same common sampling rate.

NOTE	When selecting the **Common frequency** checkbox, the *Scope* tool actually decimates the traces acquired with a higher sampling rate to ensure a common time base for all the traces acquired.

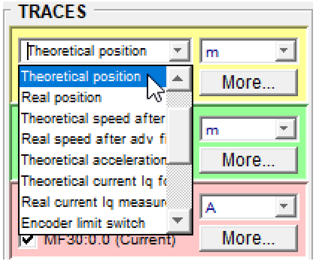
7.1.2. Trace panel

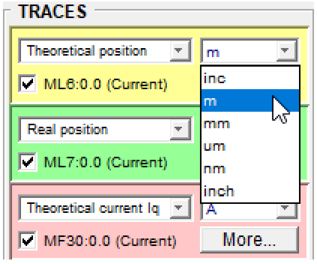
The *Scope* tool can display up to 4 traces simultaneously belonging to any axis. Only basic register types can be monitored:

- `K` (parameters);
- `M` (monitorings);
- `X` (user variables);
- `C` (common).

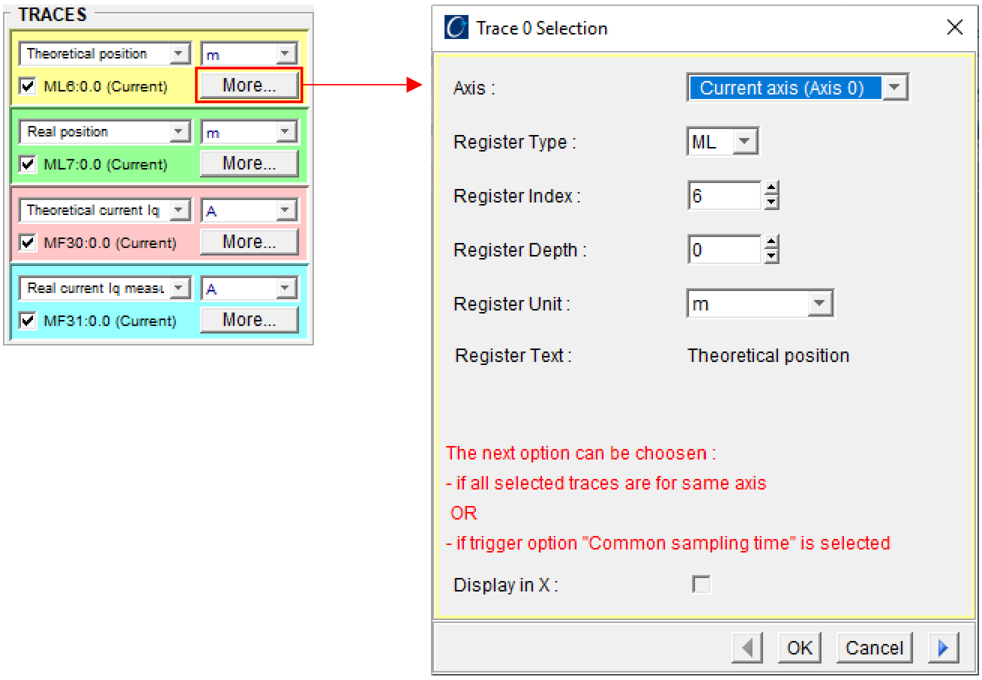
Under the **TRACES** group control, the user can select which registers to monitor on each trace, following one of two possible options:

1. Select the register from the left drop-down list. Only the most frequently used registers are listed and these are related to the current axis (i.e. axis with which the connection is established). The units used to display the trace can also be selected on the right drop-down list.





2. Click on the **More** button and configure the trace selection:
   - Axis (can be any "visible" axis);
   - Register type, index and depth;
   - Units used to display the trace.



Axis : Current axis (Axis 0)

Register Type : ML

Register Index : 6

Register Depth : 0

Register Unit : m

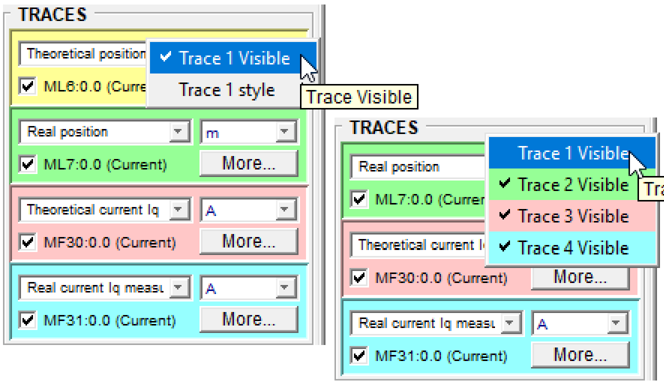
Register Text : Theoretical position

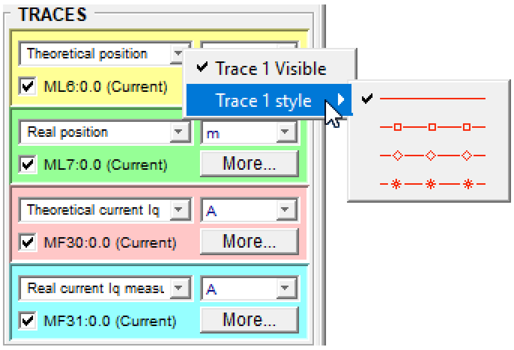
The next option can be choosen :
- if all selected traces are for same axis
OR
- if trigger option "Common sampling time" is selected

Display in X : ☐

In the *Scope* view area, the plot abscissa (horizontal **X** axis) is usually reserved for the time scale, while the ordinate (vertical **Y** axis) is used for the traces. However, when all traces acquired by the *Scope* tool belong to the same axis or have been acquired with the acquisition resolution option **Common sampling time** selected (refer to previous Section §7.1.1), it is possible to assign one of these traces to the abscissa, while the other(s) remain assigned to the ordinate. This feature can be used e.g. for displaying the 2D trajectory executed by a XY system.

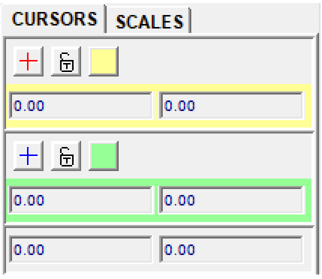
Finally, the user can hide a trace or change its style. Right-click on the **TRACES** group control to bring up the context menu allowing to show/hide traces and change their style.



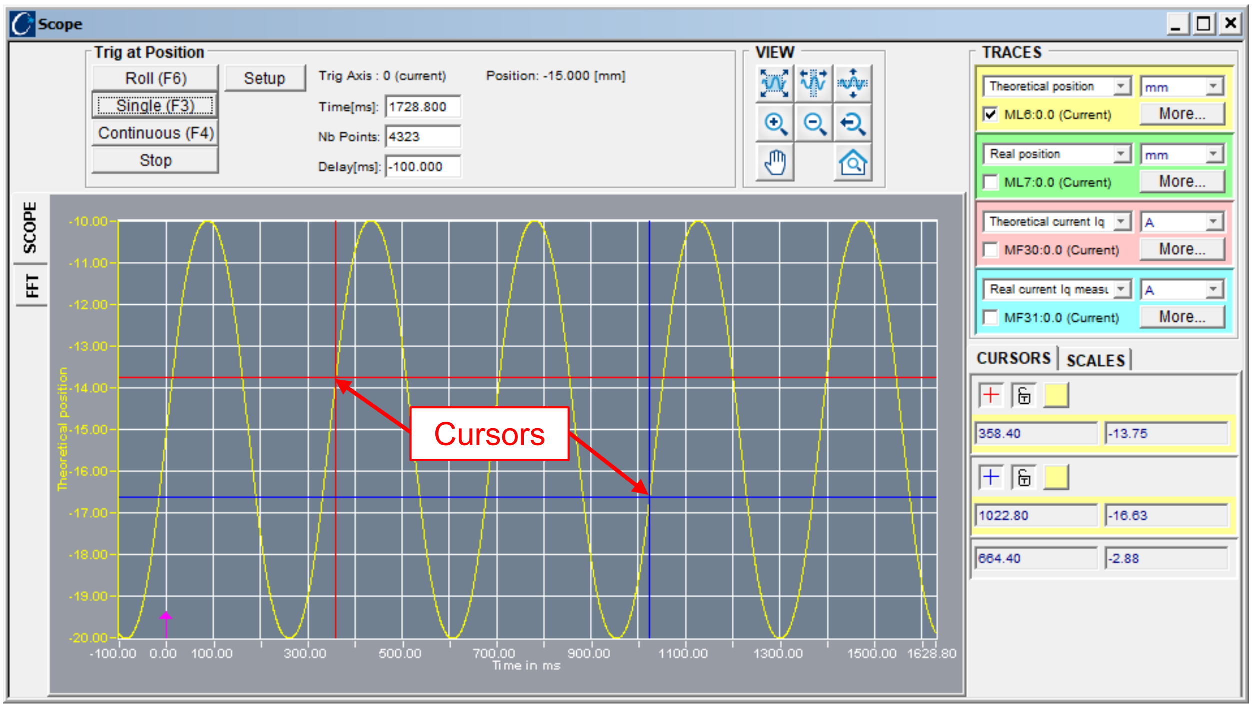


7.1.3. Scale/Cursor panel

The *Scope* tool includes a Cursor measurement function with two cursors that can be used to readout the trace(s) values and compute the difference. This function can be configured on the **CURSORS** panel.



+ +	Show/Hide cursor (red/blue).
🔓	Lock/Unlock cursor to assigned trace. When locked, the cursor will follow the trace signal.
🟨 🟩	Assign cursor (red/blue) to a trace (both cursors can be assigned to the same trace). Here, the red and blue cursors are assigned respectively to Trace 1 and Trace 2.
0.00 0.00 0.00 0.00	Cursor readouts: abscissa (horizontal) and ordinate (vertical) readings.
0.00 0.00	Difference between red and blue cursor readouts.

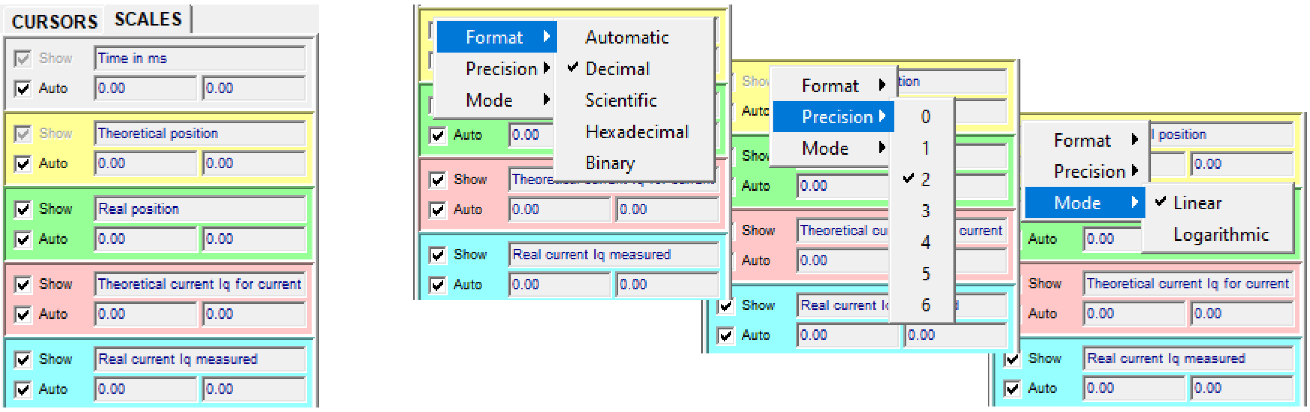


Trig Axis : 0 (current)
Position: -15.000 [mm]
Time[ms]: 1728.800
Nb Points: 4323
Delay[ms]: -100.000

358.40 -13.75
1022.80 -16.63
664.40 -2.88

Under the **SCALES** panel, the user can configure the behavior of the plot scales. Use the **Auto** checkbox to choose between automatic adjustment of the scale limits or manual setting and use the **Show** checkbox to include separate vertical scale axis for each trace.

The user can also configure the numerical representation (format and precision) to apply to the scale labels, as well as the type of scale (linear or logarithmic). Right-click on the **SCALES** panel to bring up the context menu allowing to modify these settings.



7.1.4. View

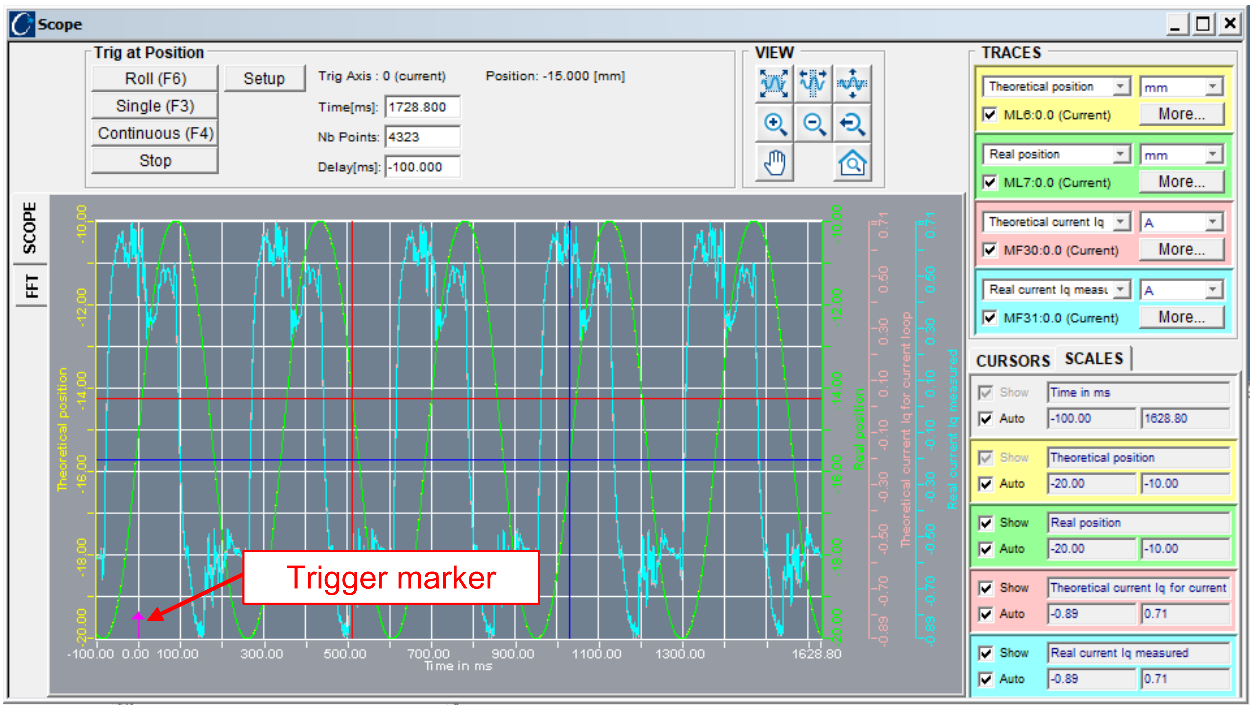
The **View** area is composed of two panels:

- **SCOPE**; and
- **FFT**.

TIP

The color of the grid, frame, background, traces, cursors and trigger for the View area of the *Scope* tool can be customized under **File → Preferences → Colors**.

In the **SCOPE** panel are displayed the time domain plots of the acquired traces (up to 4 traces simultaneously belonging to any axis can be displayed). Besides the already described cursors and scales, the user can also find in this display the trigger marker.



Trig Axis : 0 (current)
Position: -15.000 [mm]
Time[ms]: 1728.800
Nb Points: 4323
Delay[ms]: -100.000

Theoretical position – mm – ☑ ML6:0.0 (Current)
Real position – mm – ☑ ML7:0.0 (Current)
Theoretical current Iq – A – ☑ MF30:0.0 (Current)
Real current Iq measu – A – ☑ MF31:0.0 (Current)

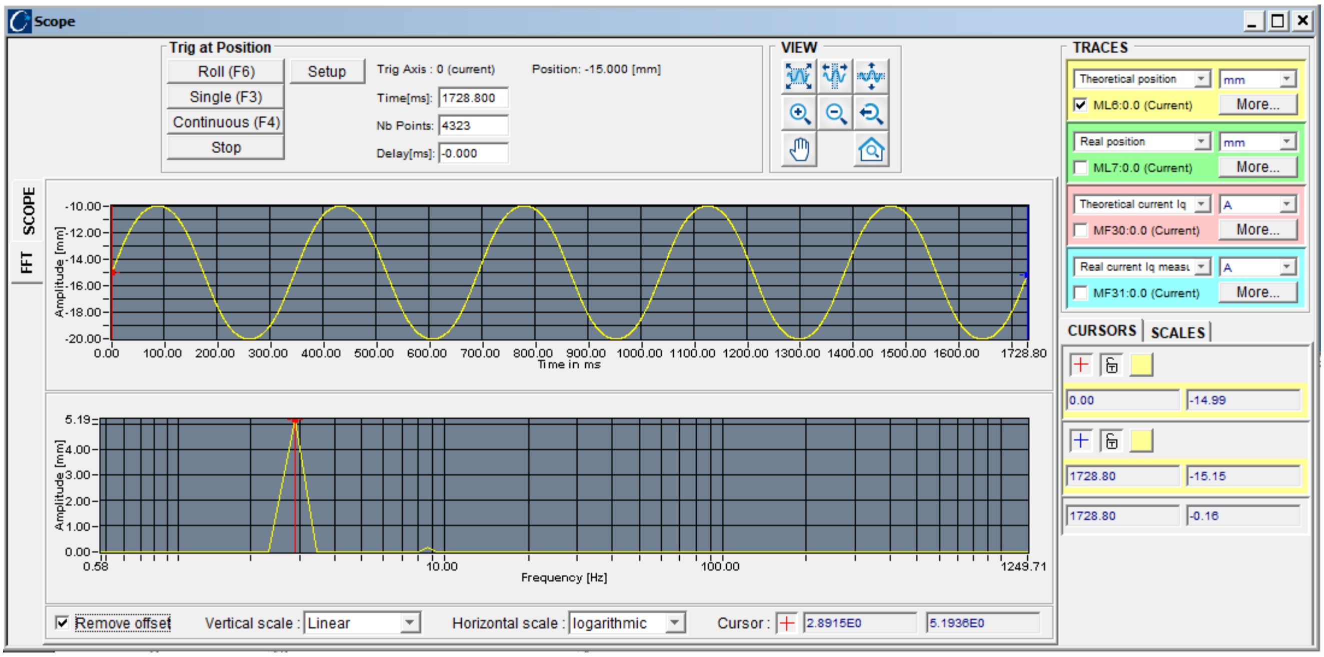
☑ Show – Time in ms – ☑ Auto – -100.00 – 1628.80
☑ Show – Theoretical position – ☑ Auto – -20.00 – -10.00
☑ Show – Real position – ☑ Auto – -20.00 – -10.00
☑ Show – Theoretical current Iq for current – ☑ Auto – -0.89 – 0.71
☑ Show – Real current Iq measured – ☑ Auto – -0.89 – 0.71

The user can adjust the view of the plots with the available view controls from the **Zoom** panel:

	Zoom to rectangle.
	Zoom along the horizontal axis while keeping the vertical axis scale fixed.
	Zoom along the vertical axis while keeping the horizontal axis scale fixed.
	Zoom in with a fixed magnification ratio.
	Zoom out with a fixed demagnification ratio.
	Undo previous Zoom action.
	Pan.
	Return to original view.

The **FFT** panel includes two plots:

- Selected trace (time domain); and
- Single-sided FFT of the selected trace (frequency domain).



Trig Axis : 0 (current)
Position: -15.000 [mm]
Time[ms]: 1728.800
Nb Points: 4323
Delay[ms]: -0.000

Theoretical position mm
☑ ML6:0.0 (Current)
Real position mm
☐ ML7:0.0 (Current)
Theoretical current Iq A
☐ MF30:0.0 (Current)
Real current Iq measu A
☐ MF31:0.0 (Current)

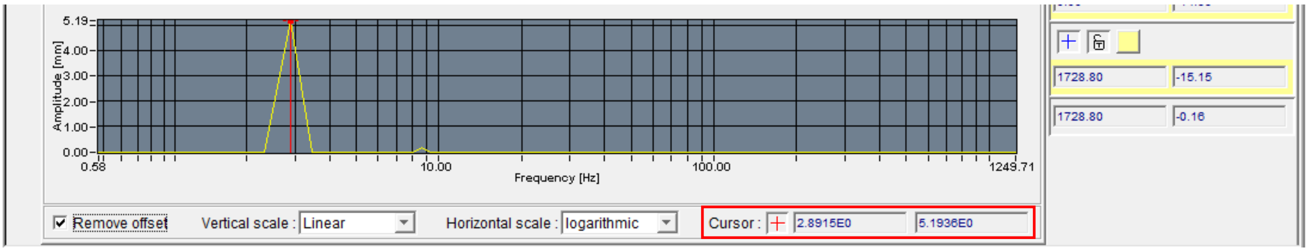
0.00 -14.99
1728.80 -15.15
1728.80 -0.16

☑ Remove offset Vertical scale : Linear Horizontal scale : logarithmic Cursor : 2.8915E0 5.1936E0

NOTE	On the **FFT** panel, only one trace can be displayed at a time. Also, changes introduced to the scales configuration in the **Scale/Cursor** panel do not affect this view.

The user can use the red and blue cursors on the time domain plot to delimit the signal for which the FFT is actually computed (these are the cursors the user can configure under the **Scale/Cursor** panel on the right side of the main window).

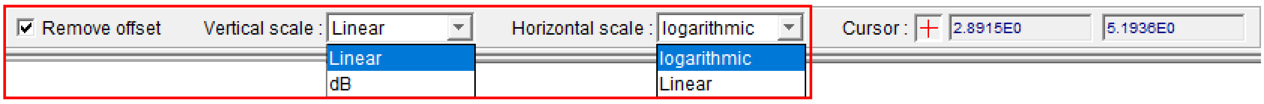
Furthermore, the **FFT** panel view has a third cursor (red) available to be used exclusively on the FFT plot. The abscissa and ordinate for this cursor, as well as the show/hide control, can be found in the bottom part of the window.



1728.80 -15.15
1728.80 -0.16

☑ Remove offset Vertical scale : Linear Horizontal scale : logarithmic Cursor : 2.8915E0 5.1936E0

Finally, the user can choose to remove the offset (DC component) and select between linear or dB for the vertical scale and logarithmic or linear for the horizontal scale.

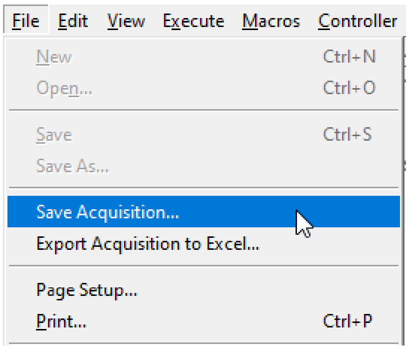


☑ Remove offset Vertical scale : Linear Horizontal scale : logarithmic Cursor : 2.8915E0 5.1936E0

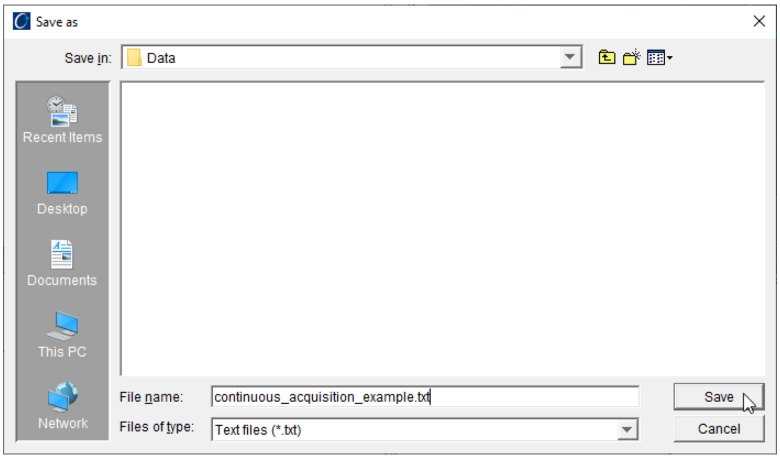
TIP The **View** area can be expanded by selecting the Menu option **View → Full/Normal Scope View** or pressing the `F7` shortcut. Use the same option to restore the default view.

7.1.5. Save acquisition data

The *Scope* acquisitions can be saved to a text file and imported back to the *Viewer* tool (refer to Section §7.2) for offline analysis. With the interface focus on the *Scope* tool window, select the menu entry **File → Save Acquisition…**.



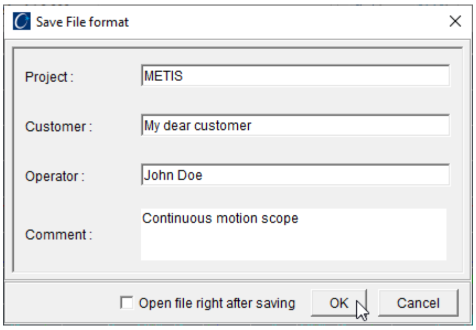
Type in the file name in the **Save As** dialog box and click on the **Save** button. Then, fill in the information in the **Save File Format** dialog box and finally press on the **OK** button to save the *Scope* acquisition data.



Save in: Data

File name: continuous_acquisition_example.txt

Files of type: Text files (*.txt)



Project: METIS

Customer: My dear customer

Operator: John Doe

Comment: Continuous motion scope

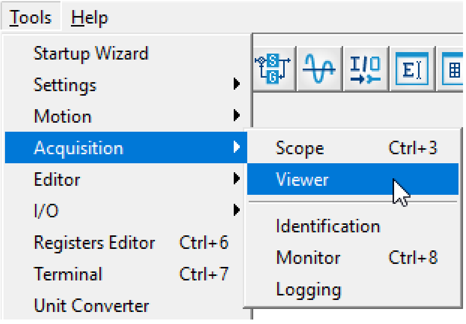
☐ Open file right after saving

Alternatively, the *Scope* acquisition data can be exported to Excel (`*.csv` file format) by selecting the menu option **File → Export Acquisition to Excel…**.

7.2. Viewer

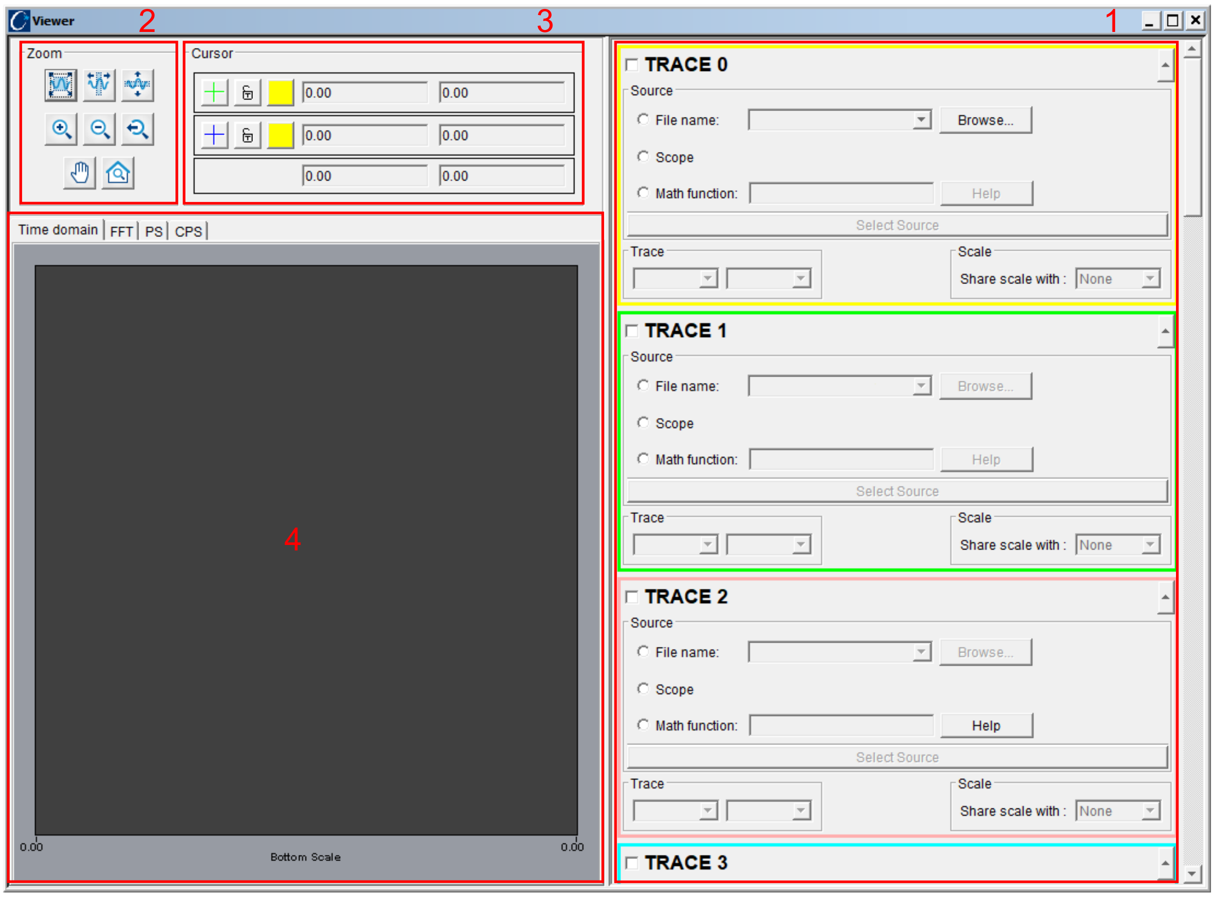
The *Viewer* tool allows the user to display acquisitions realized with the *Scope* tool. It can be used in either on-line (i.e. connection to a Controller required) or off-line modes.

To launch the *Viewer* tool, go to the Menu option **Tools → Acquisition → Viewer**:



The main window of this tool is divided in 4 areas:

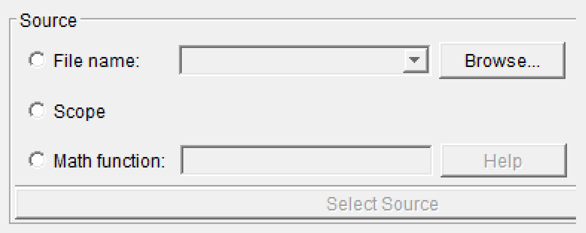
1. **Traces selection** panel;
2. **Zoom** panel;
3. **Cursors** panel; and
4. **View**.



7.2.1. Traces selection panel

This panel allows the user to load traces acquired with the *Scope* tool. Up to 16 traces are supported by the *Viewer* tool.

There are basically three sources from where to "procure" the traces to be displayed:



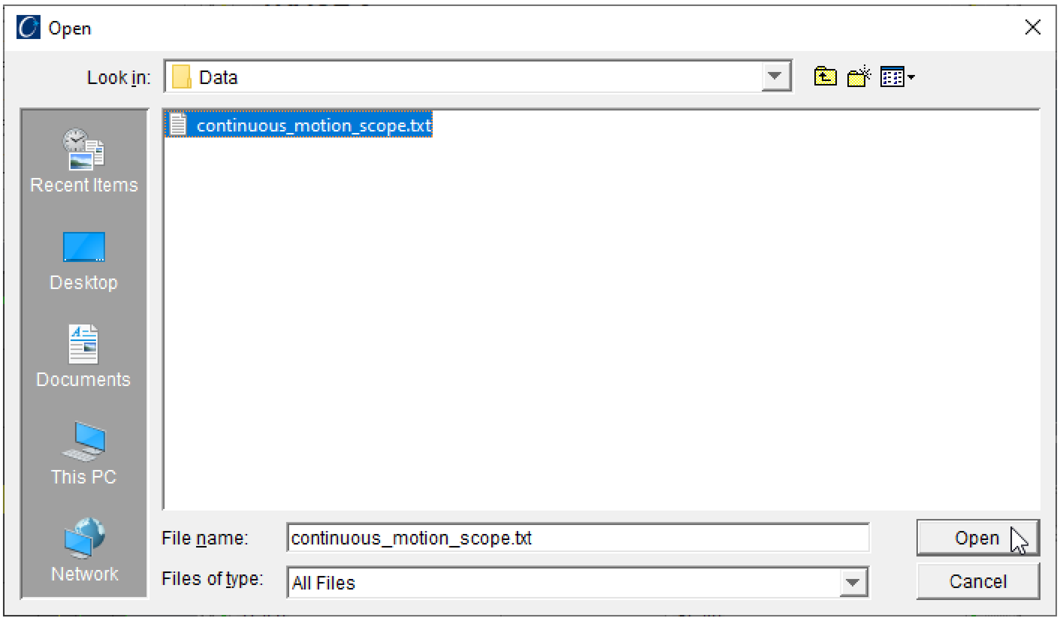
File name: load a *Scope* acquisition previously saved to a file.

Scope: load traces acquired with a running *Scope* tool.

Math function: perform mathematical operations with traces already loaded to the *Viewer* tool.

7.2.1.1. File

To load a file of a *Scope* acquisition, select the **File name** option, click on the **Browse** button to select the file and then click on **Open** to close the dialog box.

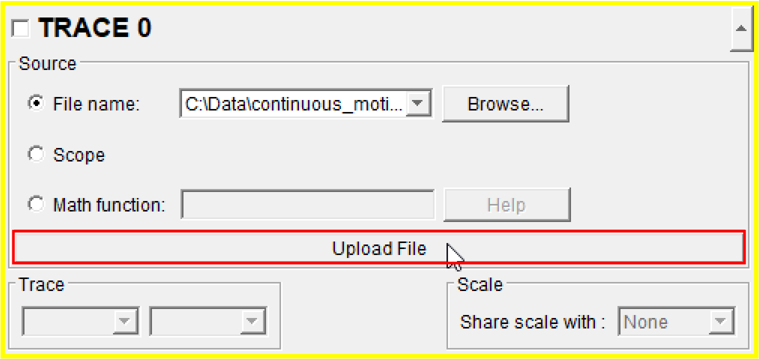


Look in: Data

File name: continuous_motion_scope.txt

Files of type: All Files

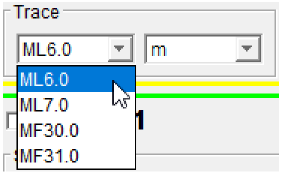
Next, click on the **Upload File** button to load the acquisition data into the *Viewer* tool.

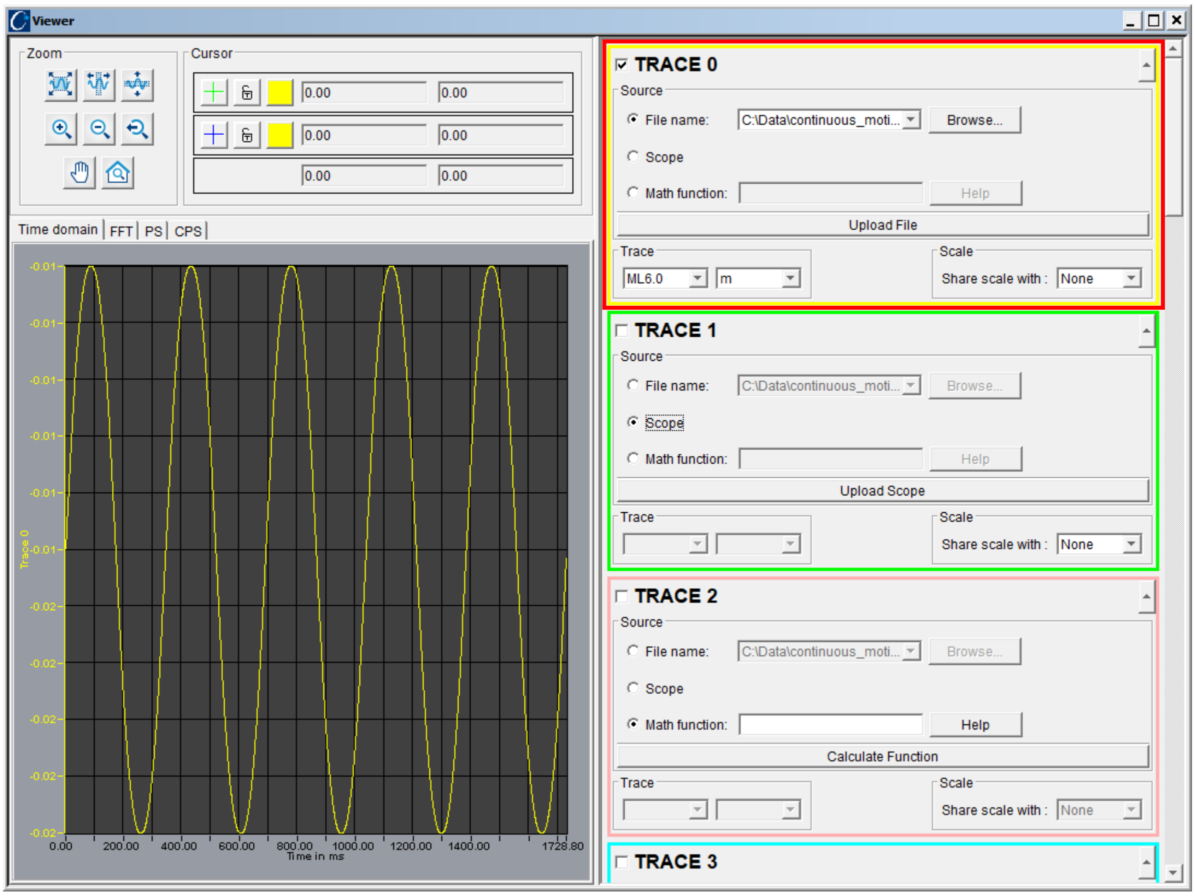


● File name: C:\Data\continuous_moti...

Share scale with : None

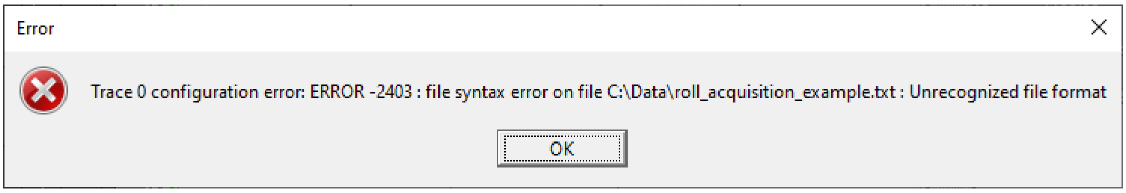
All the traces stored in the acquisition file are listed on the **Trace** drop-down list. The user can select which trace to display in the **View** area and which units to use.





NOTE	There is no need to have a connection established with a Controller to use the *Viewer* tool if all the all the traces to be displayed are loaded from a file. In other words, the *Viewer* can be used on off-line mode.

Saved *Scope* acquisition files containing traces acquired with the Roll acquisition mode (refer to Section §7.1.1 for information about the available acquisition modes in the *Scope* tool) are not supported by the *Viewer* tool and any attempt to load such files will generate the following error message:



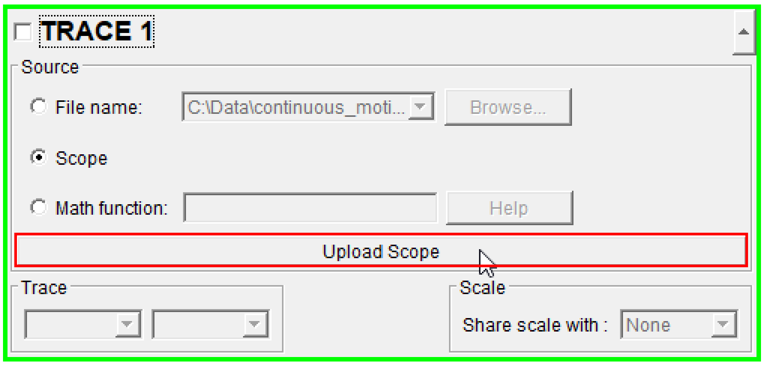
Error

Trace 0 configuration error: ERROR -2403 : file syntax error on file C:\Data\roll_acquisition_example.txt : Unrecognized file format

Click on the **OK** button to clear the message and return to the *Viewer* tool.

7.2.1.2. Scope

An alternative way to load a trace to the *Viewer* tool is to transfer it directly from the *Scope* tool. For this case, select the **Scope** option and click on the **Upload Scope** button to transfer to the *Viewer* the traces acquired by the *Scope*.



☐ TRACE 1

Source

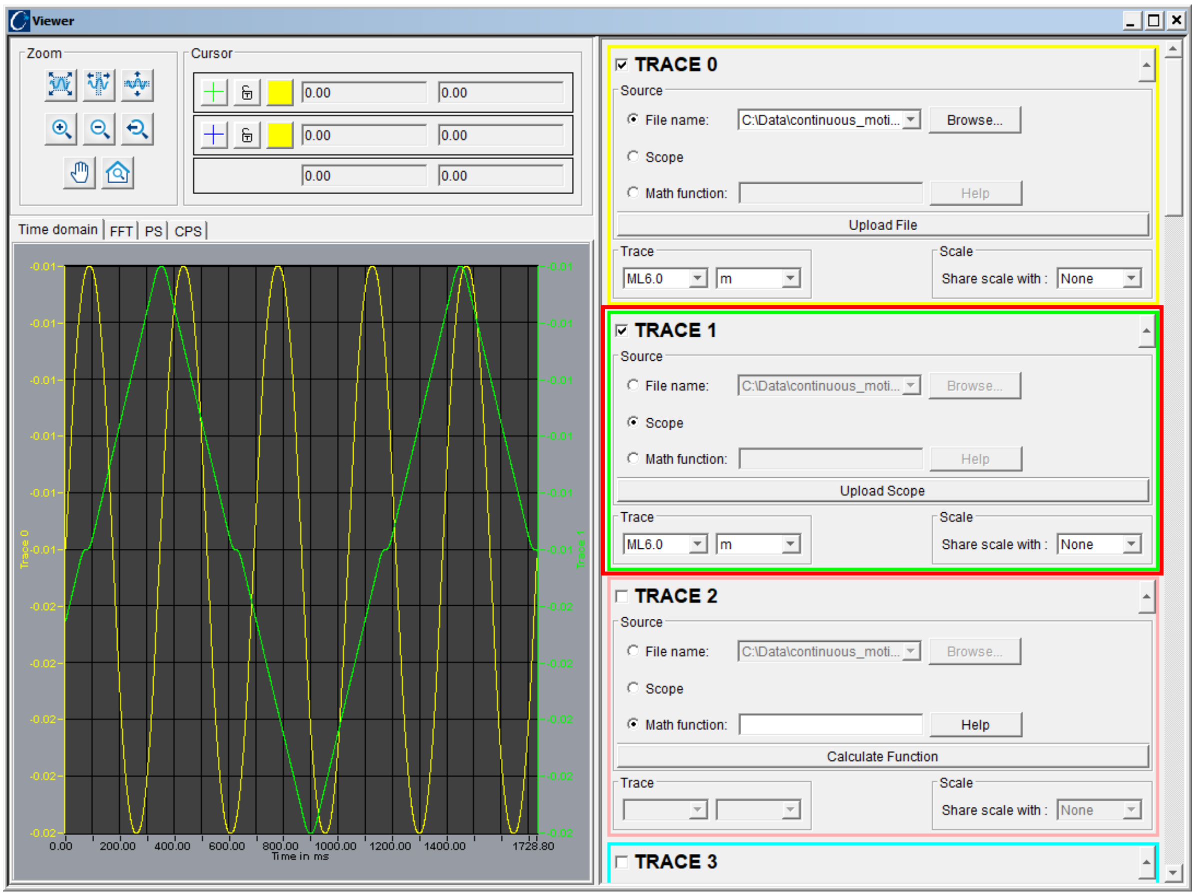
○ File name: C:\Data\continuous_moti...

● Scope

○ Math function:

Share scale with : None

As before, all the traces transferred are listed on the **Trace** drop-down list. The user can select which trace to display in the **View** area and which units to use.



Viewer

Cursor: 0.00 0.00 / 0.00 0.00 / 0.00 0.00

☑ TRACE 0 – Source: ● File name: C:\Data\continuous_moti... ; Trace: ML6.0, m; Share scale with : None

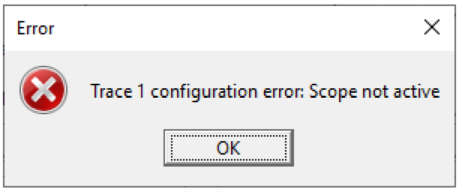
☑ TRACE 1 – Source: ● Scope; Trace: ML6.0, m; Share scale with : None

☐ TRACE 2 – Source: ● Math function; Share scale with : None

☐ TRACE 3

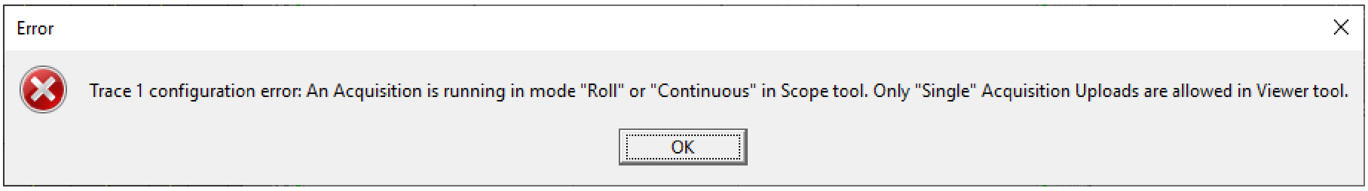
NOTE	Only the traces that are visible in the *Scope* tool will be transferred to the *Viewer* tool. This mode requires a connection with a Controller and the *Scope* tool opened with recently acquired traces.

At the moment of clicking on the **Upload Scope** button, if the *Scope* tool is not running an error message is displayed.



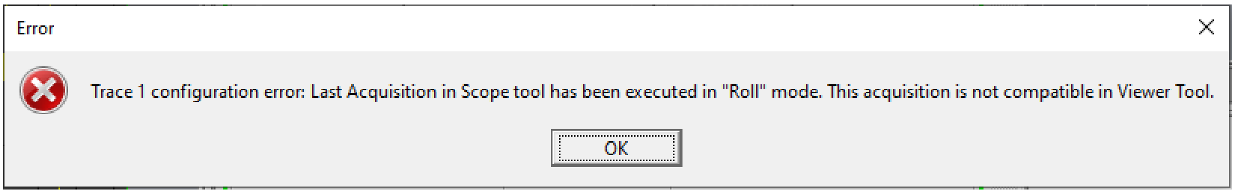
Trace 1 configuration error: Scope not active

If the *Scope* tool is performing a Continuous or Roll acquisition (refer to Section §7.1.1 for information about the available acquisition modes in the *Scope* tool) at the moment a request of transfer is issued by the *Viewer* tool, the following error message pops-up:



Trace 1 configuration error: An Acquisition is running in mode "Roll" or "Continuous" in Scope tool. Only "Single" Acquisition Uploads are allowed in Viewer tool.

A similar error message is also displayed if the last acquisition performed by the *Scope* tool was done in Roll mode.



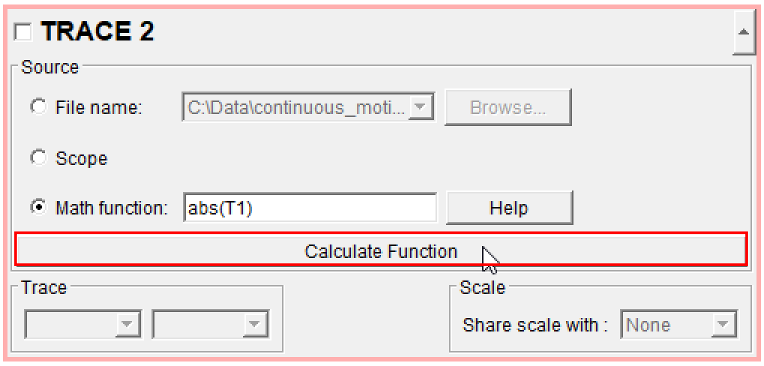
Trace 1 configuration error: Last Acquisition in Scope tool has been executed in "Roll" mode. This acquisition is not compatible in Viewer Tool.

In any case, just click on the **OK** button to clear the message and return to the *Viewer* tool.

7.2.1.3. Math function

The last option **Math function** differs from the previous ones in the sense that a virtual trace is recreated by applying mathematical operations on already loaded traces.

Consider the example of taking the absolute value of a signal. Type in `abs(T1)`, where `T1` stands for **Trace 1**, in the **Math function** edit control and click on the **Calculate Function** button.



☐ **TRACE 2**

Source

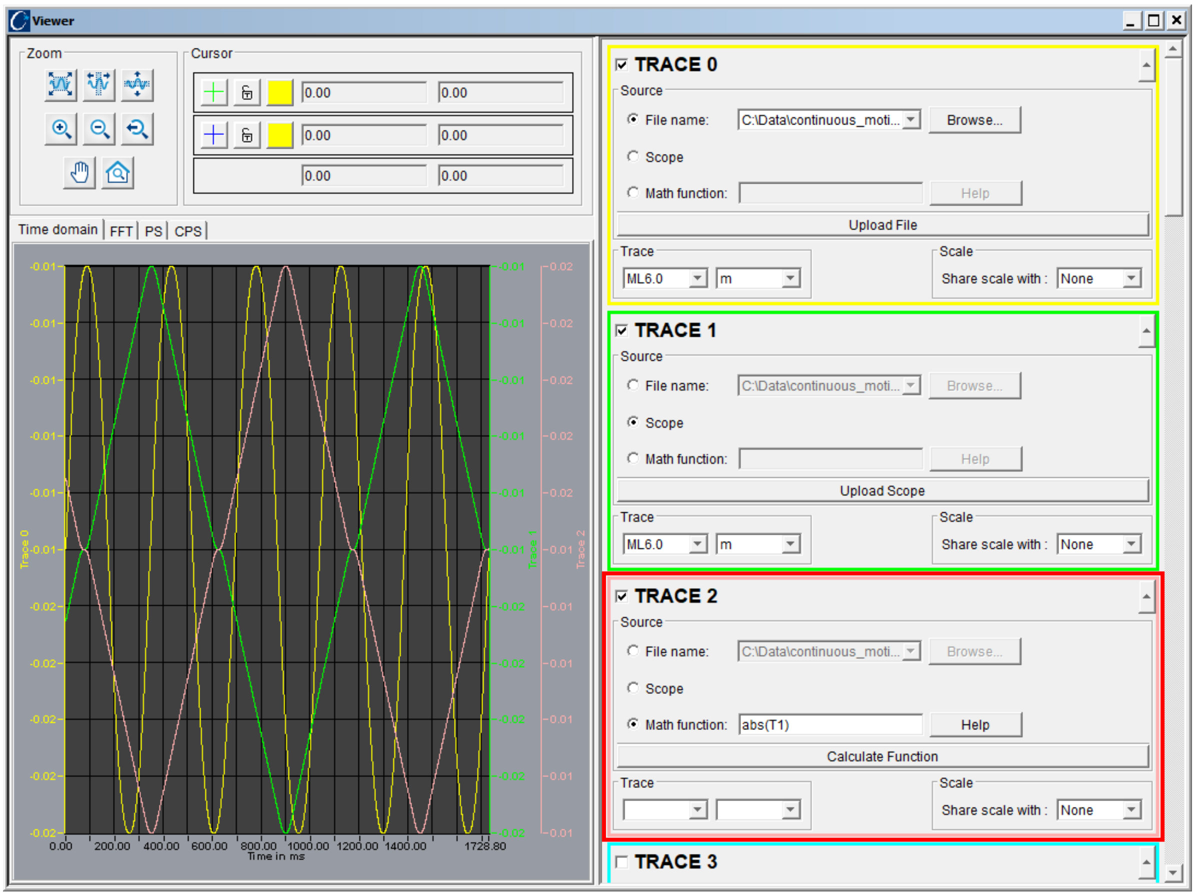
○ File name: C:\Data\continuous_moti...

○ Scope

● Math function: abs(T1)

Share scale with : None

The result is depicted below. Note that the scale of Trace 2 (rose pale scale on the right side furthest away from the plot) contains only positive numbers ranging from 0.01 to 0.02, whereas the scale of the original Trace 1 (green scale also on the right side closest to the plot) contains negative numbers ranging from -0.02 to -0.01, which is what is expected from an absolute value operation.



☑ **TRACE 0**

Source

● File name: C:\Data\continuous_moti...

○ Scope

○ Math function:

Trace: ML6.0, m

Share scale with : None

☑ **TRACE 1**

Source

○ File name: C:\Data\continuous_moti...

● Scope

○ Math function:

Trace: ML6.0, m

Share scale with : None

☑ **TRACE 2**

Source

○ File name: C:\Data\continuous_moti...

○ Scope

● Math function: abs(T1)

Share scale with : None

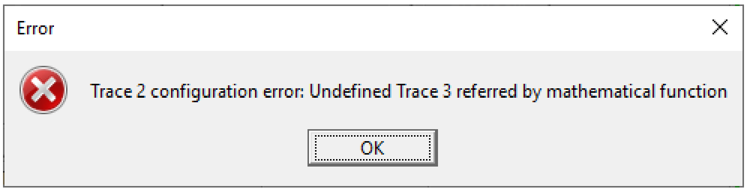
☐ **TRACE 3**

NOTE	When using the mathematical functions, `T0` refers to **Trace 0**, `T1` to **Trace 1** and so forth.

If a nonexistent mathematical function is used, an error message similar to this one is displayed.

Trace 2 configuration error: Error: Unknown function abso (col 18)

Similarly, if the mathematical function does reference to a trace not yet available in the *Viewer* tool, the following error message pops up:



Trace 2 configuration error: Undefined Trace 3 referred by mathematical function

Here is a list of the supported mathematical functions:

`a & b`	bitwise AND with a and b
`a l b`	bitwise OR with a and b
`a << b`	SHIFT LEFT a with number of bits b
`a >> b`	SHIFT RIGHT a with number of bits b
`a &~ b`	bitwise NOT AND
`a || b`	bitwise XOR with a and b
`a + b`	ADD a and b
`a - b`	SUBSTRACT b from a
`a * b`	MULTIPLY a by b
`a / b`	DIVIDE a by b
`a % b`	a MODULO b
`a ^ b`	elevate a by power of b
`abs(a)`	ABSOLUTE VALUE of a
`sqrt(a)`	SQUARE ROOT of a

Here are a few examples on how to use these mathematical functions:

- `2 * (T1 + T2) / T3 - T4;`
- `3 * abs(T1).`

Here is a list of the special series mathematical functions that are supported:

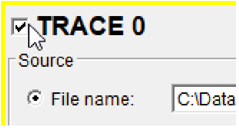
`derivative(T<n>)`	DERIVATE Trace n
`integral(T<n>)`	INTEGRATE Trace n
`undersampling(T<n>, <step>, <offset>)`	UNDERSAMPLE Trace n with step from offset
`filter(T<n>)`	MOVING AVERAGE of Trace n

NOTE

The series mathematical functions cannot be applied over a regular mathematical function. E.g. `derivative(T1 + T2)` must be handled in two steps:

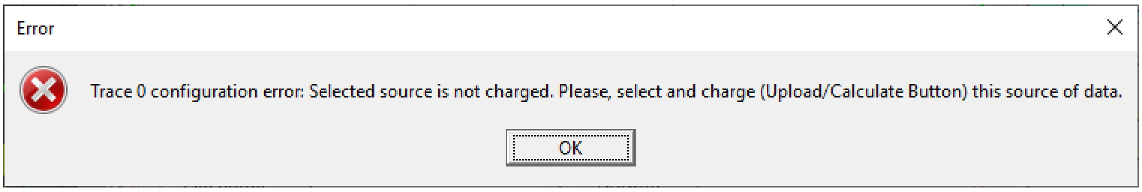
- `T3 = T1 + T2`
- `T4 = derivative(T3)`

Once a trace has been loaded to the *Viewer* tool, the user can control if the plot is actually displayed or not in the **View** area. There is checkbox control on the left of the trace name for this purpose.

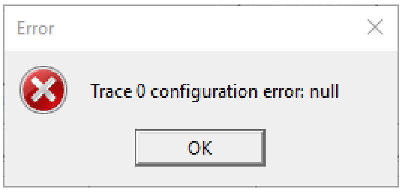


● File name: C:\Data

However, an attempt to display a trace that has not yet been loaded generates one of the following error messages, depending whether the user has already selected a Source option (i.e. **File name**, **Scope** or **Math function**) or not.

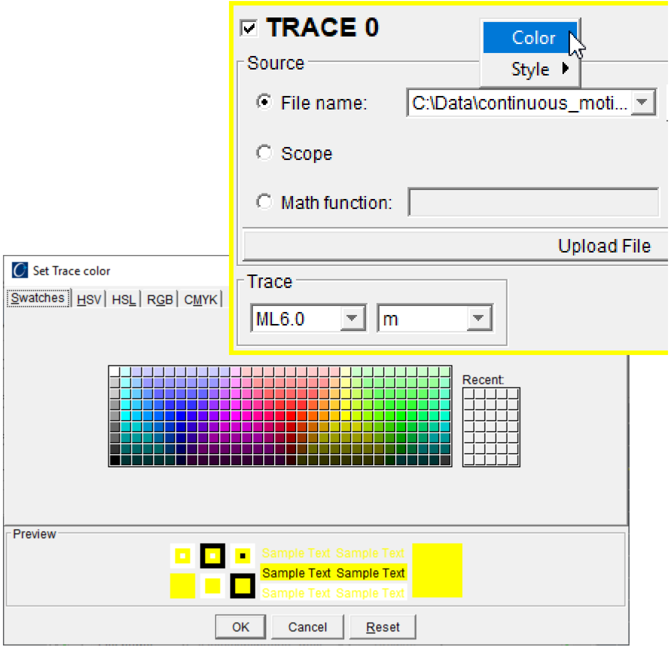


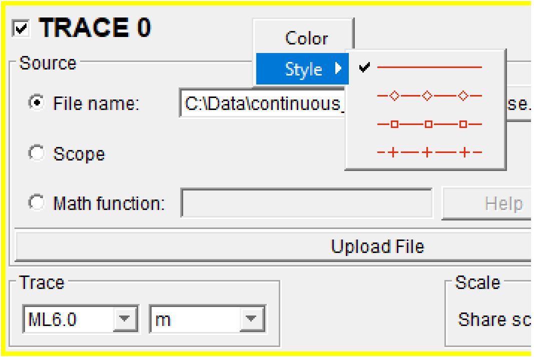
Trace 0 configuration error: Selected source is not charged. Please, select and charge (Upload/Calculate Button) this source of data.



Trace 0 configuration error: null

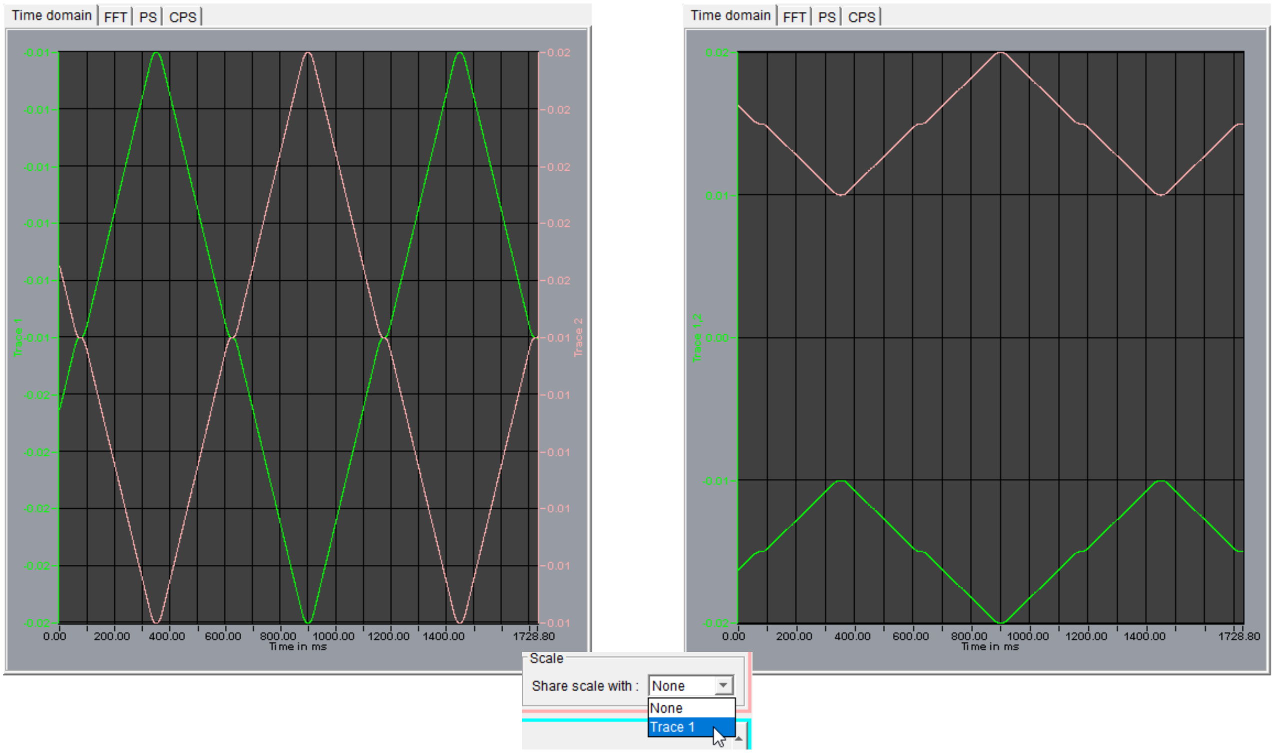
Each trace is displayed in the **View** area according to its color (border around the **Traces selection panel**). The trace color and style can be modified by right-clicking on the **Traces selection panel**.





Finally, the **Share scale with** option allows the user to apply the same scale between traces, with the corresponding update in the **View** area. In other words, one trace will be referenced to another and the same unit factor will be applied.

Take for example traces 1 and 2, where trace 2 applies the absolute value mathematical function of trace 1. If these traces do not share a common scale, each trace is displayed in the **View** area with its own scale. Selecting trace 2 to share the scale of trace 1 (or vice-versa), only one scale exists and it applies to both traces.



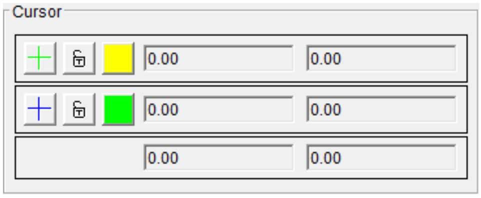
7.2.2. Zoom panel

The user can adjust the view of the plots with the available view controls from the **Zoom** panel:

⛶	Zoom to rectangle.
↔	Zoom along the horizontal axis while keeping the vertical axis scale fixed.
↕	Zoom along the vertical axis while keeping the horizontal axis scale fixed.
⊕	Zoom in with a fixed magnification ratio.
⊖	Zoom out with a fixed demagnification ratio.
↶	Undo previous Zoom action.
✋	Pan.
⌂	Return to original view.

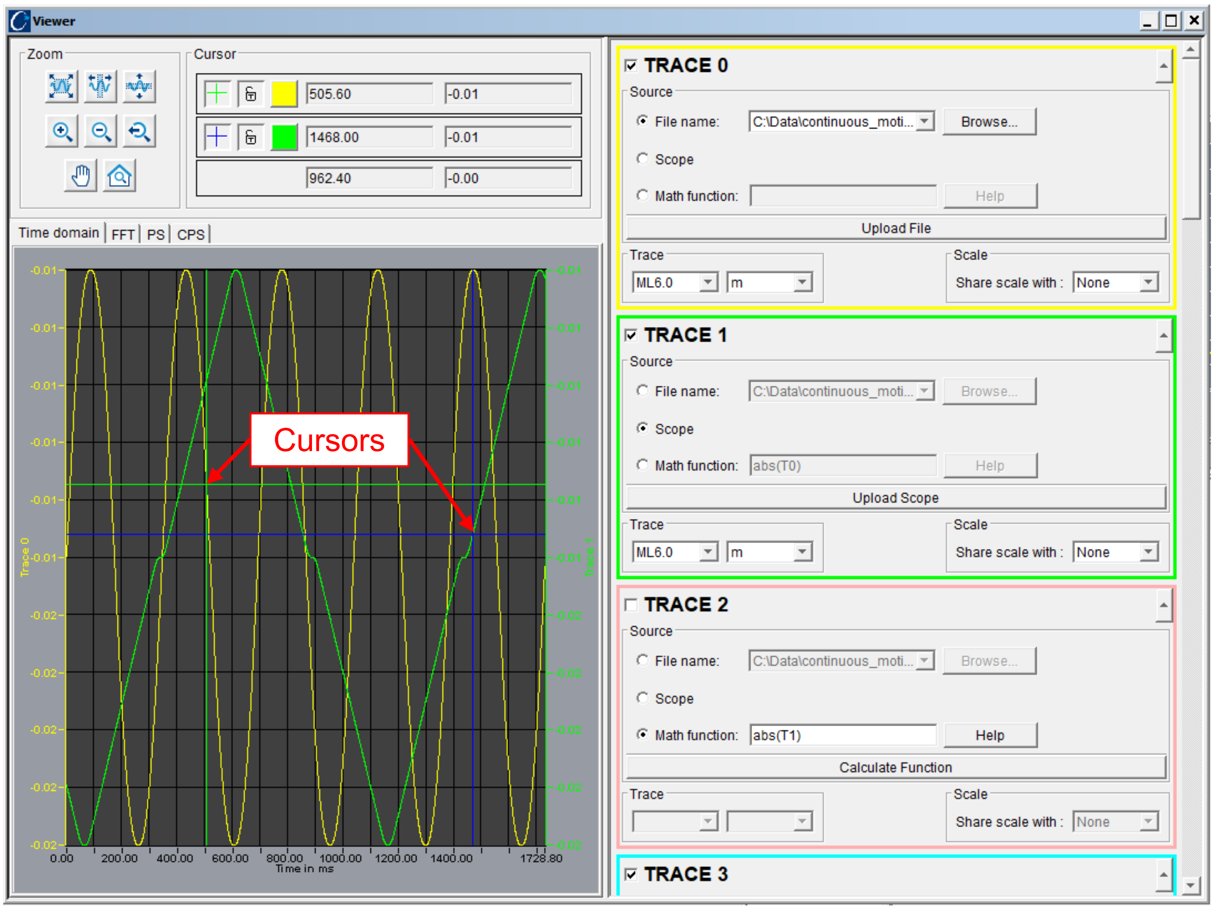
7.2.3. Cursors panel

The *Viewer* tool includes a Cursor measurement function with two cursors that can be used to readout the trace(s) values and compute the difference. This function can be configured on the **Cursors** panel.



+	🔓	🟨	0.00	0.00
+	🔓	🟩	0.00	0.00
			0.00	0.00

+	Show/Hide cursor (green/blue).
+	
🔓	Lock/Unlock cursor to assigned trace. When locked, the cursor will follow the trace signal.
🟨	Assign cursor (green/blue) to a trace (both cursors can be assigned to the same trace). Here, the green and blue cursors are assigned respectively to Trace 0 and Trace 1.
🟩	
0.00 0.00	Cursor readouts: abscissa (horizontal) and ordinate (vertical) readings. The bottom control displays the difference between green and blue cursor readouts.



505.60 -0.01
1468.00 -0.01
962.40 -0.00

☑ TRACE 0
● File name: C:\Data\continuous_moti...
○ Scope
○ Math function:
Trace: ML6.0 m
Share scale with : None

☑ TRACE 1
○ File name: C:\Data\continuous_moti...
● Scope
○ Math function: abs(T0)
Trace: ML6.0 m
Share scale with : None

☐ TRACE 2
○ File name: C:\Data\continuous_moti...
○ Scope
● Math function: abs(T1)
Share scale with : None

☑ TRACE 3

7.2.4. View

The traces loaded to the *Viewer* tool are displayed in this area. Each trace will have its own scale, except if the scale sharing option is activated in the **Traces selection panel**.

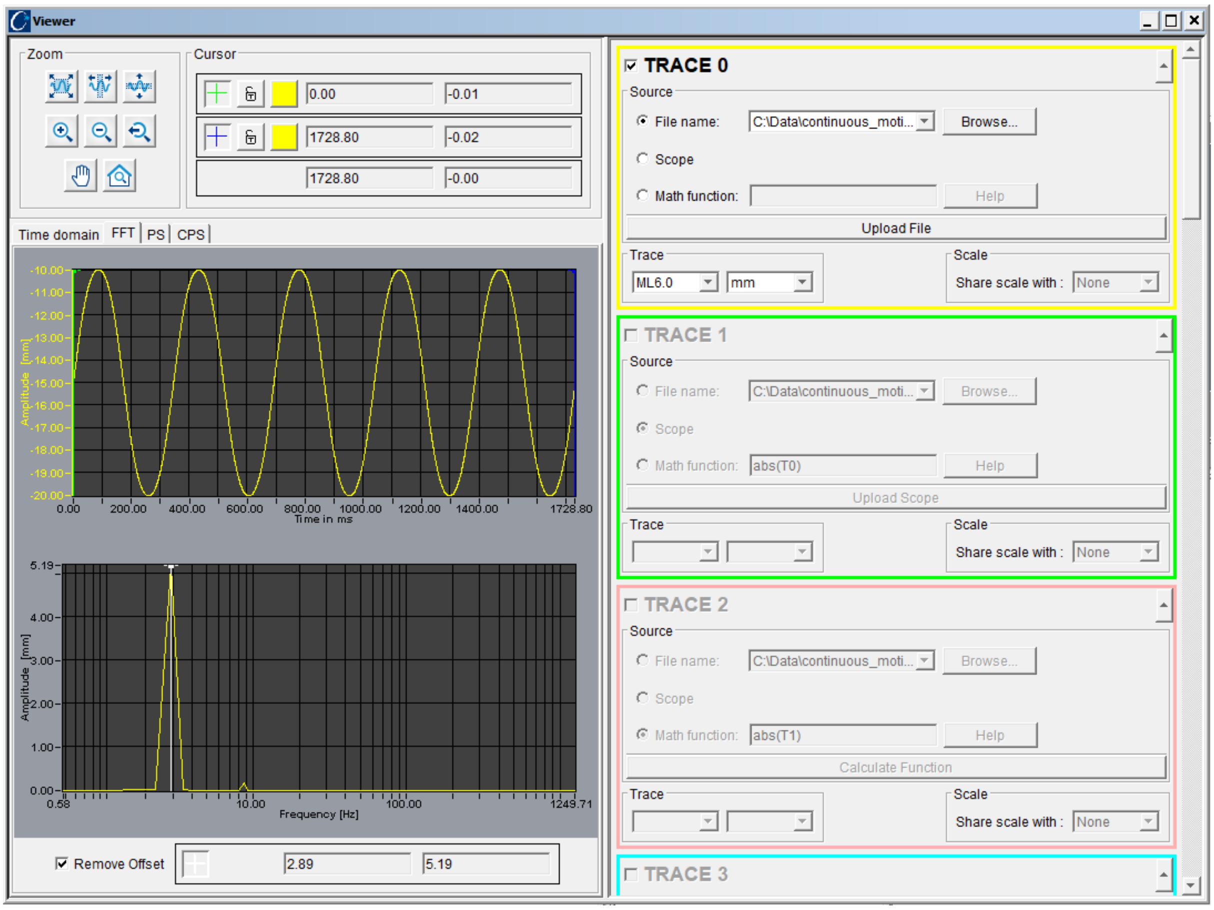
The **View** area includes four panels:

- Time domain;
- Fast Fourier Transform (FFT) of the first selected trace in the **Traces selection panel**;
- Power Spectrum (PS) of the first selected trace in the **Traces selection panel**; and
- Cumulative Power Spectrum (CPS) of the first selected trace in the **Traces selection panel**.

Two plots are displayed in the **FFT**, **PS** and **CPS** panels:

- Top plot: first selected trace in the **Traces selection panel** (time domain); and
- Bottom plot: single-sided FFT/PS/CPS of the selected trace (frequency domain).

In these **FFT**, **PS** and **CPS** panels, the user can use the green and blue cursors on the time domain plot to delimit the signal for which the FFT/PS/CPS is actually computed (these are the cursors the user can configure under the **Cursors** panel).



Cursor: 0.00 / -0.01; 1728.80 / -0.02; 1728.80 / -0.00

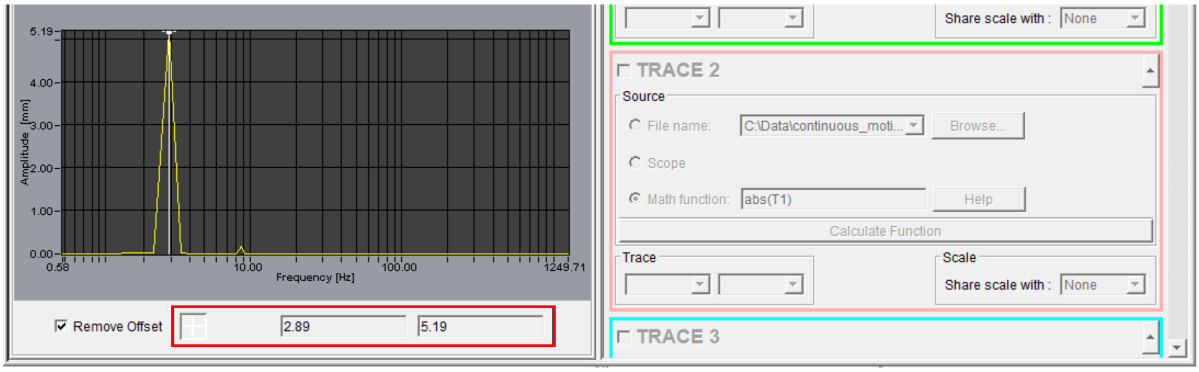
☑ TRACE 0
Source
● File name: C:\Data\continuous_moti...
○ Scope
○ Math function:
Trace: ML6.0 mm
Scale: Share scale with : None

☐ TRACE 1
Source
○ File name: C:\Data\continuous_moti...
● Scope
○ Math function: abs(T0)
Scale: Share scale with : None

☐ TRACE 2
Source
○ File name: C:\Data\continuous_moti...
○ Scope
● Math function: abs(T1)
Scale: Share scale with : None

☑ Remove Offset 2.89 5.19

Furthermore, these panels have a third cursor (white) available to be used exclusively on the frequency domain plots. The abscissa and ordinate for this cursor, as well as the show/hide control, can be found in the bottom part of the window. Finally, the user can choose to remove the offset (DC component).



Share scale with : None

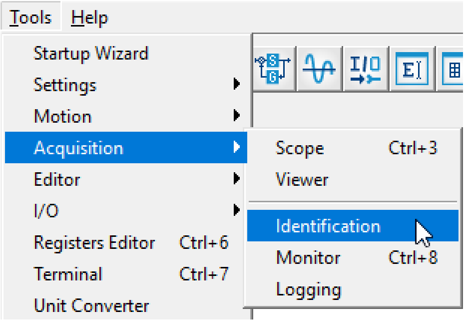
☐ TRACE 2
Source
○ File name: C:\Data\continuous_moti...
○ Scope
● Math function: abs(T1)
Scale: Share scale with : None

☑ Remove Offset 2.89 5.19

7.3. Identification

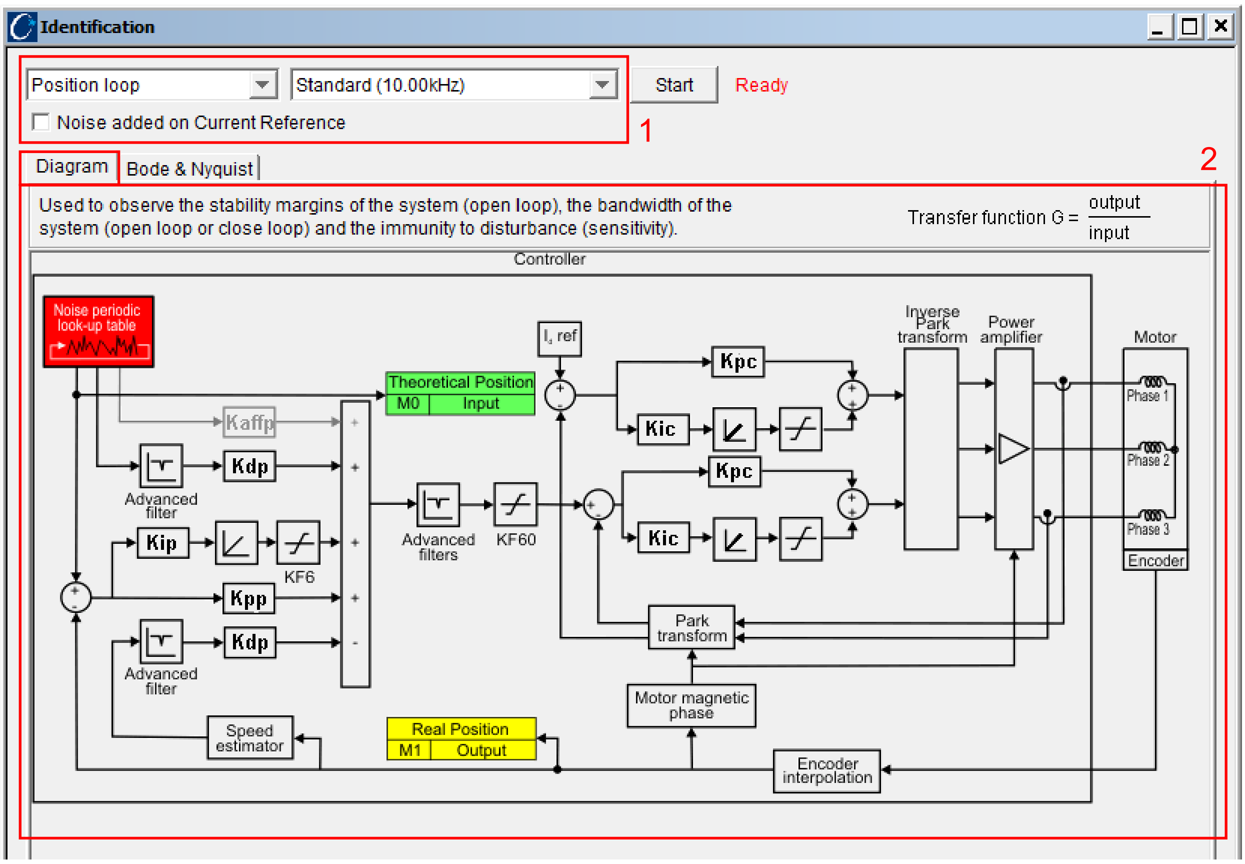
After a basic setting of the Controller is completed (refer to Section §4.1 for more information on how to realize a basic setting), the user can use the various types of identification available in the *Identification* tool to validate and fine tune the Controller's regulation.

This tool can be launched by selecting the Menu option **Tools → Acquisition → Identification**:



The main window of the *Identification* tool is divided into 2 areas:

1. Selection of the identification type and frequency limit/level of quality;
2. Panel with two tabs
    a. **Diagram** showing a representation of the Controller's regulators with the noise injection point and measurement points (inputs and outputs) corresponding to the selected type of identification; and
    b. **Bode and Nyquist** plots of the selected transfer function amongst those computed from the identification performed.

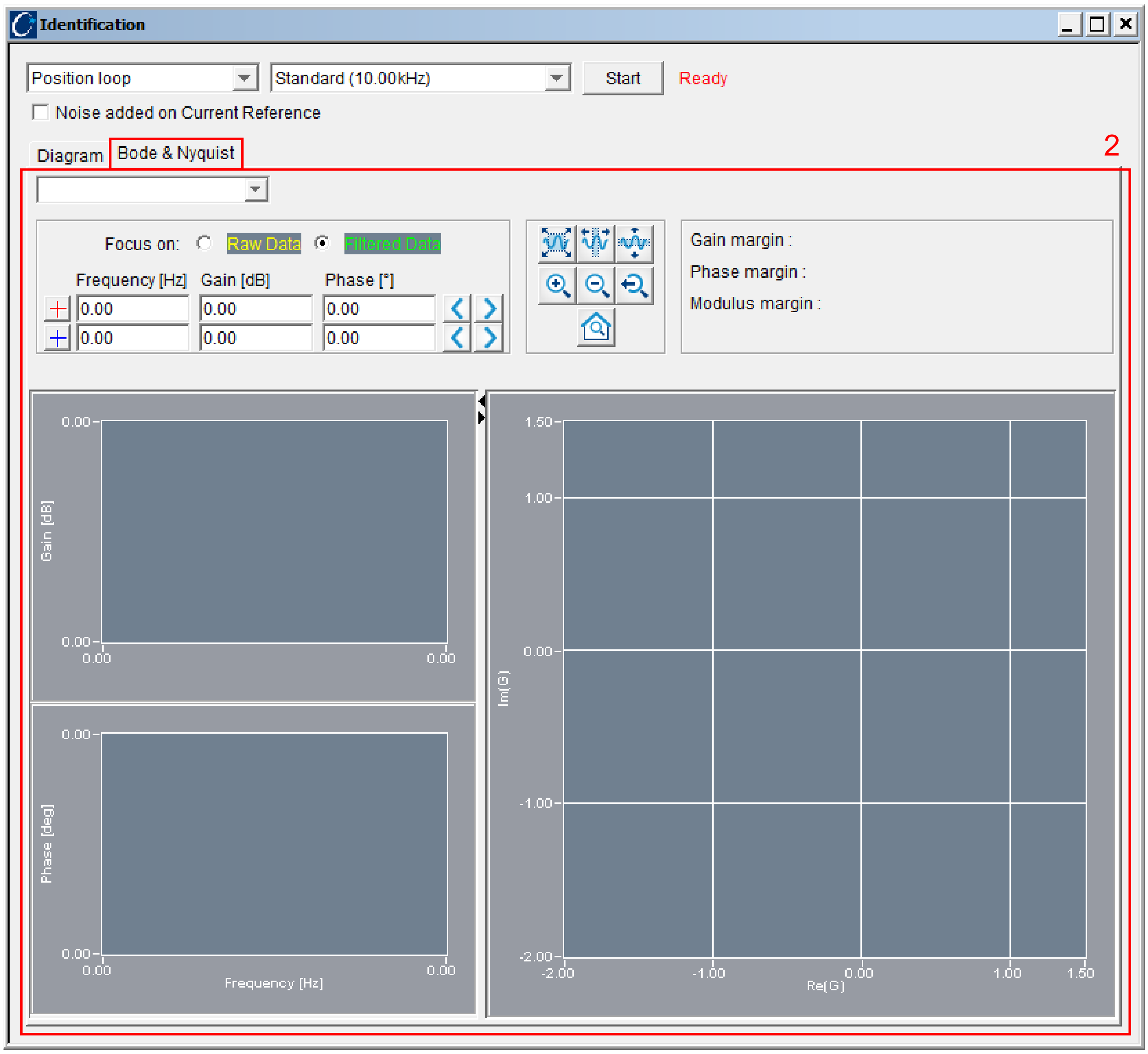

Identification

Position loop
Standard (10.00kHz)
Start
Ready
☐ Noise added on Current Reference

Diagram
Bode & Nyquist

Used to observe the stability margins of the system (open loop), the bandwidth of the system (open loop or close loop) and the immunity to disturbance (sensitivity).

Transfer function G = $\frac{\text{output}}{\text{input}}$



Identification

Position loop | Standard (10.00kHz) | Start | Ready

☐ Noise added on Current Reference

Diagram | Bode & Nyquist

Focus on: ○ Raw Data ● Filtered Data

Frequency [Hz]	Gain [dB]	Phase [°]
0.00	0.00	0.00
0.00	0.00	0.00

Gain margin :
Phase margin :
Modulus margin :

In the **Bode & Nyquist** panel, the user can adjust the view of the plots with the available tools:

⛶	Zoom to rectangle.
↔	Zoom along the horizontal axis while keeping the vertical axis scale fixed.
↕	Zoom along the vertical axis while keeping the horizontal axis scale fixed.
⊕	Zoom in with a fixed magnification ratio.
⊖	Zoom out with a fixed demagnification ratio.
↶	Undo previous Zoom action.
⌂	Return to original view.
○ Raw Data ○ Filtered Data	Select which of the plotted data has the focus for the cursors' information: raw or filtered.
+	Enable/disable the red vertical cursor.

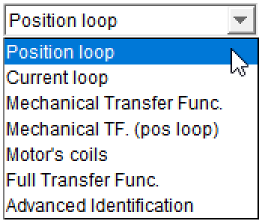
+	Enable/disable the blue vertical cursor.
<	Move to the left the vertical cursor with the focus.
>	Move to the right the vertical cursor with the focus.
◀ ▶	Extend the Nyquist plot by hiding the Bode plot and vice-versa.

The *Identification* tool is capable of realizing different types of identification. They all rely on experiments that are performed under the following basic conditions:

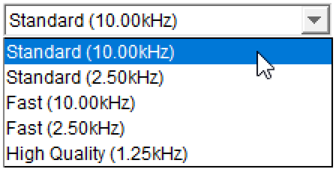
- Open or Closed position control loop; and
- Noise injected at the level of the theoretical position or theoretical current.

As for the measurement points (inputs and outputs), these vary according to the type of identification selected (refer to the following Sections for details).

Here are the types of identification supported:

Identification type		Noise injection point	Position control loop
	Position loop	Theoretical position	Closed
		Theoretical current	
	Current loop	Theoretical current	Open
	Mechanical Transfer Func.	Theoretical current	Open
	Mechanical TF. (pos loop)	Theoretical position	Closed
		Theoretical current	
	Motor's coils	Theoretical current	Open
	Full Transfer Func.	Theoretical position	Closed
		Theoretical current	
	Advanced Identification	Theoretical position	Closed
		Theoretical current	Open
			Closed

The user must also select the frequency limit and level of quality of the identification:

Frequency limit and level of quality		Frequency limit	Frequency bands		
			Number	Bands (Hz)	
	Standard (10.00 kHz)	10 kHz	8	[0 – 78.1] [156 – 313] [625 – 1250] [2500 – 5000]	[78.1 – 156] [313 – 625] [1250 – 2500] [5000 – 10000]
	Standard (2.50 kHz)	2.5 kHz	6	[0 – 78.1] [156 – 313] [625 – 1250]	[78.1 – 156] [313 – 625] [1250 – 2500]
	Fast (10.00 kHz)	10 kHz	6	[0 – 313] [625 – 1250]	[313 – 625] [1250 – 2500]

			[2500 – 5000]	[5000 – 10000]
Fast (2.50 kHz)	2.5 kHz	4	[0 – 313] [625 – 1250]	[313 – 625] [1250 – 2500]
High Quality (1.25 kHz)	1.25 kHz	8	[0 – 9.77] [19.5 – 39.1] [78.1 – 156] [313 – 625]	[9.77 – 19.5] [39.1 – 78.1] [156 – 313] [625 – 1250]

NOTE	The frequency limit depends on the Controller connected to ***ComET4***.

Once the type of identification and frequency limit/quality level have been selected, click on the **Start** button to initiate an identification.

7.3.1. Position loop

The **Position loop** identification type is suited for analyzing the stability margins and bandwidth of the system and the immunity to disturbances.

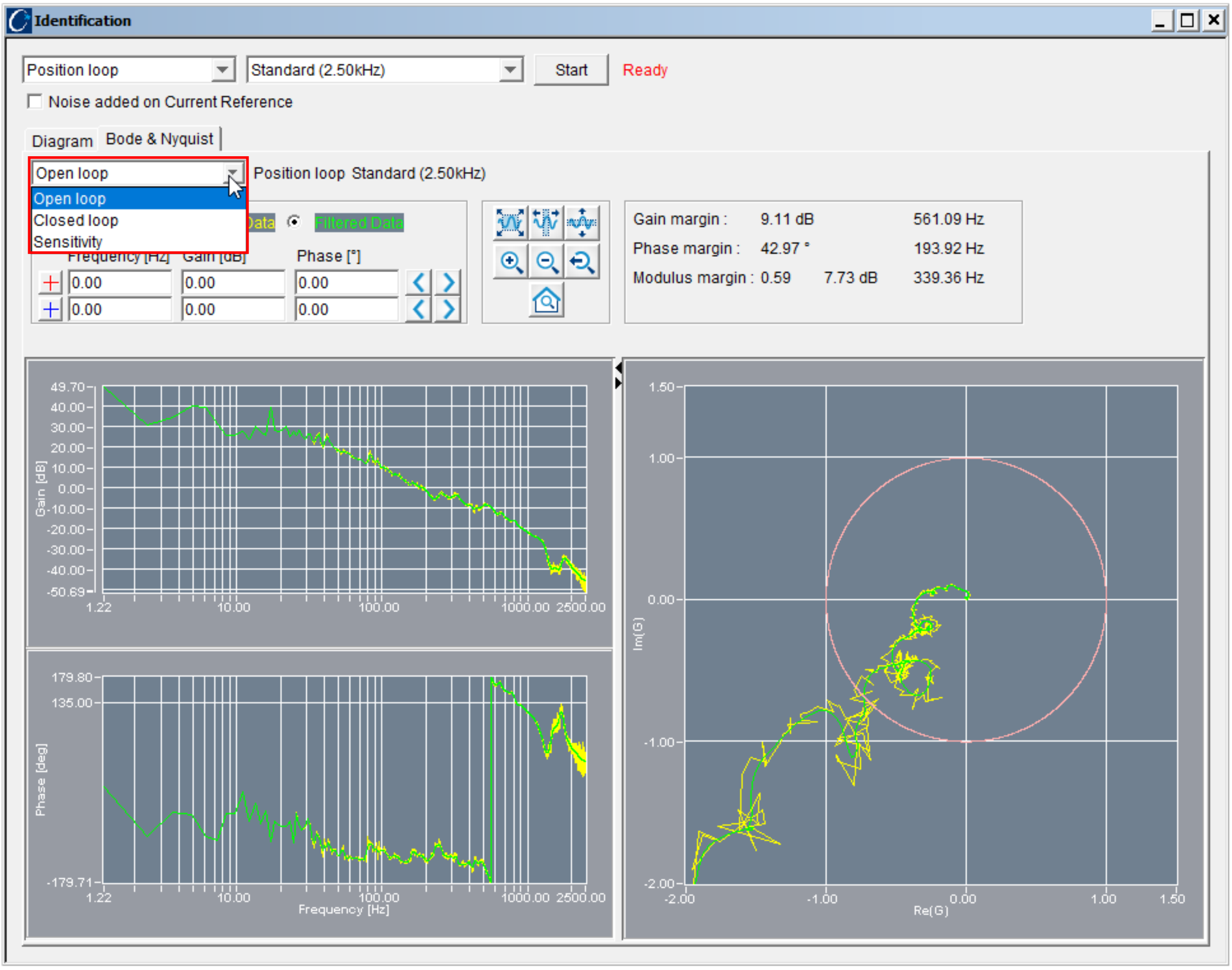
This identification is realized in position closed loop mode, with the possibility of selecting between injecting the noise at the level of the theoretical position or theoretical current through the **Noise added on Current Reference** checkbox control.

The measurement points for this type of identification are:

Noise injection point	**Measurement points**	
	Inputs	**Outputs**
Theoretical position	Theoretical position (`M0`)	Real position (`M1`)
Theoretical current	Injected noise (`MF236`)	Theoretical current before `KF60` limit (`MF233`)

Once the identification has finished, the **Bode & Nyquist** plots are displayed, with the option of selecting amongst the three transfer functions available:

- Open loop, defining the system's stability margin (gain, phase and modulus margins) and bandwidth (0 dB frequency crossing);
- Closed loop, defining the system's rigidity;
- Sensitivity, defining the system's immunity to disturbances.



Identification

Position loop | Standard (2.50kHz) | Start | Ready

☐ Noise added on Current Reference

Diagram | Bode & Nyquist

Open loop

- Open loop
- Closed loop
- Sensitivity

Position loop Standard (2.50kHz)

Gain margin :	9.11 dB		561.09 Hz
Phase margin :	42.97 °		193.92 Hz
Modulus margin :	0.59	7.73 dB	339.36 Hz

NOTE	The Nyquist diagram is only displayed for the open loop transfer function, as it has no meaning for the other two transfer functions (closed loop and sensitivity).

7.3.2. Current loop

The **Current loop** identification type is suited for observing the stability margins and bandwidth of the current loop and its immunity to disturbances.

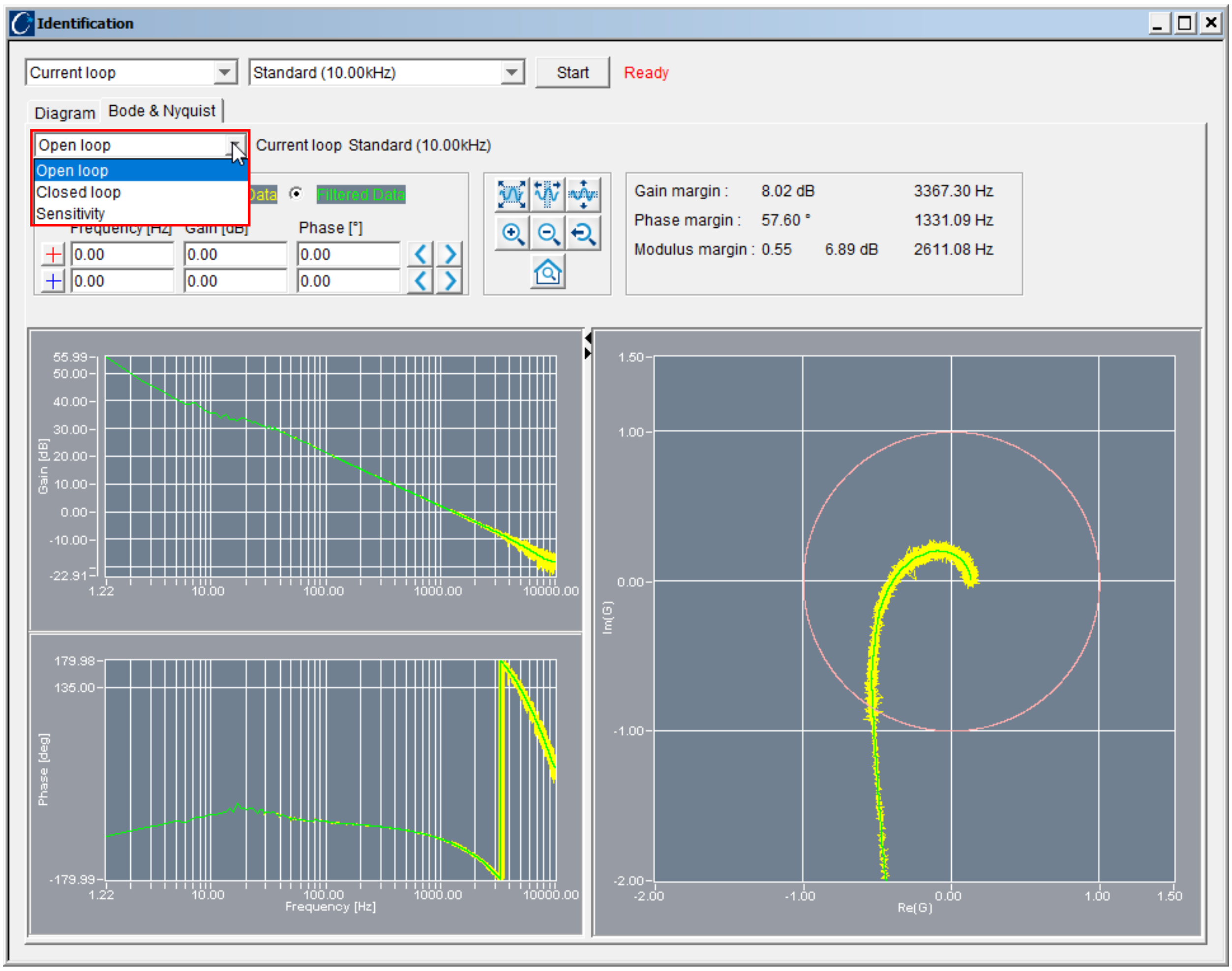
This identification is realized in position open loop mode, but current closed loop mode, with the noise injection point at the level of the theoretical current.

The measurement points for this identification type are:

Noise injection point	Measurement points	
	Inputs	Outputs
Theoretical current	Theoretical current (`MF30`)	Real current (`MF31`)

Once the identification has finished, the **Bode & Nyquist** plots are displayed, with the option of selecting amongst the three transfer functions available.

- Open loop;
- Closed loop;
- Sensitivity.



Current loop | Standard (10.00kHz) | Ready

Open loop

Current loop Standard (10.00kHz)

Frequency [Hz]	Gain [dB]	Phase [°]
0.00	0.00	0.00
0.00	0.00	0.00

Gain margin :	8.02 dB	3367.30 Hz
Phase margin :	57.60 °	1331.09 Hz
Modulus margin : 0.55	6.89 dB	2611.08 Hz

7.3.3. Mechanical Transfer Func.

The **Mechanical Transfer Func.** identification type is suited for analyzing the mechanical behavior of the system independent from the setting: resonances and anti-resonances, integrator effect, etc.

The mass (inertia) can also be determined using the mass-line (-40 dB/dec slop line in the mechanical position transfer function and -20 dB/dec slop line in the mechanical speed transfer function).

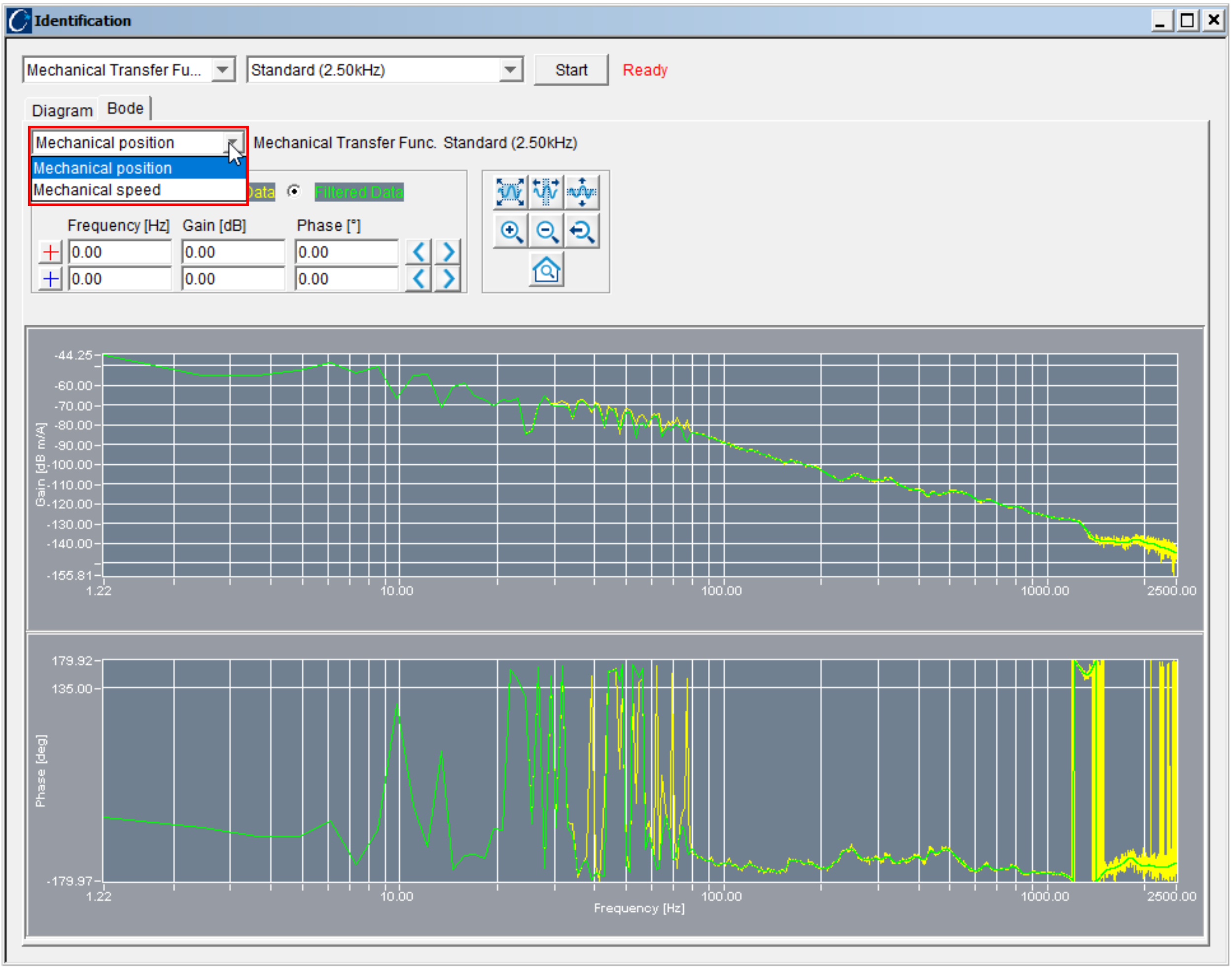
This identification is realized in position open loop mode, with the noise injection point at the level of the theoretical current.

The measurement points for this identification type are:

Noise injection point	Measurement points	
	Inputs	Outputs
Theoretical current	Real current (`MF31`)	Real position (`M1`) Real speed before advanced filter depth 0 (`M111`)

Once the identification has finished, only the **Bode** plots are displayed, with the option of selecting between the two transfer functions available:

- Mechanical position defining the force vs. position; and
- Mechanical speed defining the force vs. speed.



7.3.4. Mechanical TF. (pos loop)

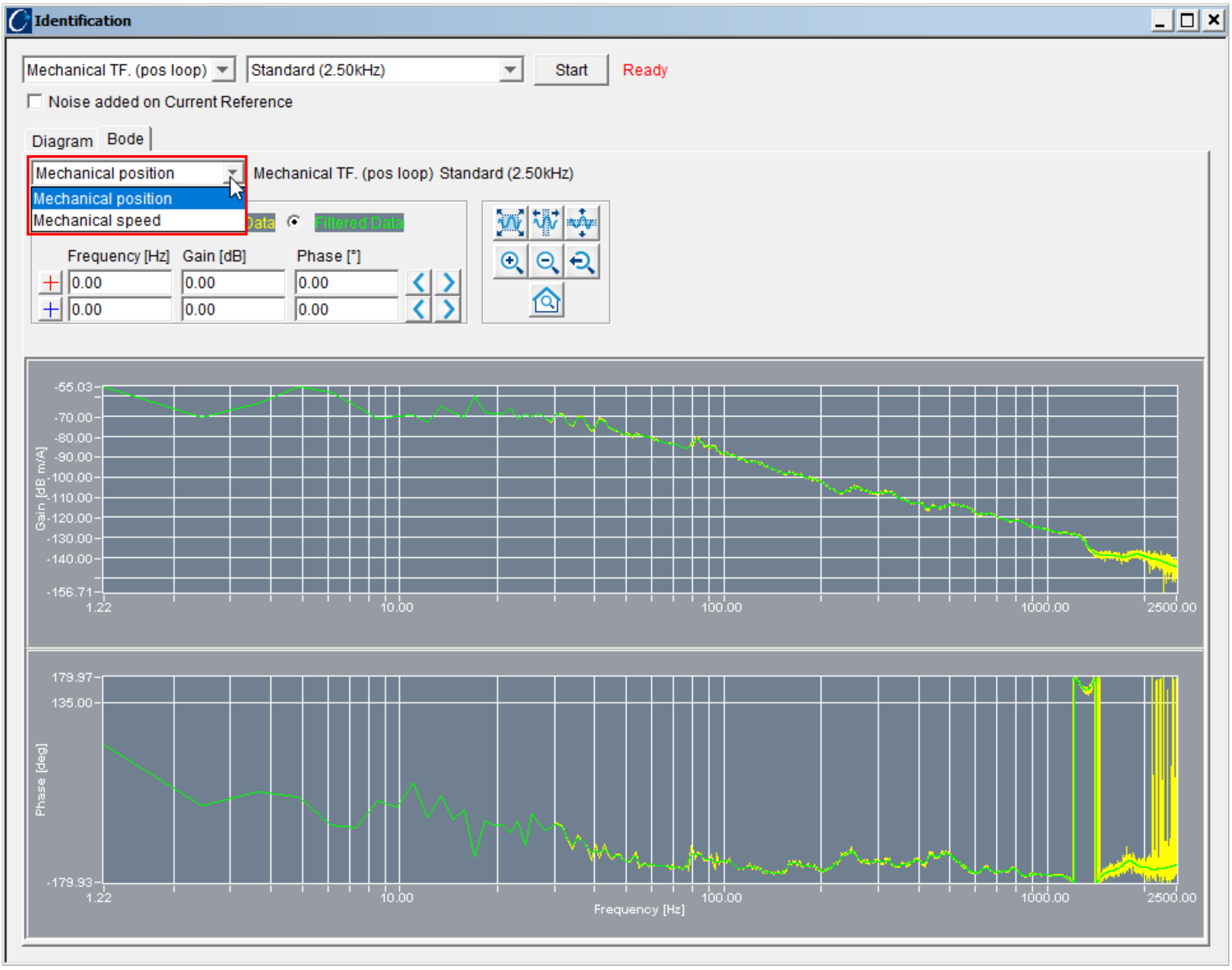
The **Mechanical TF. (pos loop)** identification type is similar to the previous one (§7.2.3), but realized in position closed loop mode. Also, the user can select between injecting the noise at the level of the theoretical position or theoretical current using the **Noise added on Current Reference** checkbox control.

The measurement points for this identification type are:

Noise injection point	Measurement points	
	Inputs	Outputs
Theoretical position	Theoretical position (`M0`)	Real position (`M1`) Real speed (`M11`) Real current (`MF31`)
Theoretical current	Injected noise (`MF236`)	

As for the previous identification type (§7.2.3), the transfer functions available for analysis are:

- Mechanical position defining the force vs. position; and
- Mechanical speed defining the force vs. speed.



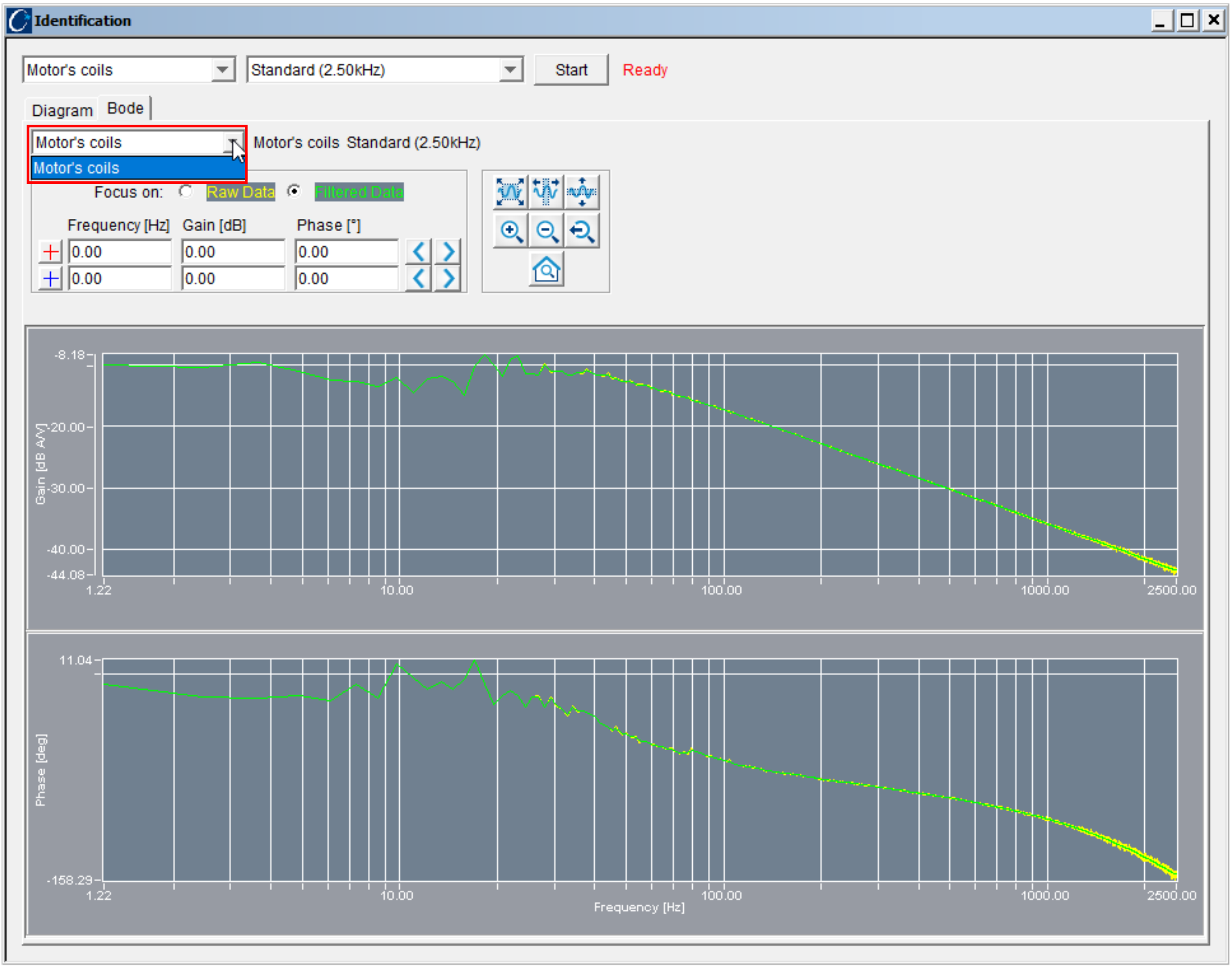
7.3.5. Motor's coils

This **Motor's coils** identification type is suited for analyzing the electrical transfer function of the first phase of the motor and it is realized in position open loop mode.

The measurement points for this identification type are:

Noise injection point	Measurement points	
	Inputs	Outputs
Theoretical current	Phase 1 theoretical voltage (`MF29`)	Real current (`MF31`)

There is only one transfer function for analysis: Motor's coils.



7.3.6. Full Transfer Func.

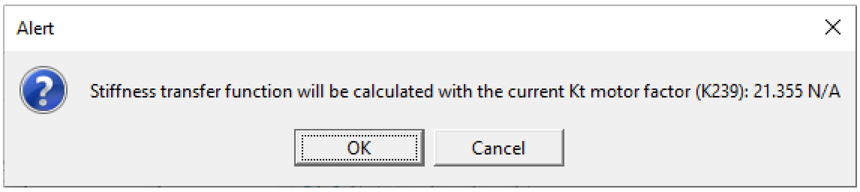
The **Full Transfer Func.** is a combination of the following identification types:

- **Position loop**;
- **Current loop**; and
- **Mechanical TF. (pos loop)**.

It is suited for analyzing the stability margins and bandwidth of the system, the immunity to disturbances, the mechanical behavior (resonances and anti-resonances) and finally the stiffness of the system. It is the most efficient way of doing all these analysis with a single identification.

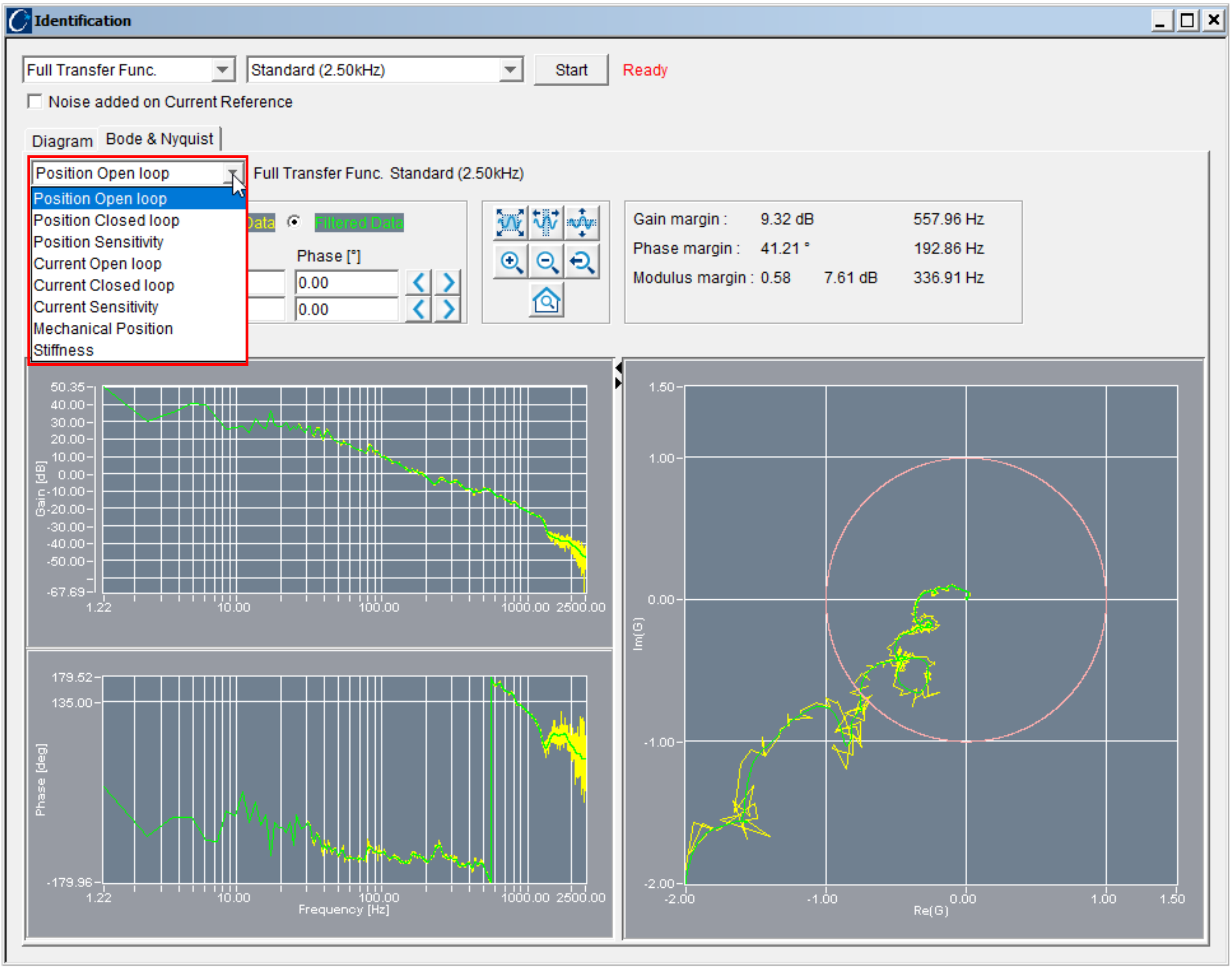
This identification is realized in position closed loop mode, with the possibility of selecting between injecting the noise at the level of the theoretical position or theoretical current using the **Noise added on Current Reference** checkbox control.

Immediately after clicking on the **Start** button to execute the identification, the following warning message is displayed to inform the user that the stiffness transfer function will be calculated using the motor Kt factor set on the Controller. Simply click on the **OK** button to proceed with the identification or **Cancel** to abort.



Stiffness transfer function will be calculated with the current Kt motor factor (K239): 21.355 N/A

The transfer functions available are the same as those for the identification types **Position loop**, **Current loop** and **Mechanical TF. (pos loop)**, with an additional **Stiffness** transfer function.

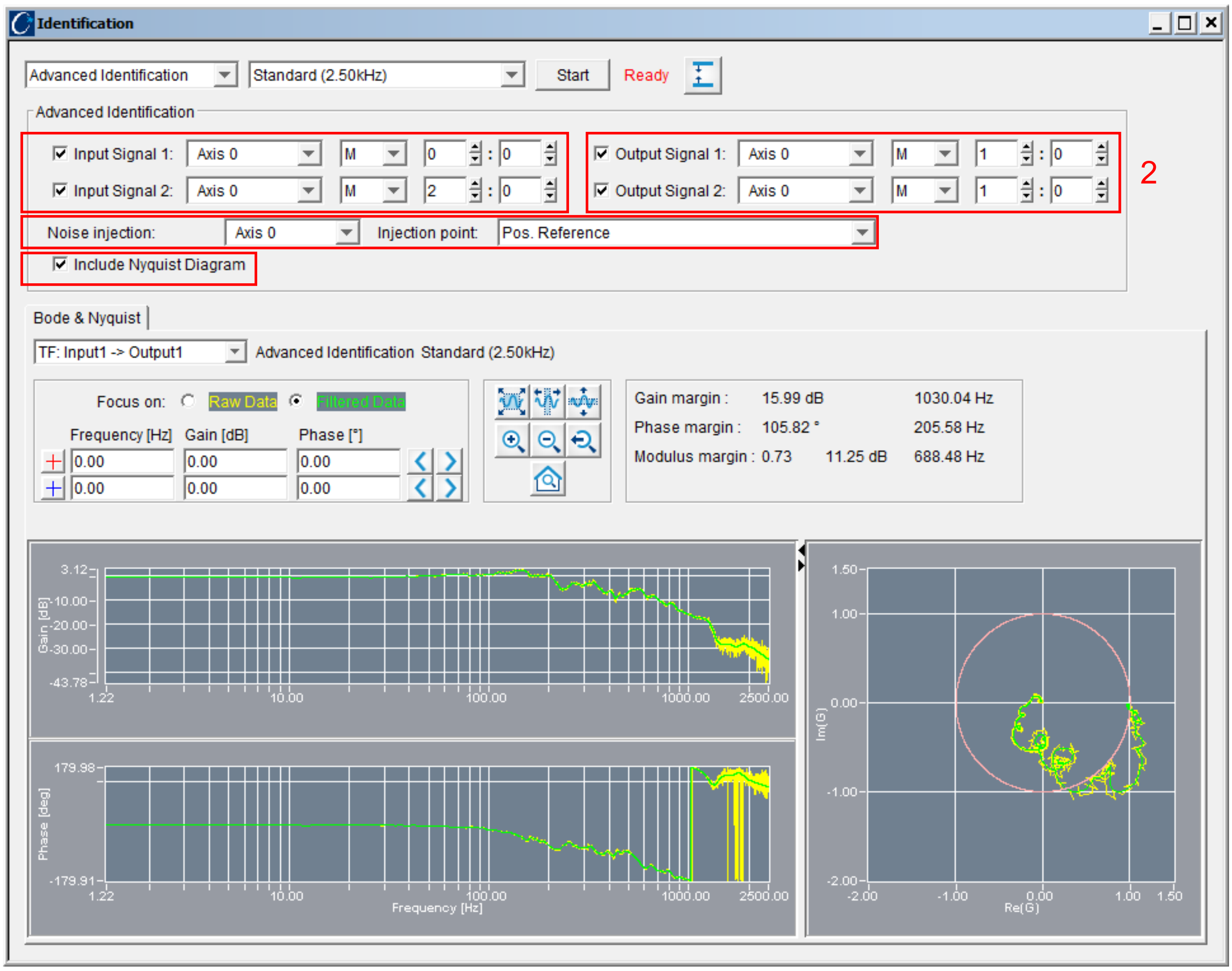


Gain margin : 9.32 dB 557.96 Hz
Phase margin : 41.21 ° 192.86 Hz
Modulus margin : 0.58 7.61 dB 336.91 Hz

7.3.7. Advanced Identification

This type of identification provides the possibility to define ad-hoc transfer functions. The user must specify:

1. Input signals: axis number and register type, index and depth;
2. Output signals: axis number and register type, index and depth;
3. Noise injection point: axis number and injection point:
    a. Theoretical position: **Pos. Reference**;
    b. Theoretical current in open loop mode: **Cur. Reference (with Pos. loop open)**;
    c. Theoretical current in closed loop mode: **Added on Cur. Reference (with Pos. loop open)**.
4. Display or not the Nyquist plot together with the Bode plot.



Identification

Advanced Identification | Standard (2.50kHz) | Start | Ready

Advanced Identification

☑ Input Signal 1: Axis 0 | M | 0 : 0
☑ Input Signal 2: Axis 0 | M | 2 : 0
☑ Output Signal 1: Axis 0 | M | 1 : 0
☑ Output Signal 2: Axis 0 | M | 1 : 0
Noise injection: Axis 0 | Injection point: Pos. Reference
☑ Include Nyquist Diagram

Bode & Nyquist

TF: Input1 -> Output1 | Advanced Identification Standard (2.50kHz)

Focus on: ○ Raw Data ● Filtered Data

Frequency [Hz]	Gain [dB]	Phase [°]
0.00	0.00	0.00
0.00	0.00	0.00

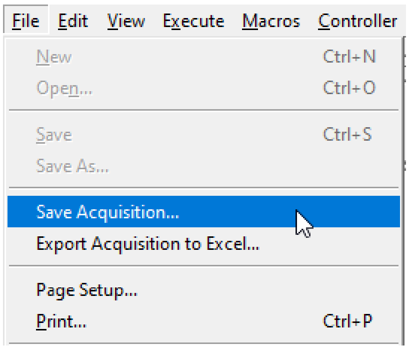
Gain margin : 15.99 dB 1030.04 Hz
Phase margin : 105.82 ° 205.58 Hz
Modulus margin : 0.73 11.25 dB 688.48 Hz

The transfer functions are then computed between the output signals and the input signals. Since it is possible to select input and output signals from different axes, crossed-identification analysis are possible with this option.

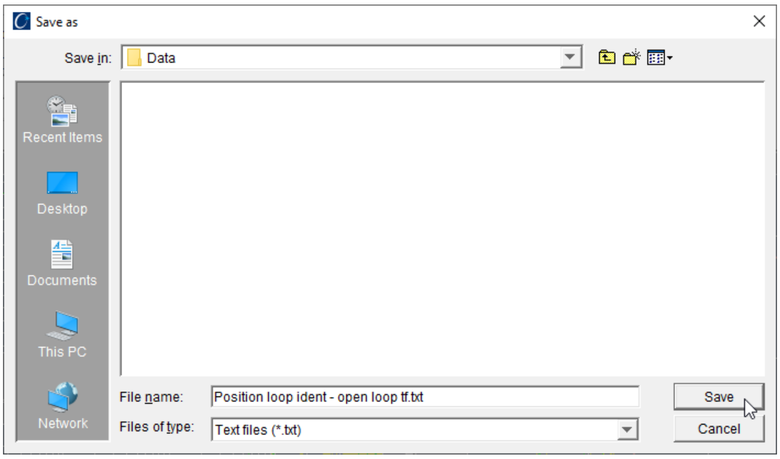
The button enables the user to hide the advanced options, leaving more space for the Bode and Nyquist plots. Click on the button to revert the view.

7.3.8. Save acquisition data

The identification information can be saved to a text file and imported into the ***ATP Analysis*** tool. With the interface focus on the *Identification* tool window, select the menu entry **File → Save Acquisition…**.



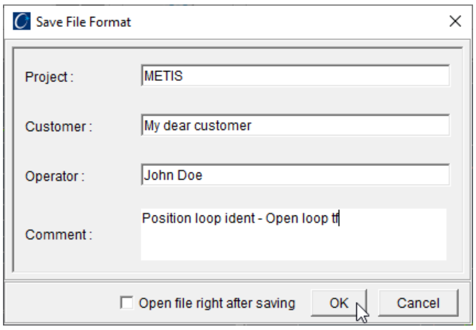
Type in the file name in the **Save As** dialog box and click on the **Save** button. Then, fill in the information in the **Save File Format** dialog box and finally press on the **OK** button to save the identification data.



Save in: Data

File name: Position loop ident - open loop tf.txt

Files of type: Text files (*.txt)



Project : METIS

Customer : My dear customer

Operator : John Doe

Comment : Position loop ident - Open loop tf

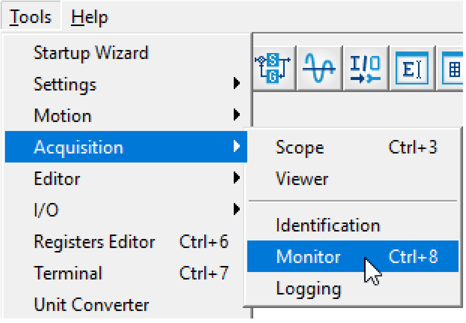
☐ Open file right after saving

Alternatively, the identification information can be exported to Excel `(*.csv` file format) by selecting the menu option **File → Export Acquisition to Excel…**.

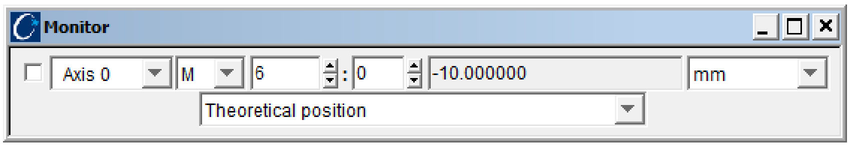
7.4. Monitor

The *Monitor* tool is one of the simplest tools available in ***ComET4*** for monitoring and troubleshooting an application.

To launch the *Monitor* tool, go to the Menu option **Tools → Acquisition → Monitor**:



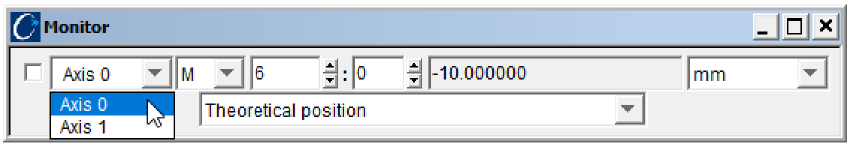
Compared to the *Scope*, the *Monitor* tool can be used to monitor a wider selection of register types (basic and advanced) belonging to any axis, but only the most recently sampled value is displayed.



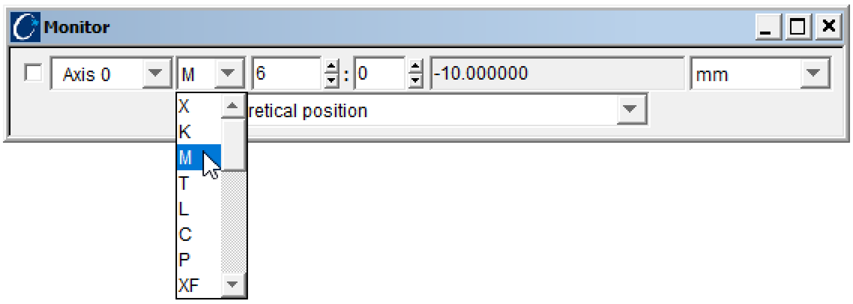
☐ Axis 0 | M | 6 : 0 | -10.000000 | mm

Theoretical position

First, select the axis from the left-most drop-down list.



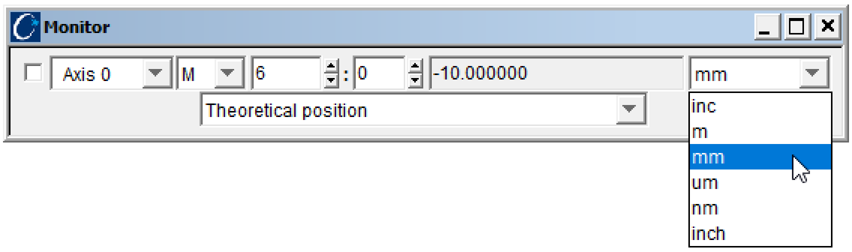
Then, choose the register type from the second drop-down list, as well as register's index and depth from the next list controls.



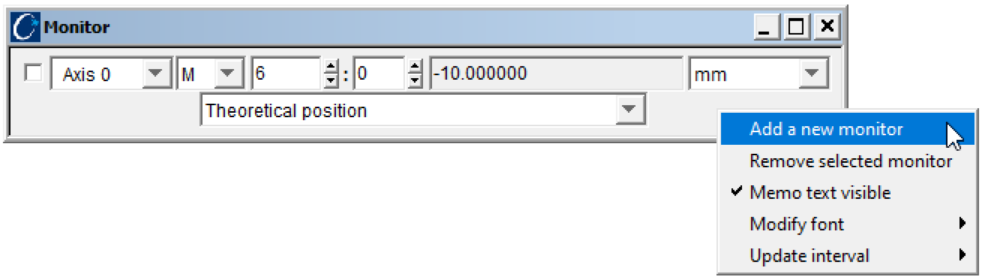
The register types supported by the *Monitor* tool are:

Register type	Description	Integer	Long	Float	Double
K	Parameter	K	KL	KF	KD
M	Monitoring	M	ML	MF	
X	User variable	X	XL	XF	XD
C	Common	C	CL	CF	CD
L	Look-up table	L			LD
T	Trace	T	TL	TF	TD
P	Mapping	P			
E	Trigger		EL		

Finally, select the units used to display the register's values from the right-most drop-down list.



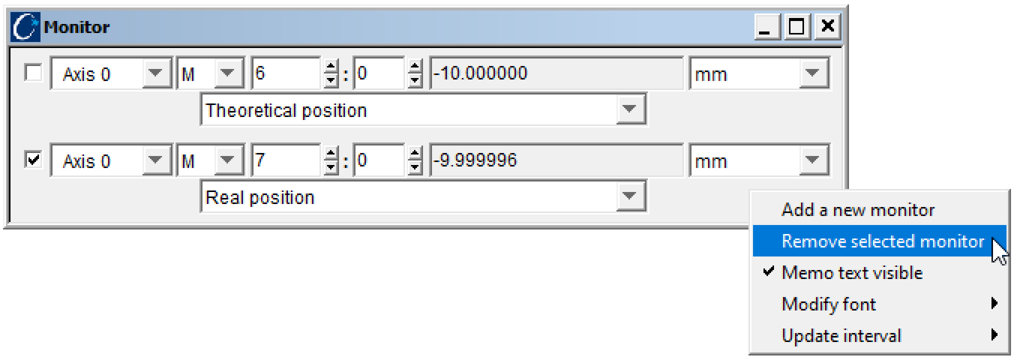
To add a new monitor to the tool, simply right-click on the tool's window and select the **Add new monitor** option from the context menu.



☐ Axis 0 | M | 6 : 0 | -10.000000 | mm
Theoretical position

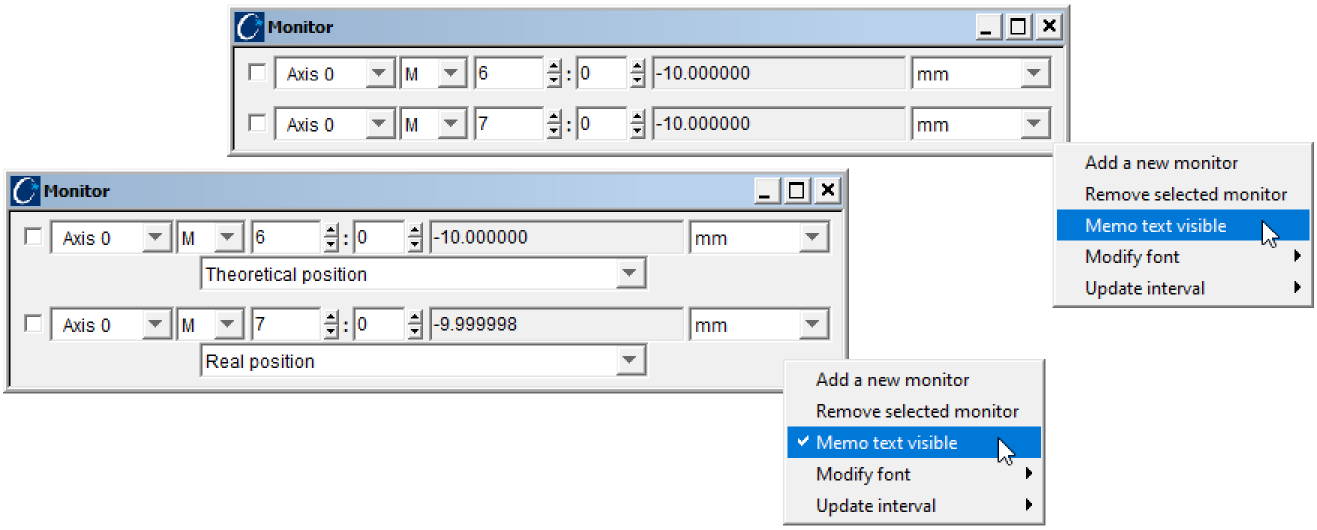
NOTE The *Monitor* tool can display as many registers as wanted. But, there is a practical limit since the tool window size is constrained to ***ComET4***'s desktop area and there is no vertical scrollbar.

For the inverse operation, first select which monitor(s) to remove by checking the correspondent checkbox control to the left of the axis drop-down list, then right-click on the tool's window and select the option **Remove selected monitor** from the context menu.



☐ Axis 0 | M | 6 : 0 | -10.000000 | mm
Theoretical position
☑ Axis 0 | M | 7 : 0 | -9.999996 | mm
Real position

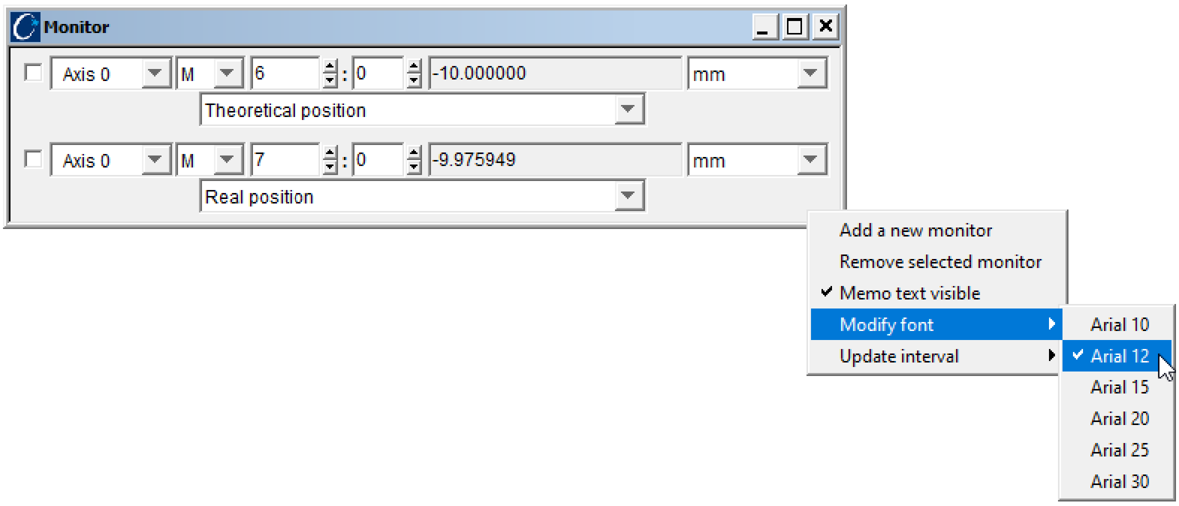
It is possible to hide the register description text to gain screen real estate for displaying more monitorings. Simply right-click on the tool's window and deselect the option **Memo text visible** from the context menu. Select the option again to revert the action.



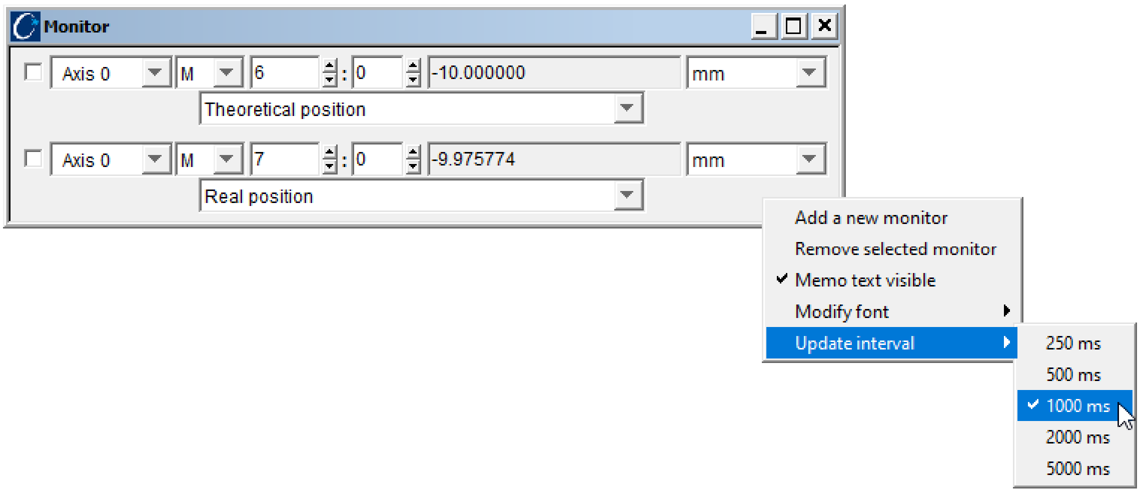
☐ Axis 0 | M | 6 : 0 | -10.000000 | mm
☐ Axis 0 | M | 7 : 0 | -10.000000 | mm

☐ Axis 0 | M | 6 : 0 | -10.000000 | mm
Theoretical position
☐ Axis 0 | M | 7 : 0 | -9.999998 | mm
Real position

The user can also adapt the font size used by the *Monitor* tool for visual convenience. Again, from the same context menu, select the option **Modify font** and choose the new font size.



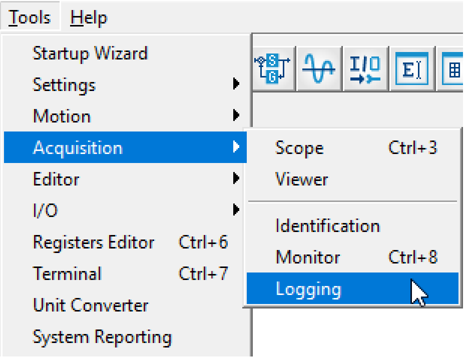
Finally, the last option available for configuring is the rate used to refresh the monitor(s) values in the *Monitor* window. To modify this setting, bring up the context menu once again by right-clicking on the tool's window and select a refresh interval value between 250 milliseconds and 5 seconds from the list under the **Update interval** option.



7.5. Logging

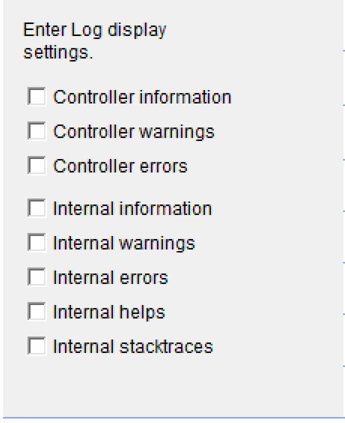
The *Logging* tool allows the user to view and log to a file all events (information, warnings and errors) occurring on the Controller with which the connection is established.

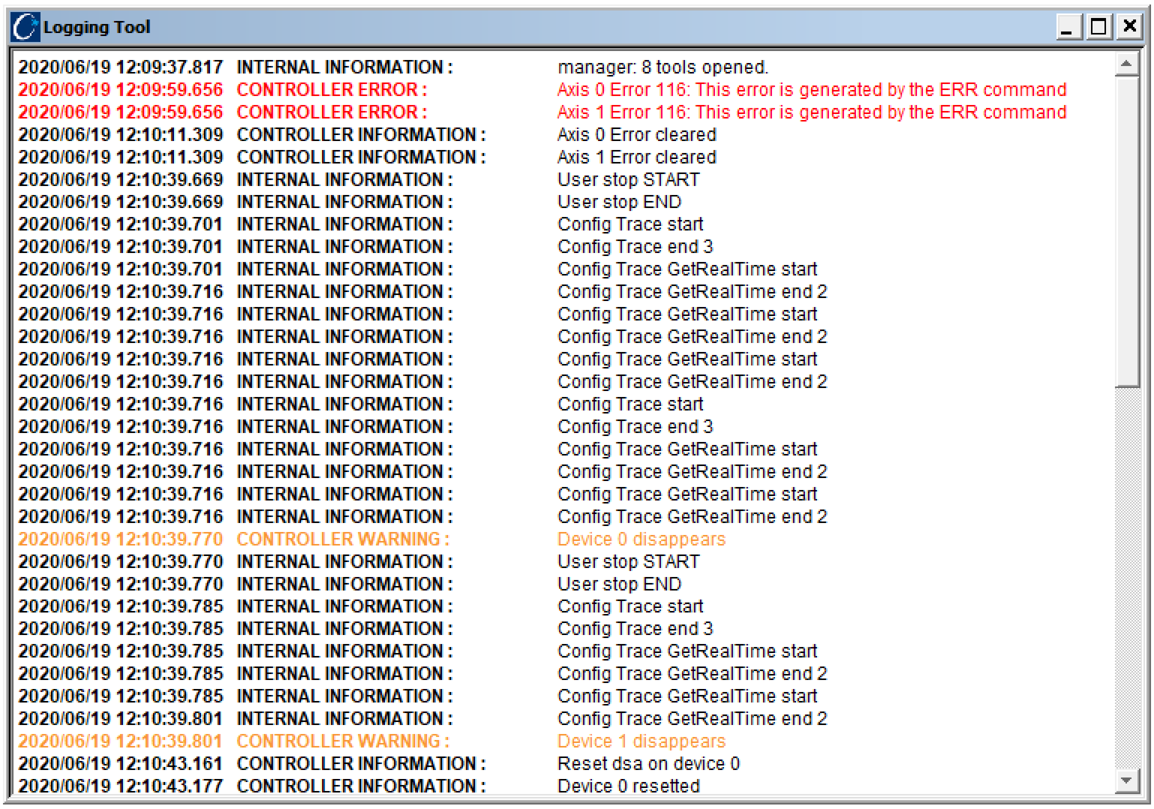
To launch the *Logging* tool, go to the Menu option **Tools → Acquisition → Logging**:



The log file is located in the folder C:\Users**xxx**\comet4.log, where **xxx** refers to the Windows user name. A maximum file size can be configured, so that when this limit is reached, a new file is automatically created. The user can also choose to erase the log file each time ***ComET4*** is launched.

To modify the *Logging* tool settings go to **File → Preferences → Logging tool** (refer to Section §2.5.7):

Preferences: *Logging* tool configuration options		
Enter Log display settings. ☐ Controller information ☐ Controller warnings ☐ Controller errors ☐ Internal information ☐ Internal warnings ☐ Internal errors ☐ Internal helps ☐ Internal stacktraces	Controller information	View and log information shared by the Controller.
	Controller warnings	View and log Controller warnings (related to monitoring `M66`).
	Controller errors	View and log Controller errors (related to monitoring `M64`).
	Internal information	***ComET4**/**EDI4*** internal information: useful for troubleshooting.
	Internal warnings	***ComET4**/**EDI4*** internal warnings: useful for troubleshooting.
	Internal errors	***ComET4**/**EDI4*** internal errors: useful for troubleshooting.
	Internal helps	***ComET4**/**EDI4*** internal debug info: useful for troubleshooting.
	Internal stacktraces	***ComET4**/**EDI4*** internal stack trace: useful for troubleshooting.



```
2020/06/19 12:09:37.817  INTERNAL INFORMATION :      manager: 8 tools opened.
2020/06/19 12:09:59.656  CONTROLLER ERROR :          Axis 0 Error 116: This error is generated by the ERR command
2020/06/19 12:09:59.656  CONTROLLER ERROR :          Axis 1 Error 116: This error is generated by the ERR command
2020/06/19 12:10:11.309  CONTROLLER INFORMATION :    Axis 0 Error cleared
2020/06/19 12:10:11.309  CONTROLLER INFORMATION :    Axis 1 Error cleared
2020/06/19 12:10:39.669  INTERNAL INFORMATION :      User stop START
2020/06/19 12:10:39.669  INTERNAL INFORMATION :      User stop END
2020/06/19 12:10:39.701  INTERNAL INFORMATION :      Config Trace start
2020/06/19 12:10:39.701  INTERNAL INFORMATION :      Config Trace end 3
2020/06/19 12:10:39.701  INTERNAL INFORMATION :      Config Trace GetRealTime start
2020/06/19 12:10:39.716  INTERNAL INFORMATION :      Config Trace GetRealTime end 2
2020/06/19 12:10:39.716  INTERNAL INFORMATION :      Config Trace GetRealTime start
2020/06/19 12:10:39.716  INTERNAL INFORMATION :      Config Trace GetRealTime end 2
2020/06/19 12:10:39.716  INTERNAL INFORMATION :      Config Trace GetRealTime start
2020/06/19 12:10:39.716  INTERNAL INFORMATION :      Config Trace GetRealTime end 2
2020/06/19 12:10:39.716  INTERNAL INFORMATION :      Config Trace start
2020/06/19 12:10:39.716  INTERNAL INFORMATION :      Config Trace end 3
2020/06/19 12:10:39.716  INTERNAL INFORMATION :      Config Trace GetRealTime start
2020/06/19 12:10:39.716  INTERNAL INFORMATION :      Config Trace GetRealTime end 2
2020/06/19 12:10:39.716  INTERNAL INFORMATION :      Config Trace GetRealTime start
2020/06/19 12:10:39.716  INTERNAL INFORMATION :      Config Trace GetRealTime end 2
2020/06/19 12:10:39.770  CONTROLLER WARNING :        Device 0 disappears
2020/06/19 12:10:39.770  INTERNAL INFORMATION :      User stop START
2020/06/19 12:10:39.770  INTERNAL INFORMATION :      User stop END
2020/06/19 12:10:39.785  INTERNAL INFORMATION :      Config Trace start
2020/06/19 12:10:39.785  INTERNAL INFORMATION :      Config Trace end 3
2020/06/19 12:10:39.785  INTERNAL INFORMATION :      Config Trace GetRealTime start
2020/06/19 12:10:39.785  INTERNAL INFORMATION :      Config Trace GetRealTime end 2
2020/06/19 12:10:39.785  INTERNAL INFORMATION :      Config Trace GetRealTime start
2020/06/19 12:10:39.801  INTERNAL INFORMATION :      Config Trace GetRealTime end 2
2020/06/19 12:10:39.801  CONTROLLER WARNING :        Device 1 disappears
2020/06/19 12:10:43.161  CONTROLLER INFORMATION :    Reset dsa on device 0
2020/06/19 12:10:43.177  CONTROLLER INFORMATION :    Device 0 resetted
```

NOTE	Internal events are useful for troubleshooting purposes by ETEL's Support team.

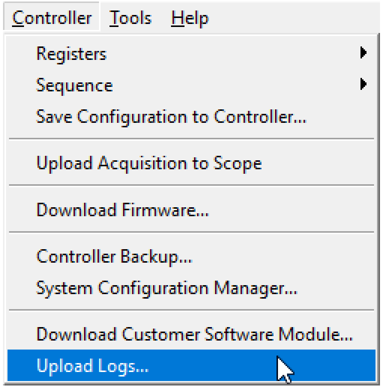
7.6. ULTIMET ADVANCED logs

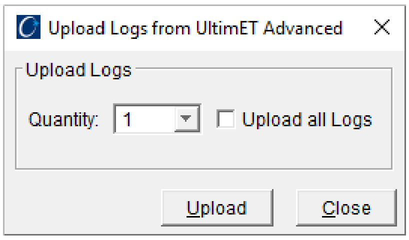
The ***ULTIMET ADVANCED*** motion controller is capable of logging relevant information about its execution flow and internal state. These logs can be particularly useful for troubleshooting the behavior of the Controller.

Refer to the *ULTIMET ADVANCED Motion Controller User's Manual* for more information about the ***ULTIMET ADVANCED*** logs.

TIP	When reporting an issue with the ***ULTIMET ADVANCED*** motion controller, please provide these log files to ETEL's Support team.

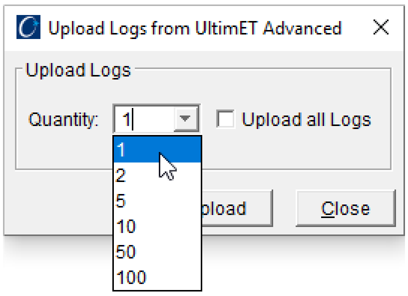
To upload the ***ULTIMET ADVANCED*** log files select the Menu option **Controller → Upload Logs**.





NOTE	Menu option **Controller → Upload Logs** is only enabled when a connection is established with an ***ULTIMET ADVANCED*** motion controller.

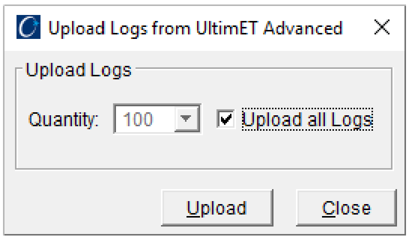
Next, select how many log files to upload using the **Quantity** drop-down list or check the **Upload all Logs** checkbox to upload all the log files stored in the Controller.



Upload Logs from UltimET Advanced

Quantity: 1

☐ Upload all Logs



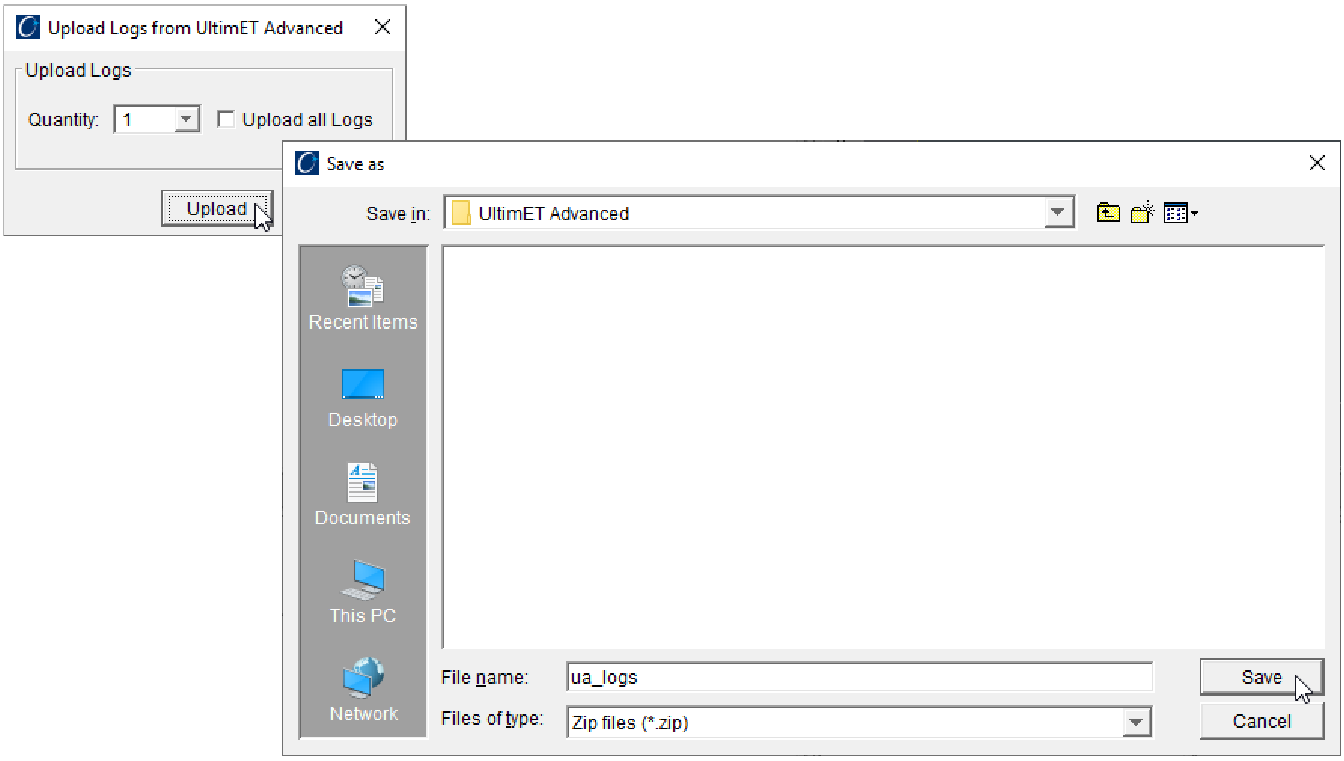
Upload Logs from UltimET Advanced

Quantity: 100

☑ Upload all Logs

NOTE	Only the most recently created logs files will be uploaded, except if the option **Upload all Logs** is selected.

To initiate the uploading click on the **Upload** button and type in the name of the target file where the log files will be saved followed by the **Save** button.



Upload Logs from UltimET Advanced

Quantity: 1

☐ Upload all Logs

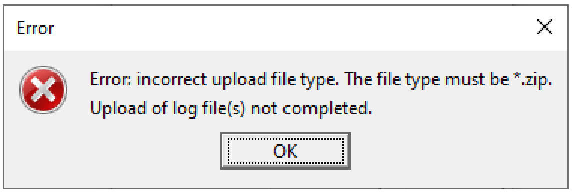
Save as

Save in: UltimET Advanced

File name: ua_logs

Files of type: Zip files (*.zip)

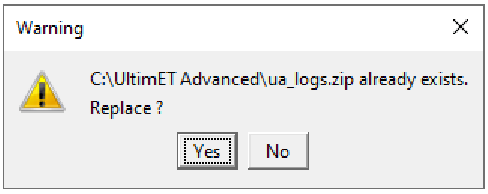
The uploaded log files are compressed to a single zip file for convenience. Therefore, the target file name must use the `*.zip` extension otherwise the following error is raised and the upload process is interrupted.



Error

Error: incorrect upload file type. The file type must be *.zip.
Upload of log file(s) not completed.

If the selected target file already exists, the following warning message is displayed. Click on the **Yes** button to proceed with the upload (overwriting the contents of the existing file) or the **No** button to cancel the action.



C:\UltimET Advanced\ua_logs.zip already exists.
Replace ?

Once the upload is completed, click on the **Close** button to close the dialog box. The log files can be now extracted from the target zip file.

8. Embedded programming

8.1. Sequence

When required by the application, the user can write a program to be executed by the Controller. This program is called a Sequence because it consists of a list of instructions that are executed sequentially by the Controller.

A Sequence is written in a specific language developed by ETEL and can be saved as text file. It can contain several functions and each function can be executed separately or combined with others to build a more complex program.

In order to be executed, the Sequence has to be compiled, downloaded and saved on the Controller. The most straightforward way of doing this it is to use ***ComET4***.

NOTE	The Sequence Compiler is only supported under Windows 32-bit environment. Compilation of a Sequence is not possible on any other environment.

NOTE	Refer to the *AccurET Modular Position Controller Operation & Software Manual* and *UltimET Light Motion Controller User's Manual* for a comprehensive explanation about programming Controllers using Sequences.

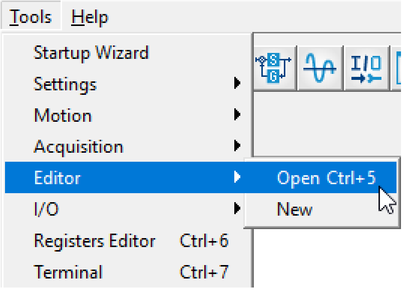
NOTE	The ***ULTIMET ADVANCED*** motion controller cannot execute Sequences. Instead, the user can program a Customer Software Module (CSM). Refer to Section §8.2 for further information about a CSM.

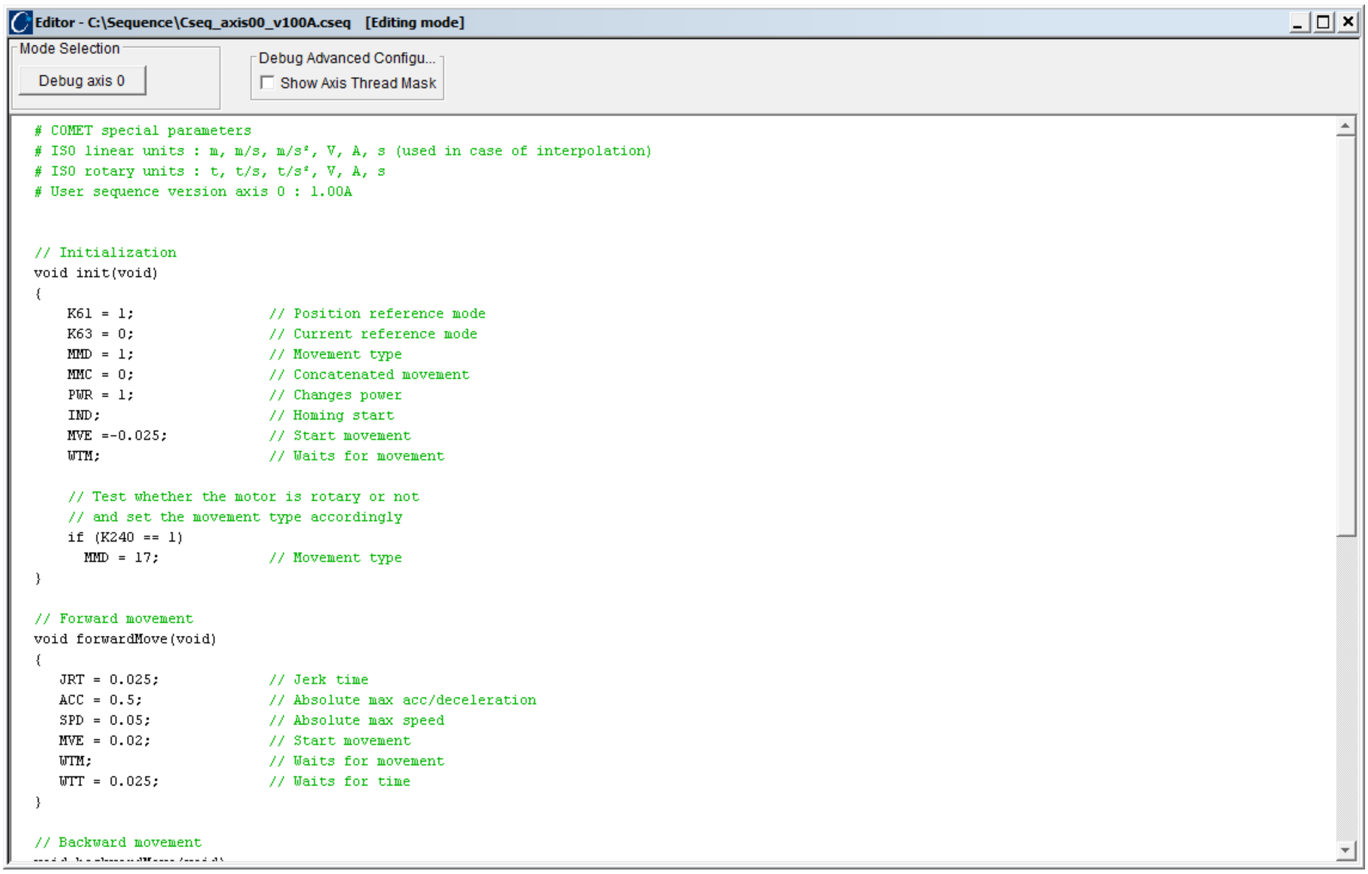
8.1.1. Writing a Sequence

The user can use the *Editor* tool to write a Sequence. There are several ways to launch the *Editor* tool, such as:

1. On the **Toolbar Tools** group, click on the button E.

2. Select the Menu option **Tools → Editor → Open**.





```
# COMET special parameters
# ISO linear units : m, m/s, m/s², V, A, s (used in case of interpolation)
# ISO rotary units : t, t/s, t/s², V, A, s
# User sequence version axis 0 : 1.00A


// Initialization
void init(void)
{
    K61 = 1;                // Position reference mode
    K63 = 0;                // Current reference mode
    MMD = 1;                // Movement type
    MMC = 0;                // Concatenated movement
    PWR = 1;                // Changes power
    IND;                    // Homing start
    MVE =-0.025;            // Start movement
    WTM;                    // Waits for movement

    // Test whether the motor is rotary or not
    // and set the movement type accordingly
    if (K240 == 1)
      MMD = 17;             // Movement type
}

// Forward movement
void forwardMove(void)
{
   JRT = 0.025;             // Jerk time
   ACC = 0.5;               // Absolute max acc/deceleration
   SPD = 0.05;              // Absolute max speed
   MVE = 0.02;              // Start movement
   WTM;                     // Waits for movement
   WTT = 0.025;             // Waits for time
}

// Backward movement
```

To modify a Sequence already stored in a Controller, the user can:

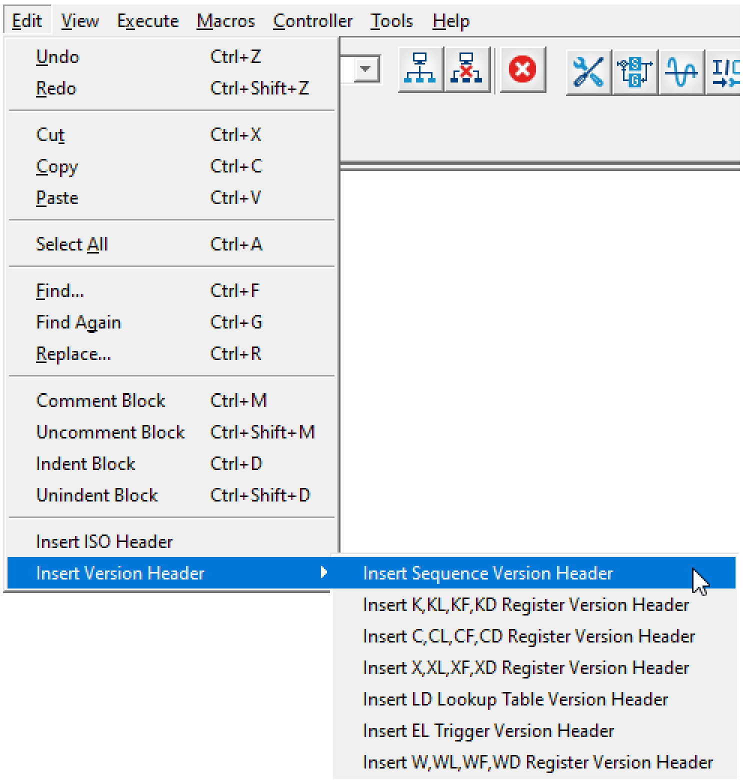
- Open the *Editor* tool and directly upload the Sequence from the Controller to the *Editor* by selecting the Menu option **Controller → Sequence → Upload to Editor** or clicking the button St from the **Toolbar Registers/Sequence** group; or
- Upload the Sequence into a file by selecting the Menu option **Controller → Sequence → Upload to File**. The file can then be opened for edition in the *Editor* tool.

TIP	Compiled Sequence source files are usually saved using the extension `*.cseq`.

It is possible to manage the Sequence version used in each Controller. The configuration of the version number can be done using the *Editor* tool or any other third-party editor before downloading the Sequence to the Controller. The Sequence file header contains the version of the Sequence, see the e.g. below.

```
# COMET special parameters
# ISO linear units : m, m/s, m/s², V, A, s (used in case of interpolation)
# ISO rotary units : t, t/s, t/s², V, A, s
# User sequence version axis 0 : 1.00A


// Initialization
void init(void)
{
    K61 = 1;                        // Position reference mode
```

In order to set the version number, the user must either modify the current header (if present) or create a new one by selecting the Menu option **Edit → Insert Version Header→ Insert Sequence Version Header**.



8.1.2. Executing a Sequence

The Sequence must be first downloaded to the Controller before it can be executed. Refer to Sections §8.1.5 and §10.2.1 for further details on how to download a Sequence to a Controller.

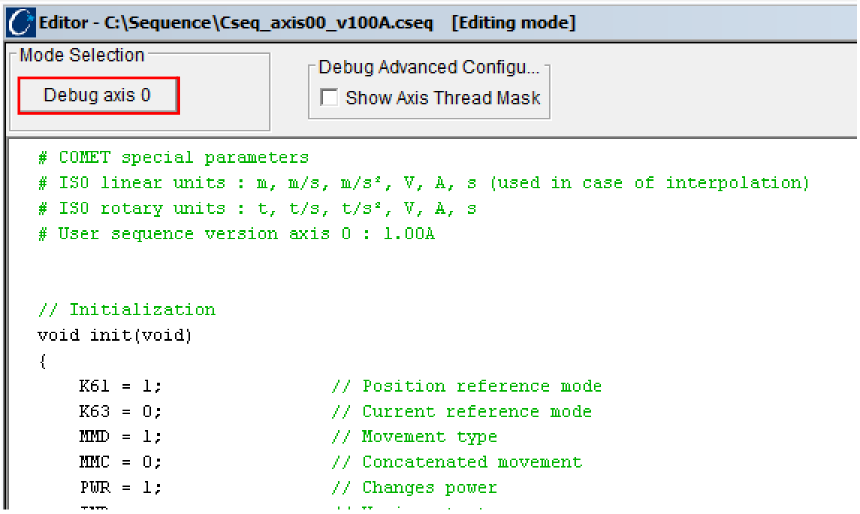
Once the Sequence has been downloaded to the Controller, the user can trigger its execution by sending the `JMP` command using the *Terminal* tool (refer to the *AccurET Modular Position Controller Operation & Software Manual* and *UltimET Light Motion Controller User's Manual* for further details on how to start a Sequence).

8.1.3. Debugging a Sequence

The *Editor* tool allows the user to debug a Sequence running on the Controller with which the connection is established by means of the **Debug Axis** button.

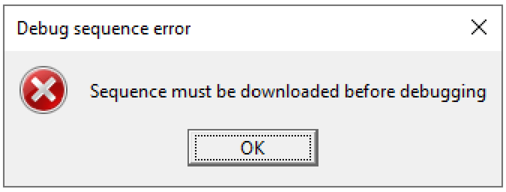
WARNING	Please read carefully this User Manual prior to using the debugging functionality. Using the debugging tools is complex and requires expertise. Misusing the debugging tools on a machine might result in material damage. Debugging is done under the user's responsibility. The debugging tools do not comply with any safety norm. Never touch a machine that is being debugged or stopped on a breakpoint. Not following this caution might result in severe injuries.

NOTE	The debug functionality is only supported for ***UltimET Light*** and ***AccurET*** controllers with firmware version 2.07A and above.



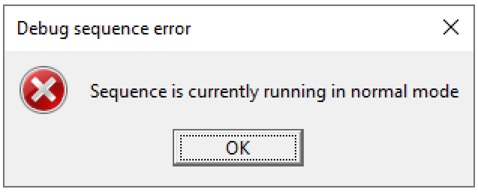
```
# COMET special parameters
# ISO linear units : m, m/s, m/s², V, A, s (used in case of interpolation)
# ISO rotary units : t, t/s, t/s², V, A, s
# User sequence version axis 0 : 1.00A


// Initialization
void init(void)
{
    K61 = 1;                    // Position reference mode
    K63 = 0;                    // Current reference mode
    MMD = 1;                    // Movement type
    MMC = 0;                    // Concatenated movement
    PWR = 1;                    // Changes power
```

The Sequence must have been downloaded prior to initiating the debug or else the following error message pops up.



Sequence must be downloaded before debugging

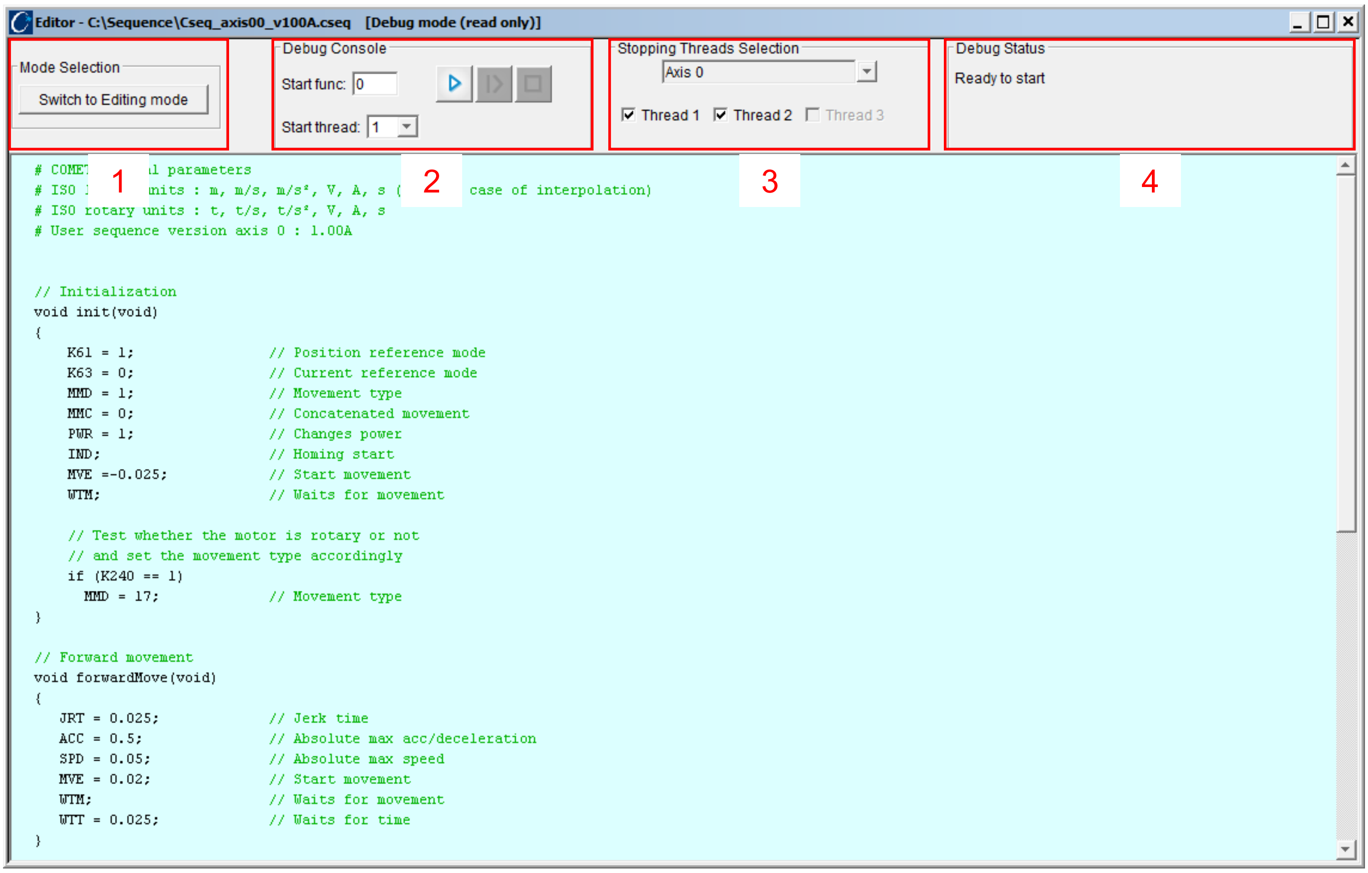
Also, it is not possible to connect to a Controller and debug the Sequence that is currently running on that Controller. If an attempt is made to debug an already running Sequence, the following error message is displayed.



Sequence is currently running in normal mode

Once in debug mode, the *Editor* window displays additional controls:

1. **Mode Selection**;
2. **Debug Console**;
3. **Stopping Threads Selection**; and
4. **Debug Status**.



Editor - C:\Sequence\Cseq_axis00_v100A.cseq [Debug mode (read only)]

Start func: 0

Start thread: 1

Axis 0

☑ Thread 1 ☑ Thread 2 ☐ Thread 3

Ready to start

```
# COMET      l parameters
# ISO        nits : m, m/s, m/s², V, A, s (        case of interpolation)
# ISO rotary units : t, t/s, t/s², V, A, s
# User sequence version axis 0 : 1.00A


// Initialization
void init(void)
{
    K61 = 1;                // Position reference mode
    K63 = 0;                // Current reference mode
    MMD = 1;                // Movement type
    MMC = 0;                // Concatenated movement
    PWR = 1;                // Changes power
    IND;                    // Homing start
    MVE =-0.025;            // Start movement
    WTM;                    // Waits for movement

    // Test whether the motor is rotary or not
    // and set the movement type accordingly
    if (K240 == 1)
      MMD = 17;             // Movement type
}

// Forward movement
void forwardMove(void)
{
   JRT = 0.025;             // Jerk time
   ACC = 0.5;               // Absolute max acc/deceleration
   SPD = 0.05;              // Absolute max speed
   MVE = 0.02;              // Start movement
   WTM;                     // Waits for movement
   WTT = 0.025;             // Waits for time
}
```

The **Mode Selection** allows the user to switch between edition and debug modes:

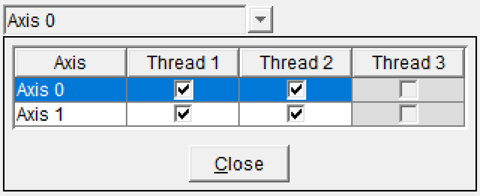
Mode Selection	
Switch to Editing mode	Leave the debug mode and return to the edition mode.

The **Debug Console** allows the user to control the execution of the Sequence in debug mode:

Debug Console	
Start func: 0	Label of the Sequence function from where to start the execution (same as the parameter of the `JMP` command).
Start thread: 1	Thread of the corresponding Controller where the Sequence will be launched (maximum of 2 threads for an ***AccurET*** position controller and 3 threads for an ***UltimET Light*** motion controller).
▷	Start debugging, stopping when Sequence reaches the next breakpoint (shortcut `F5`).

▷	Continue execution until next breakpoint is reached or the Sequence ends (shortcut `F5`).
▷	Execute to next instruction (shortcut `F10`).
☐	Stop debugging (shortcut `Shift + F5`).

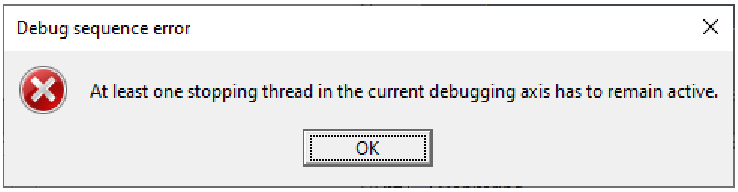
Before pressing on the **Debug Axis** button to start the debug mode, the user can check the **Show Axis Thread Mask** checkbox to get access to more advanced debugging capabilities available under the **Stopping Threads Selection** group control (if the **Show Axis Thread Mask** checkbox is not selected, the **Stopping Threads Selection** group control is not visible in debug mode).

<table>
<tr><th colspan="2">Stopping Threads Selection</th></tr>
<tr><td>
Axis 0
<table>
<tr><th>Axis</th><th>Thread 1</th><th>Thread 2</th><th>Thread 3</th></tr>
<tr><td>Axis 0</td><td>☑</td><td>☑</td><td>☐</td></tr>
<tr><td>Axis 1</td><td>☑</td><td>☑</td><td>☐</td></tr>
</table>
</td>
<td>Control the behavior of Sequence threads with regards to specific debugging events. E.g. select which threads from which axis is going to stop when a breakpoint is reached or when the Stop execution button on the Debug Console group control is pressed.

When a Sequence stops its execution on a breakpoint, it signals this event over <i>TransnET</i>. Every Controller connected to the same <i>TransnET</i> bus running a Sequence checks this signal every cycle. Depending on configuration set via the Stopping Threads Selection control, the Sequence threads of each Controller will react accordingly, i.e. stop or continue execution.

This functionality allows the user to specify several threads that must not stop when there is a Sequence that has been interrupted. This could be the case e.g. of threads in charge of collision avoidance. By default, all threads of all axes react to a debug event (i.e. threads will stop if a breakpoint is reached or the debug mode stopped).

At least one thread on the current debugging axis must be selected, otherwise the following error message is displayed:



At least one stopping thread in the current debugging axis has to remain active.
</td></tr>
<tr><td>☑ Thread 1 ☑ Thread 2 ☐ Thread 3</td><td>More direct access to select which threads of the axis being debug will stop when a debug event occurs.</td></tr>
</table>

As the name indicates, the **Debug Status** provides information about the current status of the debug mode:

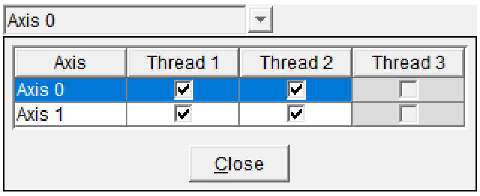
Debug Status	
Ready to start	Ready to start the execution of the Sequence in debug mode.
Running.............	Sequence is being executed.
Breakpoint reached	Sequence execution has stopped because it reached a breakpoint.
Sequence ended	Sequence execution has reached the end (it is no longer being executed).
Debugging stopped	The user has pressed the **Stop execution** button.

These are the debugging functionalities available in ***ComET4***:

- Set/Remove breakpoints;
- Execute a Sequence, which will run until the next breakpoint is reached or to the end;
- Execute a Sequence step-by-step;
- Jump into a function (step over is not supported);
- Stop the debug mode;
- Specify which threads on which axis will react to debug events, such as reaching a breakpoint or stopping the debug mode;
- Quit the debug mode and switch to edition mode.

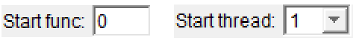
These are the recommended steps to follow for debugging a Sequence:

1. Configure for each connected Controller the behavior of the threads to debug events. Use the drop-down list in the **Stopping Threads Selection** group control.



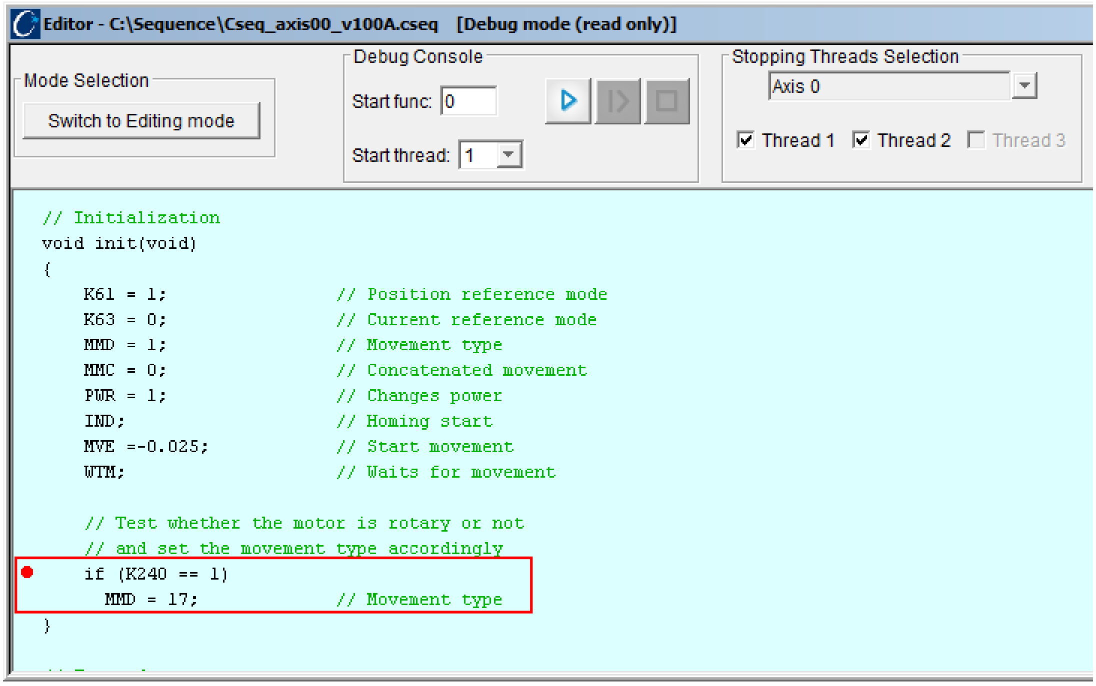
Axis	Thread 1	Thread 2	Thread 3
Axis 0	☑	☑	☐
Axis 1	☑	☑	☐

2. Specify the label of the Sequence function from where to start the execution and the thread of the corresponding Controller where the Sequence will be launched.



Start func: 0 Start thread: 1

3. Set a breakpoint by double-clicking on the mouse's left button close to the left border of the *Editor* window, on the line where the breakpoint must be set. A red dot appears to indicate that a breakpoint was set. Repeat this operation to set additional breakpoints.



Start func: 0

Start thread: 1

Axis 0

☑ Thread 1 ☑ Thread 2 ☐ Thread 3

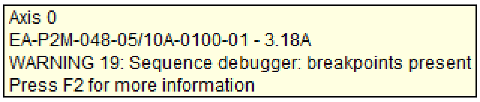
```
// Initialization
void init(void)
{
    K61 = 1;                // Position reference mode
    K63 = 0;                // Current reference mode
    MMD = 1;                // Movement type
    MMC = 0;                // Concatenated movement
    PWR = 1;                // Changes power
    IND;                    // Homing start
    MVE =-0.025;            // Start movement
    WTM;                    // Waits for movement

    // Test whether the motor is rotary or not
    // and set the movement type accordingly
●   if (K240 == 1)
      MMD = 17;             // Movement type
}
```

NOTE

As soon as a breakpoint is set on a Sequence, the Controller sets `Bit #19` (Sequence debugger: breakpoints present) on monitoring `M66` (warning code).

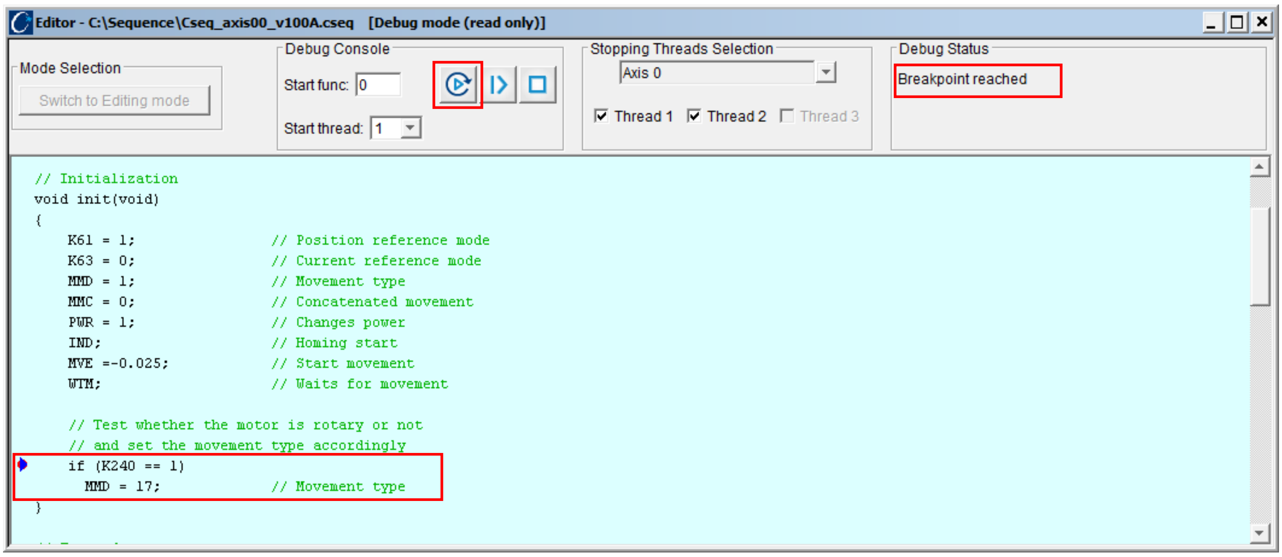
Breakpoints are never saved and restored from flash along with the Sequence. But it can happen that the communication between the application (i.e. ***ComET4***) and the Controller is lost before having the opportunity to clear existing breakpoints.

It is the application's responsibility to check monitoring `M66` before starting Sequences to make sure none will stop unexpectedly on a breakpoint. If some breakpoints are still present, the Controller will display a warning:



Axis 0
EA-P2M-048-05/10A-0100-01 - 3.18A
WARNING 19: Sequence debugger: breakpoints present
Press F2 for more information

4. Click on the **Start execution** button to initiate the debugging of the Sequence. This button changes icon to indicate that the debugging is in progress and the **Debug Status** group control status shows that a breakpoint has been reached. A small blue arrow on the left of the *Editor* window highlights the line where the execution has stopped.



Editor - C:\Sequence\Cseq_axis00_v100A.cseq [Debug mode (read only)]

Mode Selection

Debug Console
Start func: 0
Start thread: 1

Stopping Threads Selection
Axis 0
☑ Thread 1 ☑ Thread 2 ☐ Thread 3

Debug Status
Breakpoint reached

```
// Initialization
void init(void)
{
    K61 = 1;                // Position reference mode
    K63 = 0;                // Current reference mode
    MMD = 1;                // Movement type
    MMC = 0;                // Concatenated movement
    PWR = 1;                // Changes power
    IND;                    // Homing start
    MVE =-0.025;            // Start movement
    WTM;                    // Waits for movement

    // Test whether the motor is rotary or not
    // and set the movement type accordingly
    if (K240 == 1)
      MMD = 17;             // Movement type
}
```

WARNING

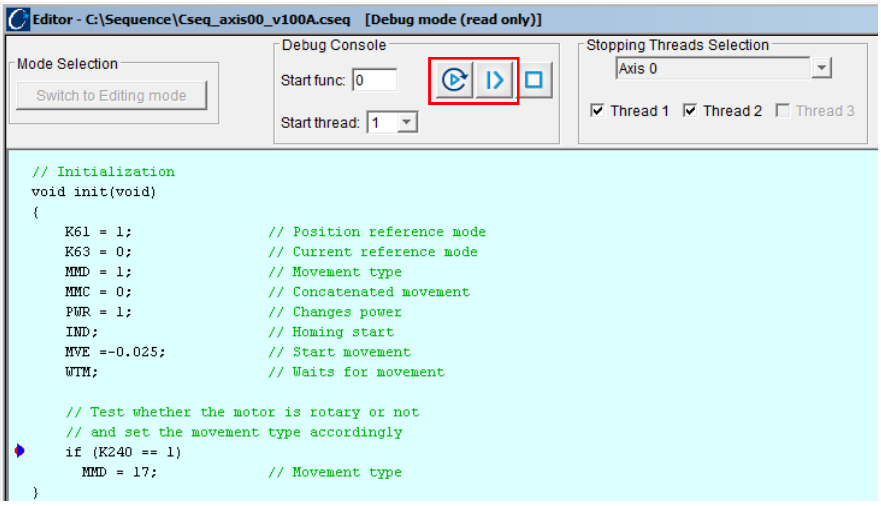
The execution of a Sequence will stop when reaching a breakpoint, but this will not stop an axis in motion due to a previous command. However, once this motion is completed, the axis will remain stopped because the Sequence is blocked at the breakpoint instruction.

This fact must be taken into account in the case this Controller is connected via ***TransnET*** to other Controllers in charge of the motion of other axes. It is important to evaluate the risk of collision between axes under such circumstances.

5. From here on, the user can follow one of the following options:

a. Continue executing until next breakpoint by clicking on the **Continue execution** button ▷;

b. Start a step-by-step execution by clicking on the **Execute next instruction** button |▷. To leave the step-by-step mode, click on the **Continue execution** button ▷; the execution will continue until the next breakpoint.



Start func: 0

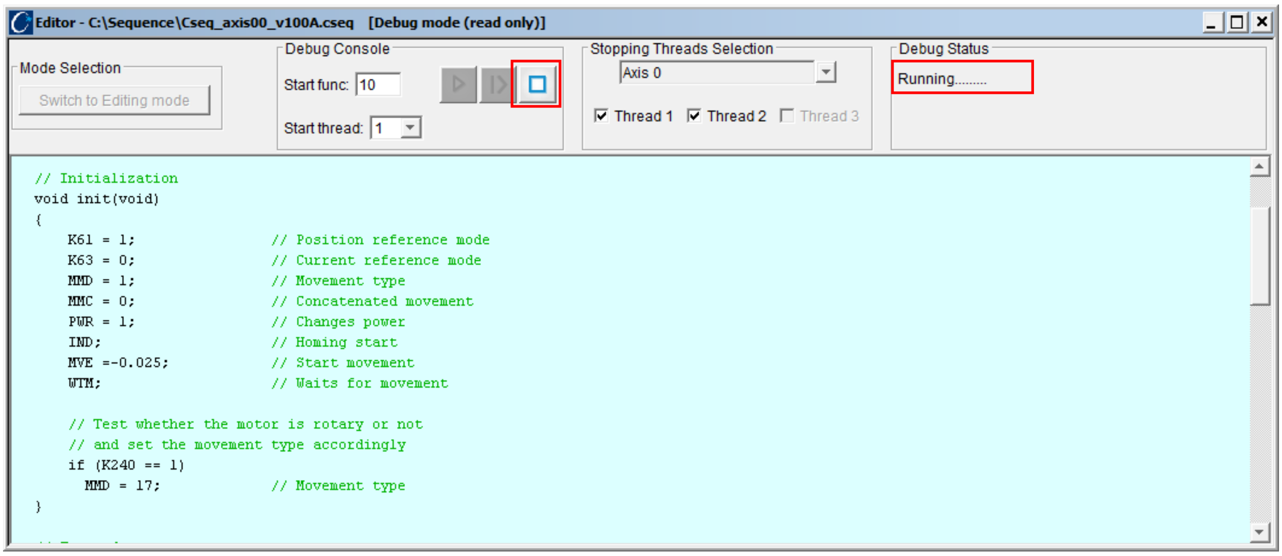
Start thread: 1

Axis 0

☑ Thread 1 ☑ Thread 2 ☐ Thread 3

```
// Initialization
void init(void)
{
    K61 = 1;                // Position reference mode
    K63 = 0;                // Current reference mode
    MMD = 1;                // Movement type
    MMC = 0;                // Concatenated movement
    PWR = 1;                // Changes power
    IND;                    // Homing start
    MVE =-0.025;            // Start movement
    WTM;                    // Waits for movement

    // Test whether the motor is rotary or not
    // and set the movement type accordingly
    if (K240 == 1)
      MMD = 17;             // Movement type
}
```

6. To let the Sequence run freely, remove all breakpoints (by double-clicking on the red dots) and click on the **Continue execution** button. Without any breakpoint set, the **Start/Continue execution** and **Execute next instruction** buttons are greyed. The only option available is to **Stop execution** button ☐.



Start func: 10

Start thread: 1

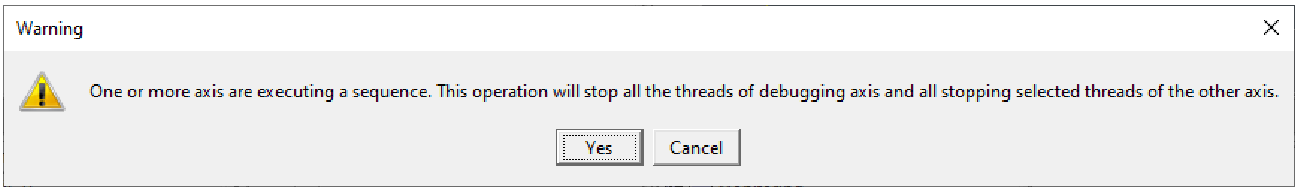
Axis 0

☑ Thread 1 ☑ Thread 2 ☐ Thread 3

Running.........

```
// Initialization
void init(void)
{
    K61 = 1;                // Position reference mode
    K63 = 0;                // Current reference mode
    MMD = 1;                // Movement type
    MMC = 0;                // Concatenated movement
    PWR = 1;                // Changes power
    IND;                    // Homing start
    MVE =-0.025;            // Start movement
    WTM;                    // Waits for movement

    // Test whether the motor is rotary or not
    // and set the movement type accordingly
    if (K240 == 1)
      MMD = 17;             // Movement type
}
```

7. Once the user clicks on the **Stop execution** button ☐, the following warning message is displayed to inform that this action will stop all threads running on the current axis being debugged, as well as those threads related to other connected axes that were configured to react to debug events.
Click on the **Yes** button to proceed with the action of stopping the debug mode or on the **Cancel** button to abort the action.



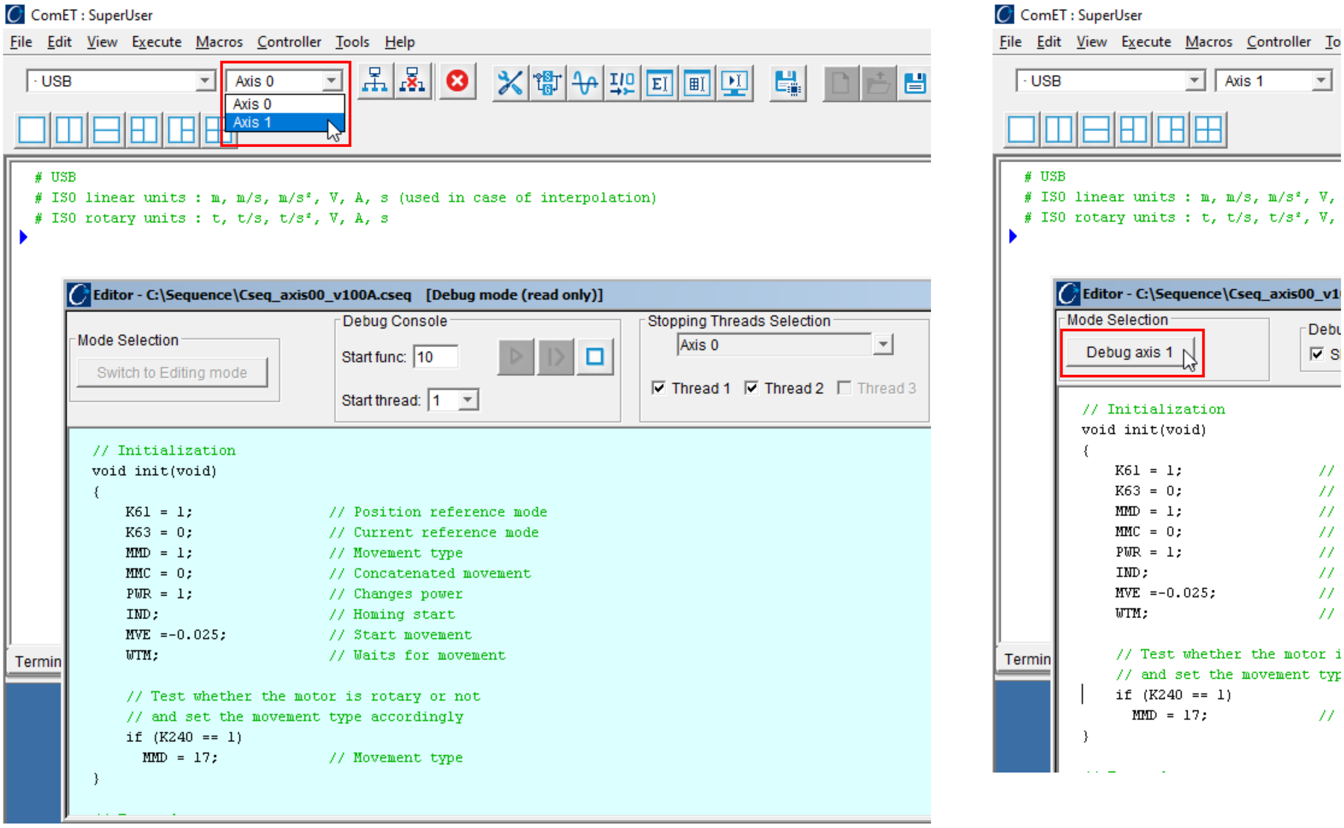
Warning

One or more axis are executing a sequence. This operation will stop all the threads of debugging axis and all stopping selected threads of the other axis.

NOTE

The debugging is carried on the axis indicated in the mainframe **Toolbar Local connection** drop-down list. The **Stopping Threads Selection** drop-down list in the *Editor* tool does not define the axis being debugged.

It is not possible to debug simultaneously two or more axes. Take e.g. the case that a Sequence running on axis 0 of a Controller is being debugged. If the user connects to another axis (e.g. axis 1) and attempts to run the debugger on that axis, an error message pops up to inform the user that the *Editor* tool is already running in debug mode on axis 0. Press the **OK** button to clear the error message.



```
# USB
# ISO linear units : m, m/s, m/s², V, A, s (used in case of interpolation)
# ISO rotary units : t, t/s, t/s², V, A, s
```

Editor - C:\Sequence\Cseq_axis00_v100A.cseq [Debug mode (read only)]

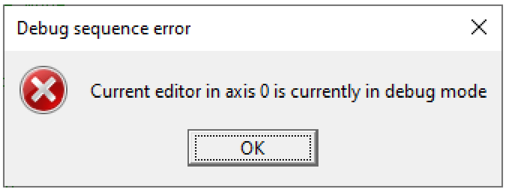
Start func: 10

Start thread: 1

Stopping Threads Selection: Axis 0

☑ Thread 1 ☑ Thread 2 ☐ Thread 3

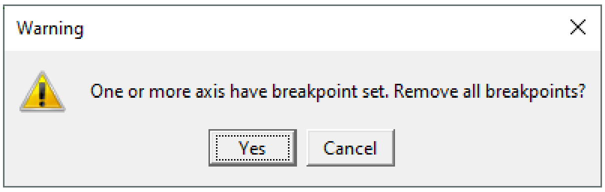
```
// Initialization
void init(void)
{
    K61 = 1;                // Position reference mode
    K63 = 0;                // Current reference mode
    MMD = 1;                // Movement type
    MMC = 0;                // Concatenated movement
    PWR = 1;                // Changes power
    IND;                    // Homing start
    MVE =-0.025;            // Start movement
    WTM;                    // Waits for movement

    // Test whether the motor is rotary or not
    // and set the movement type accordingly
    if (K240 == 1)
      MMD = 17;             // Movement type
}
```



Debug sequence error

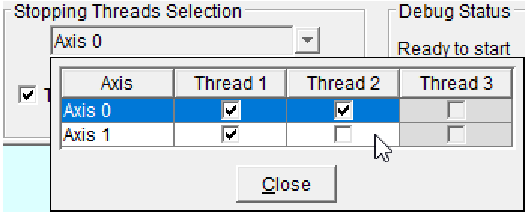
Current editor in axis 0 is currently in debug mode

To return to edition mode click on the **Switch to Editing mode** button (only possible after having stopped the debugging by clicking on the **Stop execution** button). If there are still breakpoints set, a warning message pops up to remind the user to remove all breakpoints before leaving the debug mode.



One or more axis have breakpoint set. Remove all breakpoints?

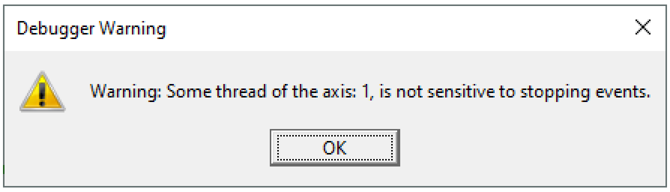
When initiating the debug mode, if there are threads on any axis that are not set to react to debug events (e.g. thread 2 of axis 1 not set), a warning message is displayed to inform the user.



Axis 0

Ready to start

Axis	Thread 1	Thread 2	Thread 3
Axis 0	☑	☑	☐
Axis 1	☑	☐	☐



Warning: Some thread of the axis: 1, is not sensitive to stopping events.

8.1.4. Pre-compiling a Sequence

In order to be executed, the Sequence has to be compiled, downloaded and saved on the Controller. Usually, these three steps are realized as a single action during the "standard" process of downloading a Sequence.

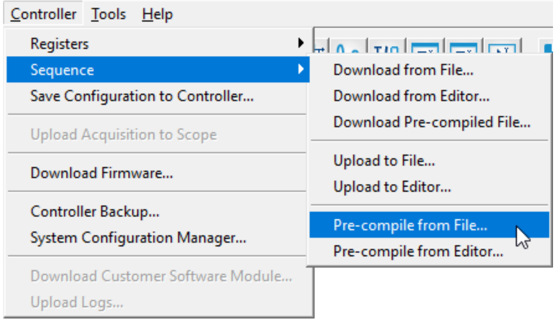
However, it is possible to compile a Sequence, store the result of this compilation in a file and download this file at a later stage to the Controller.

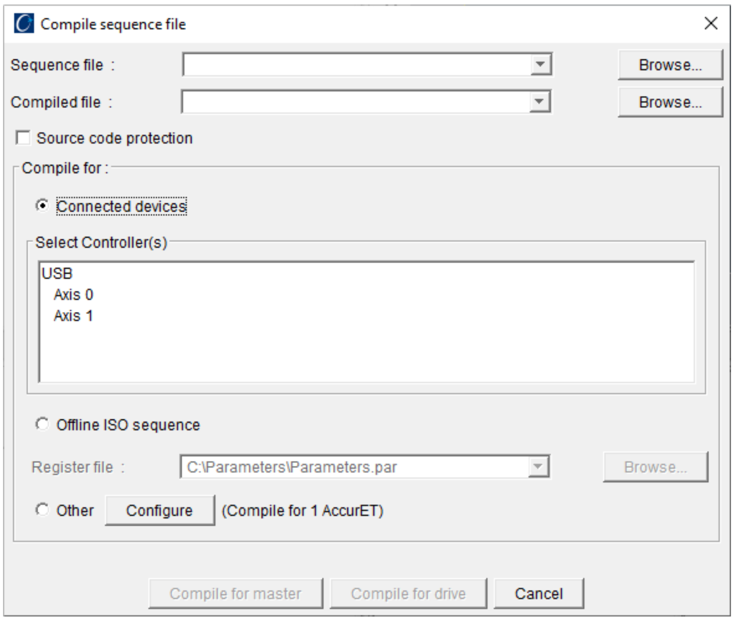
Using pre-compiled Sequences has basically two advantages:

- The downloading process becomes faster because the compilation step is skipped, as the Sequence has already been compiled; of course, the "bigger" the Sequence, the more noticeable this gain is; and
- IP protection: there is one pre-compilation option which ensures that the result of the compilation is strip-off of any Sequence source code, making it totally safe to exchange the pre-compiled file with other users (this option for IP protection is also available when downloading a Sequence using the "standard" process; refer to next Section §10.2.1 for further information).

There two options available to pre-compile a Sequence:

1. Select the Menu option **Controller → Sequence → Pre-compile from File**.





☐ Source code protection

● Connected devices

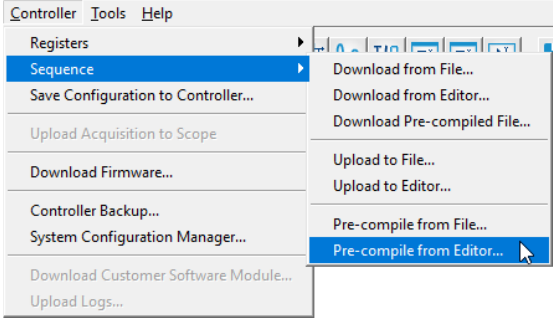
USB
Axis 0
Axis 1

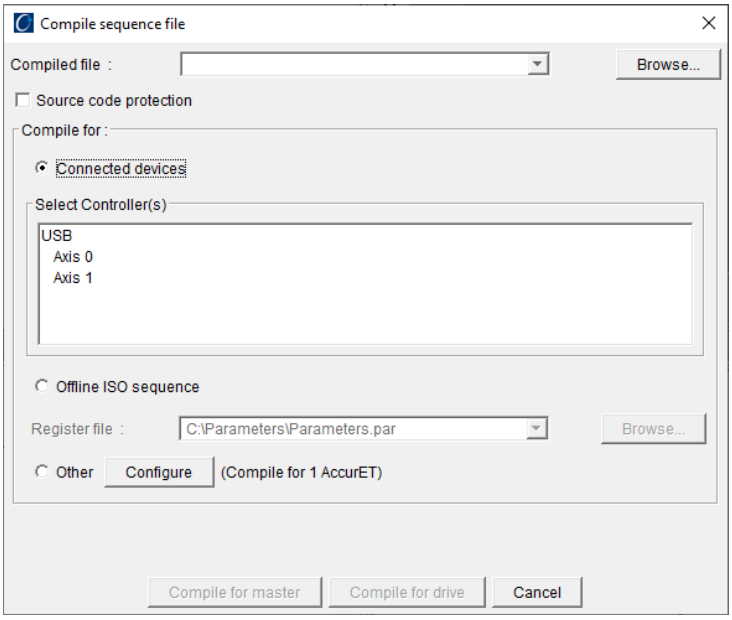
○ Offline ISO sequence

Register file : C:\Parameters\Parameters.par

○ Other (Compile for 1 AccurET)

2. Select the Menu option **Controller → Sequence → Pre-compile from Editor**.





☐ Source code protection

● Connected devices

USB
Axis 0
Axis 1

○ Offline ISO sequence

Register file : C:\Parameters\Parameters.par

○ Other (Compile for 1 AccurET)

The only difference between the two dialog boxes that pop up is that for the **Pre-compile from Editor** option there is no need to select the Sequence source file as it is taken directly from the *Editor* window detaining the scope.

Click on the corresponding **Browse** button(s) to select respectively the compiled Sequence source file (only for the option **Pre-compile from File**) and the pre-compiled Sequence result file.

TIP	Pre-compiled Sequence files are usually saved with the extension `*.eseq`.

To ensure full IP protection in regard to the Sequence source code, select the checkbox **Source code protection**. This guarantees that the pre-compiled Sequence file includes no reference to the original source code from which it was generated. In other words, when such pre-compiled Sequence file is downloaded to the Controller, only the compiled code is downloaded, not the source code. As such, it is not possible to upload from the Controller the corresponding Sequence source code because it does not exist, providing full IP protection to the owner of the Sequence.

There are three possible alternative processes to generate a pre-compiled Sequence:

○ Connected devices

The user must select the target axes for the compilation. It is an online compilation process, as it requires a valid connection to be established with all the axes referenced in the Sequence.

This compilation process can be used with any Sequence, regardless of the type of units it is using (ISO or incremental). Since there is a connection established with the axes, the compiler can retrieve the correct metadata required to handle properly the ISO conversions.

○ Offline ISO sequence

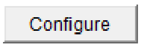
This compilation process allows the user to realize an offline compilation of the Sequence. In other words, there is no need for a connection to be established with the axes referenced in the Sequence, but the user must supply a parameter set corresponding to their configuration.

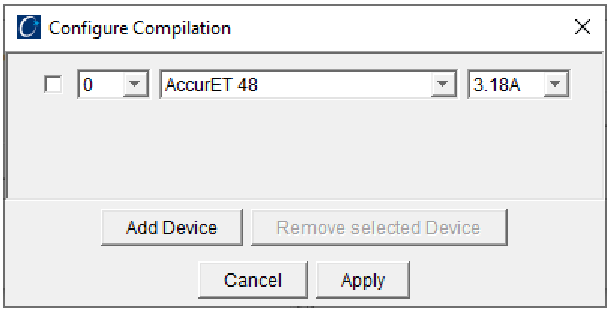
The parameter set must contain at least the following register types for all the axes referenced in the Sequence:
`K`, `KL`, `KF` and `KD`;
`C`, `CL`, `CF` and `CD`;
`M`, `MF`, `ML`.

As with the previous, this compilation process is suited for whatever Sequence, regardless of the type of units it is using (ISO or incremental). The compiler can retrieve from the parameter set the correct metadata required to handle properly the ISO conversions.

○ Other

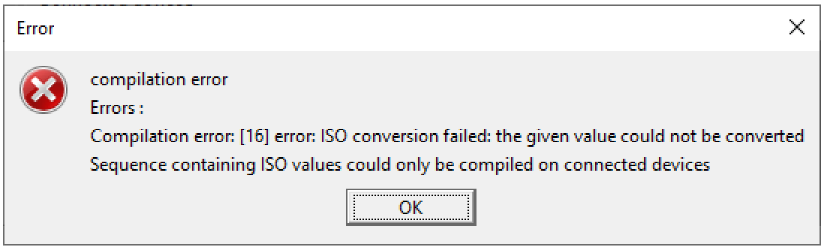
This compilation process also allows the user to realize an offline compilation as the previous **Offline ISO sequence** process, but there is no need to provide a parameter set. Instead, the user selects generic target Controllers with their default parameter set. Click on the **Configure** button to select the target devices.





To add a new device, simply click on the **Add Device** button and select the axis number, Controller model and firmware version from the corresponding drop-down lists. To remove a device, first check the corresponding checkbox to the left of the device (or devices) and click on the **Remove selected Device** button.

This compilation process cannot handle a Sequence using ISO units. The following error message will be displayed if this is the case.

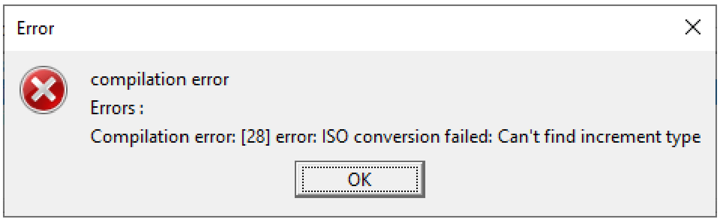


Error

compilation error
Errors :
Compilation error: [16] error: ISO conversion failed: the given value could not be converted
Sequence containing ISO values could only be compiled on connected devices

NOTE	The user must provide information about all axes being referenced in the Sequence. This can be done via an online connection to these axes (for the **Connected devices** option), via a specific parameter set containing information about all these axes (for the **Offline ISO sequence** option) or, finally, via the selection of target devices matching these axes (for the **Other** option).

The pre-compiler tool will generate an error if it does not have information about a specific axis referenced in the Sequence.

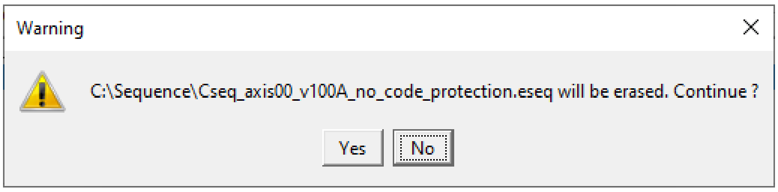


Error

compilation error
Errors :
Compilation error: [28] error: ISO conversion failed: Can't find increment type

Once everything is properly configured, the user just needs to click on one of the two buttons **Configure for master** (only available if an ***UltimET Light*** motion controller is part of the configuration) or **Configure for drive** (drive is another term to designate an ***AccurET*** position controller) to generate the pre-compiled Sequence.

If the target file already exists, the following warning message is displayed.

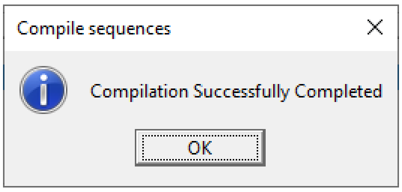


Warning

C:\Sequence\Cseq_axis00_v100A_no_code_protection.eseq will be erased. Continue ?

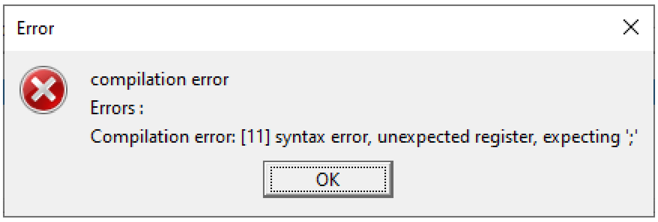
Click on **Yes** to proceed or **No** to abort the compilation and chose another target file.

Upon a successful compilation, the following information message is displayed. Clicking on the **OK** button will close this message and pre-compiler dialog box as well.


Compile sequences

Compilation Successfully Completed

However, if the Sequence contains an error (e.g. a syntax error), the compiler will flag it with an error message.


Error

compilation error
Errors :
Compilation error: [11] syntax error, unexpected register, expecting ';'

8.1.5. Download to controller

Once a Sequence has been written, the user can follow one of the three possible options to download it to the Controller for execution:

1. If the Sequence to be executed is currently being edited in the *Editor* tool, simply select the Menu option **Controller → Sequence → Download from Editor** or alternatively click the button S↓ from the **Toolbar Registers/Sequence** group;
2. If the Sequence has already been saved to a file, select the Menu option **Controller → Sequence → Download from File** and the select the Sequence source file `*.cseq` to download;
3. If the Sequence has been pre-compiled, select the Menu option **Controller → Sequence → Download Pre-compiled File** and select the pre-compiled Sequence `*.eseq` to download. Refer to the previous Section §8.1.4 for further details on how to pre-compile a Sequence.

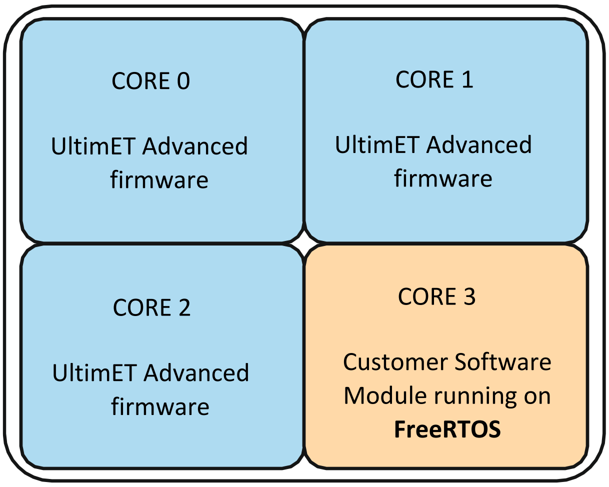
Refer to Section §10.2.1 for further details on how to pursue with the download of a Sequence to a Controller.

8.2. Customer Software Module

A Customer Software Module (CSM) is a FreeRTOS application based on the ETEL Device Interface (***EDI***) library.

Contrary to a Sequence that consists of a list of instructions written in a specific language developed by ETEL and executed sequentially by the Controller, a CSM is an embedded software application written in C based on EDI, with multithreading capabilities and running on a Real-Time Operating System (FreeRTOS). It, therefore, allows the user to develop much more advanced functionalities when compared to a Sequence.

The ***ULTIMET ADVANCED*** motion controller is the only Controller in ETEL's product range that supports CSMs as an alternative to the traditional Sequences. This motion controller is based on a quad-core ARM processor, with one of these cores dedicated to the user's CSM.



For more information about a CSM, refer to the *ULTIMET ADVANCED Motion Controller User's Manual*.

8.2.1. Development environment

Contrary to a Sequence that can be written and debugged using the *Editor* tool (refer to Sections §8.1.1 and §8.1.3 for information about writing and debugging Sequences), the development toolchain for a CSM is more complex and it is not integrated in ***ComET4***.

The Xilinx SDK environment is required for the development of a CSM. ETEL provides a CSM template containing basic functionality to support developers creating their first embedded application for the ***ULTIMET ADVANCED*** motion controller. The CSM is compiled and linked with the ***EDI*** library ported to the FreeRTOS operating system. This process generates two binary files:

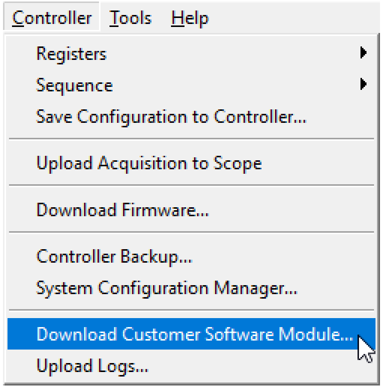
- csm.elf: used during the development phase since it can be launched, debugged and tested using the Xilinx SDK environment;
- csm.bin: used in the final product environment, where the CSM is loaded and started from a host application (it can be ***ComET4*** or a user application running on the host PC).

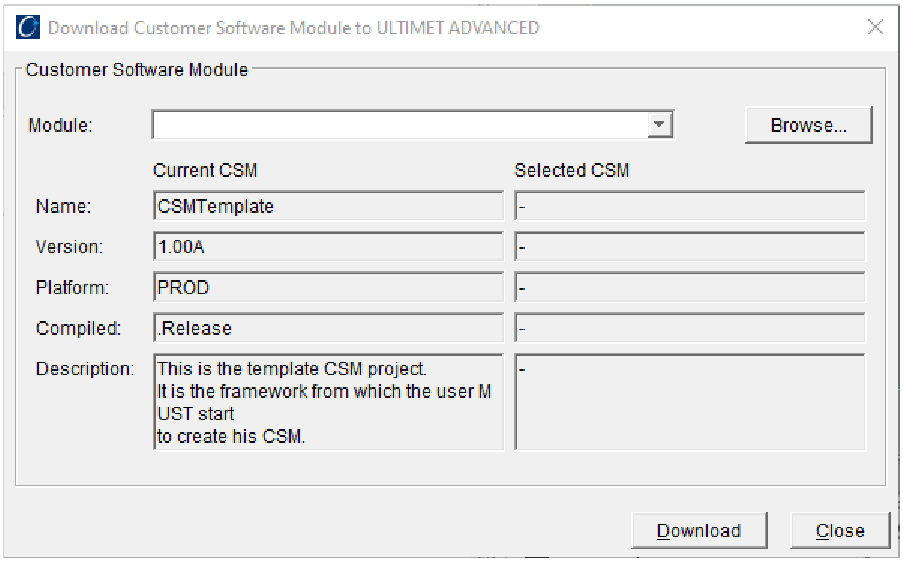
The user can use ***ComET4*** to download the csm.bin file to the ***ULTIMET ADVANCED*** motion controller.

For more information about the environment required for the development of a CSM, refer to the *ULTIMET ADVANCED Motion Controller User's Manual*.

8.2.2. Download to controller

To download a CSM to the ***ULTIMET ADVANCED***, select the Menu option **Controller → Download Customer Software Module**.



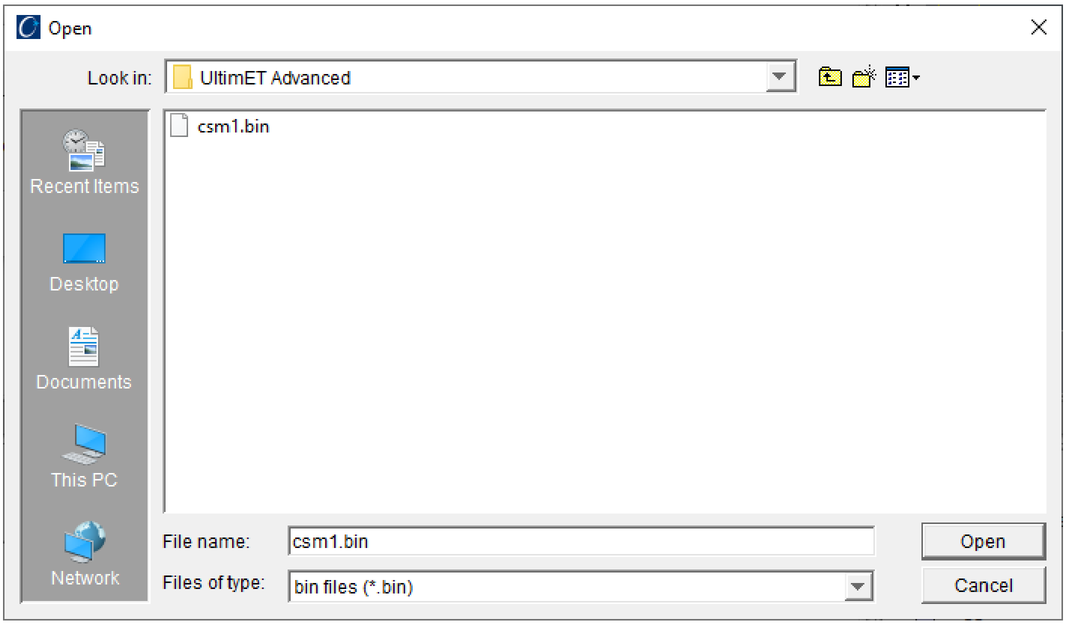


Module:

	Current CSM	Selected CSM
Name:	CSMTemplate	-
Version:	1.00A	-
Platform:	PROD	-
Compiled:	.Release	-
Description:	This is the template CSM project. It is the framework from which the user M UST start to create his CSM.	-

NOTE	Menu option **Controller → Download Customer Software Module** is only enabled when a connection is established with an ***ULTIMET ADVANCED*** motion controller.

On the dialog box that appears the user can find information about the currently loaded CSM (if any) and by clicking on the **Browse** button a new CSM binary file can be selected for downloading to the Controller.



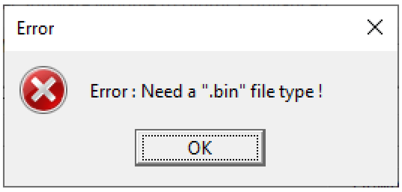
Look in: UltimET Advanced

csm1.bin

File name: csm1.bin

Files of type: bin files (*.bin)

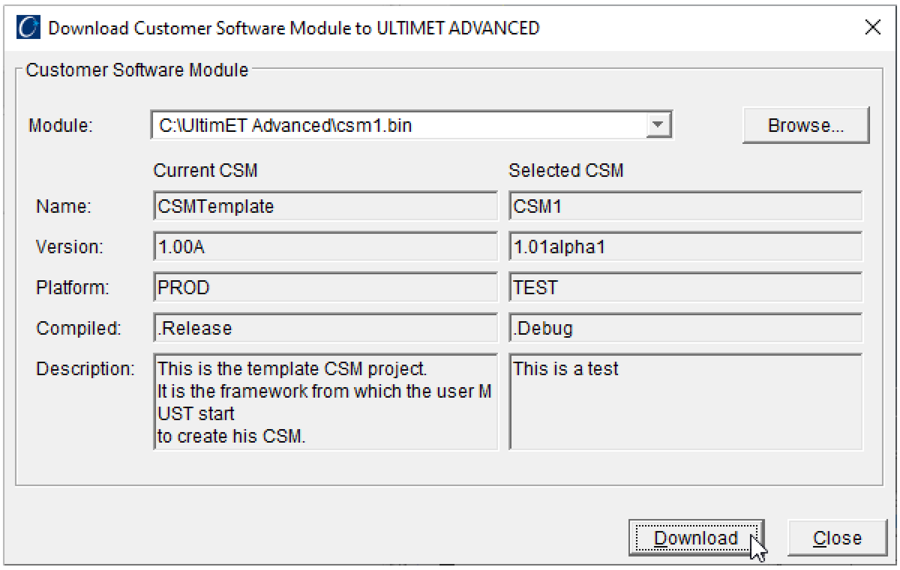
It is important to note that the selected file must have the `*.bin` extension, otherwise the following error is raised.



Error : Need a ".bin" file type !

NOTE	A part from the file extension, the tool used to download the CSM does not perform any verification on the authenticity and integrity of the binary file. If the user mistakenly selects a binary file other than a CSM, no error will be raised during the downloading process. However, the ***ULTIMET ADVANCED*** motion controller will not be able to execute it.

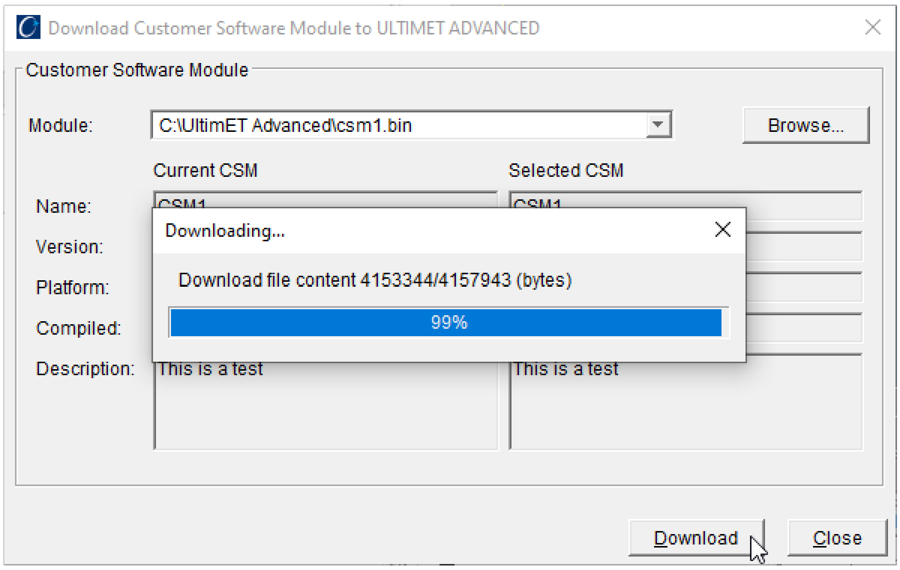
Then, click on the **Download** button to initiate the transfer of the CSM file to the Controller.



Module: C:\UltimET Advanced\csm1.bin

	Current CSM	Selected CSM
Name:	CSMTemplate	CSM1
Version:	1.00A	1.01alpha1
Platform:	PROD	TEST
Compiled:	.Release	.Debug
Description:	This is the template CSM project. It is the framework from which the user M UST start to create his CSM.	This is a test

A progress bar is displayed to inform the user of the progress of the downloading operation and an information message is displayed once the download is successfully completed. Just click on the **OK** button to close this message and then on the **Close** button on close the dialog box.



Download Customer Software Module to ULTIMET ADVANCED

Customer Software Module

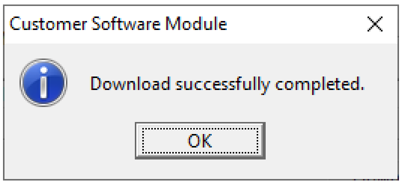
Module: C:\UltimET Advanced\csm1.bin

	Current CSM	Selected CSM
Name:	CSM1	CSM1
Version:		
Platform:		
Compiled:		
Description:	This is a test	This is a test

Downloading...

Download file content 4153344/4157943 (bytes)

99%



Customer Software Module

Download successfully completed.

Now, the CSM is ready to be executed. For further information on how to start a CSM refer to the *ULTIMET ADVANCED Motion Controller User's Manual*.

9. I/Os Configuration & Control

The table below summarizes the I/O configurations supported by ETEL Controllers and optional I/O board.

Product	Standard Digital		Fast Digital		Analog	
	Input	Output	Input	Output	Input	Output
AccurET Modular 48	4 per axis (+24V)	2 per axis (+24V)	6 (+5V)	4 (+5V)		
AccurET Modular 300						
AccurET Modular 400-600	5 per axis (+24V)	2 per axis (+24V)	4 diff. pairs (RS422)	4 diff. pairs (RS422)		
AccurET Modular VHP 48	4 per axis (+24V)	2 per axis (+24V)	6 (+5V) + 4 diff. pairs (RS422)	4 (+5V) + 4 diff. pairs (RS422)	4 diff. pairs (±10V)	4 diff. pairs (±10V)
AccurET Modular VHP 100						
UltimET Light PCI			4 diff. pairs (RS422)	4 diff. pairs (RS422)		
UltimET Light PCIe						
UltimET Light TCPIP			2 diff. pairs (RS422)	2 diff. pairs (RS422)		
ULTIMET ADVANCED			8 diff. pairs (RS485) programmable direction			
AccurET optional I/O board	8 (+24V, +5V)	8 (+24V, +Vext)			4 diff. pairs (±10V)	4 diff. pairs (±10V)

NOTE

The I/O arrangement of ***ACCURET+*** position controllers running firmware 3.5x is the same as the ***AccurET Modular*** position controllers.

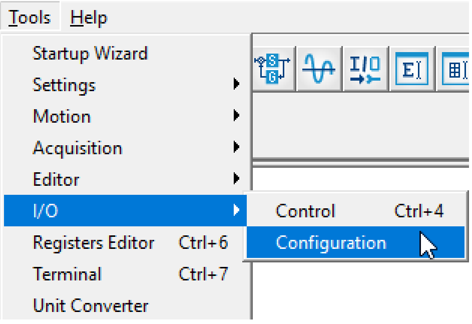
ACCURET+ position controllers are not compatible with the ***AccurET*** optional I/O board.

For more information, refer to the *AccurET Modular Position Controller Operation & Software Manual*.

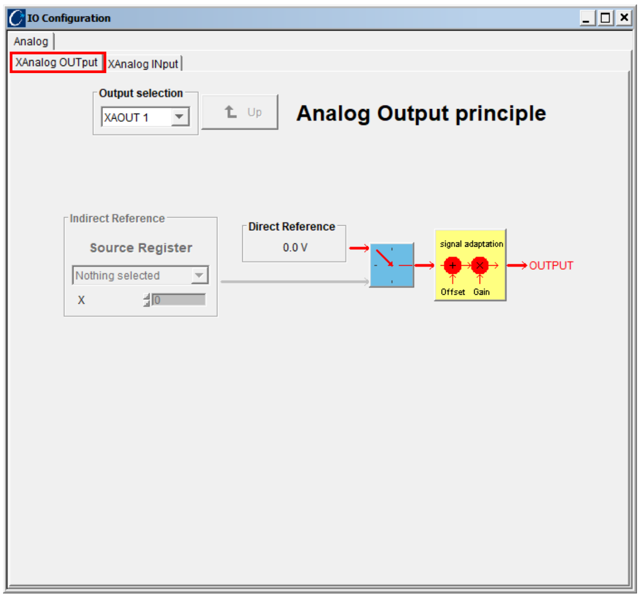
9.1. Configuration: AccurET

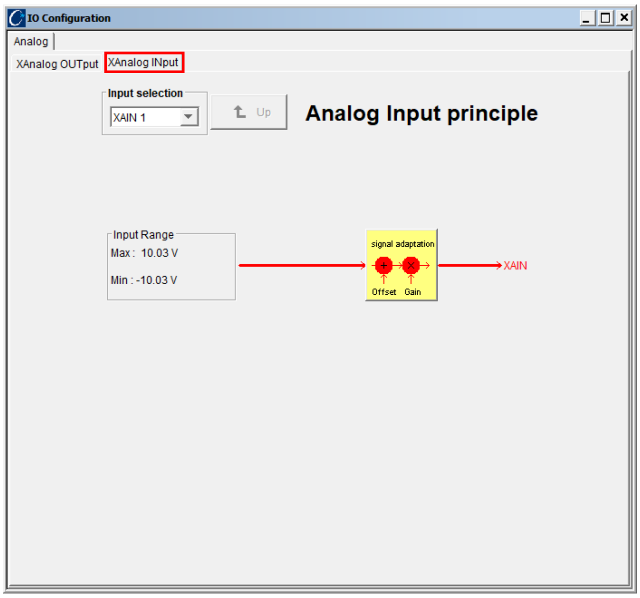
The *I/O Configuration* tool allows the user to configure the behavior of the analog I/Os available on the ***AccurET Modular VHP 48/100*** position controllers and on any other ***AccurET*** position controller equipped with an optional I/O board.

To launch the *I/O Configuration* tool select the Menu option **Tools → I/O → Configuration**:



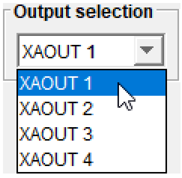
When ***ComET4*** is connected to any ***AccurET*** position controller equipped with analog I/Os, the view of the *I/O Configuration* tool is composed of two panels, one reserved for the configuration of the analog outputs and another for the analog inputs (the screenshots below refer to an ***AccurET*** position controller equipped with an optional I/O board).





9.1.1. Analog outputs

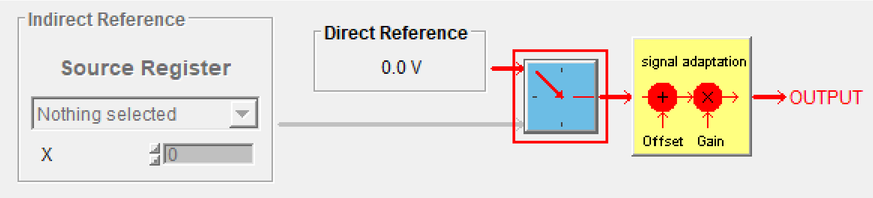
The user starts by selecting which analog output to configure.

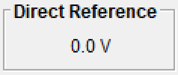
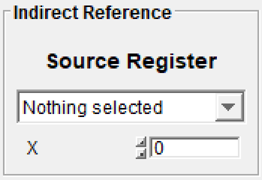
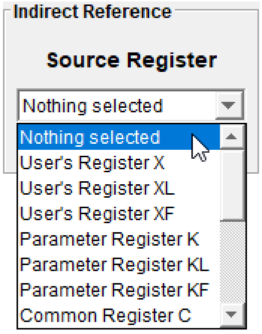


Next, the user must select between one of the two modes of operation available:

- Direct reference mode; or
- Indirect reference mode.

The selection of mode of operation is done via the blue switch button.



Analog output operation modes	
	In the **Direct Reference** mode (default mode), the reference of the analog output is given directly by the value of parameter `CF107` (`AOUT`) for an ***AccurET Modular VHP 48/100*** position controller or parameter `C7` (`XOUT`) for an ***AccurET*** equipped with an optional I/O board. This value is displayed in the **Direct Reference** field and it can be adjusted using the *I/O Control* tool, under the **analog** panel (refer to Section §9.3.2 for further details).
	In the **Indirect Reference** mode, the reference of the analog output can be given by any `X`, `K`, `C` or `M` registers named as **Source Register**.  This source register corresponds to the value of parameters `C130` (source register type), `C131` (source register index) and `C132` (source register axis) for an ***AccurET Modular VHP 48/100*** position controller or the equivalent `C30`, `C31` and `C32` parameters for an ***AccurET*** equipped with an optional I/O board.

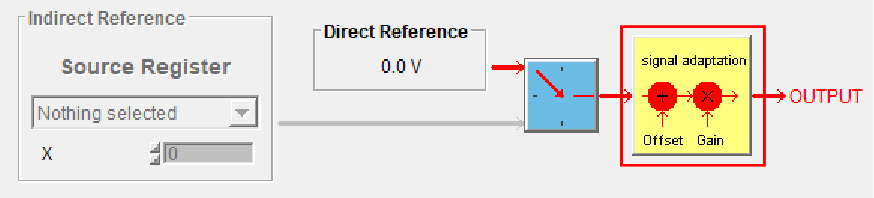
The user can adjust the output signal amplitude suited for his application by clicking on the yellow button **signal adaptation**.

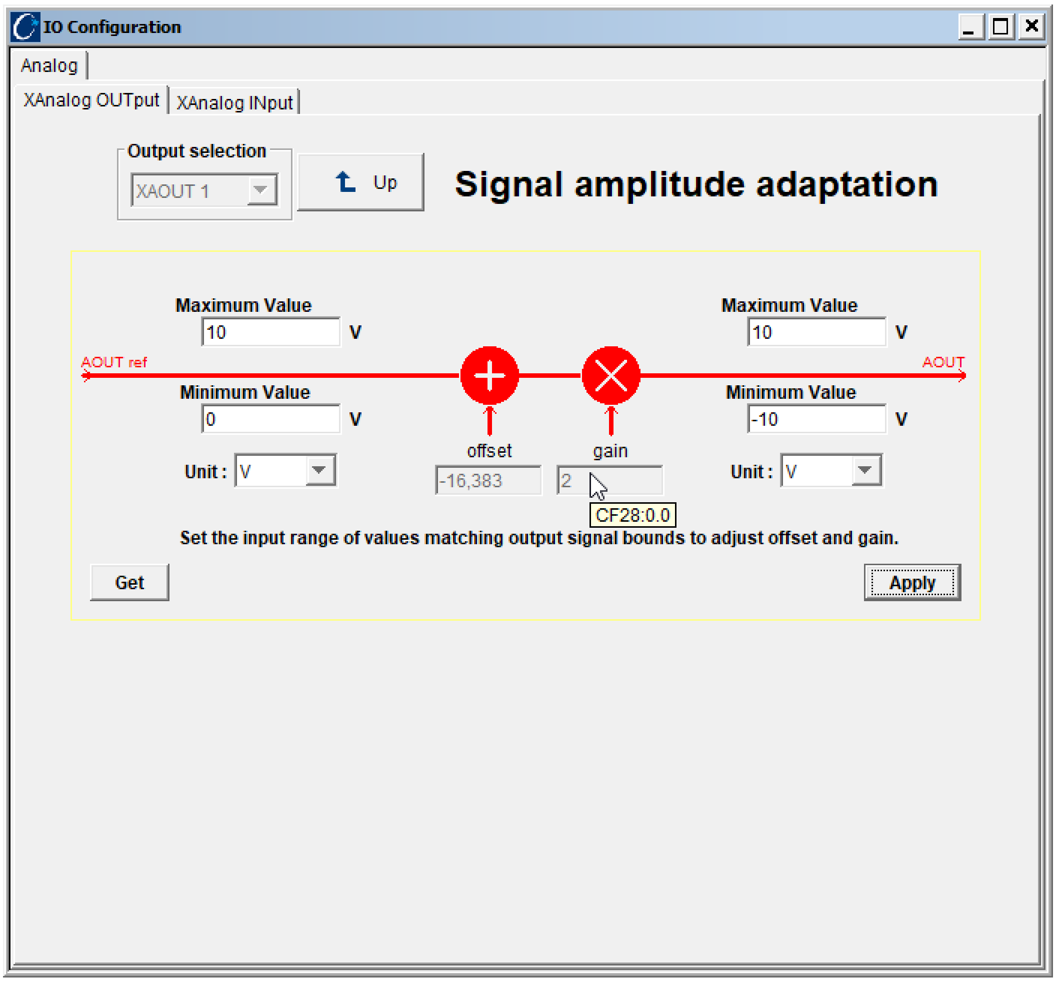
When hovering with the mouse pointer over the **offset** or **gain** fields, a tooltip is displayed with a description of the parameter corresponding to each field (respectively parameters `CF127` and `CF128` for an ***AccurET Modular VHP 48/100*** position controller and parameters `CF27` and `CF28` for an ***AccurET*** equipped with an optional I/O board).

The values of the **offset** and **gain** fields are automatically computed after pressing the **Apply** button, taking into account the range set by the user for the analog output signal before and after the signal adaptation. This action also sets the corresponding offset and gain registers on the Controller.

Click on the **Get** button to retrieve the offset and gain registers set on the Controller and update the corresponding **offset** and **gain** fields. To return to the analog output main configuration panel, click on the **Up** button Up.

NOTE	The *I/O Configuration* tool does not perform any verification of the values entered by the user. If the signal range defined by the user is beyond the capabilities of the electronics, the output signal will saturate at the supported min/max values.





Output selection: XAOUT 1

Signal amplitude adaptation

Maximum Value: 10 V
Minimum Value: 0 V
Unit : V
offset: -16,383
gain: 2
Maximum Value: 10 V
Minimum Value: -10 V
Unit : V

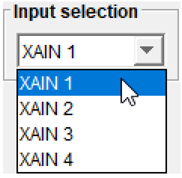
Set the input range of values matching output signal bounds to adjust offset and gain.

Finally, the user must save the configuration to the Controller. For this, select the Menu option **Controller → Save Configuration to Controller** or click on the **Save configuration to controller** toolbar button 💾. On the **Save on Controller** dialog box that pops-up, select the Controller to save, select the radio button control corresponding to the `SAV = 2` command for saving all the Registers and then click on the **Save** button.

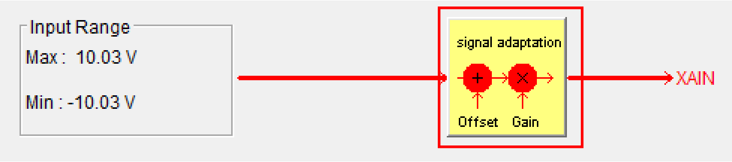
Alternatively, this command can also be typed in the *Terminal* tool. Refer to Section §10.3 for more information about saving a Controller's configuration.

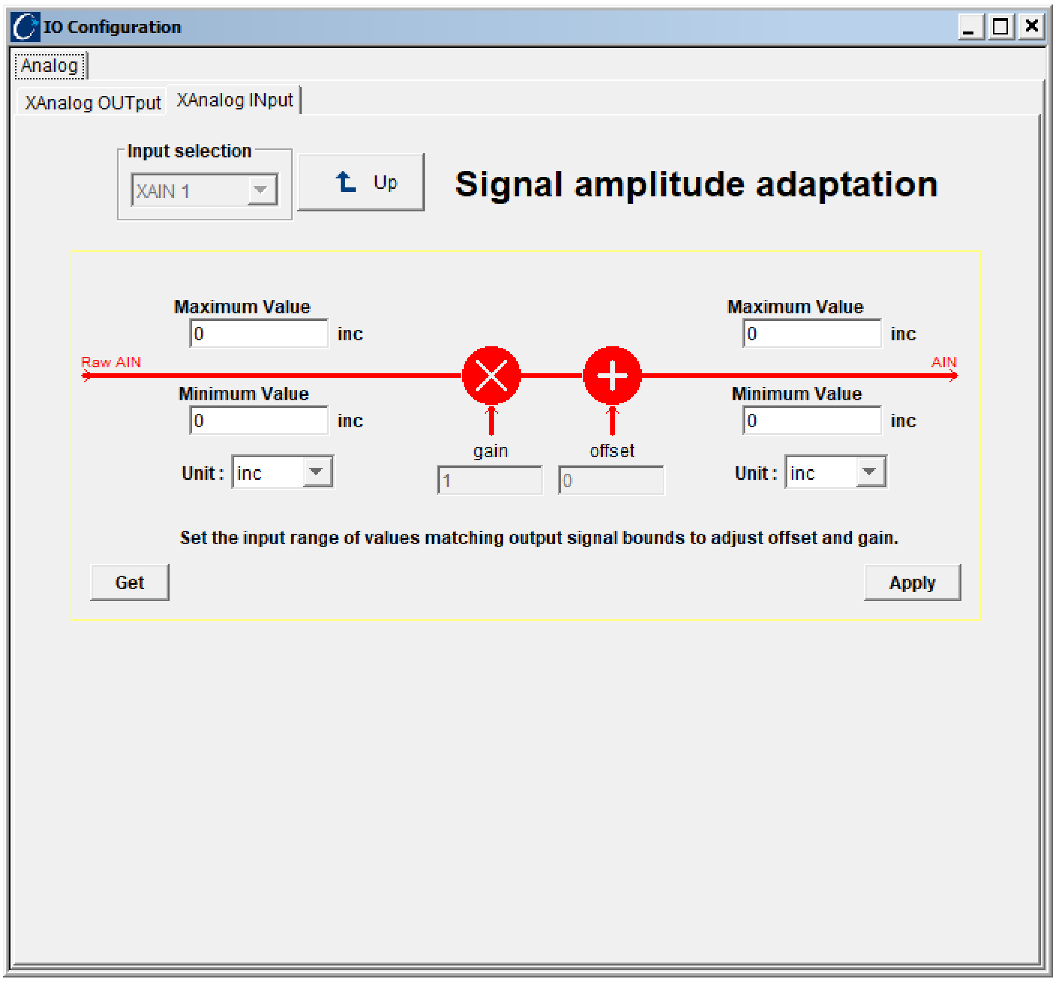
9.1.2. Analog inputs

The user must first select the analog input to configure from the selection drop-down list.



Next, by clicking on the **signal adaptation** yellow button the user can adjust the input signal amplitude suited for his application.





Signal amplitude adaptation

Input selection: XAIN 1

Maximum Value: 0 inc

Minimum Value: 0 inc

Unit : inc

gain: 1

offset: 0

Maximum Value: 0 inc

Minimum Value: 0 inc

Unit : inc

Set the input range of values matching output signal bounds to adjust offset and gain.

When hovering with the mouse pointer over the **offset** or **gain** fields, a tooltip is displayed with a description of the parameter corresponding to each field (respectively parameters `CF117` and `CF118` for an ***AccurET Modular VHP 48/100*** position controller and parameters `C17` and `CF18` for an ***AccurET*** equipped with an optional I/O board).

The values of the **offset** and **gain** fields are automatically computed after pressing the **Apply** button, taking into account the range set by the user for the analog input signal before and after the signal adaptation. This action also sets the corresponding offset and gain registers on the Controller.

Click on the **Get** button to retrieve the offset and gain registers set on the Controller and update the corresponding **offset** and **gain** fields. To return to the analog input main configuration panel, click on the **Up** button ↥ Up.

Finally, the user must save the configuration to the Controller. For this, select the Menu option **Controller → Save Configuration to Controller** or click on the **Save configuration to controller** toolbar button 💾. On the **Save on Controller** dialog box that pops-up, select the Controller to save, select the radio button control corresponding to the `SAV = 2` command for saving all the Registers and then click on the **Save** button.

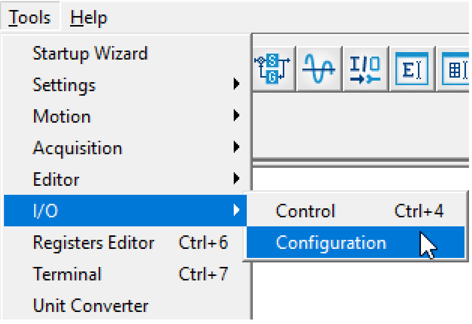
Alternatively, this command can also be typed in the *Terminal* tool. Refer to Section §10.3 for more information about saving a Controller's configuration.

NOTE	Refer to the *AccurET Modular Position Controller Operation & Software Manual* for further information about management of the analog inputs and outputs.

9.2. Configuration: UltimET

The *I/O Configuration* tool allows the user to configure the behavior of the ***UltimET Light*** motion controller local I/Os, as well as to configure the interface of this Controller to external I/O modules from the company WAGO.

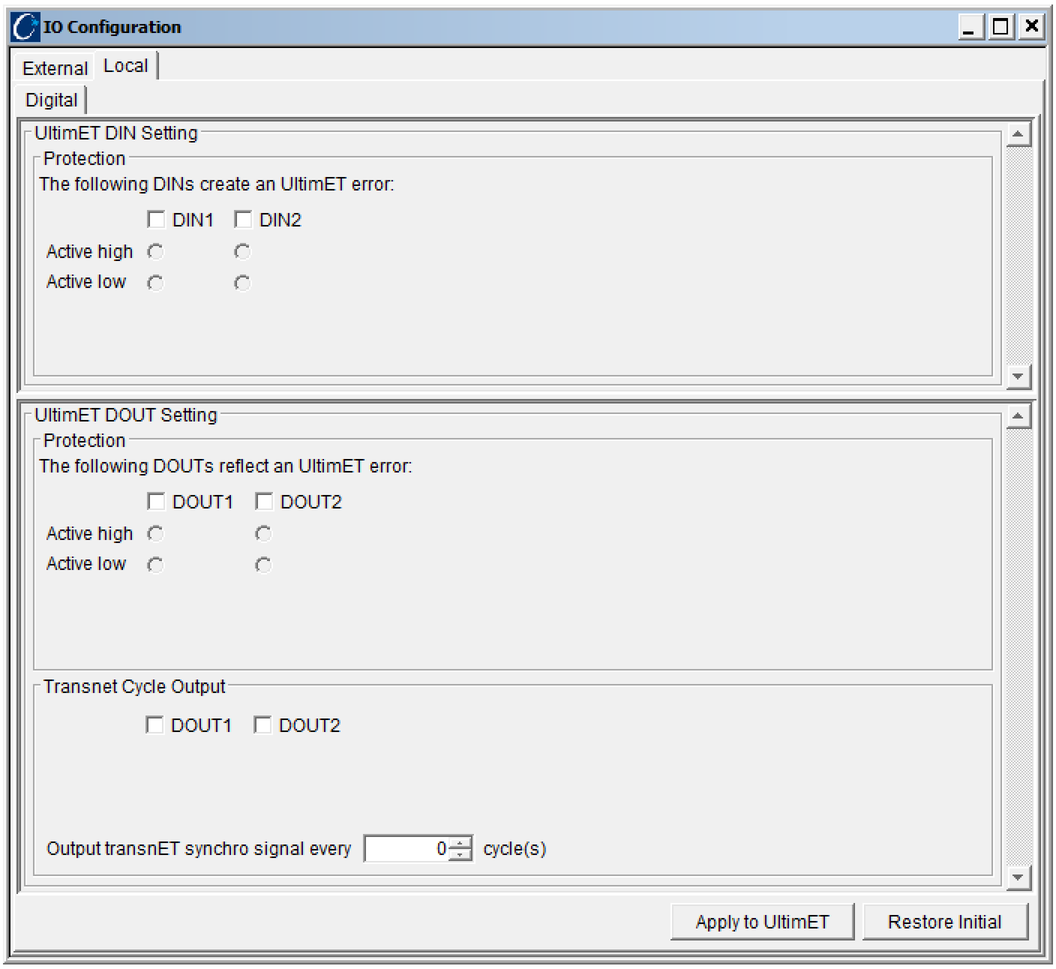
To launch the *I/O Configuration* tool select the Menu option **Tools → I/O → Configuration**:



When ***ComET4*** is connected to an ***UltimET Light*** motion controller, the view of the *I/O Configuration* tool is composed of two panels, **External** and **Local**, reserved for the configuration of the external I/O modules and local I/Os, respectively.

9.2.1. Local I/Os

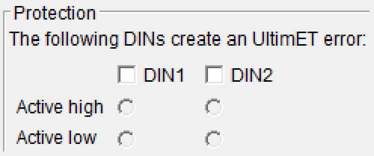
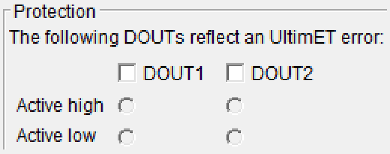
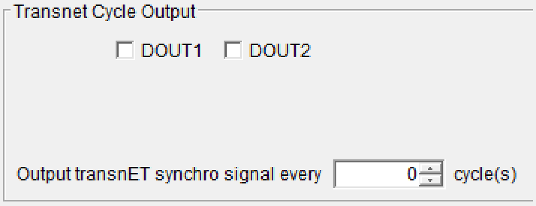
In the **Local** panel view the user can configure the functionality of the ***UltimET Light***'s native digital I/Os.



The following DINs create an UltimET error:

The following DOUTs reflect an UltimET error:

Output transnET synchro signal every 0 cycle(s)

Digital I/Os operation modes	
 Protection The following DINs create an UltimET error: ☐ DIN1 ☐ DIN2 Active high ○ ○ Active low ○ ○	Configure the ***UltimET Light*** to raise an error depending on the state (programmable "high" or "low") of the digital inputs `DIN1` and/or `DIN2`. This can be used for protection purposes, where a protection related third-party device can control the ***UltimET Light***'s execution. In addition, the error propagation mechanism can be set in such a way to also impact the operation of any ***AccurET*** connected to the same ***TransnET*** communication bus.
 Protection The following DOUTs reflect an UltimET error: ☐ DOUT1 ☐ DOUT2 Active high ○ ○ Active low ○ ○	Configure the ***UltimET Light*** to drive the state (programmable "high" or "low") of the digital outputs `DOUT1` and/or `DOUT2` whenever it falls into error. This can be used to inform protection related third-party devices that the ***UltimET Light*** is in error.
 Transnet Cycle Output ☐ DOUT1 ☐ DOUT2 Output transnET synchro signal every 0 cycle(s)	Configure the ***UltimET Light*** to generate up to two synchronization signals in phase with the ***TransnET*** cycle. The user can configure the frequency of such signals (not independently).

Click on the **Apply to UltimET** button to apply the configuration to the ***UltimET Light*** motion controller. To revert to the initial configuration click on the button **Restore Initial** (if the new configuration was not yet saved to the Controller).

Finally, the user must save the configuration to the Controller. For this, select the Menu option **Controller → Save Configuration to Controller** or click on the **Save configuration to controller** toolbar button . On the **Save on Controller** dialog box that pops-up, select the Master Controller, select the radio button control corresponding to the `SAV = 2` command for saving all the Registers and then click on the **Save** button.

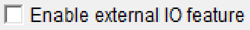
9.2.2. External I/O modules

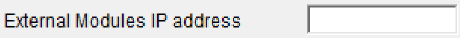
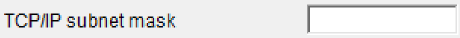
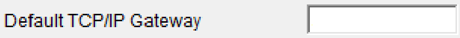
The **External** panel reserved for configuring the external I/O modules is further sub-divided in 4 sub-panels:

- Communication;
- Modules;
- Digital;
- Analog.

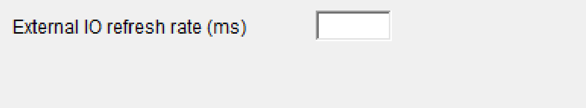
9.2.2.1. Communication sub-panel

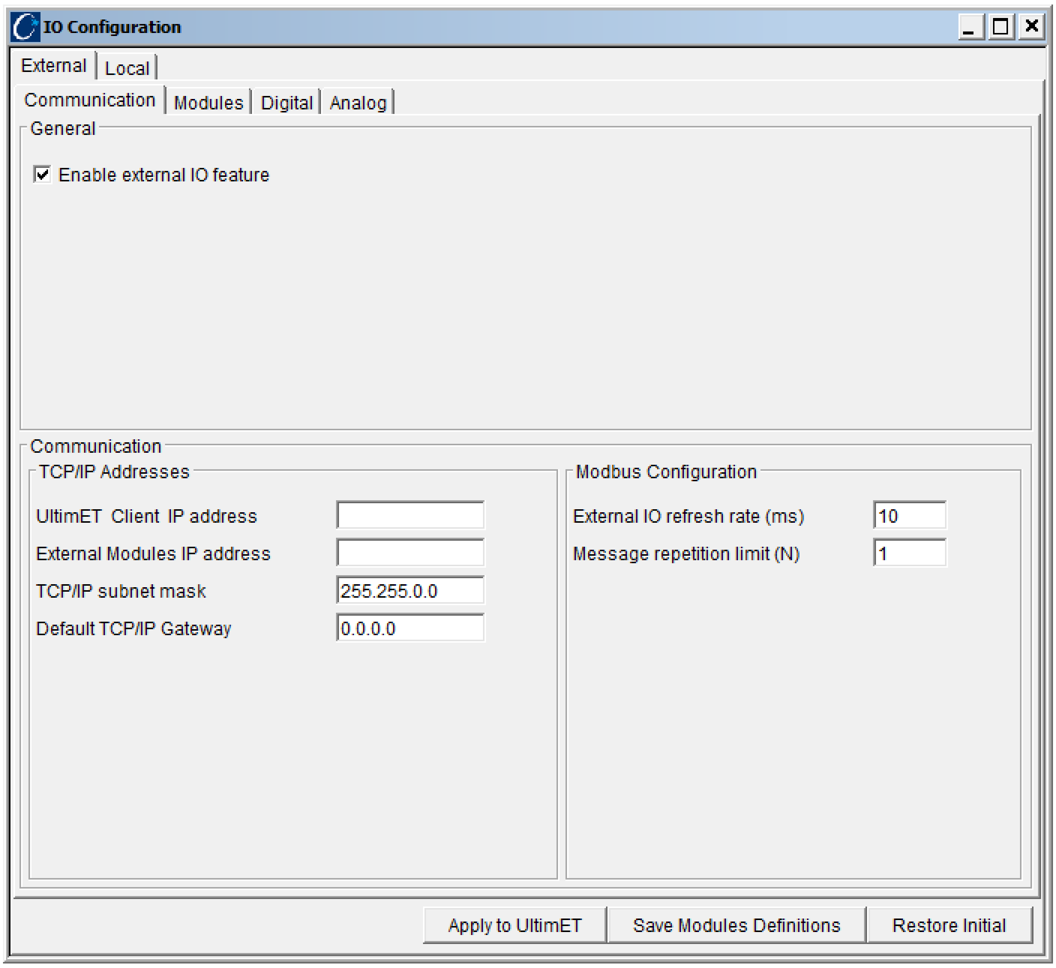
These are the settings that must be configured by the user under the **Communication** sub-panel:

General	
☐ Enable external IO feature	Enable the external I/Os feature (switch on all the features related to external I/Os). It corresponds to setting `*K727` (`*EIOEN`) to "1". The new value is taken into account only after the next switch on of the Controller. The activation state may be checked through the monitoring `*M698` (`*IOENBLD`).

TCP/IP Addresses	
UltimET Client IP address	Set the ***UltimET Light*** client IP address. It corresponds to setting `*K721` (`*IPCLADR`). This address must be in the same network range as the WAGO module IP address (e.g. ***UltimET Light*** client IP address is 192.168.10.140, WAGO module IP address is 192.168.1.10 and sub-net mask is 255.255.0.0).
External Modules IP address	Set the WAGO IP address as defined in the module. It corresponds to setting `*K722` (`*IOIPADR`).
TCP/IP subnet mask	Set the external I/Os sub-net mask. It corresponds to setting `*K725` (`*IOSUBNET`).
Default TCP/IP Gateway	If necessary for the application, set the IP address of the default gateway. It corresponds to setting `*K726` (`*IOGATEWY`). It is not useful for point-to-point connection.

Modbus Configuration

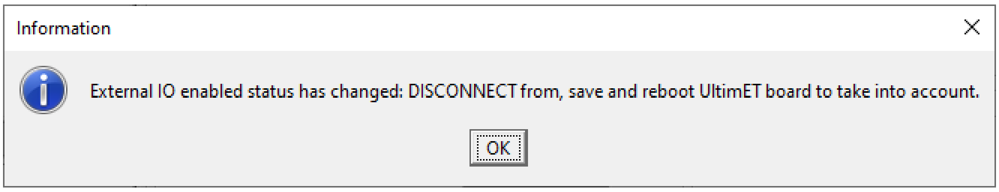
 External IO refresh rate (ms)	Set the external I/Os refresh rate expressed in milliseconds. It corresponds to setting `*K729` (`*IOREFRESH`). This parameter is set to 10 milliseconds by default.
 Message repetition limit (N)	Set the external I/Os number of repetition of UDP messages before raising an error. It corresponds to setting `*K734` (`*IONBREP`).



☑ Enable external IO feature

UltimET Client IP address:
External Modules IP address:
TCP/IP subnet mask: 255.255.0.0
Default TCP/IP Gateway: 0.0.0.0
External IO refresh rate (ms): 10
Message repetition limit (N): 1

If the user modifies the checkbox **Enable external IO feature** the following message is displayed to inform that the change will only be taken into account once the ***UltimET Light*** motion controller is rebooted.



External IO enabled status has changed: DISCONNECT from, save and reboot UltimET board to take into account.

If the user does not respect the notation for the IP addresses, the following error is raised.

Malformed IP Address: 1xxxx

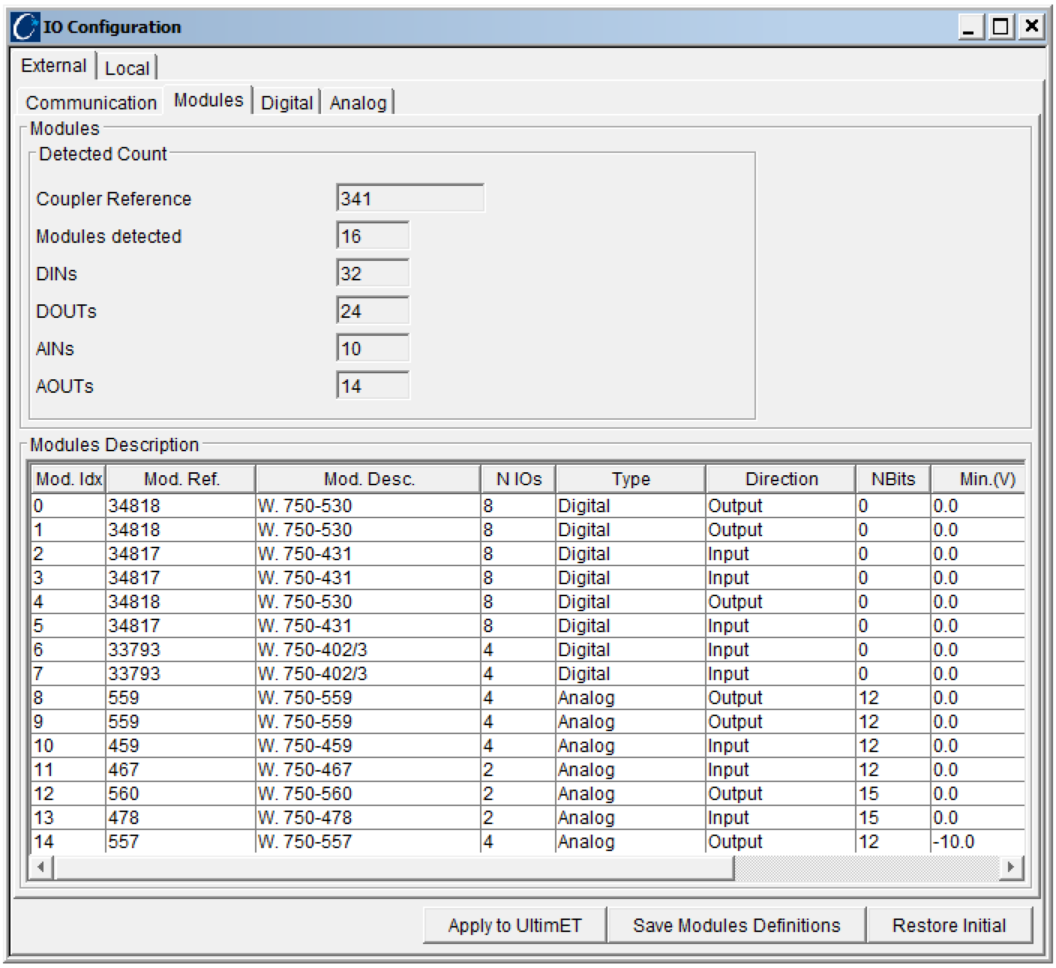
For the remaining edit controls, if the user inputs an invalid character and hits the return key, the new value will not be accepted and the edit control will revert to the last valid value.

9.2.2.2. Modules sub-panel

This sub-panel contains information about the detected configuration:

- Reference of the WAGO coupler;
- Number of modules detected;
- Number of DINs, DOUTs, AINs and AOUTs available through these modules.

The column concerning the module description in the modules listing (**Mod. Desc.**) is obtained from ETEL's or user's description files based on the module's reference.

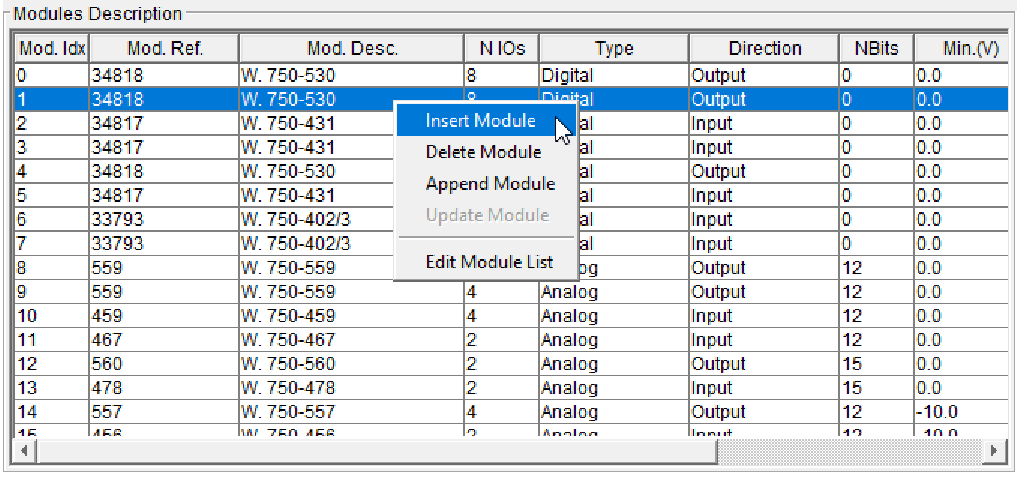


Coupler Reference	341
Modules detected	16
DINs	32
DOUTs	24
AINs	10
AOUTs	14

Mod. Idx	Mod. Ref.	Mod. Desc.	N IOs	Type	Direction	NBits	Min.(V)
0	34818	W. 750-530	8	Digital	Output	0	0.0
1	34818	W. 750-530	8	Digital	Output	0	0.0
2	34817	W. 750-431	8	Digital	Input	0	0.0
3	34817	W. 750-431	8	Digital	Input	0	0.0
4	34818	W. 750-530	8	Digital	Output	0	0.0
5	34817	W. 750-431	8	Digital	Input	0	0.0
6	33793	W. 750-402/3	4	Digital	Input	0	0.0
7	33793	W. 750-402/3	4	Digital	Input	0	0.0
8	559	W. 750-559	4	Analog	Output	12	0.0
9	559	W. 750-559	4	Analog	Output	12	0.0
10	459	W. 750-459	4	Analog	Input	12	0.0
11	467	W. 750-467	2	Analog	Input	12	0.0
12	560	W. 750-560	2	Analog	Output	15	0.0
13	478	W. 750-478	2	Analog	Input	15	0.0
14	557	W. 750-557	4	Analog	Output	12	-10.0

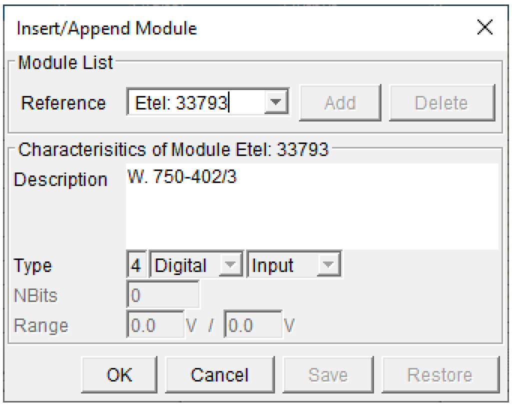
Right-click on the modules list to open a context menu enabling the following actions:

- Insert or Append a module to the hardware configuration;
- Delete a module from the hardware configuration;
- Edit the modules list.



Mod. Idx	Mod. Ref.	Mod. Desc.	N IOs	Type	Direction	NBits	Min.(V)
0	34818	W. 750-530	8	Digital	Output	0	0.0
1	34818	W. 750-530	8	Digital	Output	0	0.0
2	34817	W. 750-431		al	Input	0	0.0
3	34817	W. 750-431		al	Input	0	0.0
4	34818	W. 750-530		al	Output	0	0.0
5	34817	W. 750-431		al	Input	0	0.0
6	33793	W. 750-402/3		al	Input	0	0.0
7	33793	W. 750-402/3		al	Input	0	0.0
8	559	W. 750-559		og	Output	12	0.0
9	559	W. 750-559	4	Analog	Output	12	0.0
10	459	W. 750-459	4	Analog	Input	12	0.0
11	467	W. 750-467	2	Analog	Input	12	0.0
12	560	W. 750-560	2	Analog	Output	15	0.0
13	478	W. 750-478	2	Analog	Input	15	0.0
14	557	W. 750-557	4	Analog	Output	12	-10.0

Selecting either the menu option **Insert Module** or **Append Module** opens the following dialog box from which the user can insert/append a new module by typing in a new reference in the **Reference** drop-down list edit field and completing the missing information or, alternatively, insert/append an already existing module by selecting it from the **Reference** drop-down list.



Reference: Etel: 33793

Characterisitics of Module Etel: 33793

Description: W. 750-402/3

Type: 4 Digital Input

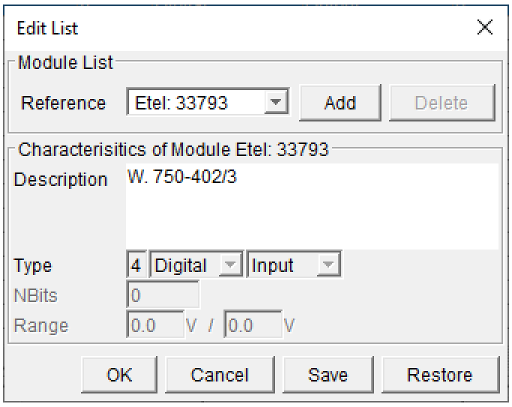
NBits: 0

Range: 0.0 V / 0.0 V

Selecting the menu option **Delete Module** deletes a module from the hardware configuration.

NOTE	The **Delete Module** option does not remove the module from the description file. It only removes this particular module from the hardware configuration list.

Selecting the menu option **Edit Module List** opens the following dialog box:



Reference Etel: 33793
Description W. 750-402/3
Type 4 Digital Input
NBits 0
Range 0.0 V / 0.0 V

With this dialog box, the user can add and remove modules from the known user modules list which is created from the user's description file without actually impacting the existing hardware configuration. The user cannot add or remove an ETEL native module. In the **Reference** drop-down list, ETEL native modules are prefixed with the label "Etel:", while the user modules are prefixed with the label "User:" (automatically inserted whenever a user inserts a new module).

Click on the **Save** button to save the changes to the user modules description file. With the **Restore** button, the user can revert to the list of modules existing at the moment the *I/O Configuration* tool was launched.

Clicking on the **Save Modules Definitions** button also writes the new definitions to the user modules description file. With the **Restore Initial** button, the user can revert the list to its initial condition when the *I/O Configuration* tool was launched.

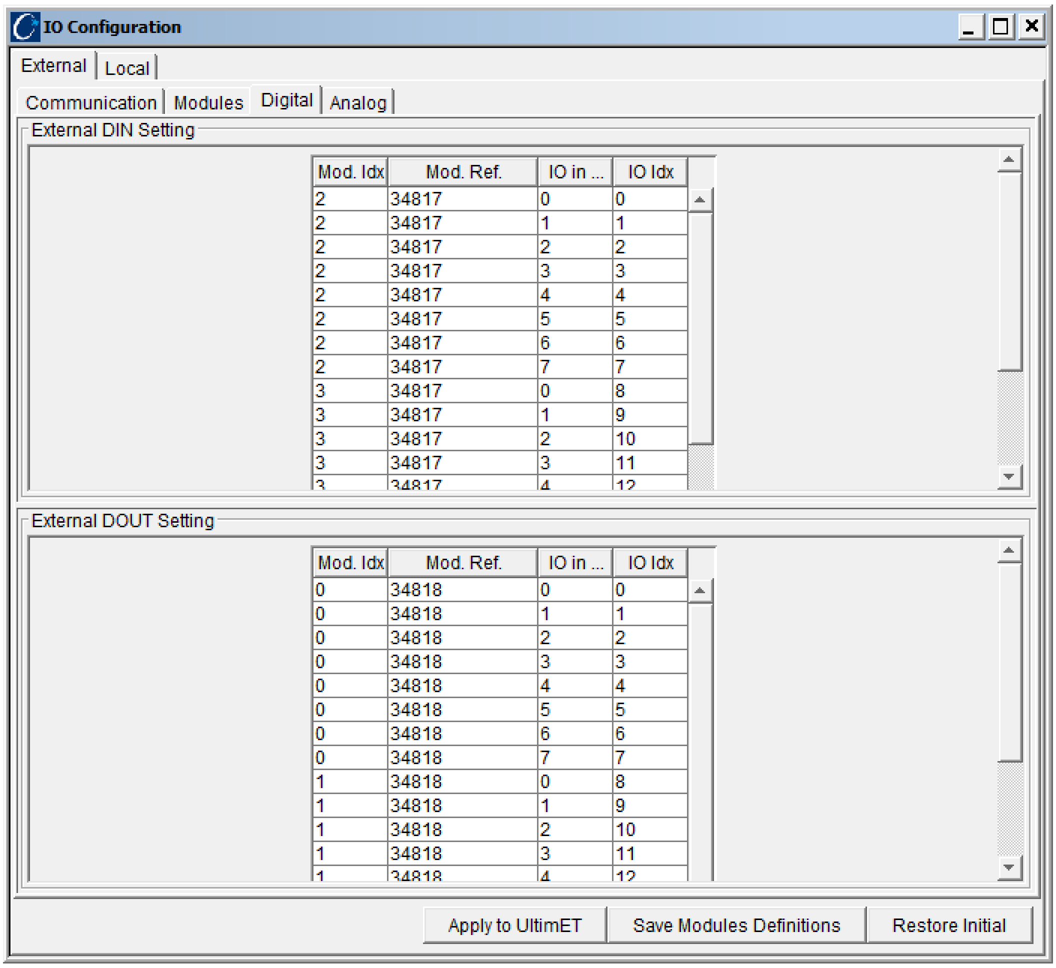
NOTE

Clicking on the **Restore Initial** button also reverts the analog I/Os gain and offset settings to their initial values. Refer to the **Analog** sub-panel Section further below for additional information on this topic.

9.2.2.3. Digital sub-panel

This sub-panel is purely informative listing the digital I/Os:

Column Nr.	Column Header	Description
1	**Mod. Idx**	Module's index in the hardware configuration list.
2	**Mod. Ref**	Module's reference.
3	**IO in Mod.**	I/O index in the list of I/Os belonging to the same module.
4	**IO Idx**	I/O index in the list of all digital I/Os available in the hardware configuration list.



External DIN Setting

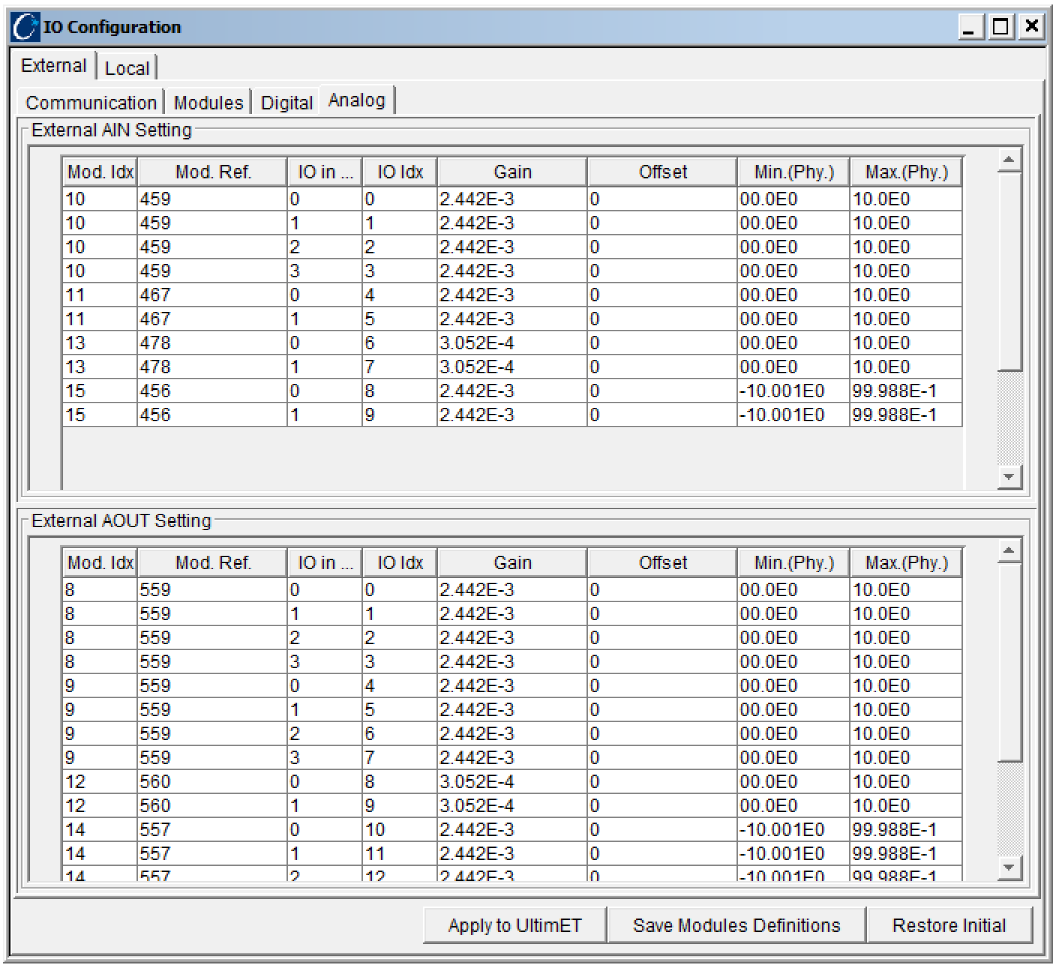
Mod. Idx	Mod. Ref.	IO in ...	IO Idx
2	34817	0	0
2	34817	1	1
2	34817	2	2
2	34817	3	3
2	34817	4	4
2	34817	5	5
2	34817	6	6
2	34817	7	7
3	34817	0	8
3	34817	1	9
3	34817	2	10
3	34817	3	11
3	34817	4	12

External DOUT Setting

Mod. Idx	Mod. Ref.	IO in ...	IO Idx
0	34818	0	0
0	34818	1	1
0	34818	2	2
0	34818	3	3
0	34818	4	4
0	34818	5	5
0	34818	6	6
0	34818	7	7
1	34818	0	8
1	34818	1	9
1	34818	2	10
1	34818	3	11
1	34818	4	12

9.2.2.4. Analog sub-panel

In this sub-panel the user can set the gain and offset of the analog I/Os. If these have never been set before, the tool displays the default values based on the modules' characteristics. The user can modify these settings according to his application.



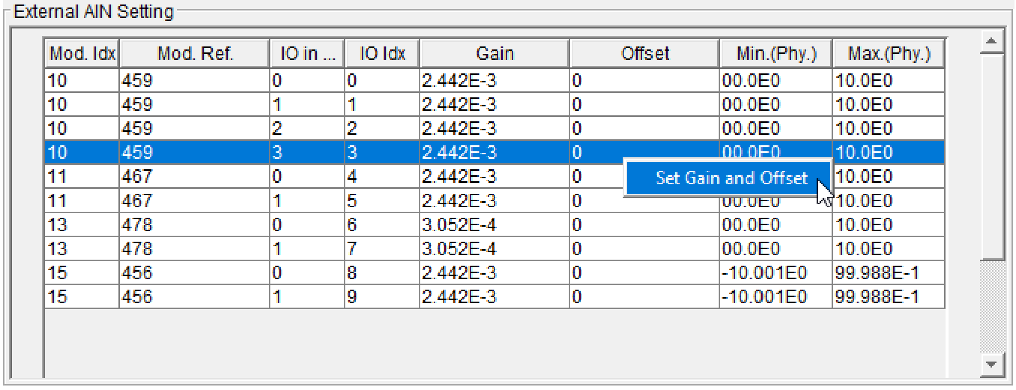
External AIN Setting

Mod. Idx	Mod. Ref.	IO in ...	IO Idx	Gain	Offset	Min.(Phy.)	Max.(Phy.)
10	459	0	0	2.442E-3	0	00.0E0	10.0E0
10	459	1	1	2.442E-3	0	00.0E0	10.0E0
10	459	2	2	2.442E-3	0	00.0E0	10.0E0
10	459	3	3	2.442E-3	0	00.0E0	10.0E0
11	467	0	4	2.442E-3	0	00.0E0	10.0E0
11	467	1	5	2.442E-3	0	00.0E0	10.0E0
13	478	0	6	3.052E-4	0	00.0E0	10.0E0
13	478	1	7	3.052E-4	0	00.0E0	10.0E0
15	456	0	8	2.442E-3	0	-10.001E0	99.988E-1
15	456	1	9	2.442E-3	0	-10.001E0	99.988E-1

External AOUT Setting

Mod. Idx	Mod. Ref.	IO in ...	IO Idx	Gain	Offset	Min.(Phy.)	Max.(Phy.)
8	559	0	0	2.442E-3	0	00.0E0	10.0E0
8	559	1	1	2.442E-3	0	00.0E0	10.0E0
8	559	2	2	2.442E-3	0	00.0E0	10.0E0
8	559	3	3	2.442E-3	0	00.0E0	10.0E0
9	559	0	4	2.442E-3	0	00.0E0	10.0E0
9	559	1	5	2.442E-3	0	00.0E0	10.0E0
9	559	2	6	2.442E-3	0	00.0E0	10.0E0
9	559	3	7	2.442E-3	0	00.0E0	10.0E0
12	560	0	8	3.052E-4	0	00.0E0	10.0E0
12	560	1	9	3.052E-4	0	00.0E0	10.0E0
14	557	0	10	2.442E-3	0	-10.001E0	99.988E-1
14	557	1	11	2.442E-3	0	-10.001E0	99.988E-1
14	557	2	12	2.442E-3	0	-10.001E0	99.988E-1

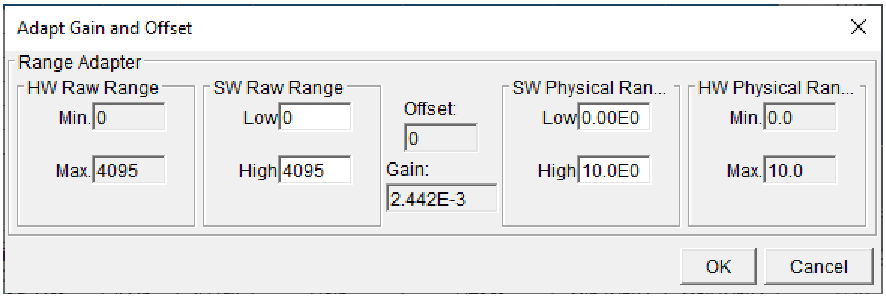
To modify the gain and offset of one of the analog I/Os, select the corresponding I/O from the listing, right-click and select the only option available from the context menu.



External AIN Setting

Mod. Idx	Mod. Ref.	IO in ...	IO Idx	Gain	Offset	Min.(Phy.)	Max.(Phy.)
10	459	0	0	2.442E-3	0	00.0E0	10.0E0
10	459	1	1	2.442E-3	0	00.0E0	10.0E0
10	459	2	2	2.442E-3	0	00.0E0	10.0E0
10	459	3	3	2.442E-3	0	00.0E0	10.0E0
11	467	0	4	2.442E-3	0		10.0E0
11	467	1	5	2.442E-3	0	00.0E0	10.0E0
13	478	0	6	3.052E-4	0	00.0E0	10.0E0
13	478	1	7	3.052E-4	0	00.0E0	10.0E0
15	456	0	8	2.442E-3	0	-10.001E0	99.988E-1
15	456	1	9	2.442E-3	0	-10.001E0	99.988E-1

Then, adjust the software raw and physical ranges and the gain and offset settings are automatically computed. Press on the **OK** button to accept the settings.



Adapt Gain and Offset

Range Adapter

HW Raw Range
Min. 0
Max. 4095

SW Raw Range
Low 0
High 4095

Offset: 0
Gain: 2.442E-3

SW Physical Ran...
Low 0.00E0
High 10.0E0

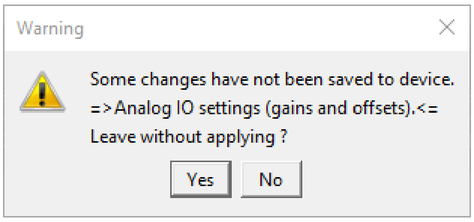
HW Physical Ran...
Min. 0.0
Max. 10.0

Finally, click on the **Apply to UltimET** button to take these settings into account.

NOTE	When clicking on the **Apply to UltimET** button the values are taken immediately into account, but not saved to the ***UltimET Light*** motion controller. In order words, the values will be lost once the Controller is powered off.

Clicking on the **Restore Initial** button to revert the analog I/Os gain and offset settings to their initial values. However, this action will also revert the modules list configured in the **Modules** sub-panel to their initial state.

If the user only wants to revert the analog I/Os gains and offsets to their initial state, the workaround is to save the modules' list by clicking on the **Save Modules Definitions** button, close the *I/O Configuration* tool by clicking on the top right most button ☒ and press on the **Yes** button on the warning message that pops-up.



Warning

Some changes have not been saved to device.
=>Analog IO settings (gains and offsets).<=
Leave without applying ?

Then, re-open the *I/O Configuration* tool and return to the **Analog** sub-panel on the **External** panel. The gains and offsets have the same values as before the changes made by the user.

Finally, after having configured all the I/O settings, the user must save the configuration to the Controller and reboot it. For the first step, select the Menu option **Controller → Save Configuration to Controller** or click on the **Save configuration to controller** toolbar button 💾. On the **Save on Controller** dialog box that pops-up, select the Master Controller, select the radio button control corresponding to the `SAV = 2` command for saving all the Registers and then click on the **Save** button.

To reboot, simply power cycle the ***UltimET Light*** motion controller. For the PCI/PCIe version this means powering off and on the computer hosting the Controller. For the TCP/IP version this means powering off and on the ***AccurET*** hosting the ***UltimET Light***.

NOTE

To properly reboot an ***UltimET Light PCI/PCIe*** motion controller it is not sufficient to restart the computer hosting the Controller. The user must shut down the computer to ensure that the motherboard does not continue powering the ***UltimET Light PCI/PCIe*** card.

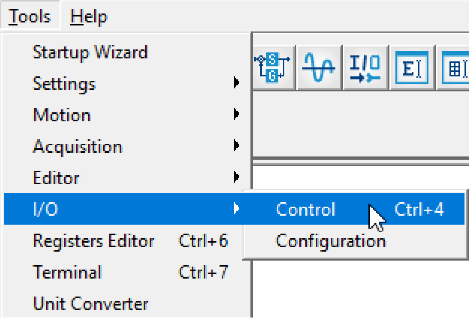
9.3. Control

The *I/O Control* tool allows the user to view the value of the input signals and control the value of the output signals available on a Controller, an ***AccurET*** optional I/O board (if available) or any external I/O modules interfacing an ***UltimET Light*** motion controller (if available).

There are several ways to launch the *I/O Control* tool, such as:

1. On the **Toolbar Tools** group, click on the button .

2. Select the Menu option **Tools → I/O → Control**.



The *I/O Control* tool window contains 3 panels:

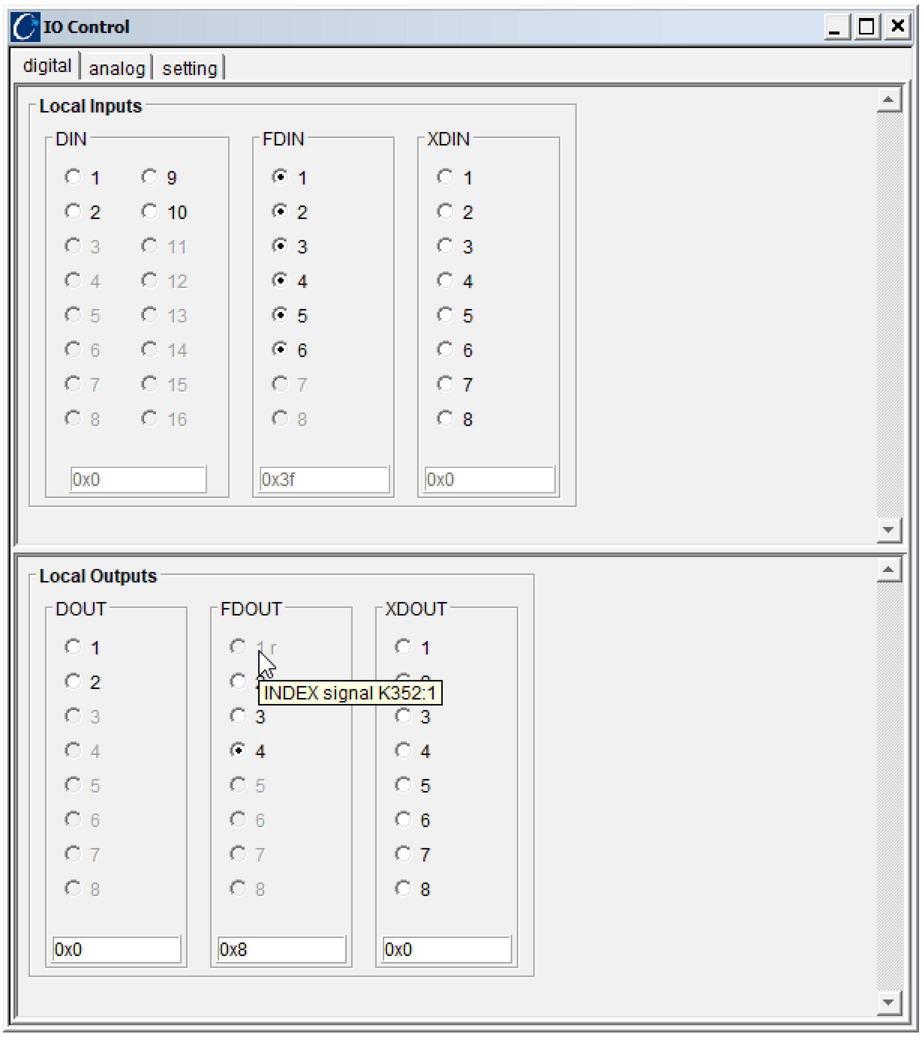
1. **Digital**;
2. **Analog**;
3. **Setting**.

9.3.1. Digital panel

The **digital** panel allows the user to:

- Monitor the digital inputs of the selected Controller and optional I/O board, if present;
- Set the state of the digital outputs of the selected Controller and optional I/O board, if present.

The view below corresponds to the digital panel when connected to an ***AccurET*** position controller with an optional I/O board. The collection of digital input signals `DIN`/`FDIN` and digital output signals `DOUT`/`FDOUT` are native to the Controller, while the collection of digital signals `XDIN`/`XDOUT` belong to the optional I/O board.



When the letter **r** (for reserved) is displayed next to a digital output, it means it is being used to drive a specific signal (e.g. 1Vpp sin, cos, index, …). When hovering with the mouse pointer over the corresponding output a tooltip is displayed with a description of the signal being driven.

NOTE

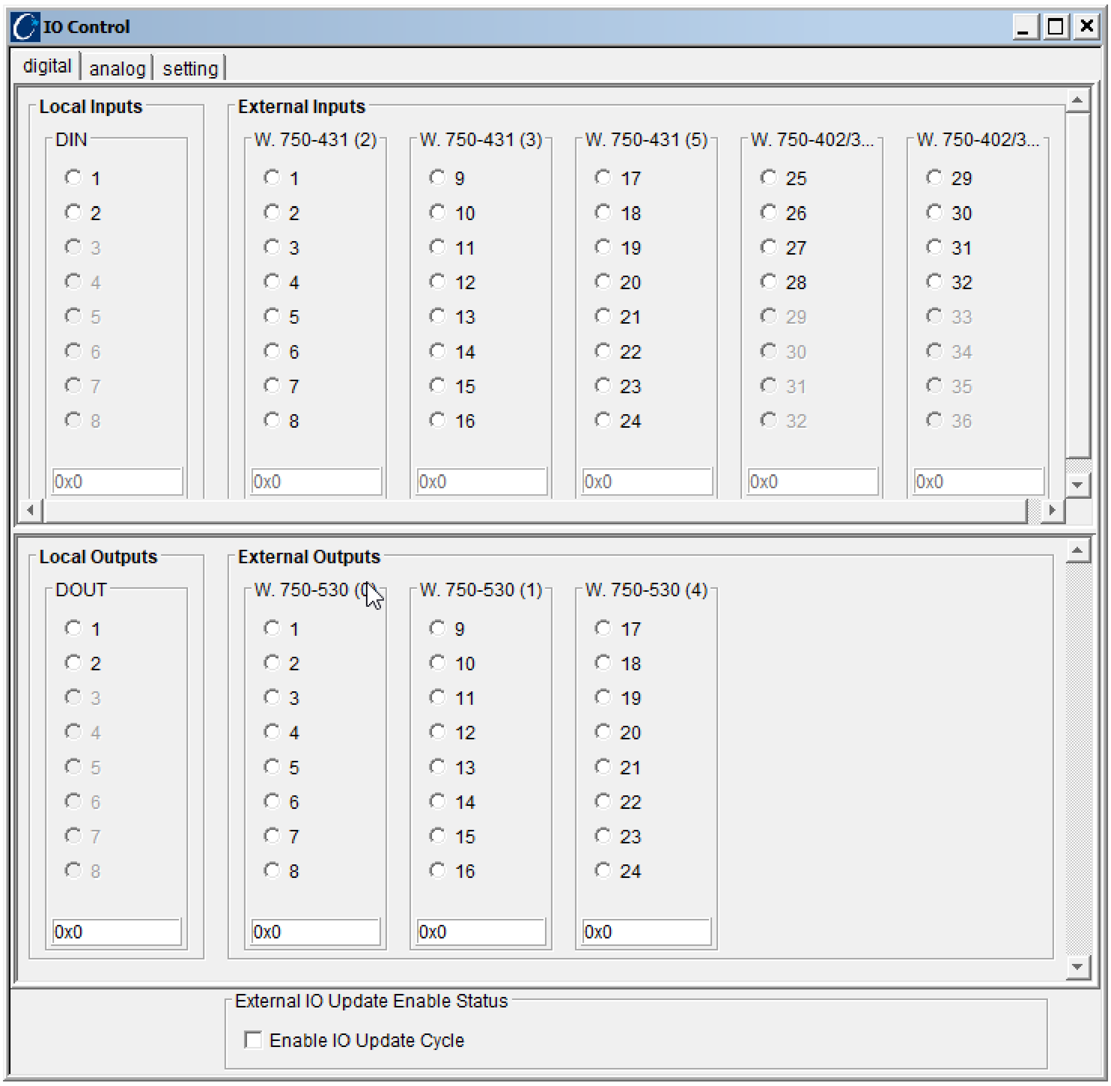
Refer to the *AccurET Modular Position Controller Operation & Software Manual* for further information about the signals that can be driven by the `DOUT` and `FDOUT` digital outputs.

The radio button controls reflect the status of the individual I/Os of a collection:

- A radio button set means that the corresponding input or output state is driven "high";
- A radio button unset means that the corresponding input or output state is driven "low".

The edit control below the radio buttons contains the hexadecimal representation of the respective I/O collection, with each individual I/O belonging to this collection corresponding to a bit ("high" state is equivalent to bit = "1" and "low" state is equivalent to bit = "0"). E.g., the value of 0x08 for the `FDOUT` collection means that the state of the output `FDOUT4` "high" (bit = "1").

The view below corresponds to the digital panel when connected to an ***UltimET Light PCI/PCIe*** motion controller with an external I/O module (WAGO coupler).



The **External Inputs** and **External Outputs** group frames contain as many 'sub-' group frames as digital I/O modules connected. The title of each "sub-" group frame contains the module's reference, followed by its index (within brackets) relative to the full hardware configuration, starting counting from the WAGO coupler and including any analog modules.

Each digital I/O is also numbered with its position within the configuration, also starting counting from the WAGO coupler (but only accounting for the digital I/Os).

While the **Enable I/O Update Cycle** checkbox is not selected, the display shows the actual state of the I/Os and no changes can be made. An output signal whose value is attempted to be modified will revert to its current state.

As soon as the checkbox is selected (which is equivalent to sending the command `*EIOSTA = 1` to the ***UltimET Light***), changes are taken into account and the *I/O Control* tool displays the value set for the output. Of course, the value of input signals can never be modified, regardless if the checkbox is selected or not. The *I/O Control* tool always displays their current state.

The values of a given module can be modified by either toggling individually the outputs using the radio button controls or by introducing the hexadecimal value in the corresponding edit control.

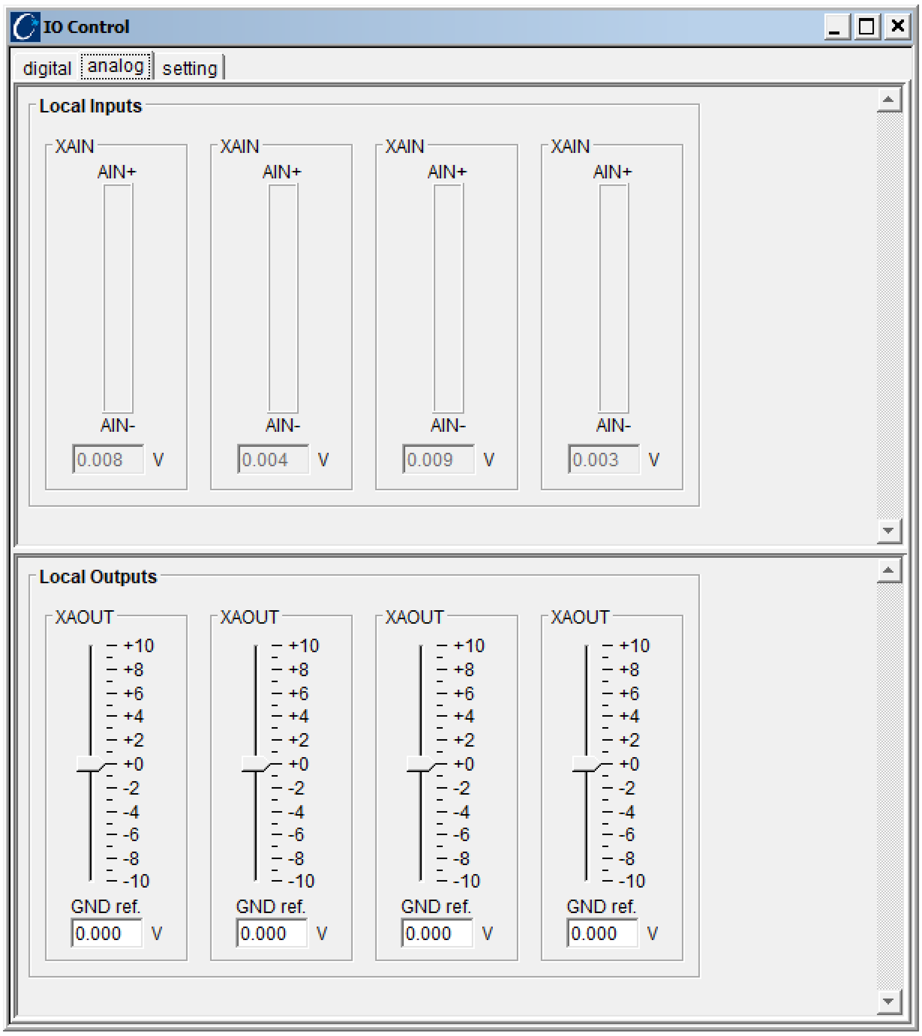
NOTE	Refer to Section §9.1.2 for details on how to configure an ***UltimET Light*** motion controller to use external I/O modules.

9.3.2. Analog panel

The **analog** panel allows the user to:

- Monitor the analog inputs of the selected Controller and optional I/O board, if present;
- Set the level of the analog outputs of the selected Controller and optional I/O board, if present.

The view below corresponds to the analog panel when connected to an ***AccurET*** position controller with an optional I/O board. In this particular example, the collection of analog signals `XAIN`/`XAOUT` belong to the optional I/O board, as the ***AccurET Modular 48*** being used does not include any analog I/Os.

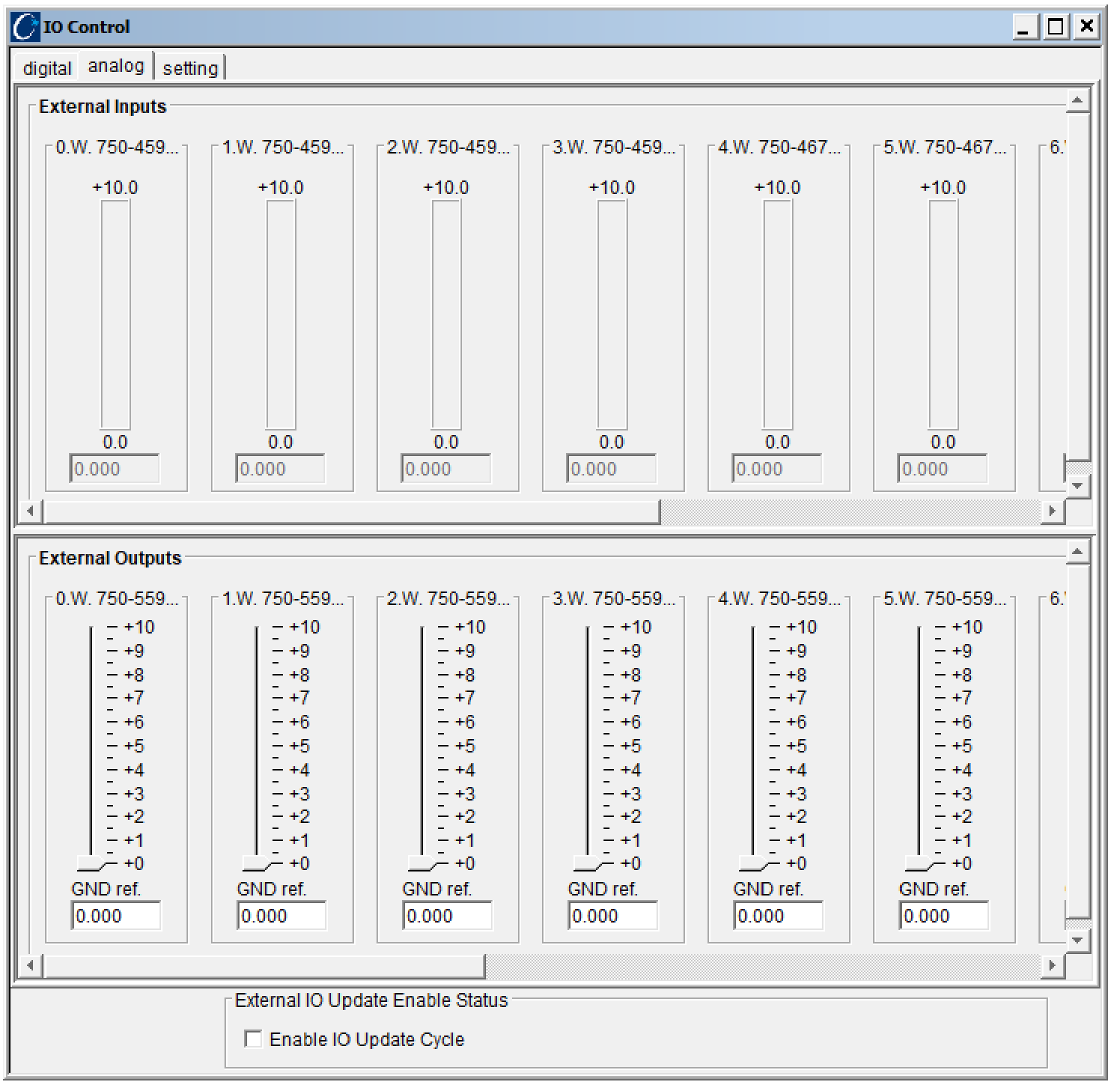


XAIN: 0.008 V, 0.004 V, 0.009 V, 0.003 V

XAOUT: 0.000 V, 0.000 V, 0.000 V, 0.000 V

The level of the analog outputs can be adjusted using the slider controls or inputting directly the value expressed in Volts (V) in the corresponding edit control. Values are saturated to the minimum and maximum limits (±10V).

The view below corresponds to the analog panel when connected to an ***UltimET Light*** motion controller with an external I/O module (WAGO coupler).



☐ Enable IO Update Cycle

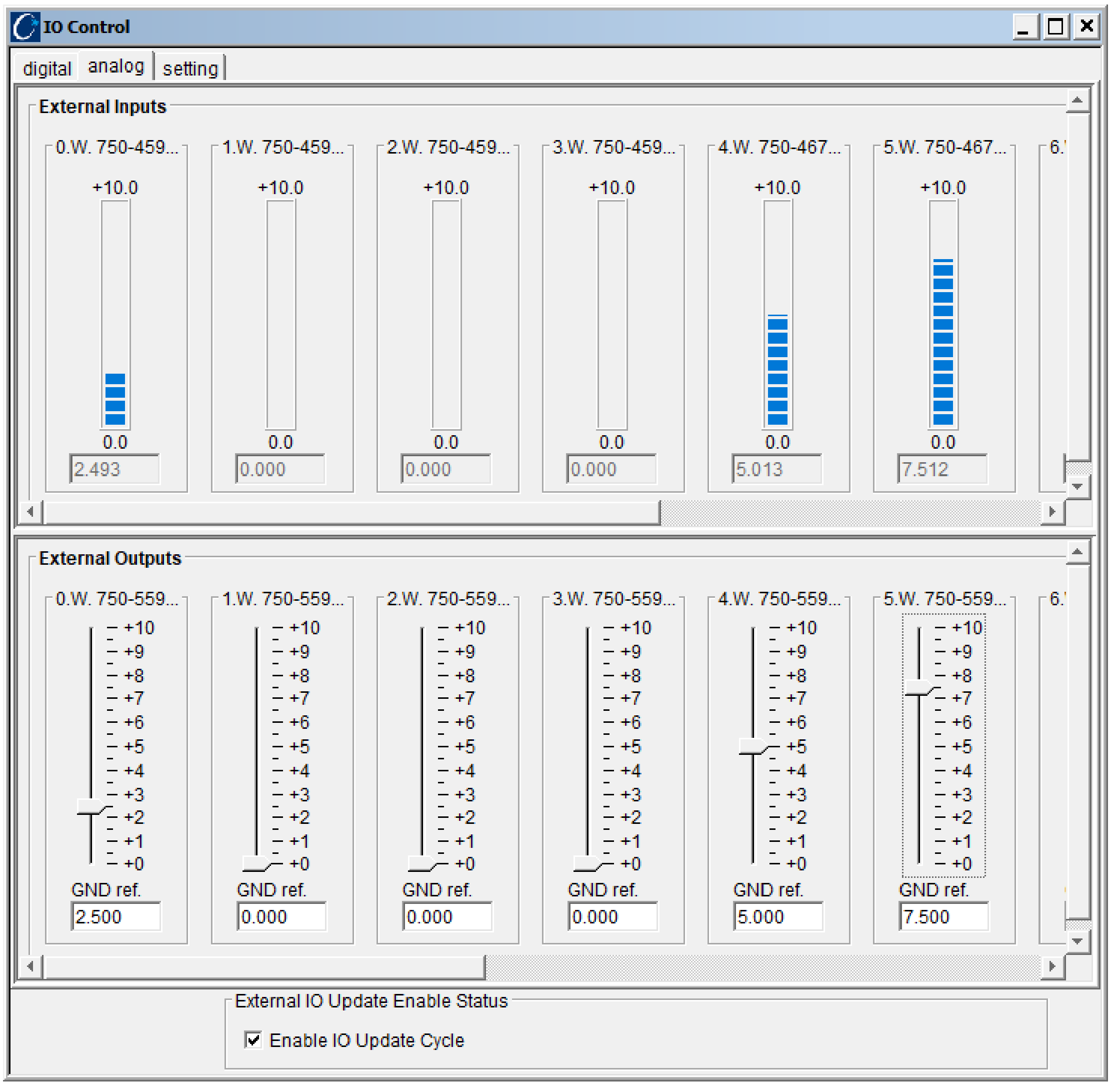
The **External Inputs** and **External Outputs** group frames contain as many 'sub-' group frames as analog I/O modules connected. The title of each "sub-" group frame is the same as in the **digital** panel (i.e. module's reference, followed by its index in the current configuration), except it also includes a prefix corresponding to the index of the I/O within its type in the current configuration.

Again, while the **Enable I/O Update Cycle** checkbox is not selected, the display shows the actual level of the I/Os and no changes can be made. An output signal whose value was attempted to be modified will revert to its current level.

As soon as the checkbox is selected (which is equivalent to sending the command `*EIOSTA = 1` to the ***UltimET Light***), changes are taken into account and the *I/O Control* tool displays the value set for the output. Of course, the value of input signals can never be modified, regardless if the checkbox is selected or not. The *I/O Control* tool always displays their current level.

The level of the analog outputs can be controlled using the slider controls or inputting directly the value expressed in Volts (V) in the corresponding edit control. Values are saturated to the minimum or maximum limits resulting from the modules' number of bits and range, and the gains and offsets set by the user.

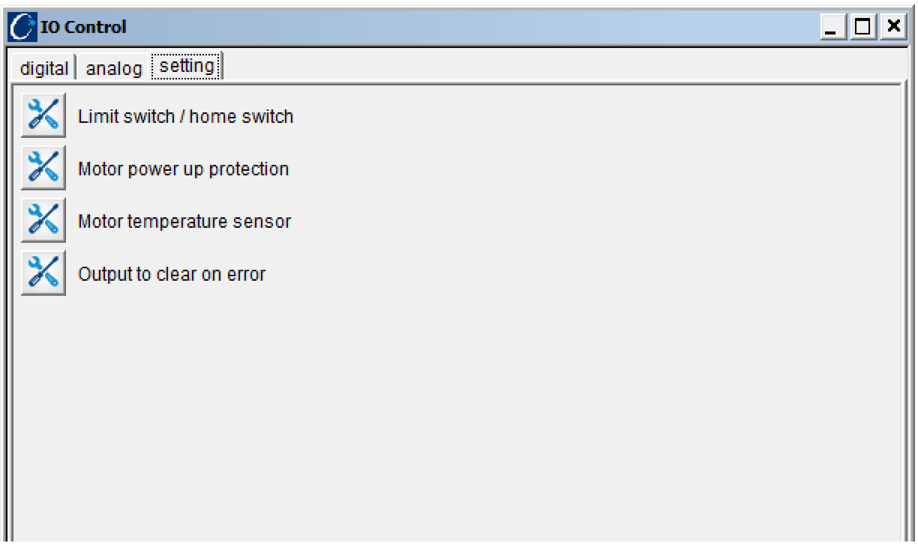
In the example below, a few analog outputs are directly connected to the analog inputs just above them and one can directly observe the impact of adjusting the level of the output signals on the corresponding input signals.

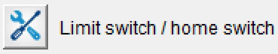
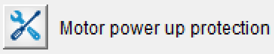
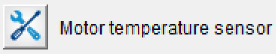
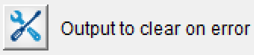


☑ Enable IO Update Cycle

9.3.3. Setting panel

The **setting** tab allows the user to activate or deactivate the specific functions dedicated to the I/Os.



 Limit switch / home switch	Redirects the user to the *Setting* tool wizard panel #3 (**Motor environment**), sub-panel **Home & Limit switches**. Refer to Section §4.1.3 for further details. If home and/or limits switches are required by the application, the user can define which analog inputs are used for reading their condition.
 Motor power up protection	Redirects the user to the *Setting* tool wizard panel #9 (**Protections**), sub-panel **Misc. protections**. Refer to Section §4.1.9 for further details. The user can define if a Controller can only deliver power to a motor if a certain state of a digital input is observed. A typical use case is to have a sensor detecting the condition of a door giving access to safety critical parts of a machine and if door is opened, the Controller powers off the motors to reduce the risk of injuring the user.
 Motor temperature sensor	Redirects the user to the *Setting* tool wizard panel #3 (**Motor environment**), sub-panel **Temperature sensor**. Refer to Section §4.1.3 for further details. The user can configure the connection of a thermal sensor to one of the digital inputs for detecting e.g. motor overheating.
 Output to clear on error	Redirects the user to the *Setting* tool wizard panel #9 (**Protections**), sub-panel **Misc. protections**. Refer to Section §4.1.9 for further details. The user can define to use digital outputs to indicate error status of the Controller.

NOTE	All options available in the **Setting** panel are disabled when connected to an ***UltimET Light*** motion controller.

10. Controller configuration

10.1. Registers

Registers store all the Controller's internal values. Each register has an identification number preceded by one or two letters corresponding to its type/sub-type. There are ten main types of Registers, four basic (often used) and six advanced (reserved for specific applications).

The basic Registers' types are:

- `K`, for parameters;
- `M`, for monitorings;
- `X`, for user variables; and
- `C`, for common (only available on the ***AccurET*** position controllers).

Belonging to the group of advanced Registers' type are:

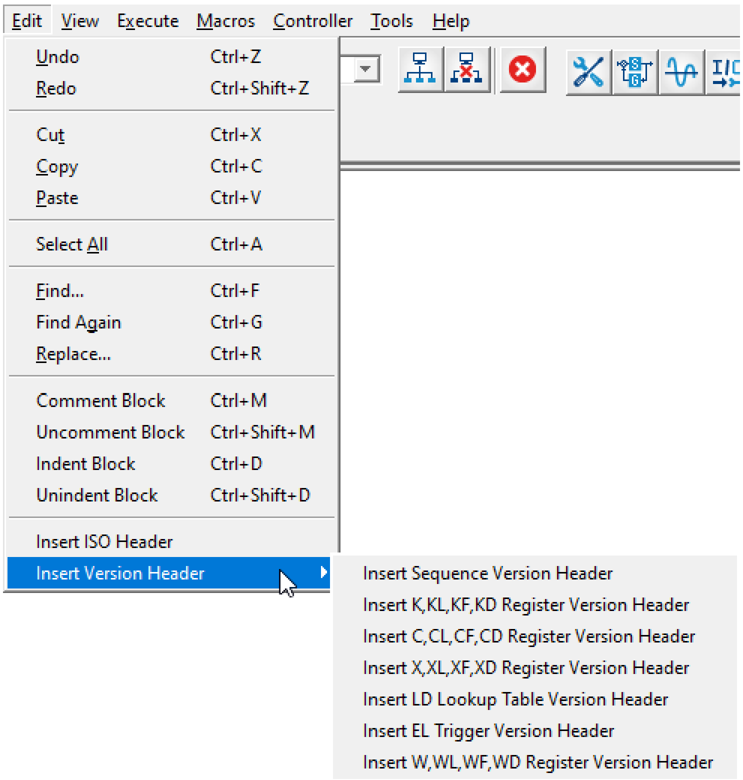
- `E`, for triggers (only available on the ***AccurET*** position controllers);
- `L`, for look-up tables;
- `T`, for traces;
- `P`, for mapping (only available on the ***AccurET*** position controllers);
- `Y`, are advanced user registers (only available on the ***UltimET Light/ADVANCED*** motion controllers); and
- `W` and `R`, equivalent to `K` and `M` registers, but dedicated to a given ETEL Software Module (only available on the ***ULTIMET ADVANCED*** motion controller).

For more information about Registers, refer to the *AccurET Modular Position Controller Operation & Software Manual* and *UltimET Light/ADVANCED Motion Controller User's Manuals*.

It is possible to manage the Registers versions used in each Controller. The configuration of the version number can be done using the *Editor* tool or any other third-party editor before downloading the Registers to the Controller. The Registers file header contains the version of each register type present in the file, see e.g. below.

```
# COMET special parameters
# ISO linear units : m, m/s, m/s², V, A, s
# ISO rotary units : t, t/s, t/s², V, A, s
# ComET version: 4.22A
# ETEL Parameters Upload
# Written by "edi-tra" v4.18A
# Date: [redacted] 2020
# User K,KL,KF,KD register version axis 0 : 1.01A
# User C,CL,CF,CD register version axis 0 : 1.01A
# User X,XL,XF,XD register version axis 0 : 2.00B
# User LD lookup table version axis 0 : 3.00A
```

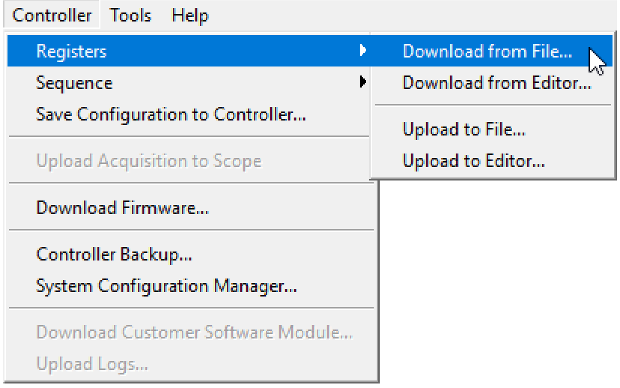
In order to set the version number, the user must either modify the current header (if present) or create a new one by selecting the Menu option **Edit → Insert Version Header**.



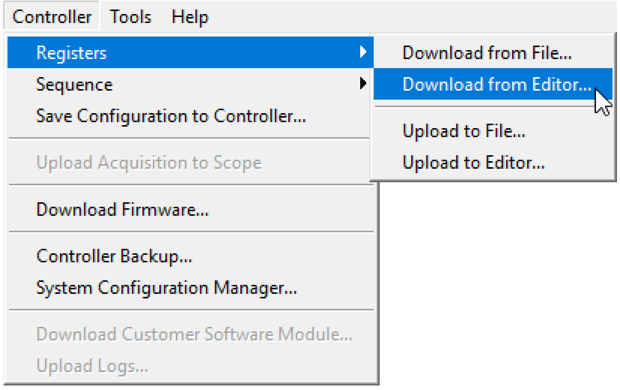
10.1.1. Download to controller

To download Registers to the Controller, the user can select one of the two options available:

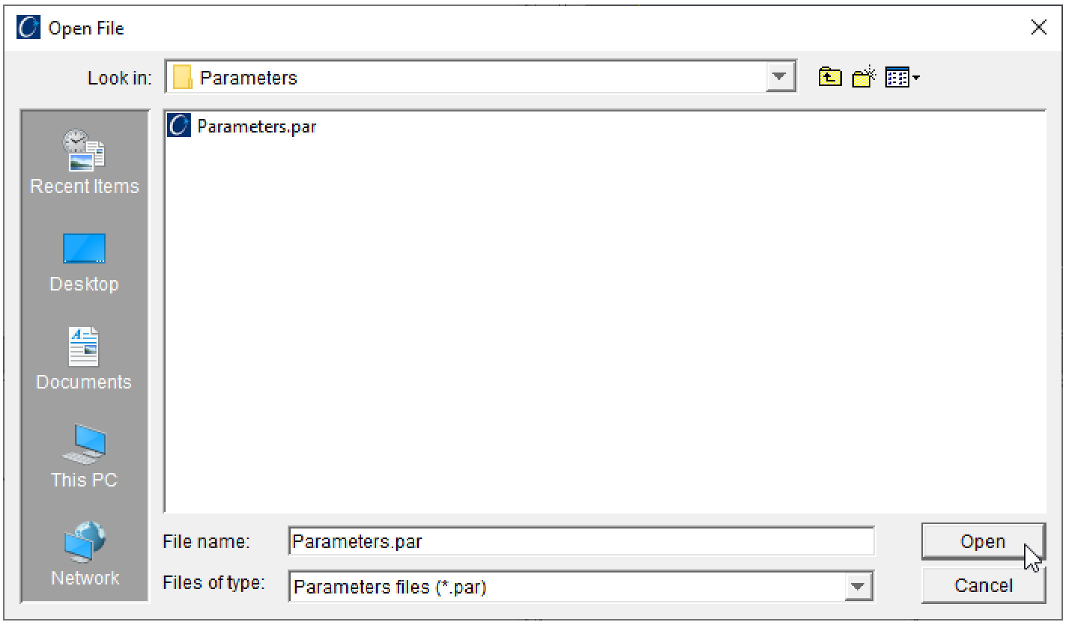
1. Select the Menu option **Controller → Registers → Download from File**.
   Use this option when the Registers are stored in a file.



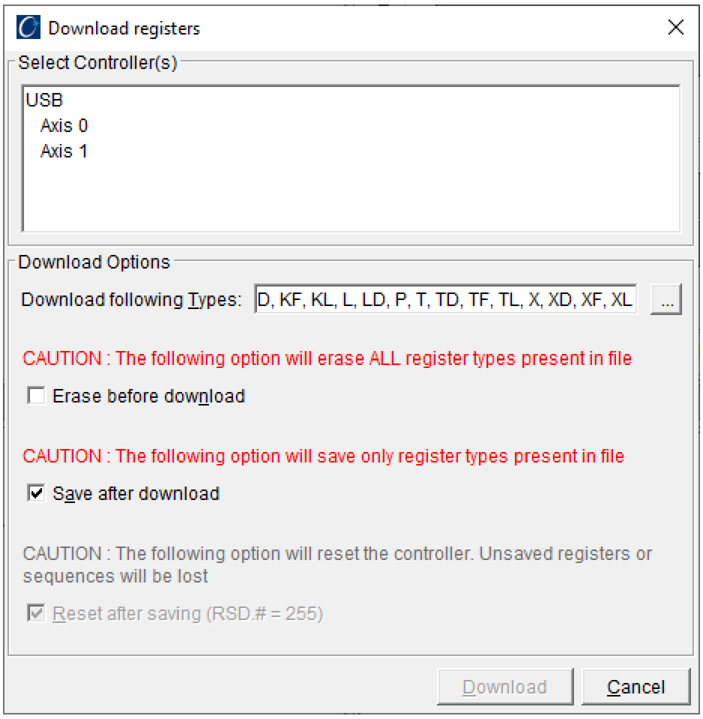
2. Select the Menu option **Controller → Registers → Download from Editor** or click on the button of the **Toolbar Registers/Sequence** group. Use this option if the Registers to download are currently being edited in the *Editor* tool.



Going for option 1 (**Download from File**), the user must select the Registers file to download and click on the **Open** button.



Next, the following dialog box is displayed.



Download registers

Select Controller(s)

USB
Axis 0
Axis 1

Download Options

Download following Types: D, KF, KL, L, LD, P, T, TD, TF, TL, X, XD, XF, XL

CAUTION : The following option will erase ALL register types present in file

☐ Erase before download

CAUTION : The following option will save only register types present in file

☑ Save after download

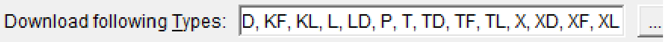
CAUTION : The following option will reset the controller. Unsaved registers or sequences will be lost

☑ Reset after saving (RSD.# = 255)

NOTE The procedure to follow from this point forward is the same regardless if the download is done from a file or from the *Editor* tool.

The user must select the axis or axes onto which download the Registers and configure the downloading options:

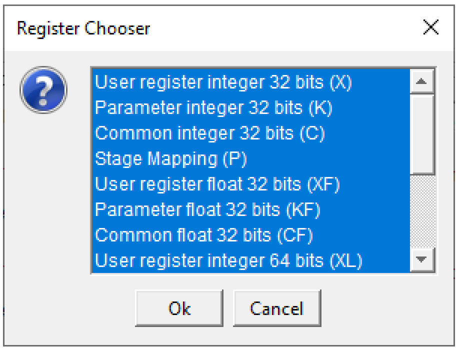
Download options



Download following Types: D, KF, KL, L, LD, P, T, TD, TF, TL, X, XD, XF, XL

The user can select which register types (and sub-types) to download in two different ways (by default, all register types included in the file are selected):

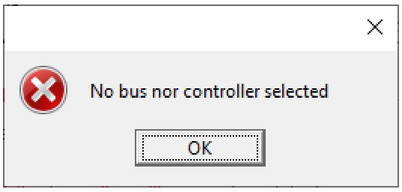
- by entering directly in the edit control the register type (using commas to separate between types); or
- by clicking on the button ... and selecting the register types from the list available in the dialog box that appears.



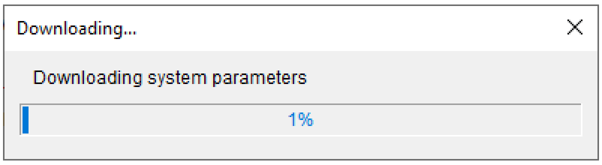
Register Chooser

User register integer 32 bits (X)
Parameter integer 32 bits (K)
Common integer 32 bits (C)
Stage Mapping (P)
User register float 32 bits (XF)
Parameter float 32 bits (KF)
Common float 32 bits (CF)
User register integer 64 bits (XL)

This dialog box is only displayed if an axis has been previously selected, otherwise the following error is raised.

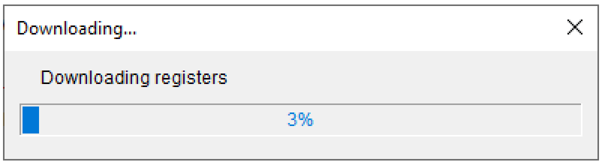
	 No bus nor controller selected OK
☐ Erase before download	Select this option to erase from the Controller all Registers of the selected register types before downloading the new Registers. Be aware that this is an irreversible action.
☐ Save after download	Select this option to save to the Controller's flash memory the Registers just downloaded. Be aware that only the Registers of the selected register types will be saved.
☐ Reset after saving (RSD.# = 255)	Select this option to perform a hardware reset of the Controller(s) after downloading. Be aware that all unsaved Registers and Sequences will be lost (in case of ***AccurET*** position controllers, the hardware reset impacts both axes).

Finally, clicking on the **Download** button starts the transfer of the Registers to the Controller(s), with a progress bar giving an indication of the status.


Downloading...

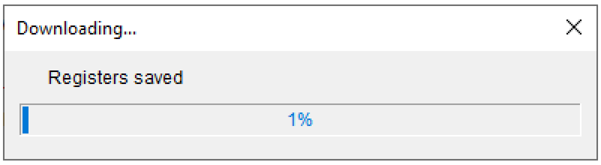
Downloading system parameters

1%


Downloading...

Downloading registers

3%


Downloading...

Registers saved

1%

Of course, the user can always interrupt the downloading procedure by clicking on the progress dialog box close button on the top right corner.

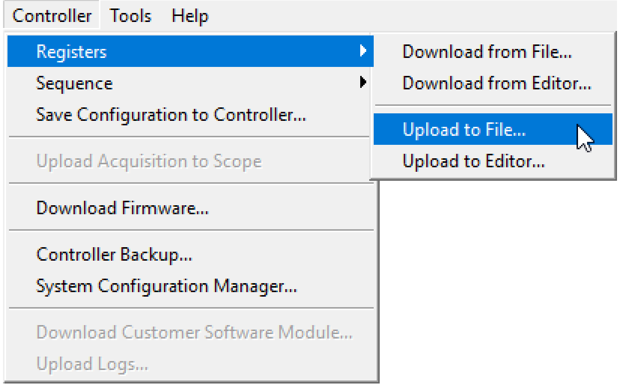
NOTE	Be aware that interrupting the process of downloading the Registers to a Controller might leave it in an inconsistent condition, with a configuration which is a mix between "old" and "new" Registers. In such case, it is highly recommended to perform subsequently a full successful download of the Registers to ensure full consistency of the configuration.

Once the download completed, the tool can be closed clicking on the **Close** button.

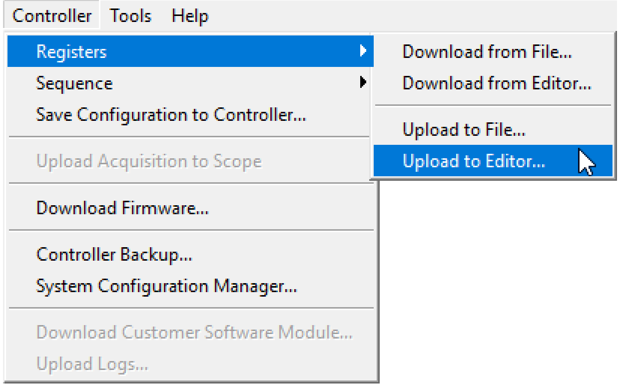
10.1.2. Upload from controller

To upload Registers from the Controller, the user can select one of the two options available:

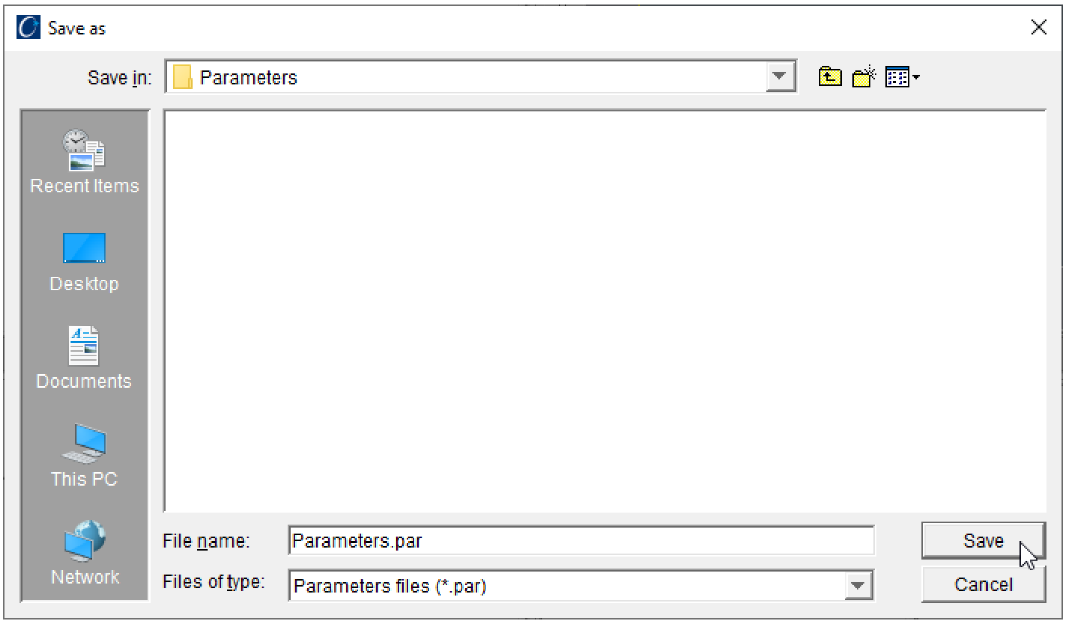
1. Select the Menu option **Controller → Registers → Upload to File**.
   Use this option to save the Registers directly to a file.



2. Select the Menu option **Controller → Registers → Upload to Editor** or click on the button of the **Toolbar Registers/Sequence** group. Use this option to upload the Registers directly to the *Editor* tool for edition.



Going for option 1 (**Upload to File**), the user must select the target file to use for saving the Registers and click on the **Save** button. If the target file already exists, the user will be asked to confirm the use of the file or abort the action.



Save in: Parameters

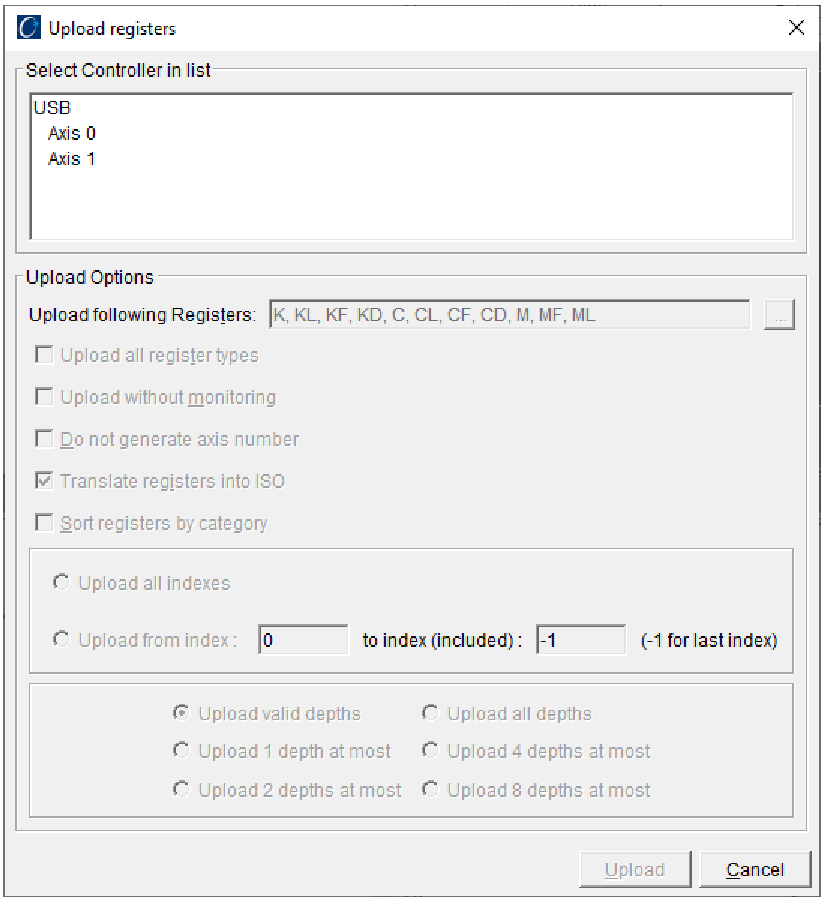
File name: Parameters.par

Files of type: Parameters files (*.par)

TIP	Registers (parameters) files are usually saved using the extension `*.par`.

Going for option 2 (**Upload to Editor**), if the *Editor* tool is currently loaded with an unsaved file, the user will be given the option to save it before performing the upload of the Registers to the *Editor* tool.

Next, the following dialog box is displayed.



Upload registers

Select Controller in list

USB
  Axis 0
  Axis 1

Upload Options

Upload following Registers: K, KL, KF, KD, C, CL, CF, CD, M, MF, ML

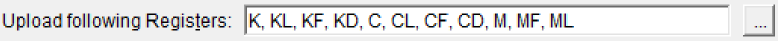
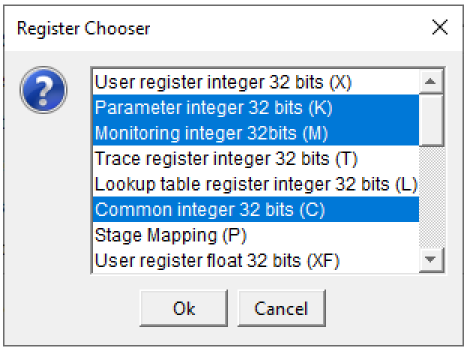
☐ Upload all register types
☐ Upload without monitoring
☐ Do not generate axis number
☑ Translate registers into ISO
☐ Sort registers by category

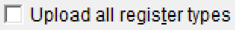
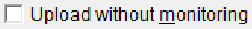
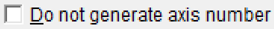
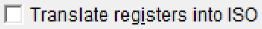
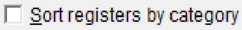
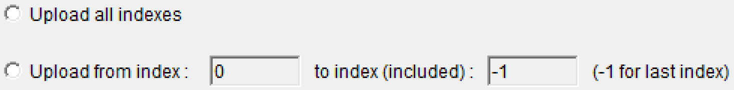
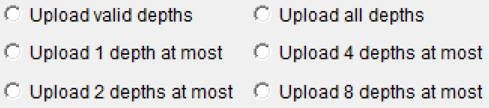
○ Upload all indexes
○ Upload from index : 0 to index (included) : -1 (-1 for last index)

● Upload valid depths ○ Upload all depths
○ Upload 1 depth at most ○ Upload 4 depths at most
○ Upload 2 depths at most ○ Upload 8 depths at most

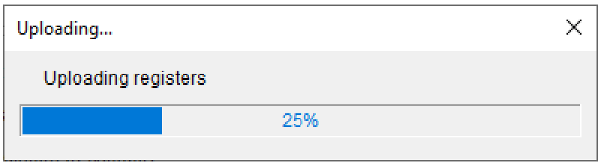
NOTE	The procedure to follow from this point forward is the same regardless if the upload is done to a file or to the *Editor* tool.

The user must select the axis or axes from which to upload the Registers and configure the uploading options:

Upload options	
 Upload following Registers: K, KL, KF, KD, C, CL, CF, CD, M, MF, ML	The user can select which register types (and sub-types) to upload in two different ways: - by entering directly in the edit control the register type (using commas to separate between types); or - by clicking on the button ... and selecting the register types from the list available in the dialog box that appears.  Register Chooser User register integer 32 bits (X) Parameter integer 32 bits (K) Monitoring integer 32bits (M) Trace register integer 32 bits (T) Lookup table register integer 32 bits (L) Common integer 32 bits (C) Stage Mapping (P) User register float 32 bits (XF) Ok Cancel

 ☐ Upload all register types	Force the upload of all Registers of whatever type.
 ☐ Upload without monitoring	Do not upload Monitoring (`M`) registers.
 ☐ Do not generate axis number	Do not store the axis number together with the registers (e.g. `K0.0 = 0` is stored as `K0 = 0`). The resulting file is more generic and can be downloaded to other similar Controllers which happen to have different axis identifier.
 ☐ Translate registers into ISO	Convert the uploaded registers to ISO values (as opposed to the native Incremental values).
 ☐ Sort registers by category	Sort registers by category.
 ○ Upload all indexes ○ Upload from index : 0 to index (included) : -1 (-1 for last index)	Upload all indexes or select a range of indexes.
 ○ Upload valid depths ○ Upload all depths ○ Upload 1 depth at most ○ Upload 4 depths at most ○ Upload 2 depths at most ○ Upload 8 depths at most	Upload all depths or only valid depths or only depths 1, 2, 4 or 8.

Finally, clicking on the **Upload** button starts the transfer of the Registers from the Controller (s), with a progress bar giving an indication of the status.



Uploading...

Uploading registers

25%

Of course, the user can always interrupt the uploading procedure by clicking on the progress dialog box close button on the top right corner.

Once the upload completed, the tool can be closed clicking on the **Close** button.

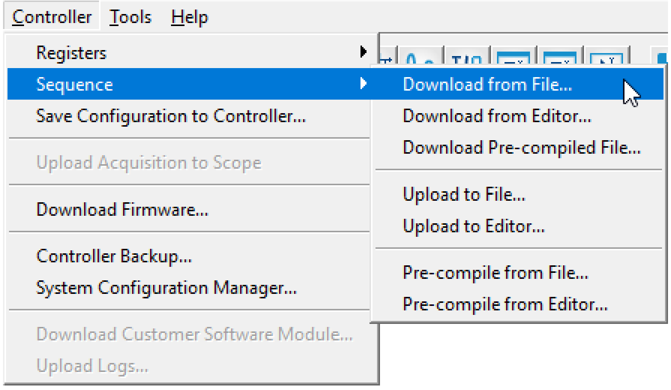
10.2. Sequence

A Sequence is a program to be executed by a Controller. It consists of a list of instructions written in a specific language developed by ETEL that are executed sequentially by the Controller. In order to be executed, the Sequence has to be compiled and then downloaded to the Controller. For more information about Sequences, refer to Section §8.1.

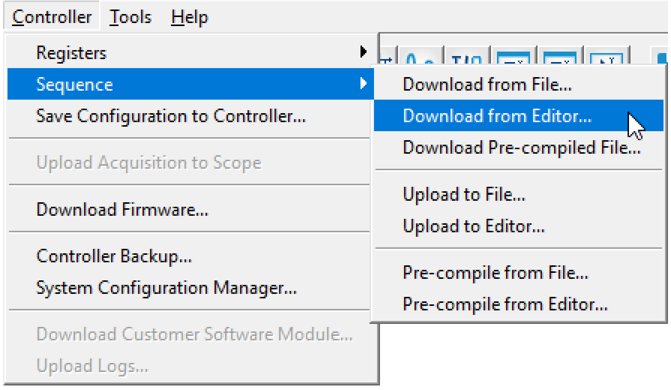
10.2.1. Download to controller

To download a Sequence to the Controller, the user can select one of the three options available:

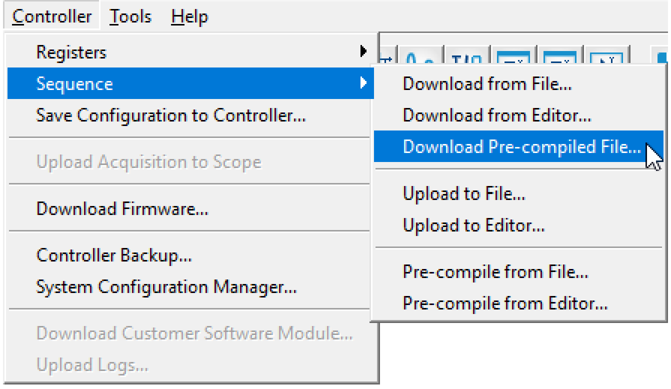
1. Select the Menu option **Controller → Sequence → Download from File**.
   Use this option if the Sequence has already been saved to a file.



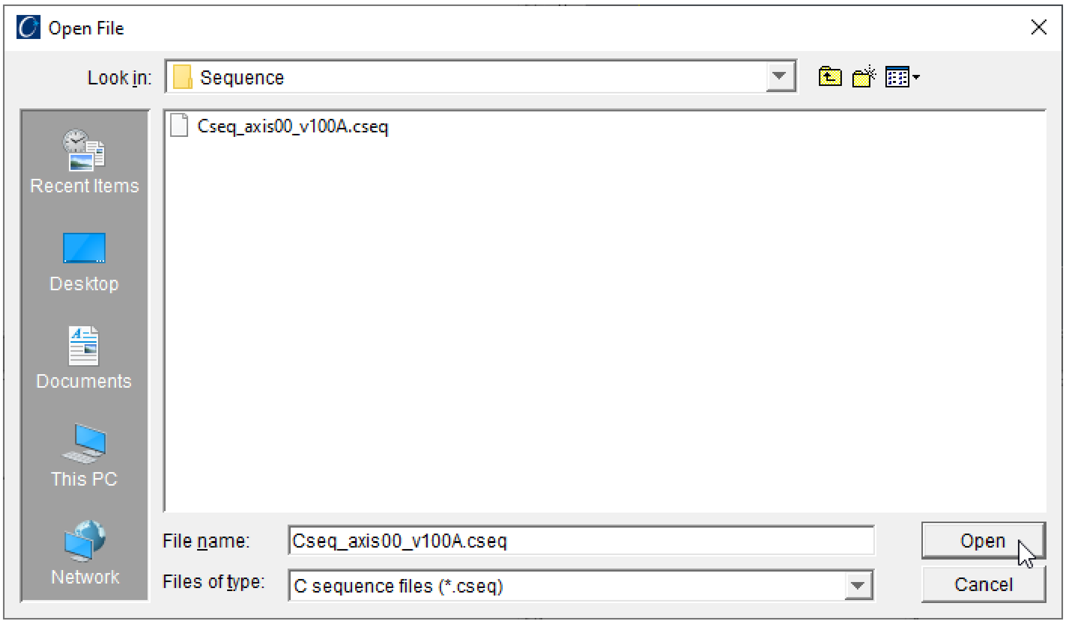
2. Select the Menu option **Controller → Sequence → Download from Editor** or click on the button of the **Toolbar Registers/Sequence** group. Use this option if the Sequence to download is currently being edited in the *Editor* tool.



3. Select the Menu option **Controller → Sequence → Download Pre-compiled File**.
This option is only valid for a Sequence that has been pre-compiled. Refer to Section §8.1.4 for further details on how to pre-compile a Sequence.



Going for option 1 (**Download from a File**), the user must select the Sequence file to download and click on the **Open** button.



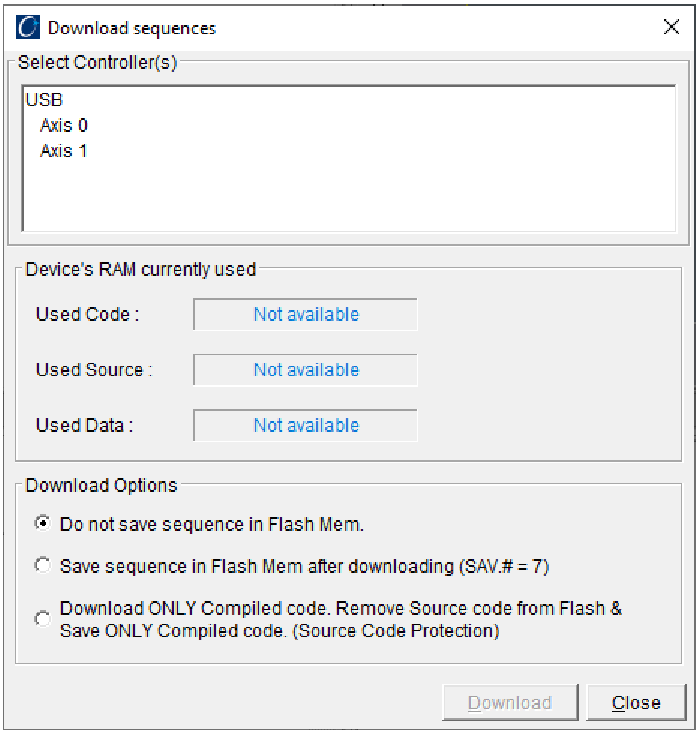
Look in: Sequence

Cseq_axis00_v100A.cseq

File name: Cseq_axis00_v100A.cseq

Files of type: C sequence files (*.cseq)

Next, the following dialog box is displayed.



Select Controller(s)

USB
  Axis 0
  Axis 1

Device's RAM currently used

Used Code : Not available

Used Source : Not available

Used Data : Not available

Download Options

● Do not save sequence in Flash Mem.

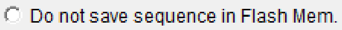
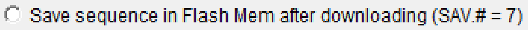
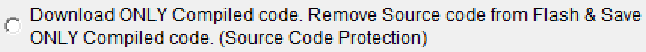
○ Save sequence in Flash Mem after downloading (SAV.# = 7)

○ Download ONLY Compiled code. Remove Source code from Flash & Save ONLY Compiled code. (Source Code Protection)

NOTE

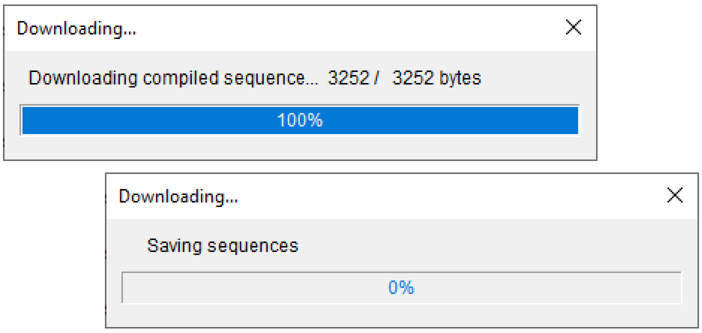
The procedure to follow from this point on is the same regardless of the option chosen. A minor detail concerning option 3 (**Download Pre-compiled File**), the previous dialog box has an additional control on the top part for the user to select the pre-compiled Sequence to download.

The user must select the axis or axes onto which download the Sequence and configure the downloading options:

Download options	
 ○ Do not save sequence in Flash Mem.	Download Sequence without saving it to the flash memory. If the Controller is powered off, the Sequence is lost and must be downloaded again to be executed.
 ○ Save sequence in Flash Mem after downloading (SAV.# = 7)	After downloading, the Sequence is saved to the flash memory and remains on the Controller even after being powered off.
 ○ Download ONLY Compiled code. Remove Source code from Flash & Save ONLY Compiled code. (Source Code Protection)	After downloading, the Sequence is saved to the flash memory and remains on the Controller even after being powered off. Furthermore, no source code is downloaded and saved on the Controller (IP protection).

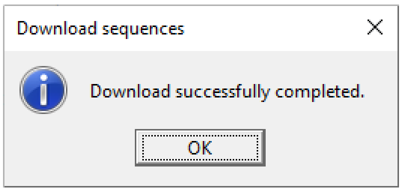
NOTE A Sequence can be saved at any time by clicking on the **Toolbar Macros** SAV button (saves only the current axis) or the **Save configuration to controller** 💾 button (can save multiple axes).

Finally, clicking on the **Download** button starts the Sequence compilation (except if the user has selected the option to download a pre-compiled Sequence), followed by the transfer to the Controller and finally saving into flash memory (except if **Do not save sequence in Flash Mem.** download option was selected). A progress bar gives an indication of the status and an information message is displayed once the download is successfully completed.



Downloading compiled sequence... 3252 / 3252 bytes

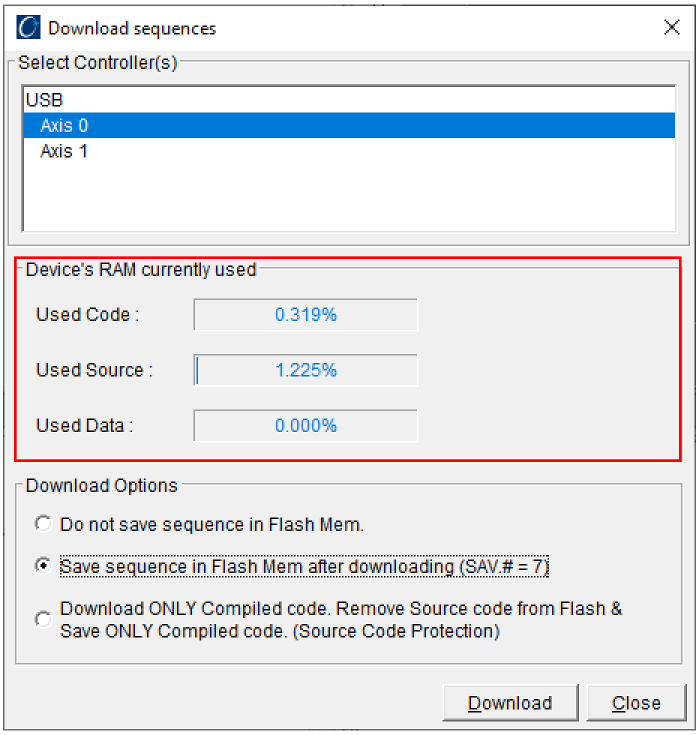
Saving sequences



Download successfully completed.

Returning to the main dialog box, the user can find information about the usage of the Controller's RAM (volatile) memory in terms of:

- Percentage of memory being used by the compiled code;
- Percentage of memory being used for the source code (displays **Not downloaded** if the option **Download ONLY Compiled code** was selected);
- Percentage of memory being used for data.


Download sequences

Select Controller(s)

USB
- Axis 0
- Axis 1

Device's RAM currently used

Used Code : 0.319%

Used Source : 1.225%

Used Data : 0.000%

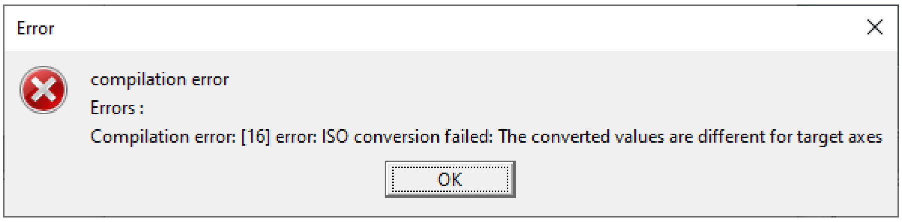
Download Options

○ Do not save sequence in Flash Mem.

● Save sequence in Flash Mem after downloading (SAV.# = 7)

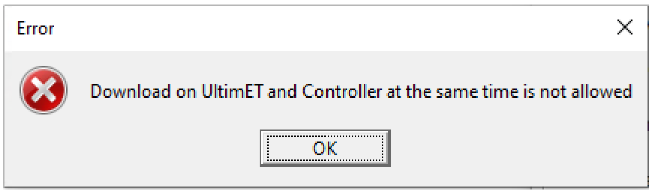
○ Download ONLY Compiled code. Remove Source code from Flash & Save ONLY Compiled code. (Source Code Protection)

It is possible to download a Sequence to more than one axis of an ***AccurET*** position controller if the ISO conversions are the same. Otherwise, an error is raised.


Error

compilation error
Errors :
Compilation error: [16] error: ISO conversion failed: The converted values are different for target axes

However, it is not possible to download a Sequence simultaneously to an ***AccurET*** position controller axis and to an ***UltimET Light*** motion controller. The following error will be raised.

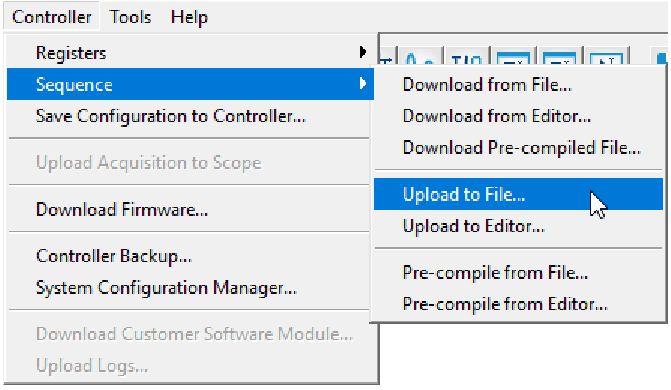

Error

Download on UltimET and Controller at the same time is not allowed

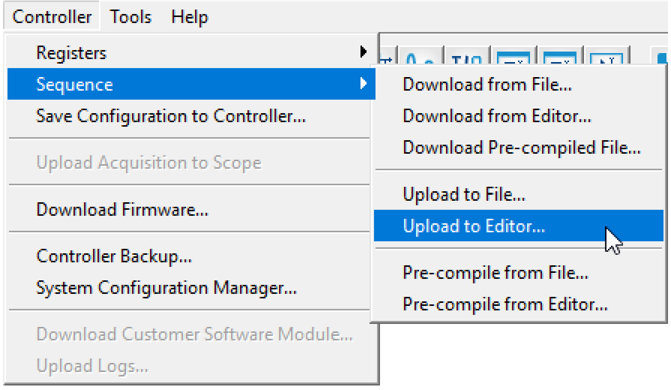
10.2.2. Upload from controller

To upload a Sequence from the Controller, the user can select one of the two options available:

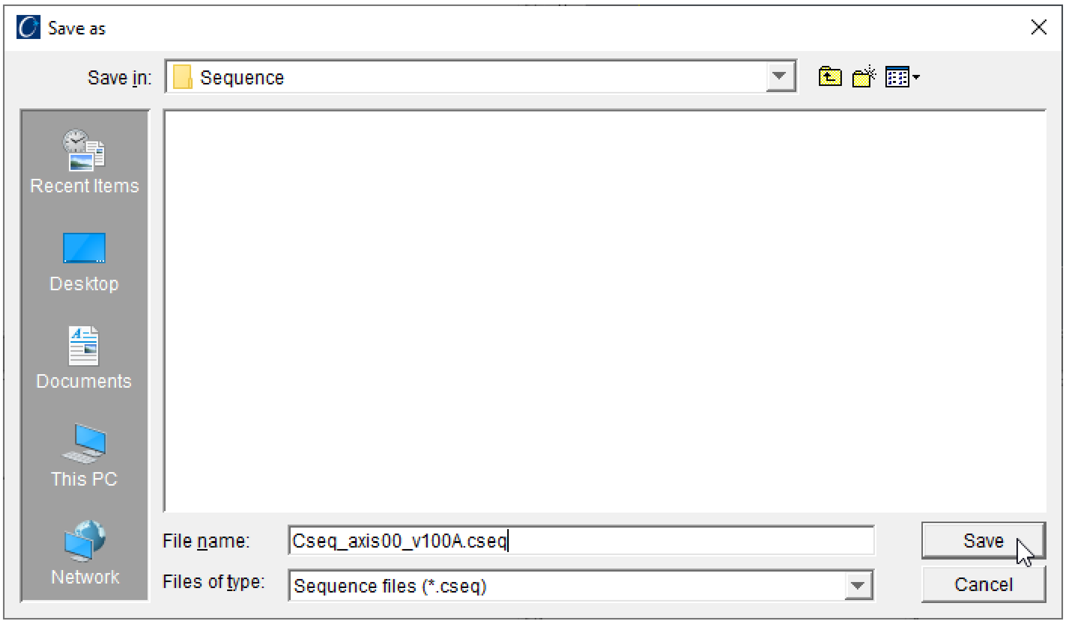
1. Select the Menu option **Controller → Sequence → Upload to File.**
   Use this option to save the Sequence directly to a file.



2. Select the Menu option **Controller → Sequence → Upload to Editor** or click on the button St of the **Toolbar Registers/Sequence** group. Use this option to upload the Sequence directly to the *Editor* tool for edition.



Going for option 1 (**Upload to File**), the user must select the target file used for saving the Sequence and click on the **Save** button. If the target file already exists, the user will be asked to confirm overwriting of the file or abort the action.



Save in: Sequence

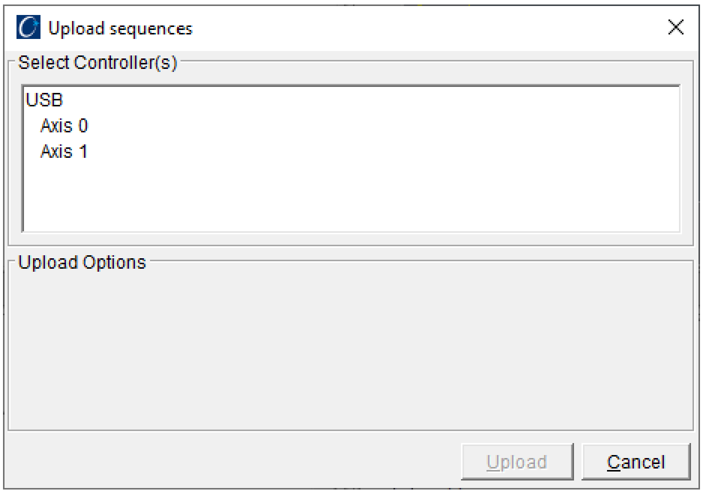
File name: Cseq_axis00_v100A.cseq

Files of type: Sequence files (*.cseq)

TIP	Compiled Sequence source files are usually saved using the extension `*.cseq`.

Going for option 2 (**Upload to Editor**), if the *Editor* tool is currently loaded with an unsaved file, the user will be given the option to save it before performing the upload of the Sequence to the *Editor* tool.

Next, the following dialog box displayed:



NOTE	The procedure to follow from this point on is the same regardless of the option chosen.

The user must select the axis from which to upload the Sequence (only one axis can be selected at a time) and press the **Upload** button to start transferring the Sequence from the Controller. The progress bar gives an indication of the status of the upload.

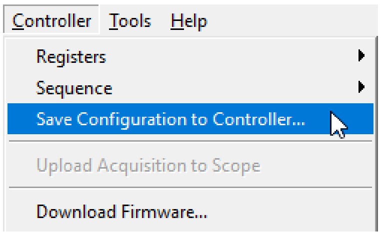
Of course, the user can always interrupt the uploading procedure by clicking on the progress dialog box close button on the top right corner.

Once the upload completed, the dialog box closes automatically without further action required from the user.

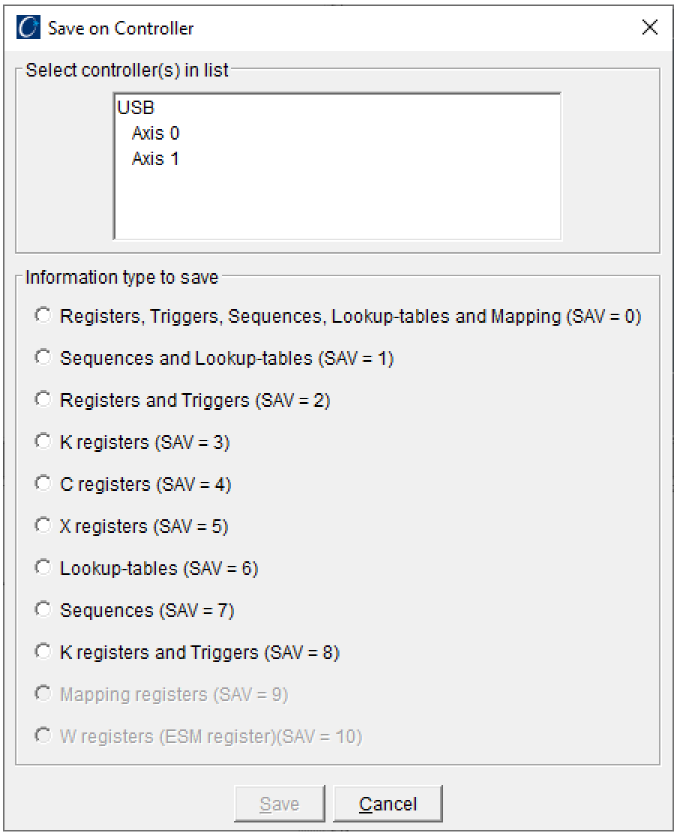
10.3. Save Configuration to Controller

To save the Controller's configuration, follow one of two options:

1. Select the Menu option **Controller → Save Configuration to Controller**, or



2. Click on the **Toolbar Save configuration to controller** button.



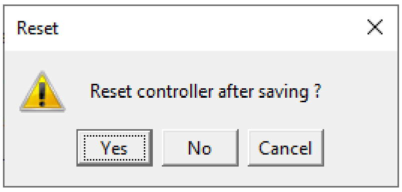
The user must select the axis or axes to save and configure which information to be saved on the Controller(s) flash memory:

Information type to save	
○ Registers, Triggers, Sequences, Lookup-tables and Mapping (SAV = 0)	Save all information. This is equivalent to the `SAV = 0` command.
○ Sequences and Lookup-tables (SAV = 1)	Save Sequences and Look-up Table (`L`) registers. This is equivalent to a `SAV = 1` command. **NOTE:** Sequences are not supported by ***ULTIMET ADVANCED*** controllers.
○ Registers and Triggers (SAV = 2)	Save Parameter (`K`), User Variable (`X`), Common (`C`) and Trigger (`E`) registers. This is equivalent to a `SAV = 2` command. **NOTE:** `C` and `E` parameters are not supported by ***UltimET Light*** and ***ULTIMET ADVANCED*** controllers. These controllers also save the Advanced User (`Y`) registers. ***ULTIMET ADVANCED*** controllers with an ESM module also save the ESM (`W`) registers.
○ K registers (SAV = 3)	Save Parameter (`K`) registers. This is equivalent to a `SAV = 3` command.

	NOTE: ***AccurET*** controllers also save the Trigger (`E`) registers.
○ C registers (SAV = 4)	Save Common (`C`) registers. This is equivalent to a `SAV = 4` command. **NOTE:** Not applicable to ***UltimET Light*** and ***ULTIMET ADVANCED*** controllers.
○ X registers (SAV = 5)	Save User Variable (`X`) registers. This is equivalent to a `SAV = 5` command. **NOTE:** ***UltimET Light*** and ***ULTIMET ADVANCED*** controllers also save the Advanced User (`Y`) registers.
○ Lookup-tables (SAV = 6)	Save Look-up Table (`L`) registers. This is equivalent to a `SAV = 6` command.
○ Sequences (SAV = 7)	Save Sequences. This is equivalent to a `SAV = 7` command. **NOTE:** Not applicable to ***ULTIMET ADVANCED*** controllers.
○ K registers and Triggers (SAV = 8)	Save Parameter (`K`) and Trigger (`E`) registers. This is equivalent to a `SAV = 8` command. **NOTE:** Only applicable to ***AccurET*** controllers.
○ Mapping registers (SAV = 9)	Save Mapping (`P`) registers. This is equivalent to a `SAV = 9` command. **NOTE:** Only applicable to ***AccurET*** controllers.
○ W registers (ESM register)(SAV = 10)	Save ESM (`W`) registers (***ULTIMET ADVANCED*** only). This is equivalent to a `SAV = 10` command. **NOTE:** Only applicable to ***ULTIMET ADVANCED*** controllers with an ESM module.

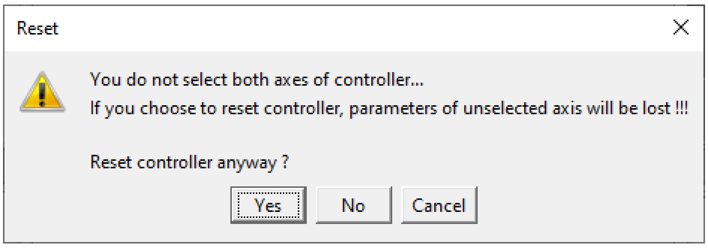
Click on the **Save** button to save the configuration of the Controller to its non-volatile (flash) memory according to the options selected.

The user can choose to reset the Controller after saving.


Reset

Reset controller after saving ?

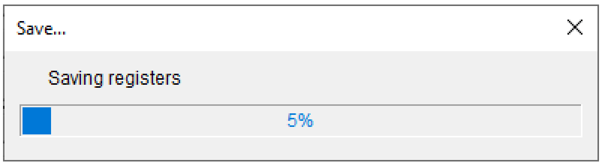
If only one Controller axis is selected the following warning message informs the user that any unsaved settings of the non-selected axis will be lost if the Controller is reset after saving.


Reset

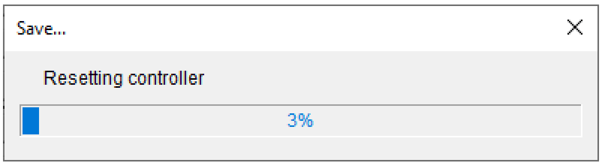
You do not select both axes of controller...
If you choose to reset controller, parameters of unselected axis will be lost !!!

Reset controller anyway ?

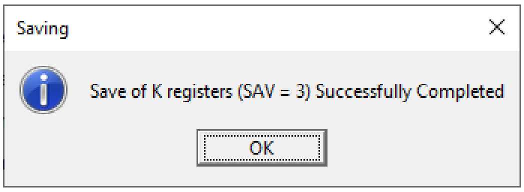
A progress bar gives an indication of the status and an information message is displayed once the saving is completed successfully.



Saving registers



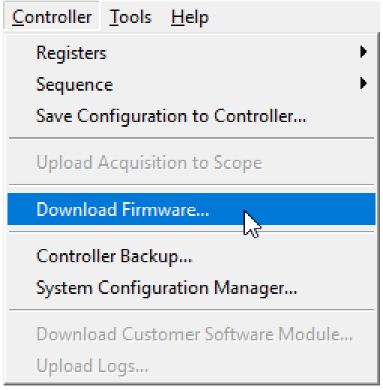
Resetting controller



Save of K registers (SAV = 3) Successfully Completed

10.4. Download Firmware

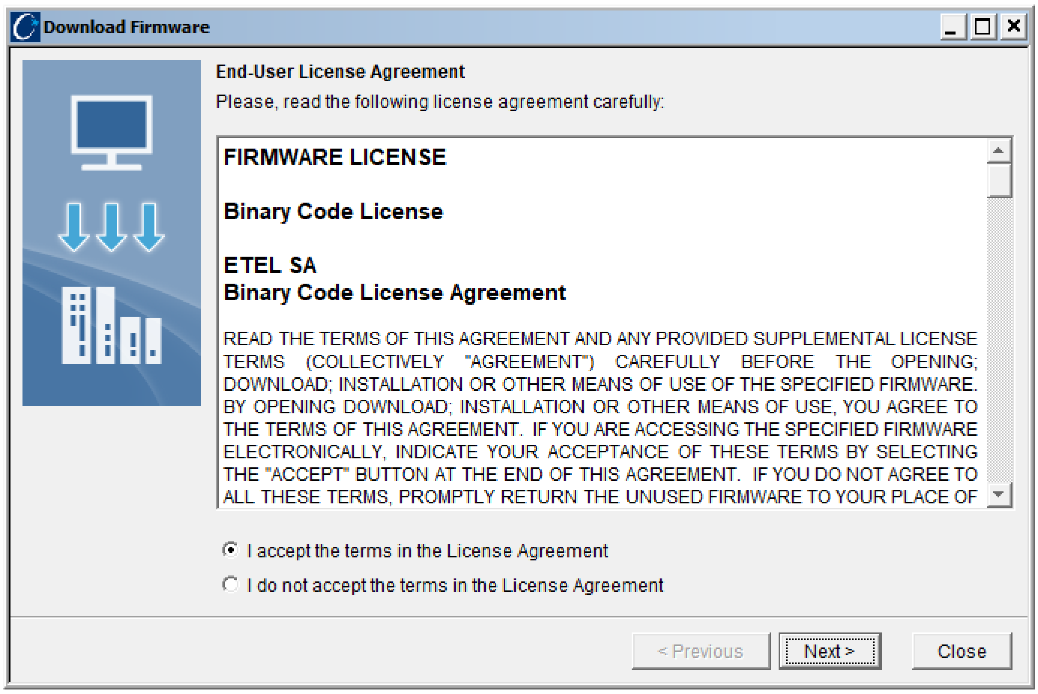
To update the Controller's firmware select the Menu option **Controller → Download Firmware**:



ComET4's *Download Firmware* wizard tool guides the user through the process of downloading a new firmware to one or multiple Controllers.

10.4.1. Panel #1: EULA

On the first panel the user is presented with the End-User License Agreement (EULA) terms.



End-User License Agreement

Please, read the following license agreement carefully:

FIRMWARE LICENSE

Binary Code License

ETEL SA
Binary Code License Agreement

READ THE TERMS OF THIS AGREEMENT AND ANY PROVIDED SUPPLEMENTAL LICENSE TERMS (COLLECTIVELY "AGREEMENT") CAREFULLY BEFORE THE OPENING; DOWNLOAD; INSTALLATION OR OTHER MEANS OF USE OF THE SPECIFIED FIRMWARE. BY OPENING DOWNLOAD; INSTALLATION OR OTHER MEANS OF USE, YOU AGREE TO THE TERMS OF THIS AGREEMENT. IF YOU ARE ACCESSING THE SPECIFIED FIRMWARE ELECTRONICALLY, INDICATE YOUR ACCEPTANCE OF THESE TERMS BY SELECTING THE "ACCEPT" BUTTON AT THE END OF THIS AGREEMENT. IF YOU DO NOT AGREE TO ALL THESE TERMS, PROMPTLY RETURN THE UNUSED FIRMWARE TO YOUR PLACE OF

● I accept the terms in the License Agreement

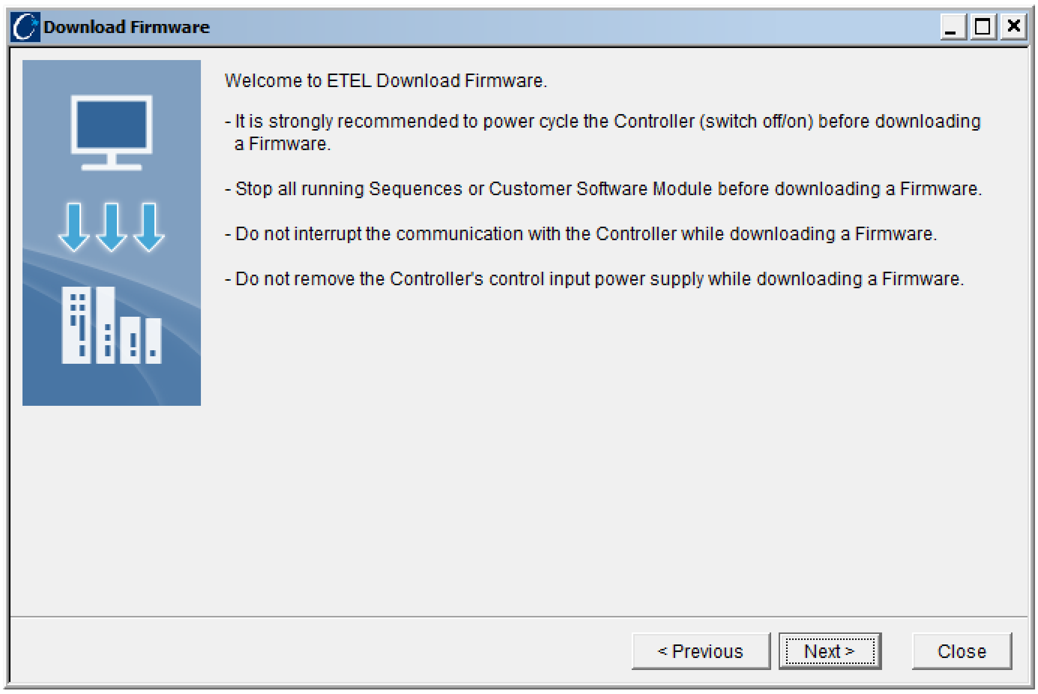
○ I do not accept the terms in the License Agreement

To proceed to the next panel, click on the **Next** button after having accepted the terms of the license agreement.

10.4.2. Panel #2: Recommendations

This panel contains very important recommendations that the user should follow to ensure a successful upgrade of the Controller(s):

- It is strongly recommended to power cycle the Controller (switch off and back on) before downloading a Firmware;
- Stop all running Sequences or CSM before downloading a Firmware.
- Do not interrupt the communication with the Controller while downloading a Firmware.
- Do not remove the Controller's control input power supply while downloading a Firmware.



Welcome to ETEL Download Firmware.

- It is strongly recommended to power cycle the Controller (switch off/on) before downloading a Firmware.

- Stop all running Sequences or Customer Software Module before downloading a Firmware.

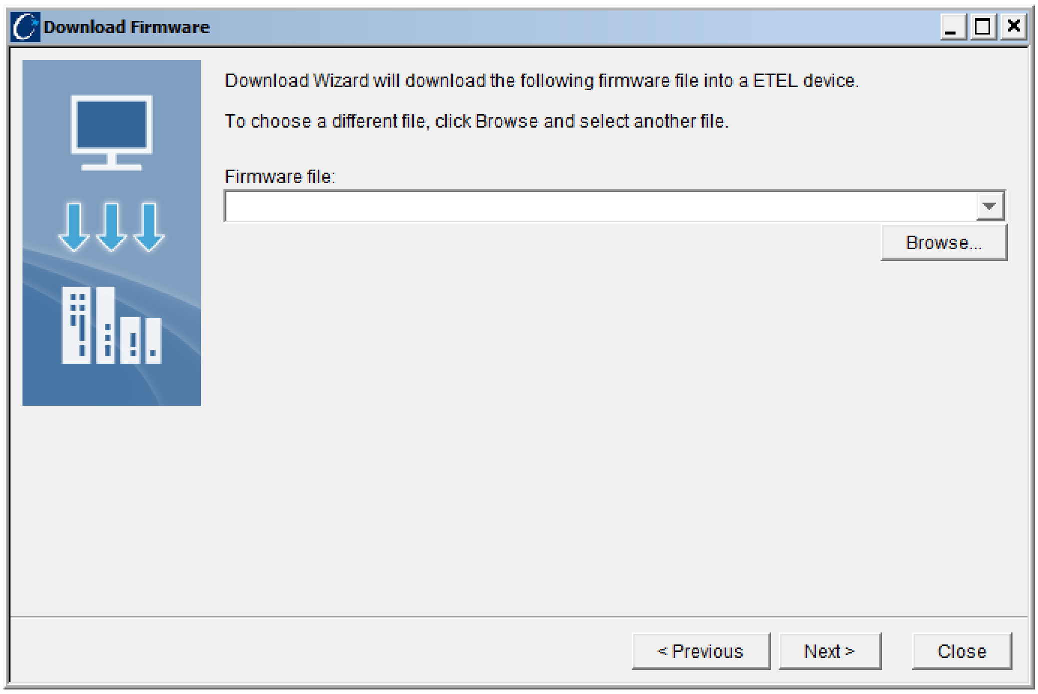
- Do not interrupt the communication with the Controller while downloading a Firmware.

- Do not remove the Controller's control input power supply while downloading a Firmware.

To proceed to the next panel, click on the **Next** button.

10.4.3. Panel #3: Firmware file

This third panel allows the user to select the new firmware file or use the one already selected.

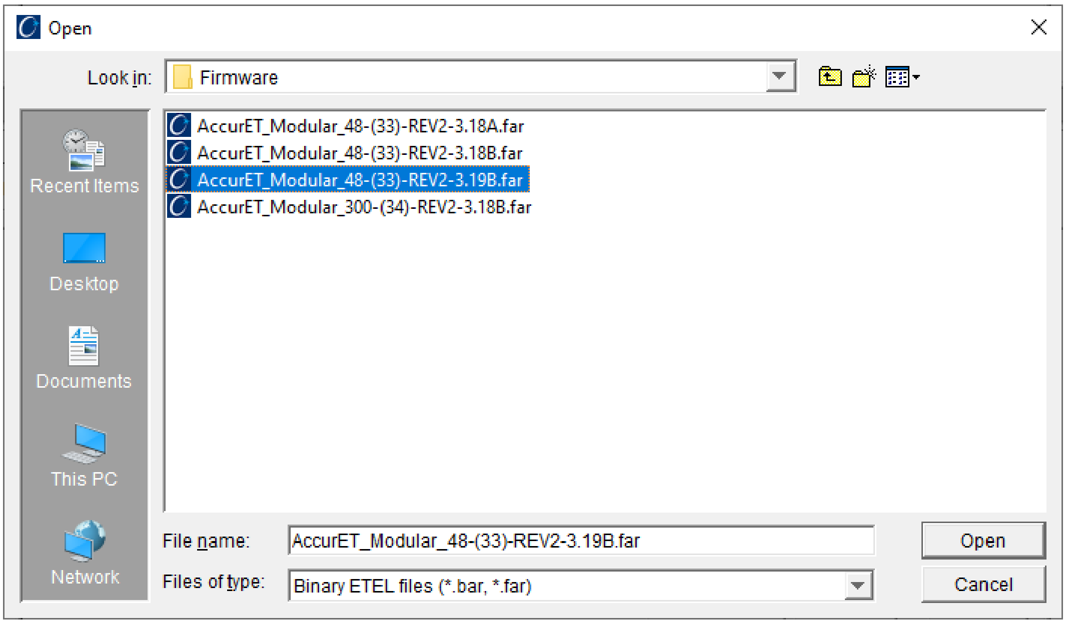


Download Wizard will download the following firmware file into a ETEL device.

To choose a different file, click Browse and select another file.

Firmware file:

Use the **Browse** button to select another firmware file.



File name: AccurET_Modular_48-(33)-REV2-3.19B.far

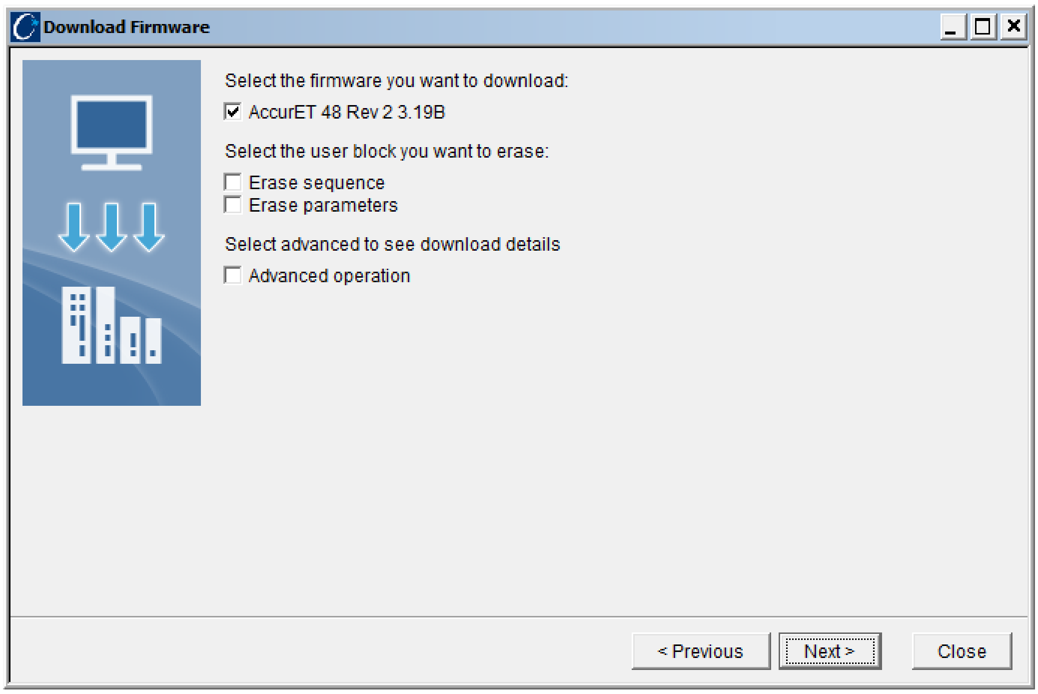
Files of type: Binary ETEL files (*.bar, *.far)

NOTE	A firmware file always bears a `*.far` file extension. But, the *Download Firmware* tool can also be used to download a Controller backup `*.bar` file (refer to Section §10.5 for further information).

Once the firmware file has been selected, to proceed to the next panel, click on the **Next** button.

10.4.4. Panel #4: Download options

The user must verify and confirm the firmware version to download to the Controller(s) and configure the downloading options.



Select the firmware you want to download:

☑ AccurET 48 Rev 2 3.19B

Select the user block you want to erase:

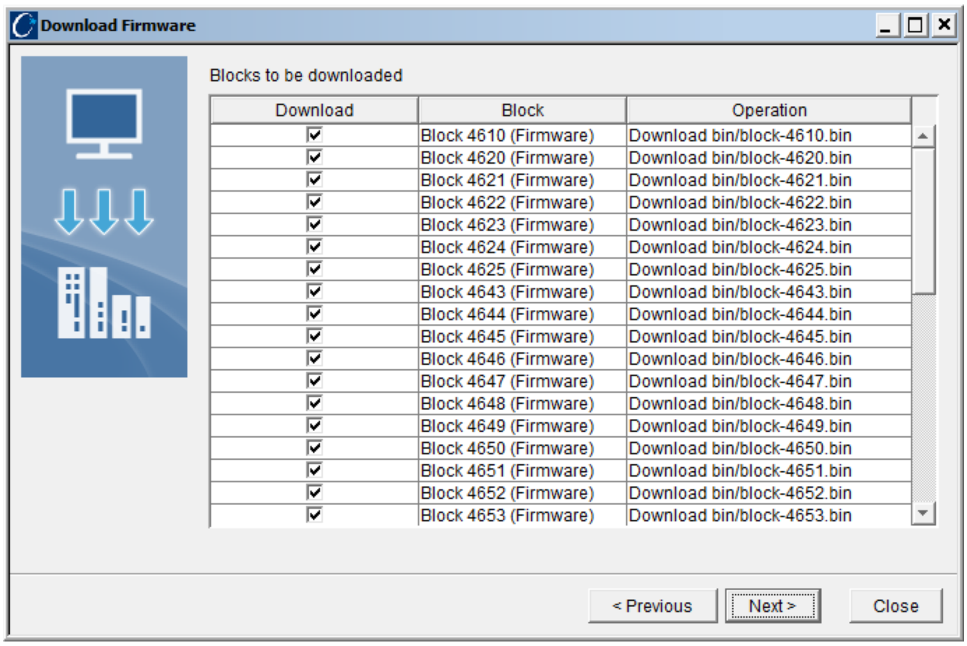
☐ Erase sequence

☐ Erase parameters

Select advanced to see download details

☐ Advanced operation

These are the available options to configure:

Download options	
☐ Erase sequence	Select this option to erase the flash memory block reserved for the Sequences. This ensures that no Sequences remain on the Controller(s) after the firmware update.
☐ Erase parameters	Select this option to erase the memory block reserved for the parameters (Registers). This ensures that a after the firmware update the Controller(s) has (have) default values for all Registers.
☐ Advanced operation	This option is reserved for advanced users. If selected, when clicking on the **Next** button there is an additional panel that is added to the normal flow. This panel depicted below allows the user to select which blocks of the firmware to download. 

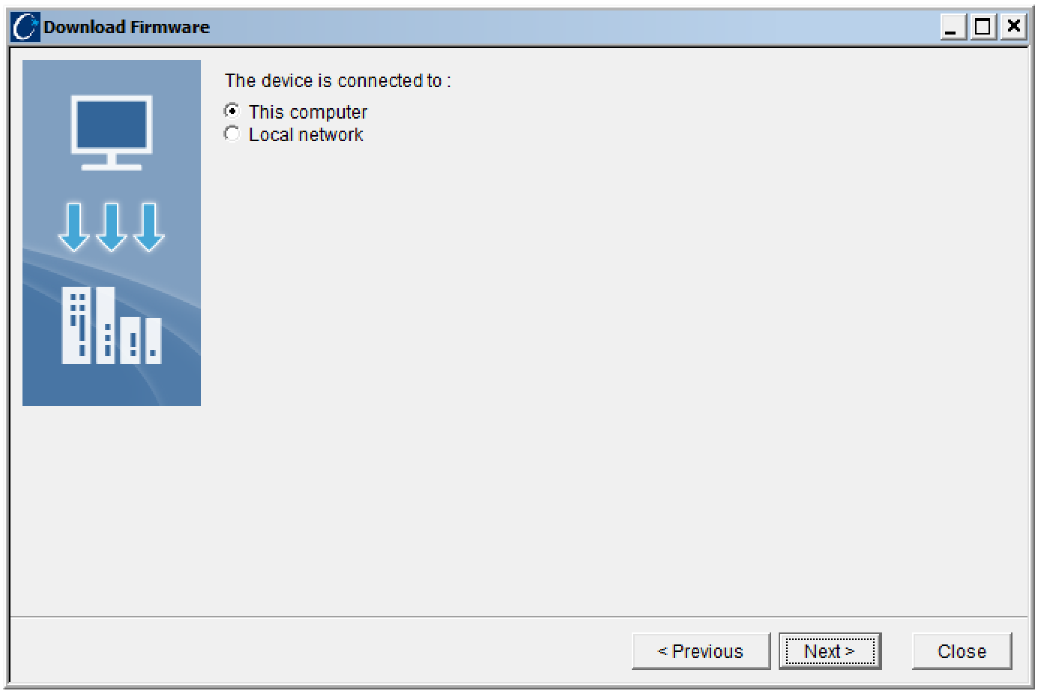
Blocks to be downloaded

Download	Block	Operation
☑	Block 4610 (Firmware)	Download bin/block-4610.bin
☑	Block 4620 (Firmware)	Download bin/block-4620.bin
☑	Block 4621 (Firmware)	Download bin/block-4621.bin
☑	Block 4622 (Firmware)	Download bin/block-4622.bin
☑	Block 4623 (Firmware)	Download bin/block-4623.bin
☑	Block 4624 (Firmware)	Download bin/block-4624.bin
☑	Block 4625 (Firmware)	Download bin/block-4625.bin
☑	Block 4643 (Firmware)	Download bin/block-4643.bin
☑	Block 4644 (Firmware)	Download bin/block-4644.bin
☑	Block 4645 (Firmware)	Download bin/block-4645.bin
☑	Block 4646 (Firmware)	Download bin/block-4646.bin
☑	Block 4647 (Firmware)	Download bin/block-4647.bin
☑	Block 4648 (Firmware)	Download bin/block-4648.bin
☑	Block 4649 (Firmware)	Download bin/block-4649.bin
☑	Block 4650 (Firmware)	Download bin/block-4650.bin
☑	Block 4651 (Firmware)	Download bin/block-4651.bin
☑	Block 4652 (Firmware)	Download bin/block-4652.bin
☑	Block 4653 (Firmware)	Download bin/block-4653.bin

To proceed to the next panel, click on the **Next** button.

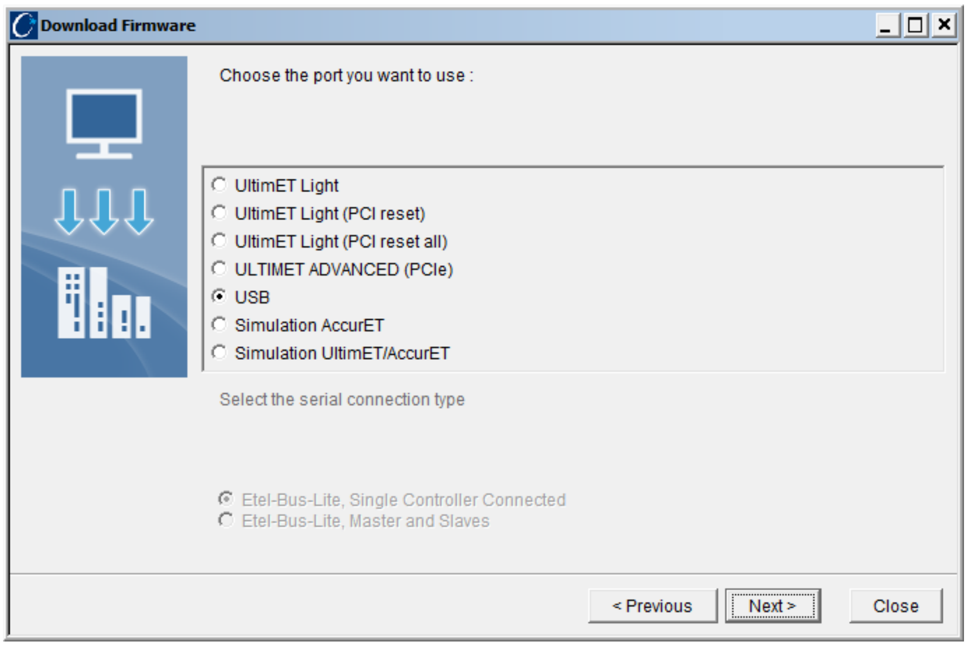
10.4.5. Panel #5: Connection

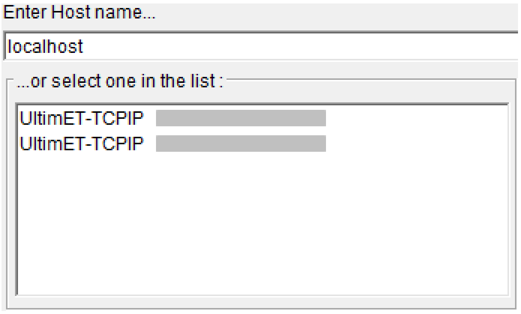
In this panel, the user decides the type of connection to use, either the Controller is directly connected to the computer running ***ComET4*** or can be reached via the Local network.



The device is connected to :

● This computer
○ Local network

Connection options	
○ This computer	If selected, when clicking on the **Next** button there is an additional panel that is added to the normal flow. This panel depicted below allows the user to select the connection port.  Choose the port you want to use : ○ UltimET Light ○ UltimET Light (PCI reset) ○ UltimET Light (PCI reset all) ○ ULTIMET ADVANCED (PCIe) ● USB ○ Simulation AccurET ○ Simulation UltimET/AccurET Select the serial connection type ● Etel-Bus-Lite, Single Controller Connected ○ Etel-Bus-Lite, Master and Slaves
○ Local network	If selected, the user must enter the hostname or select one from the list (if any).



Enter Host name...

localhost

...or select one in the list :

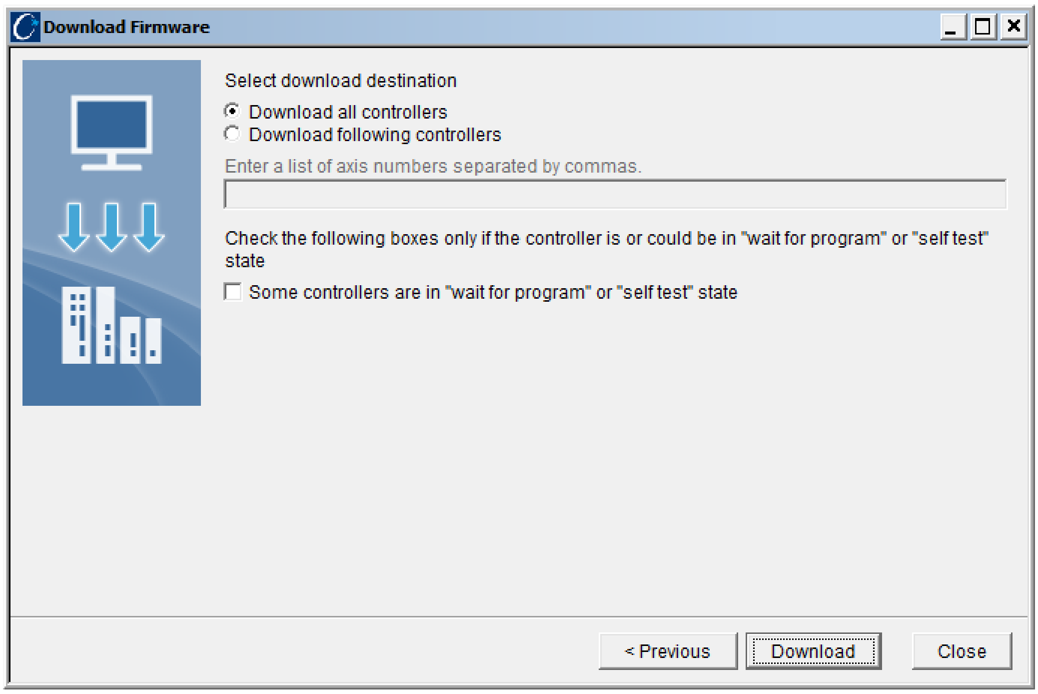
UltimET-TCPIP [redacted]

UltimET-TCPIP [redacted]

To proceed to the next panel, click on the **Next** button.

10.4.6. Panel #6: Targets

In this last panel the user specifies the target Controller(s) that will be updated with the new firmware.



Select download destination

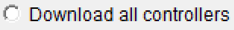
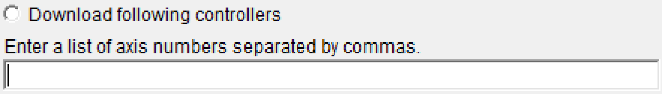
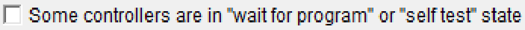
● Download all controllers

○ Download following controllers

Enter a list of axis numbers separated by commas.

Check the following boxes only if the controller is or could be in "wait for program" or "self test" state

☐ Some controllers are in "wait for program" or "self test" state

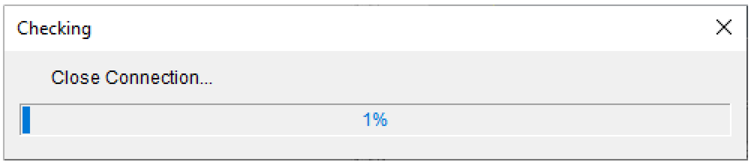
Target options	
 ○ Download all controllers	Download the firmware to all Controllers (typically when connected to an ***UltimET Light/ADVANCED*** motion controller, all the axes connected to the ***TransnET*** bus can be updated with a new firmware).
 ○ Download following controllers Enter a list of axis numbers separated by commas.	Specify to which axes download the firmware.
 ☐ Some controllers are in "wait for program" or "self test" state	To be used to recover a Controller after a previous problem with the download of a firmware (not applicable to the ***ULTIMET ADVANCED*** motion controller for which there is another way for recovering from a firmware download issue).

NOTE	For further details about downloading a firmware to a Controller and how to recover it in case of a problem, refer to the *AccurET Modular Position Controller Operation & Software Manual* and *UltimET Light/ADVANCED User's Manual*.

Finally, clicking on the **Download** button starts downloading the firmware to the Controller(s), with the following sequence of actions taking place:

1. Closing connection;
2. Re-opening connection in bridge boot mode (specific connection mode required to update the firmware);
3. Analyzing new firmware to validate the compatibility with the target Controller(s) and compare it with the current firmware running on the Controller(s); if the new and current firmware are the same, the download is not executed;
4. Downloading of the new firmware blocks to the Controller(s);
5. Closing of connection.

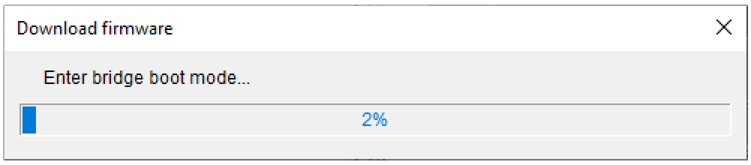
A progress bar gives an indication of the status of each these actions.



Checking

Close Connection...

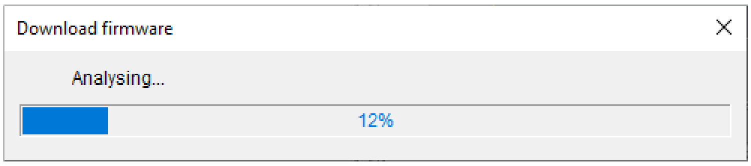
1%



Download firmware

Enter bridge boot mode...

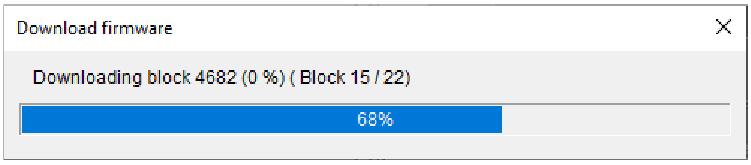
2%



Download firmware

Analysing...

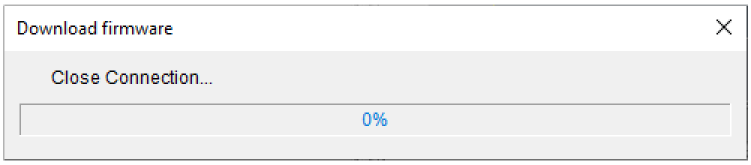
12%



Download firmware

Downloading block 4682 (0 %) (Block 15 / 22)

68%

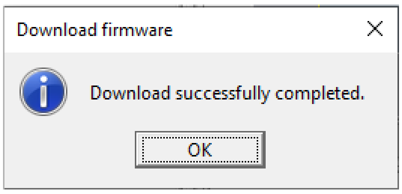


Download firmware

Close Connection...

0%

An information message is displayed once the download is successfully completed.



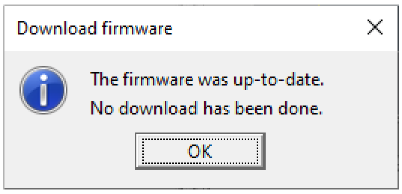
Download firmware

Download successfully completed.

NOTE

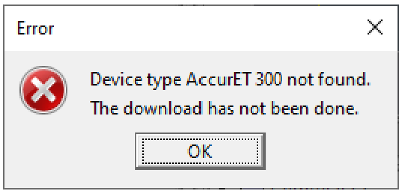
A Controller must be rebooted after a firmware update. While in the case of ***AccurET*** position controllers, the rebooting is realized as part of the firmware downloading process (except if USB is the selected connection type), to properly reboot an ***UltimET Light PCI/PCIe*** motion controller it is mandatory to shut down the computer to ensure that the motherboard does not continue powering the Controller.

If the firmware to download is the same as the one already running on the Controller(s), the download is not executed and the following information message is presented.


Download firmware

The firmware was up-to-date.
No download has been done.

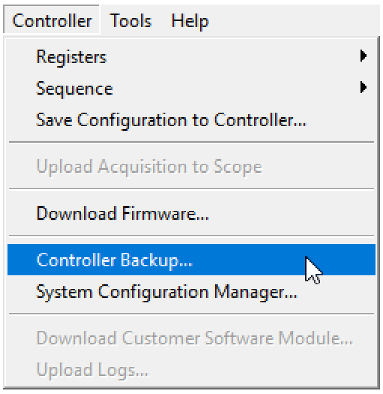
If the firmware to download is not compatible with the target Controller(s), the download is aborted and the following error is raised.


Error

Device type AccurET 300 not found.
The download has not been done.

10.5. Controller backup

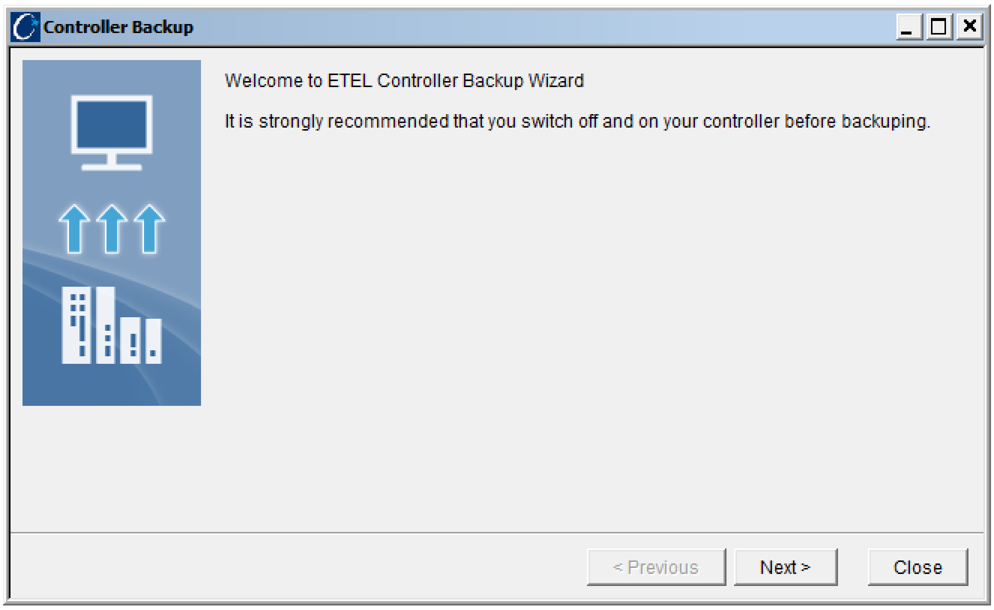
To back up the configuration of a Controller select the Menu option **Controller → Controller Backup**:



ComET4's *Controller Backup* wizard guides the user through the process of backing up the configuration of a Controller.

10.5.1. Panel #1: Recommendations

The wizard's first panel is purely informative. It contains an important recommendation that the user should observe before realizing the configuration backup: power cycle the Controller off and on to ensure that it is in a well-known configuration.



Welcome to ETEL Controller Backup Wizard

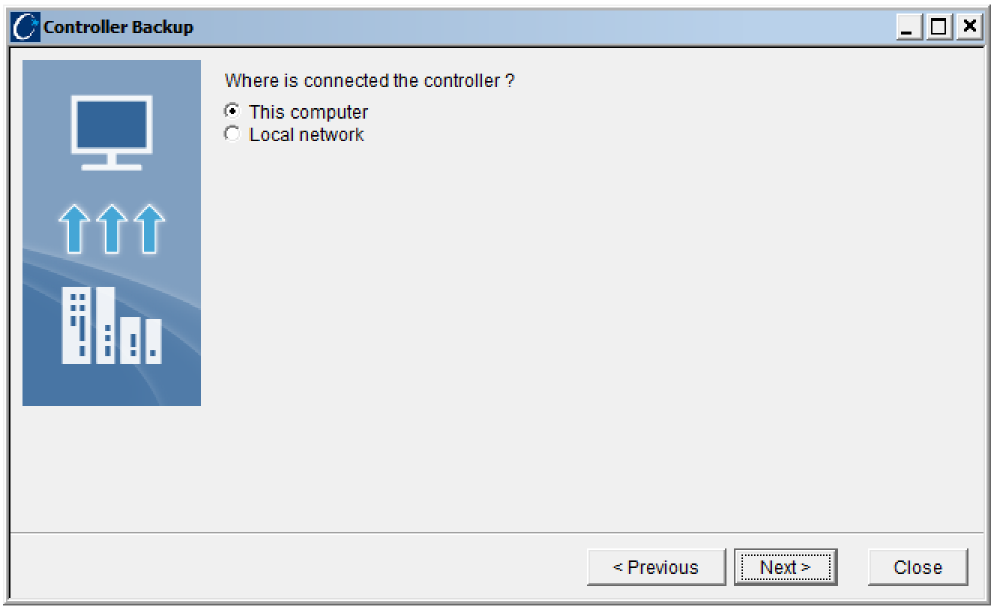
It is strongly recommended that you switch off and on your controller before backuping.

NOTE	To properly reboot an ***UltimET Light PCI/PCIe*** motion controller it is not sufficient to restart the computer hosting the Controller. The user must shut down the computer to ensure that the motherboard does not continue powering the ***UltimET Light PCI/PCIe*** card.

To proceed to the next panel, click on the **Next** button.

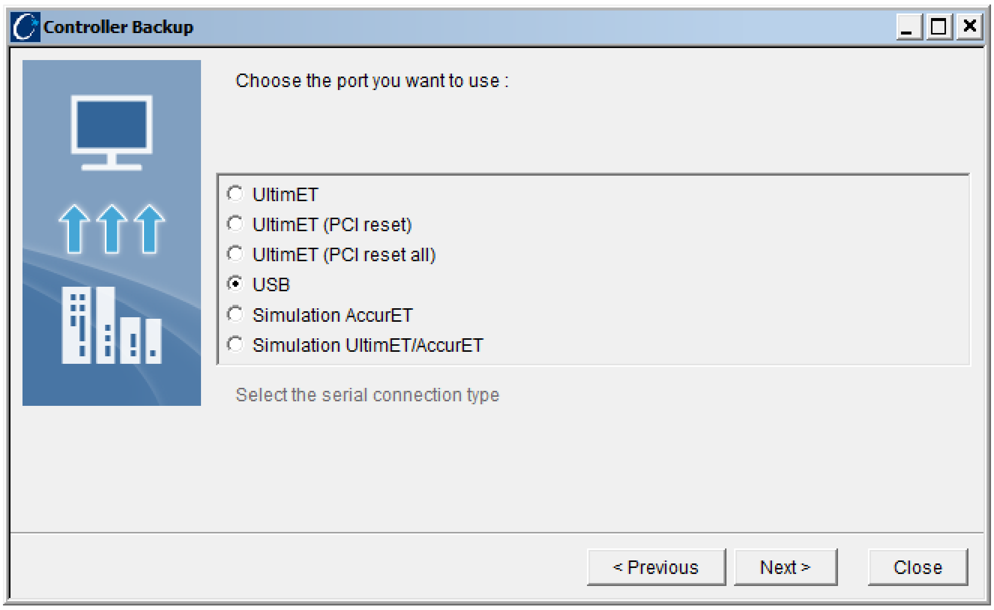
10.5.2. Panel #2: Connection

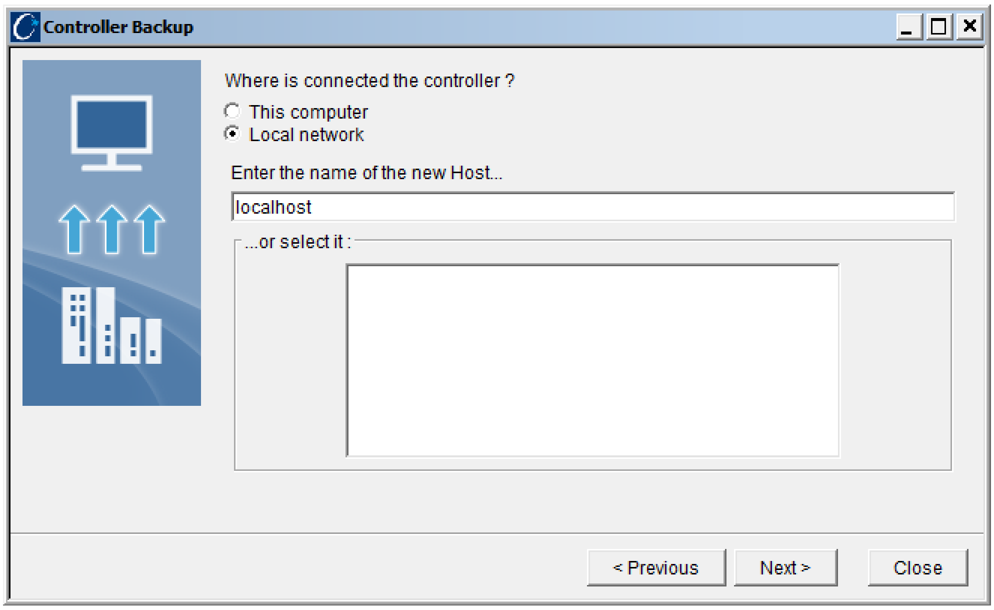
In this panel, the user decides the type of connection to be used, either the Controller is directly connected to the computer running ***ComET4*** or can be reached via the Local network.



Where is connected the controller ?
● This computer
○ Local network

Connection options

○ This computer	If selected, when clicking on the **Next** button there is an additional panel that is added to the normal flow. This panel depicted below allows the user to select the connection port.  Choose the port you want to use : ○ UltimET ○ UltimET (PCI reset) ○ UltimET (PCI reset all) ● USB ○ Simulation AccurET ○ Simulation UltimET/AccurET Select the serial connection type
○ Local network	If selected, the user must enter the hostname or select one from the list (if any).



Where is connected the controller ?
○ This computer
● Local network

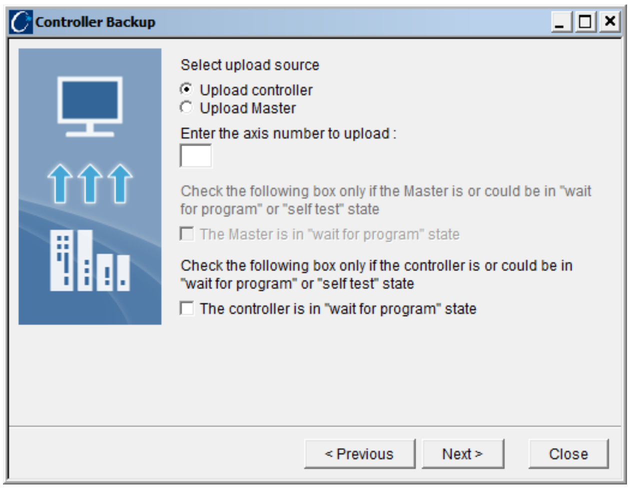
Enter the name of the new Host...
localhost

...or select it :

To proceed to the next panel, click on the **Next** button.

10.5.3. Panel #3: Upload source

The third panel allows the user to select the Controller to backup. The options are either backing up a controller (i.e. ***AccurET*** position controller), in which case the axis number must be specified, or a Master (i.e. ***UltimET Light/ADVANCED*** motion controller).

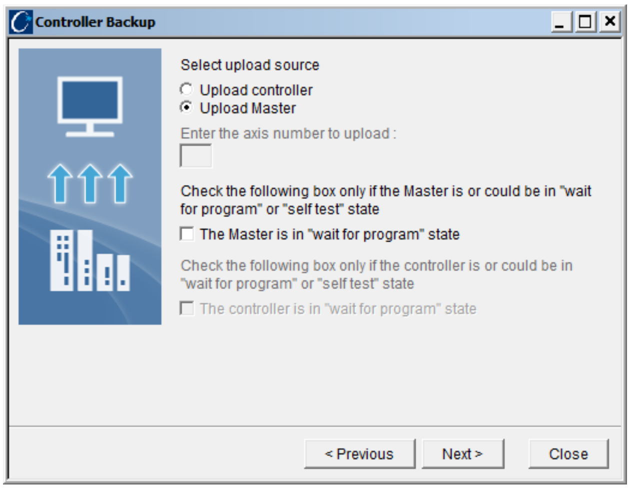


Select upload source
● Upload controller
○ Upload Master

Enter the axis number to upload :

Check the following box only if the Master is or could be in "wait for program" or "self test" state
☐ The Master is in "wait for program" state

Check the following box only if the controller is or could be in "wait for program" or "self test" state
☐ The controller is in "wait for program" state



Select upload source
○ Upload controller
● Upload Master

Enter the axis number to upload :

Check the following box only if the Master is or could be in "wait for program" or "self test" state
☐ The Master is in "wait for program" state

Check the following box only if the controller is or could be in "wait for program" or "self test" state
☐ The controller is in "wait for program" state

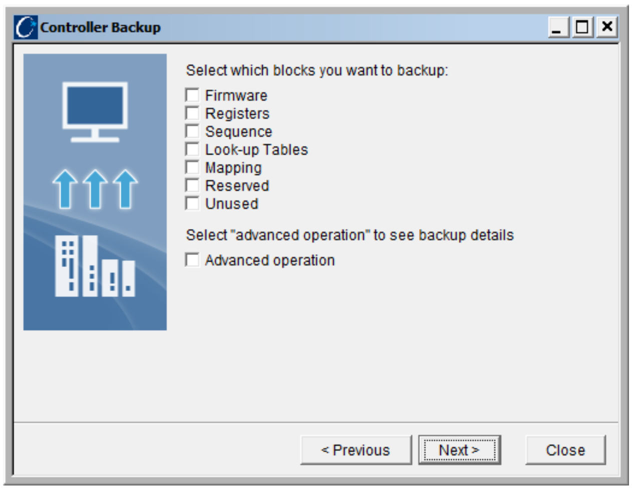
The user must check the **The controller is in "wait for program" state** checkbox (or equivalently **The Master is in "wait for program" state** checkbox) to recover a controller (or Master) after a previous problem with a firmware download (this option is not applicable for an ***ULTIMET ADVANCED*** motion controller).

NOTE	For further details about downloading a firmware to a Controller and how to recover it in case of a problem, refer to the *AccurET Modular Position Controller Operation & Software Manual* and *UltimET Light/ADVANCED User's Manual*.

To proceed to the next panel, click on the **Next** button.

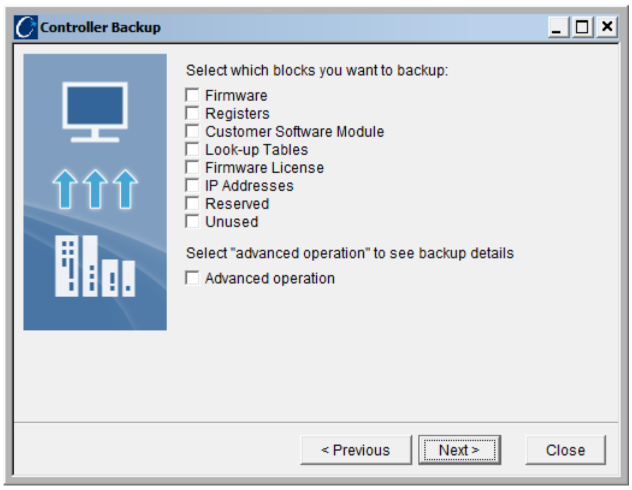
10.5.4. **Panel #4: Backup options**

In this panel the user can select what will be backed up from the controller. The screenshot on the left depicts the backup options available for the ***AccurET*** and ***UltimET Light*** controllers, while the screenshot on the right depicts the backup options available for the ***ULTIMET ADVANCED*** controller.



Select which blocks you want to backup:
☐ Firmware
☐ Registers
☐ Sequence
☐ Look-up Tables
☐ Mapping
☐ Reserved
☐ Unused

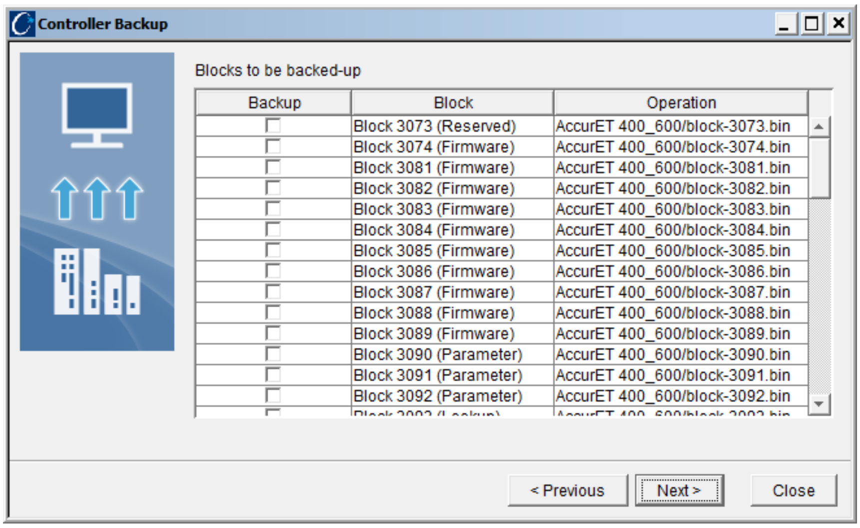
Select "advanced operation" to see backup details
☐ Advanced operation



Select which blocks you want to backup:
☐ Firmware
☐ Registers
☐ Customer Software Module
☐ Look-up Tables
☐ Firmware License
☐ IP Addresses
☐ Reserved
☐ Unused

Select "advanced operation" to see backup details
☐ Advanced operation

Backup options	
☐ Firmware	Backup the Controller's firmware and metadata. For the case of an ***ULTIMET ADVANCED*** motion controller, the backup will also include the contents of the flash memory, the VxWorks real-time operating system image and the registers/configuration of existent ETEL Software Modules (ESM).
☐ Registers	Backup the Controller's `K`, `X`, `C`, `E`, `Y` and `W` register types. Backup of `C` and `E` register types only applies to ***AccurET*** position controllers. Backup of `Y` register type only applies to ***UltimET Light/ADVANCED*** motion controllers. Backup of `W` register type only applies to ***ULTIMET ADVANCED*** motion controllers.
☐ Sequence	Backup the Controller's Sequence programs only applies to ***AccurET*** and ***UltimET Light*** controllers.
☐ Customer Software Module	Backup the Controller's Customer Software Module (CSM) only applies to ***ULTIMET ADVANCED*** motion controllers.
☐ Look-up Tables	Backup the Controller's `L` register type.
☐ Mapping	Backup the Controller's `P` register type only applies to ***AccurET*** position controllers.
☐ Firmware License	Backup the Firmware license file only applies to ***ULTIMET ADVANCED*** motion controllers. **NOTE:** a Firmware license file is unique and linked to a specific ***ULTIMET ADVANCED*** motion controller through its serial number (refer to the *ULTIMET ADVANCED User's Manual*

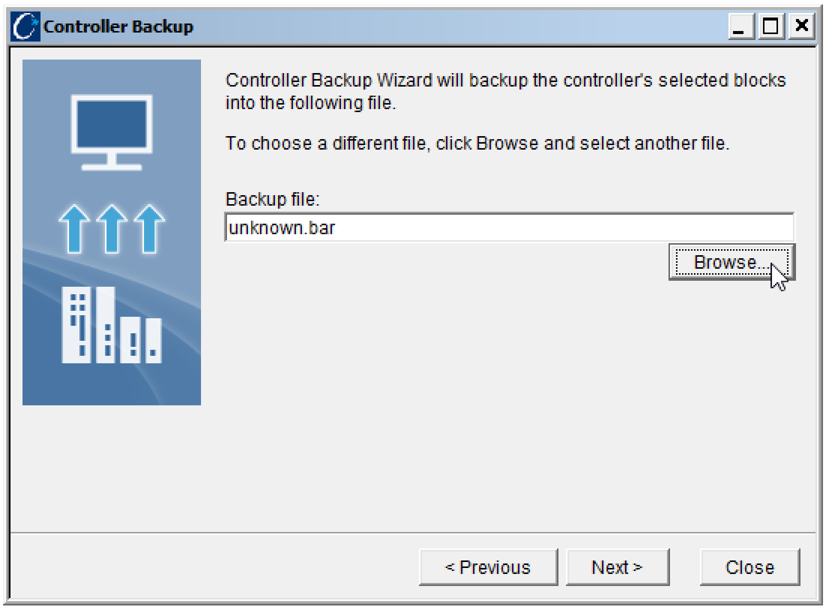
	for further information). Uncheck this option if this backup is intended to be downloaded to another controller with a different serial number.
☐ IP Addresses	Backup the IP addresses only applies to ***ULTIMET ADVANCED*** motion controllers.
☐ Reserved	Backup memory blocks reserved for future use. It might be useful to backup such blocks as in more recent firmware versions these blocks could be used for some other purpose.
☐ Unused	Backup memory blocks not currently used. It might be useful to backup such blocks as in more recent firmware versions these blocks could be used for some other purpose.
☐ Advanced operation	This option is reserved for advanced users. If selected, when clicking on the **Next** button there is an additional panel that is added to the normal flow. This panel depicted below allows the user to select which blocks to backup. 

Blocks to be backed-up

Backup	Block	Operation
☐	Block 3073 (Reserved)	AccurET 400_600/block-3073.bin
☐	Block 3074 (Firmware)	AccurET 400_600/block-3074.bin
☐	Block 3081 (Firmware)	AccurET 400_600/block-3081.bin
☐	Block 3082 (Firmware)	AccurET 400_600/block-3082.bin
☐	Block 3083 (Firmware)	AccurET 400_600/block-3083.bin
☐	Block 3084 (Firmware)	AccurET 400_600/block-3084.bin
☐	Block 3085 (Firmware)	AccurET 400_600/block-3085.bin
☐	Block 3086 (Firmware)	AccurET 400_600/block-3086.bin
☐	Block 3087 (Firmware)	AccurET 400_600/block-3087.bin
☐	Block 3088 (Firmware)	AccurET 400_600/block-3088.bin
☐	Block 3089 (Firmware)	AccurET 400_600/block-3089.bin
☐	Block 3090 (Parameter)	AccurET 400_600/block-3090.bin
☐	Block 3091 (Parameter)	AccurET 400_600/block-3091.bin
☐	Block 3092 (Parameter)	AccurET 400_600/block-3092.bin

10.5.5. Panel #5: Backup file

This panel allows the user to select the backup file.

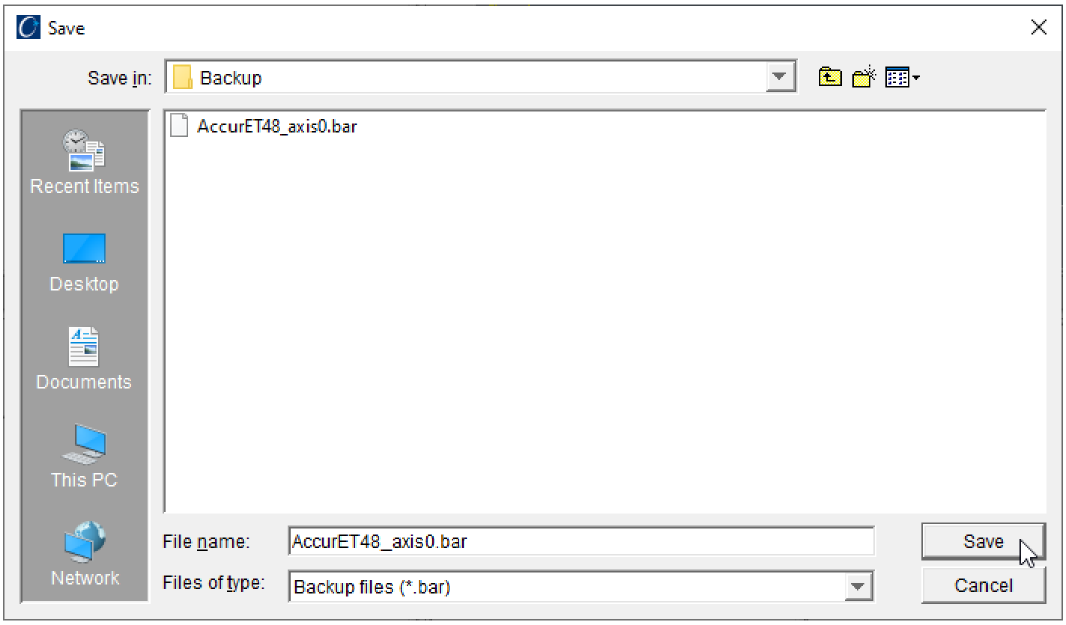


Controller Backup Wizard will backup the controller's selected blocks into the following file.

To choose a different file, click Browse and select another file.

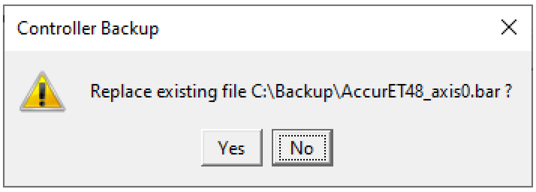
Backup file: unknown.bar

Use the **Browse** button to select the file where the backup will be stored.



NOTE	A backup file should bear the `*.bar` file extension.

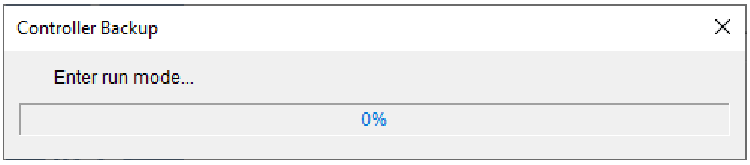
In case the file already exists, the user is informed with the following a warning message. Click on the **Yes** button to accept overwriting the existing file with the backup that is going to be uploaded.


Controller Backup

Replace existing file C:\Backup\AccurET48_axis0.bar ?

Once the backup file has been selected, to start the backup procedure click on the **Next** button.

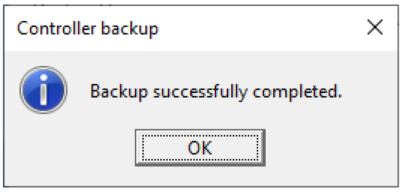
A progress bar gives an indication of the status of the backup.


Controller Backup

Enter run mode...

0%

And an information message is displayed once the backup is successfully completed.

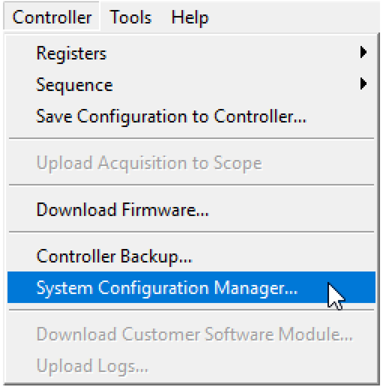


Backup successfully completed.

NOTE To restore a backup to a Controller use the *Download Firmware* tool. Refer to Section §10.4 for further details.

10.6. System Configuration Manager

The *System Configuration Manager* tool allows the user to manage the entire configuration of a motion system. To launch this tool select the Menu option **Controller → System Configuration Manager**.



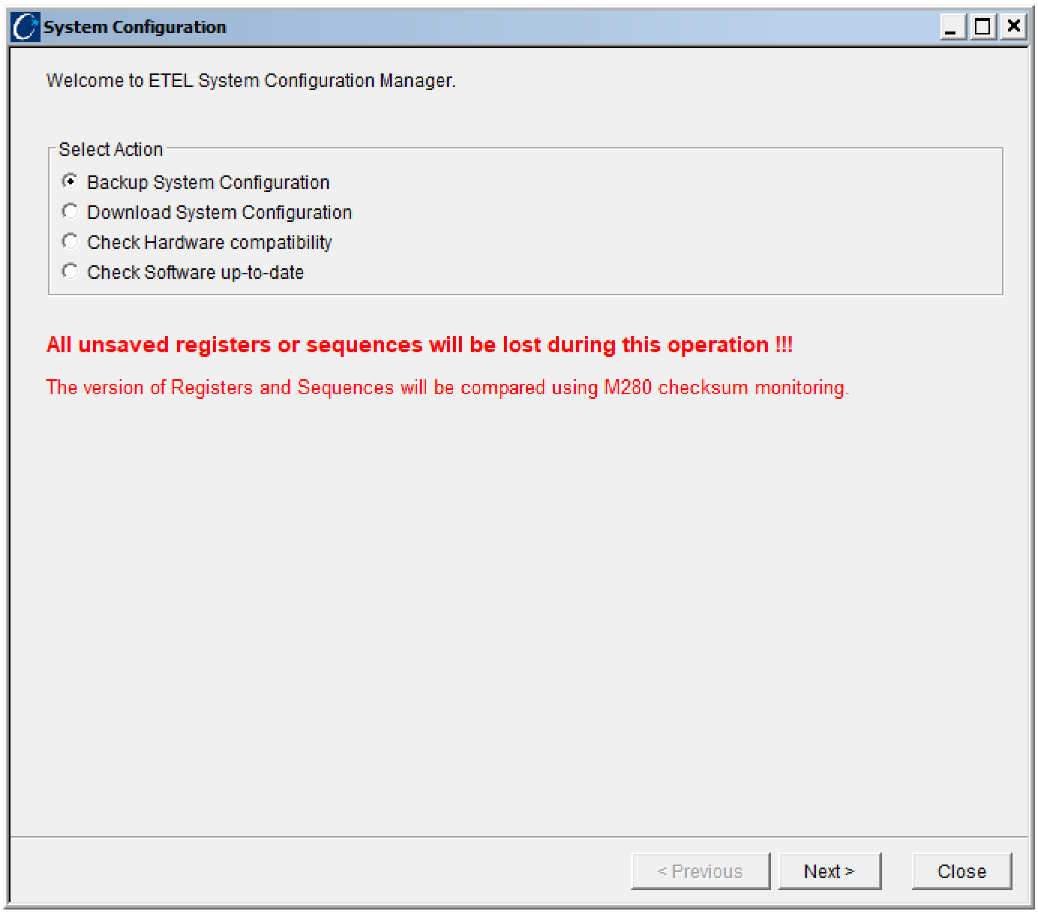
With this tool the user can:

○ Backup System Configuration	Make an image of the configuration of all the Controllers connected to a selected bus (or buses) into a backup `*.zip` file.
○ Download System Configuration	Extract from the backup `*.zip` file the system configuration image and download it to a compatible set of Controllers.
○ Check Hardware compatibility	Verify if the set of Controllers connected to the selected bus (or buses) is hardware compatible with a given system configuration image.
○ Check Software up-to-date	Verify if the software configuration (firmware, registers, Sequences…) of set of Controllers connected to the selected bus (or buses) corresponds to a given system configuration image.

The *System Configuration Manager* tool is well suited for managing a system's software configuration in a series production environment.

10.6.1. Backup

To back up a system configuration, the user must select the **Backup System Configuration** checkbox in the first panel of the *System Configuration Manager* wizard.



Welcome to ETEL System Configuration Manager.

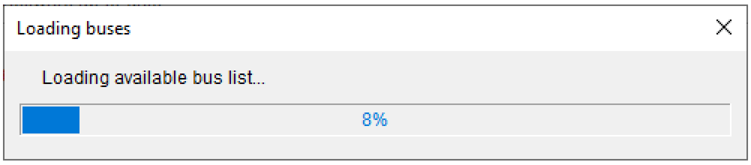
Select Action

- ● Backup System Configuration
- ○ Download System Configuration
- ○ Check Hardware compatibility
- ○ Check Software up-to-date

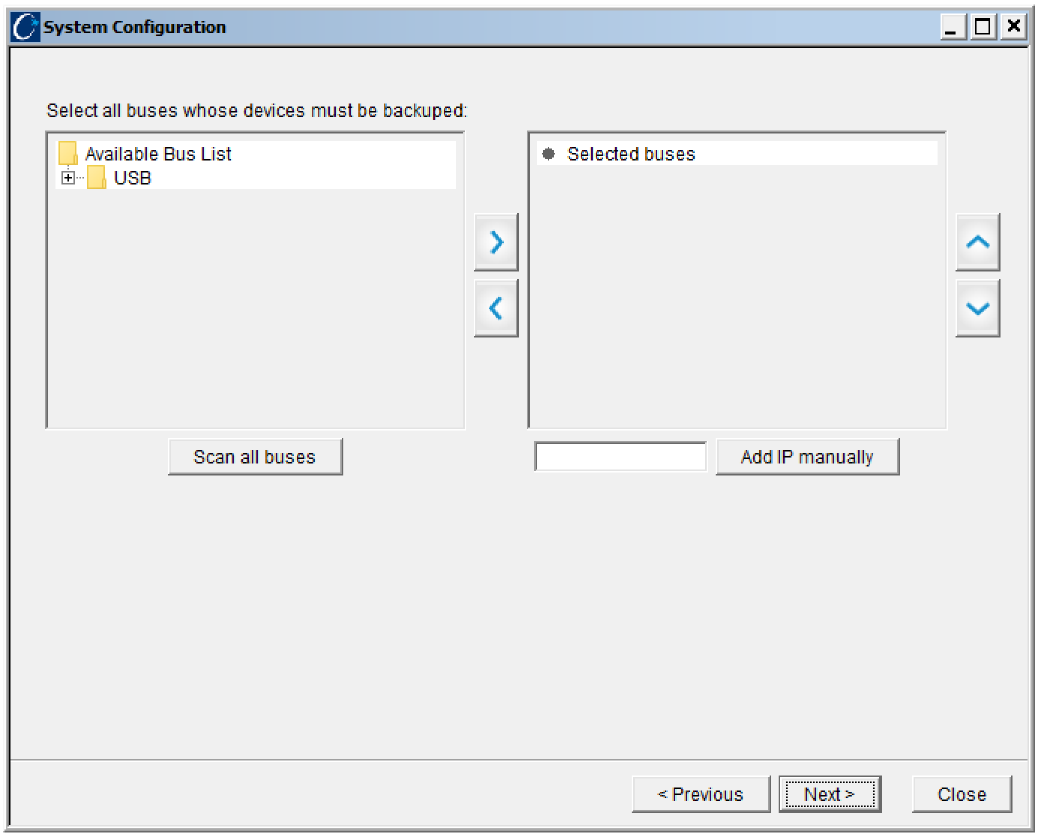
All unsaved registers or sequences will be lost during this operation !!!

The version of Registers and Sequences will be compared using M280 checksum monitoring.

To proceed to the next panel, click on the **Next** button. The tool starts searching for the available connection buses and displays the ones found on the second panel.

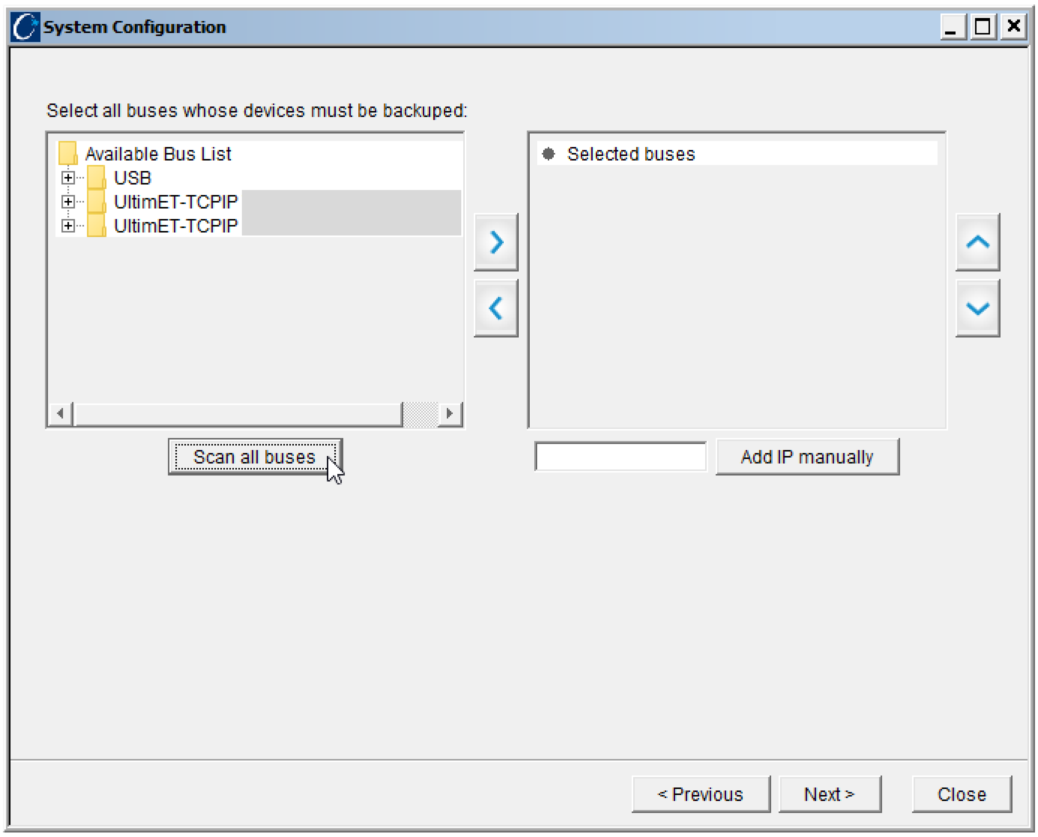


Loading available bus list...



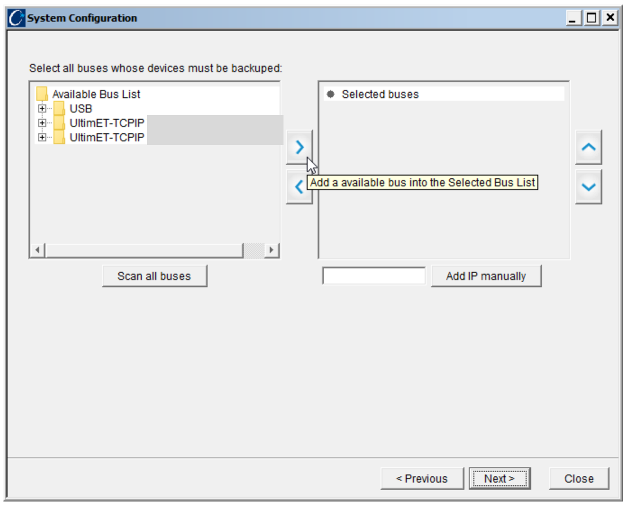
Select all buses whose devices must be backuped:

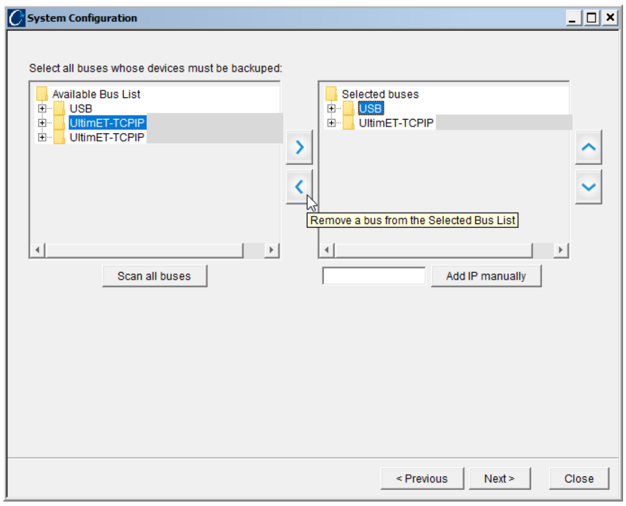
The user can select and operate on several buses at the same time. To scan for all available buses just click on the **Scan all buses** button.



The list on the left displays all the available buses and the list on the right displays the selected buses. To add a bus to the selected bus list, the user must first select the bus in the available bus list and then click on the arrow pointing to the right placed in between both lists.

To remove an item from the selected buses, the user needs to select the bus to be removed in the selected bus list and then click on the arrow pointing to the left placed in between both lists.





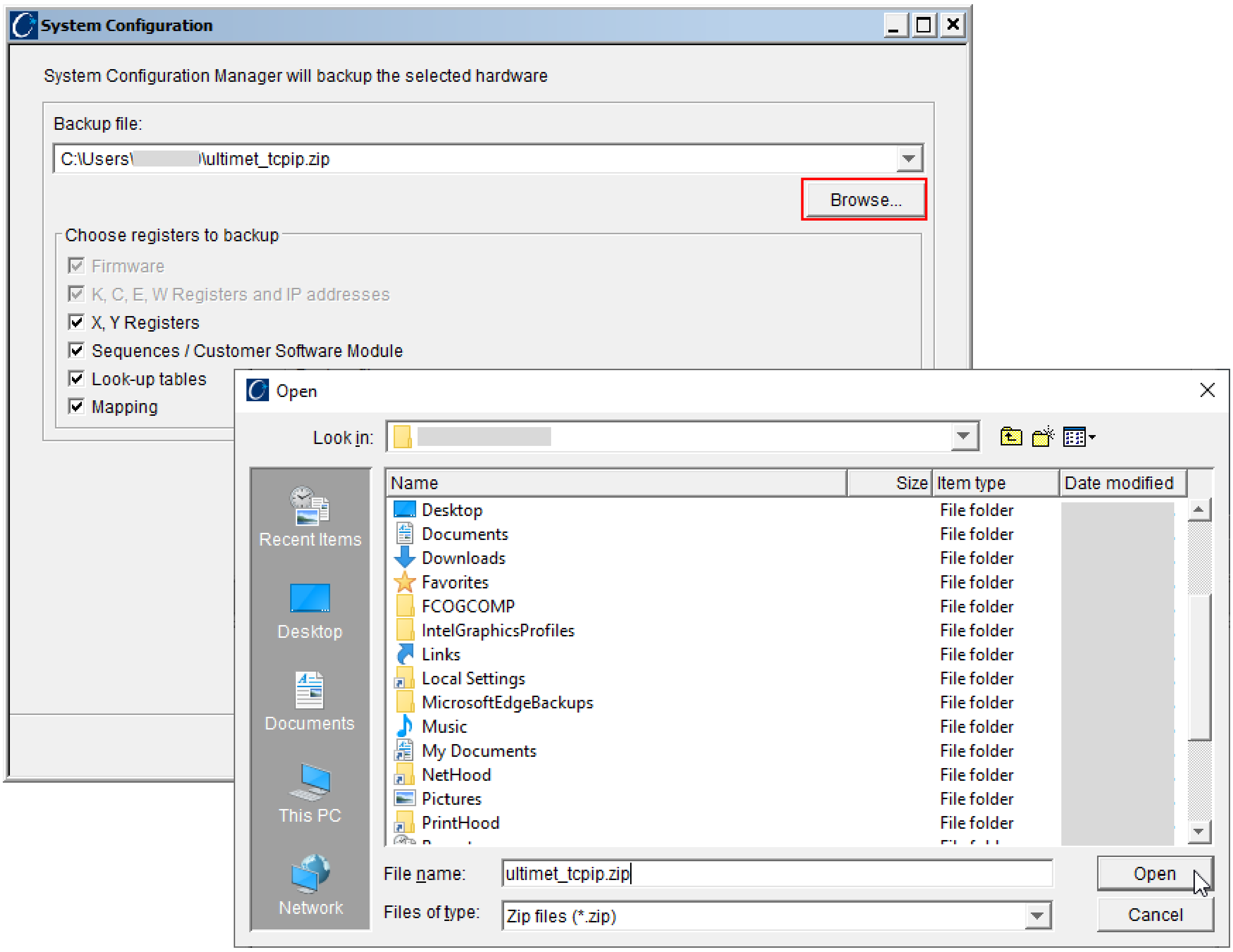
To change the order of the selected buses in the list, the user can use the arrows pointing up or down on the right of the panel.

Finally, the user can also enter an IP address manually:

›	Add a bus to the list of selected buses.
‹	Remove a bus from the list of selected buses.
˄	Move up a bus in the list of selected buses (the configuration backup starts from the bus on the top most of the list).
˅	Move down a bus in the list of selected buses.
☐ Add IP manually	Find a bus by introducing directly its IP address.

To proceed to the next panel, click on the **Next** button.

On the next panel, the user must select the file where to store the system configuration backup by clicking on the **Browse** button.



System Configuration Manager will backup the selected hardware

Backup file: C:\Users\[redacted]\ultimet_tcpip.zip

Choose registers to backup
- ☑ Firmware
- ☑ K, C, E, W Registers and IP addresses
- ☑ X, Y Registers
- ☑ Sequences / Customer Software Module
- ☑ Look-up tables
- ☑ Mapping

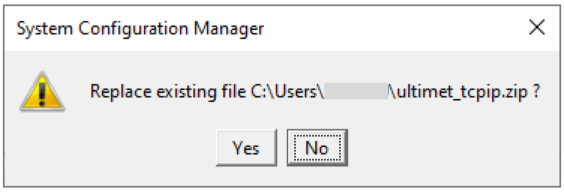
Look in: [redacted]

Name	Size	Item type	Date modified
Desktop		File folder	[redacted]
Documents		File folder	[redacted]
Downloads		File folder	[redacted]
Favorites		File folder	[redacted]
FCOGCOMP		File folder	[redacted]
IntelGraphicsProfiles		File folder	[redacted]
Links		File folder	[redacted]
Local Settings		File folder	[redacted]
MicrosoftEdgeBackups		File folder	[redacted]
Music		File folder	[redacted]
My Documents		File folder	[redacted]
NetHood		File folder	[redacted]
Pictures		File folder	[redacted]
PrintHood		File folder	[redacted]

File name: ultimet_tcpip.zip

Files of type: Zip files (*.zip)

In case the file already exists, the user is informed with the following warning message. Click on the **Yes** button to accept overwriting the existing file with the new backup.


System Configuration Manager

Replace existing file C:\Users\[redacted]\ultimet_tcpip.zip ?

The user can also define which information to backup:

☑ Firmware	Backup the firmware and metadata of the Controllers connected to a selected bus (or buses). When backing up an ***ULTIMET ADVANCED*** motion controller, it also backs up the flash memory, the image of the VxWorks real-time operating system and the internal parameters of any existent ETEL Software Module (ESM). This option is always selected.
☑ K, C, E, W Registers and IP addresses	Backup the `K`, `C`, `E` and `W` register types of the Controllers connected to a selected bus (or buses). Backup the IP addresses. This option is always selected. Backup of `C` and `E` register types only applies for ***AccurET*** position controllers. Backup of `W` register type only applies for ***ULTIMET ADVANCED*** motion controllers. Backup of IP addresses only applies for ***ULTIMET ADVANCED*** motion controllers.
☐ X, Y Registers	Backup the `X` and `Y` register types of the Controllers connected to a selected bus (or buses). Backup of `Y` register type only applies for ***UltimET Light/ADVANCED*** motion controllers.
☐ Sequences / Customer Software Module	Backup the Sequence programs or Customer Software Module (CSM) of the Controllers connected to a selected bus (or buses). Backup of Sequences does not apply for ***ULTIMET ADVANCED*** motion controllers. Backup of CSM only applies for ***ULTIMET ADVANCED*** motion controllers.
☐ Look-up tables	Backup the `L` register type of the Controllers connected to a selected bus (or buses).
☐ Mapping	Backup the `P` register type of the Controllers connected to a selected bus (or buses). Backup of `P` register type only applies for ***AccurET*** position controllers.

NOTE

The backup options that are displayed may vary with the type of Controllers present on the connection bus (***AccurET*** only, ***UltimET Light*** or ***ULTIMET ADVANCED***).

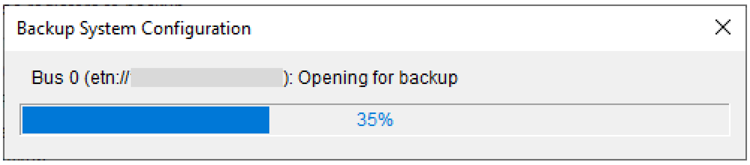
The example above corresponds to the case where an ***ULTIMET ADVANCED*** motion controller is present on the selected bus (or buses).

NOTE

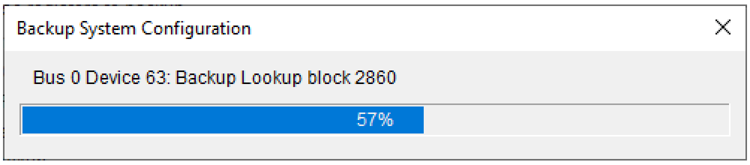
When cloning the configuration from one system to another, the user must be aware that some data may need to be reconfigured on the new system after the download. Typical examples are linked to the Look-up and Mapping register types (e.g. scale mapping, stage mapping and cogging correction tables are valid on a given system only; they are machine dependent).

Once the backup file has been selected and the backup options configured, to start the system configuration backup procedure click on the **Next** button.

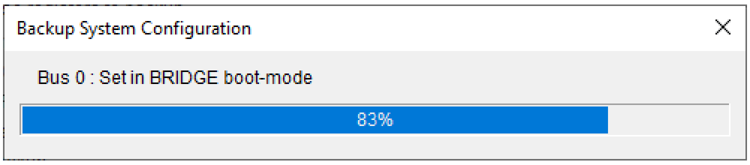
A progress bar gives an indication of the status of the backup.



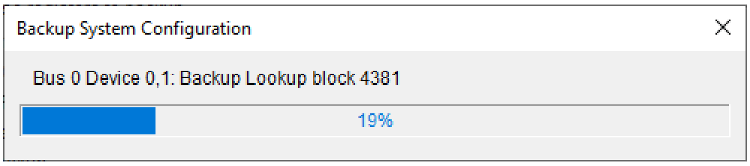
Bus 0 (etn://[redacted]): Opening for backup



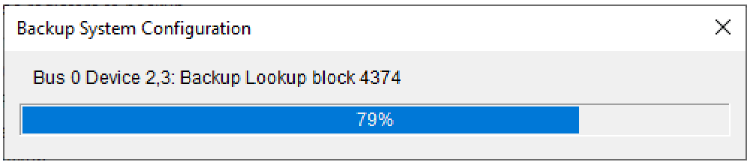
Bus 0 Device 63: Backup Lookup block 2860



Bus 0 : Set in BRIDGE boot-mode

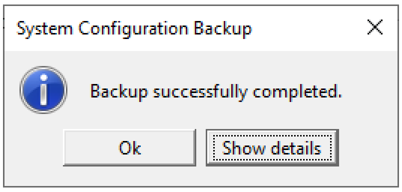


Bus 0 Device 0,1: Backup Lookup block 4381



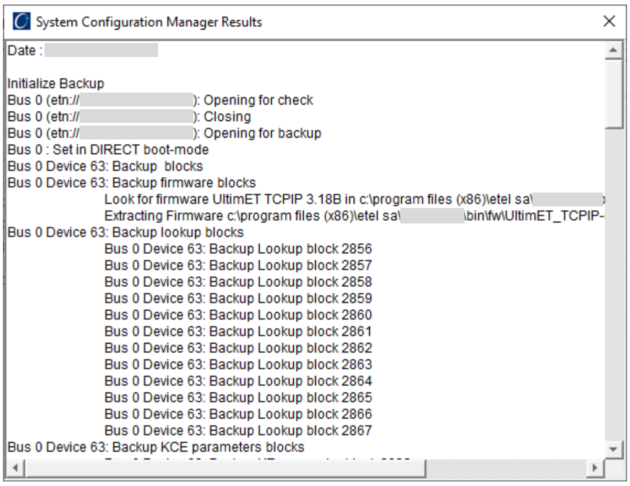
Bus 0 Device 2,3: Backup Lookup block 4374

And an information message is displayed once the backup is successfully completed.

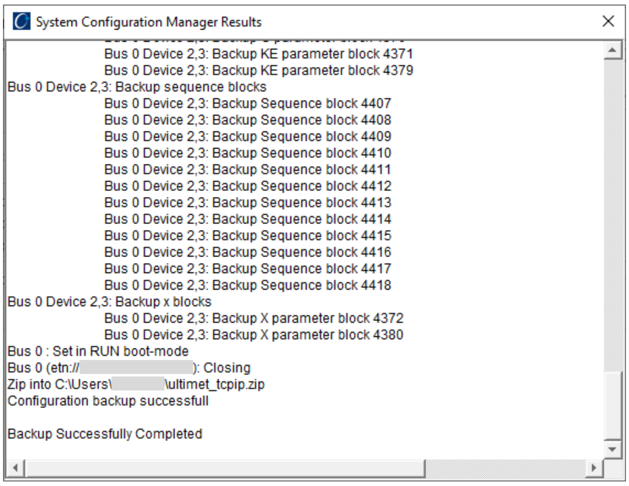


Backup successfully completed.

Click on the **Show details** button to view details of the system configuration backup.



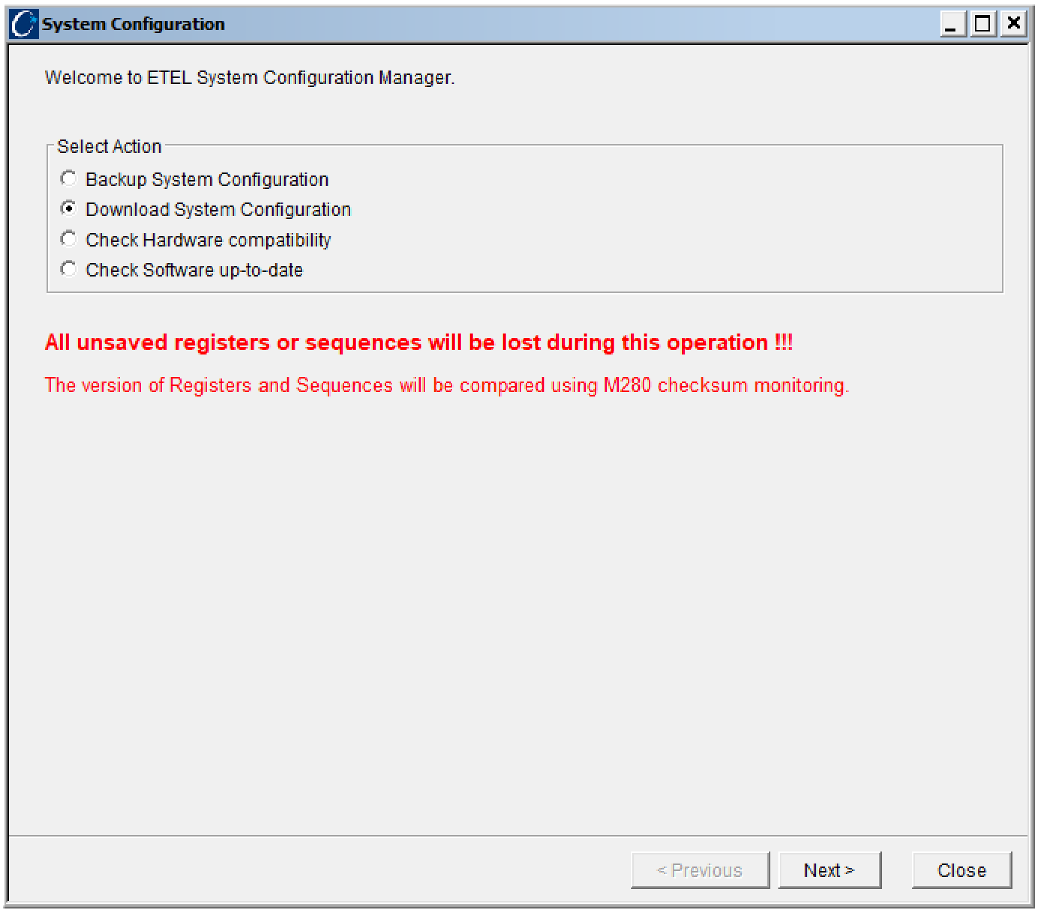
```
Date : [redacted]

Initialize Backup
Bus 0 (etn://[redacted]): Opening for check
Bus 0 (etn://[redacted]): Closing
Bus 0 (etn://[redacted]): Opening for backup
Bus 0 : Set in DIRECT boot-mode
Bus 0 Device 63: Backup  blocks
Bus 0 Device 63: Backup firmware blocks
                Look for firmware UltimET TCPIP 3.18B in c:\program files (x86)\etel sa\[redacted]
                Extracting Firmware c:\program files (x86)\etel sa\[redacted]\bin\fw\UltimET_TCPIP-
Bus 0 Device 63: Backup lookup blocks
                Bus 0 Device 63: Backup Lookup block 2856
                Bus 0 Device 63: Backup Lookup block 2857
                Bus 0 Device 63: Backup Lookup block 2858
                Bus 0 Device 63: Backup Lookup block 2859
                Bus 0 Device 63: Backup Lookup block 2860
                Bus 0 Device 63: Backup Lookup block 2861
                Bus 0 Device 63: Backup Lookup block 2862
                Bus 0 Device 63: Backup Lookup block 2863
                Bus 0 Device 63: Backup Lookup block 2864
                Bus 0 Device 63: Backup Lookup block 2865
                Bus 0 Device 63: Backup Lookup block 2866
                Bus 0 Device 63: Backup Lookup block 2867
Bus 0 Device 63: Backup KCE parameters blocks
```



```
                Bus 0 Device 2,3: Backup KE parameter block 4371
                Bus 0 Device 2,3: Backup KE parameter block 4379
Bus 0 Device 2,3: Backup sequence blocks
                Bus 0 Device 2,3: Backup Sequence block 4407
                Bus 0 Device 2,3: Backup Sequence block 4408
                Bus 0 Device 2,3: Backup Sequence block 4409
                Bus 0 Device 2,3: Backup Sequence block 4410
                Bus 0 Device 2,3: Backup Sequence block 4411
                Bus 0 Device 2,3: Backup Sequence block 4412
                Bus 0 Device 2,3: Backup Sequence block 4413
                Bus 0 Device 2,3: Backup Sequence block 4414
                Bus 0 Device 2,3: Backup Sequence block 4415
                Bus 0 Device 2,3: Backup Sequence block 4416
                Bus 0 Device 2,3: Backup Sequence block 4417
                Bus 0 Device 2,3: Backup Sequence block 4418
Bus 0 Device 2,3: Backup x blocks
                Bus 0 Device 2,3: Backup X parameter block 4372
                Bus 0 Device 2,3: Backup X parameter block 4380
Bus 0 : Set in RUN boot-mode
Bus 0 (etn://[redacted]): Closing
Zip into C:\Users\[redacted]\ultimet_tcpip.zip
Configuration backup successfull

Backup Successfully Completed
```

10.6.2. Download

To download a system configuration to a motion system, the user must select the **Download System Configuration** checkbox in the first panel of the *System Configuration Manager* wizard.



Welcome to ETEL System Configuration Manager.

Select Action

○ Backup System Configuration
● Download System Configuration
○ Check Hardware compatibility
○ Check Software up-to-date

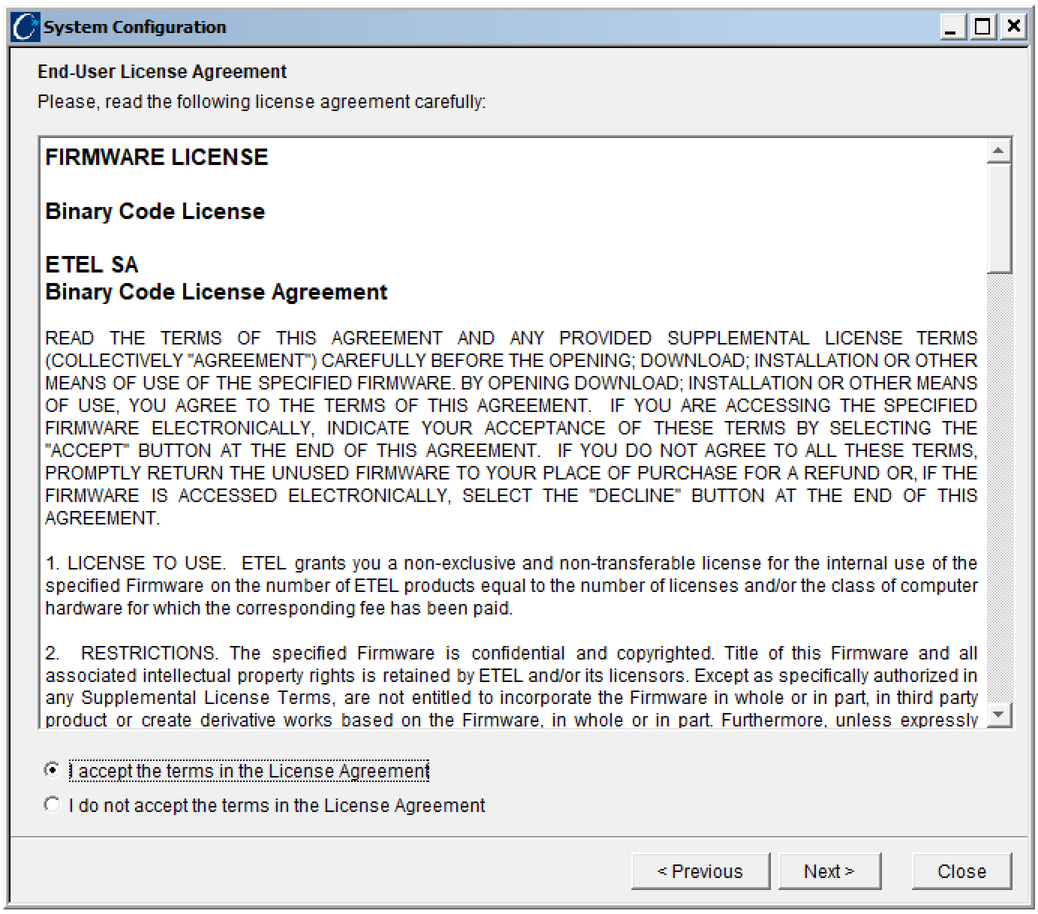
All unsaved registers or sequences will be lost during this operation !!!

The version of Registers and Sequences will be compared using M280 checksum monitoring.

NOTE	All unsaved Registers or Sequences will be lost during this operation.

To proceed to the next panel, click on the **Next** button.

On the second panel the user is presented with the End-User License Agreement (EULA) terms.



End-User License Agreement

Please, read the following license agreement carefully:

FIRMWARE LICENSE

Binary Code License

ETEL SA
Binary Code License Agreement

READ THE TERMS OF THIS AGREEMENT AND ANY PROVIDED SUPPLEMENTAL LICENSE TERMS (COLLECTIVELY "AGREEMENT") CAREFULLY BEFORE THE OPENING; DOWNLOAD; INSTALLATION OR OTHER MEANS OF USE OF THE SPECIFIED FIRMWARE. BY OPENING DOWNLOAD; INSTALLATION OR OTHER MEANS OF USE, YOU AGREE TO THE TERMS OF THIS AGREEMENT. IF YOU ARE ACCESSING THE SPECIFIED FIRMWARE ELECTRONICALLY, INDICATE YOUR ACCEPTANCE OF THESE TERMS BY SELECTING THE "ACCEPT" BUTTON AT THE END OF THIS AGREEMENT. IF YOU DO NOT AGREE TO ALL THESE TERMS, PROMPTLY RETURN THE UNUSED FIRMWARE TO YOUR PLACE OF PURCHASE FOR A REFUND OR, IF THE FIRMWARE IS ACCESSED ELECTRONICALLY, SELECT THE "DECLINE" BUTTON AT THE END OF THIS AGREEMENT.

1. LICENSE TO USE. ETEL grants you a non-exclusive and non-transferable license for the internal use of the specified Firmware on the number of ETEL products equal to the number of licenses and/or the class of computer hardware for which the corresponding fee has been paid.

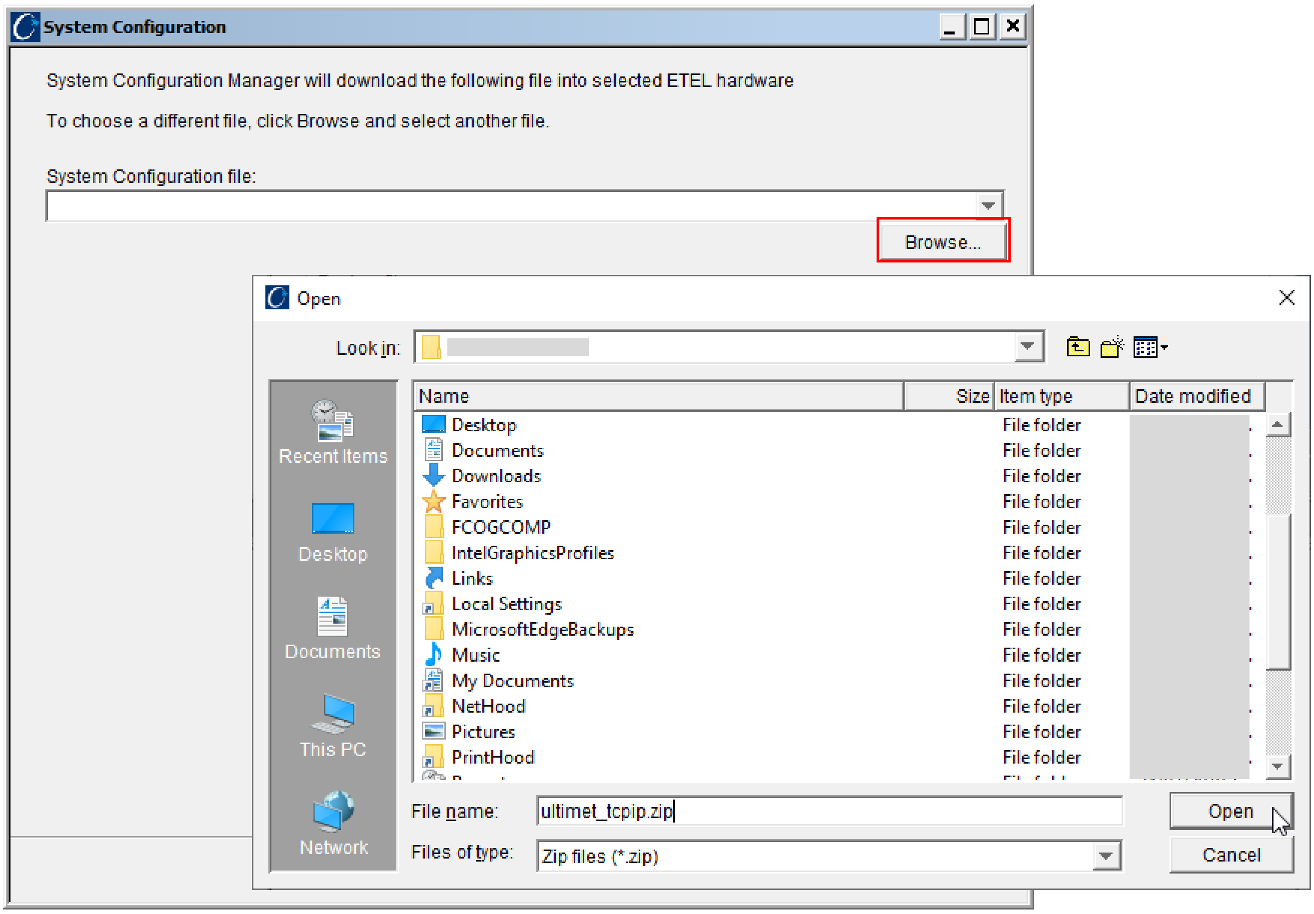
2. RESTRICTIONS. The specified Firmware is confidential and copyrighted. Title of this Firmware and all associated intellectual property rights is retained by ETEL and/or its licensors. Except as specifically authorized in any Supplemental License Terms, are not entitled to incorporate the Firmware in whole or in part, in third party product or create derivative works based on the Firmware, in whole or in part. Furthermore, unless expressly

● I accept the terms in the License Agreement

○ I do not accept the terms in the License Agreement

To proceed to the next panel, click on the **Next** button after having accepted the terms of the license agreement.

On the next panel, the user must select the system configuration backup file by clicking on the **Browse** button.



System Configuration Manager will download the following file into selected ETEL hardware

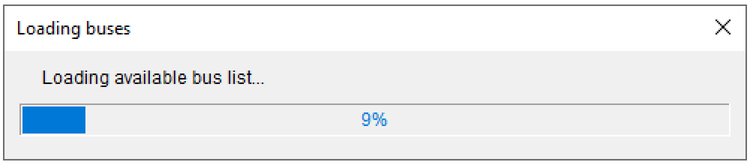
To choose a different file, click Browse and select another file.

System Configuration file:

File name: ultimet_tcpip.zip

Files of type: Zip files (*.zip)

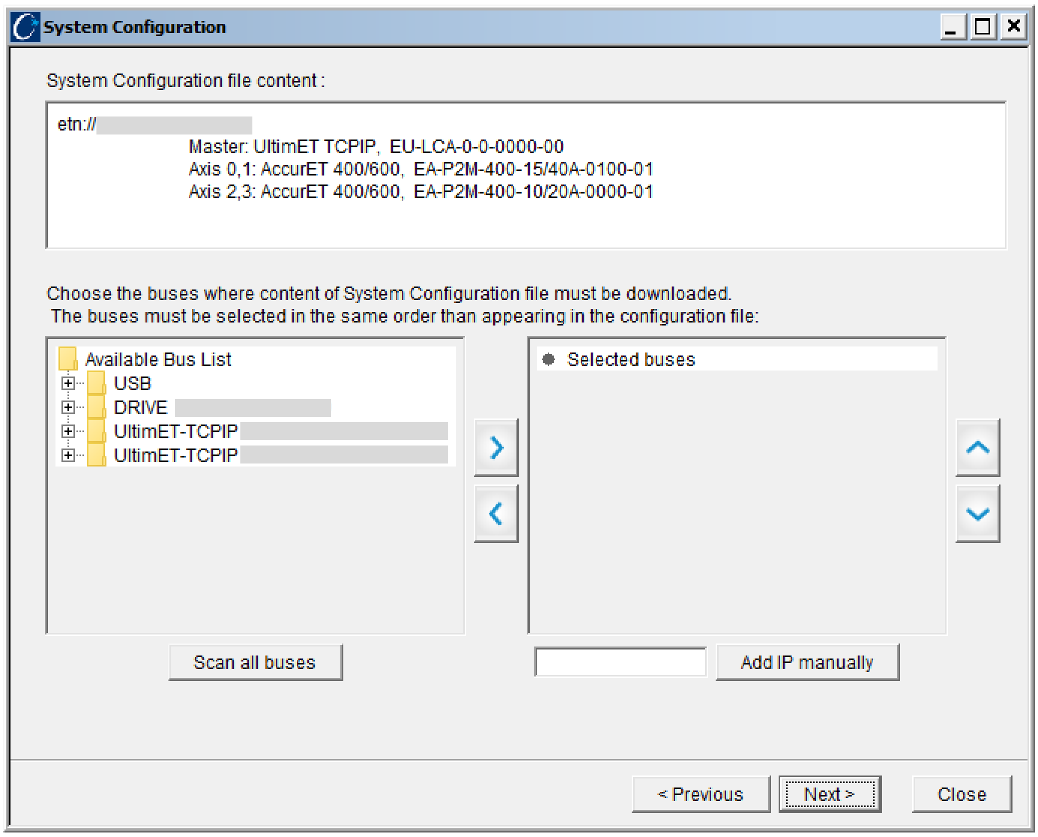
To proceed to the next panel, click on the **Next** button. The tool starts searching for the available connection buses and displays the ones found on the next panel. To scan for all available buses just click on the **Scan all buses** button.



Loading buses

Loading available bus list...

9%



System Configuration

System Configuration file content :

```
etn://[redacted]
                Master: UltimET TCPIP,  EU-LCA-0-0-0000-00
                Axis 0,1: AccurET 400/600,  EA-P2M-400-15/40A-0100-01
                Axis 2,3: AccurET 400/600,  EA-P2M-400-10/20A-0000-01
```

Choose the buses where content of System Configuration file must be downloaded.
The buses must be selected in the same order than appearing in the configuration file:

Available Bus List
- USB
- DRIVE [redacted]
- UltimET-TCPIP [redacted]
- UltimET-TCPIP [redacted]

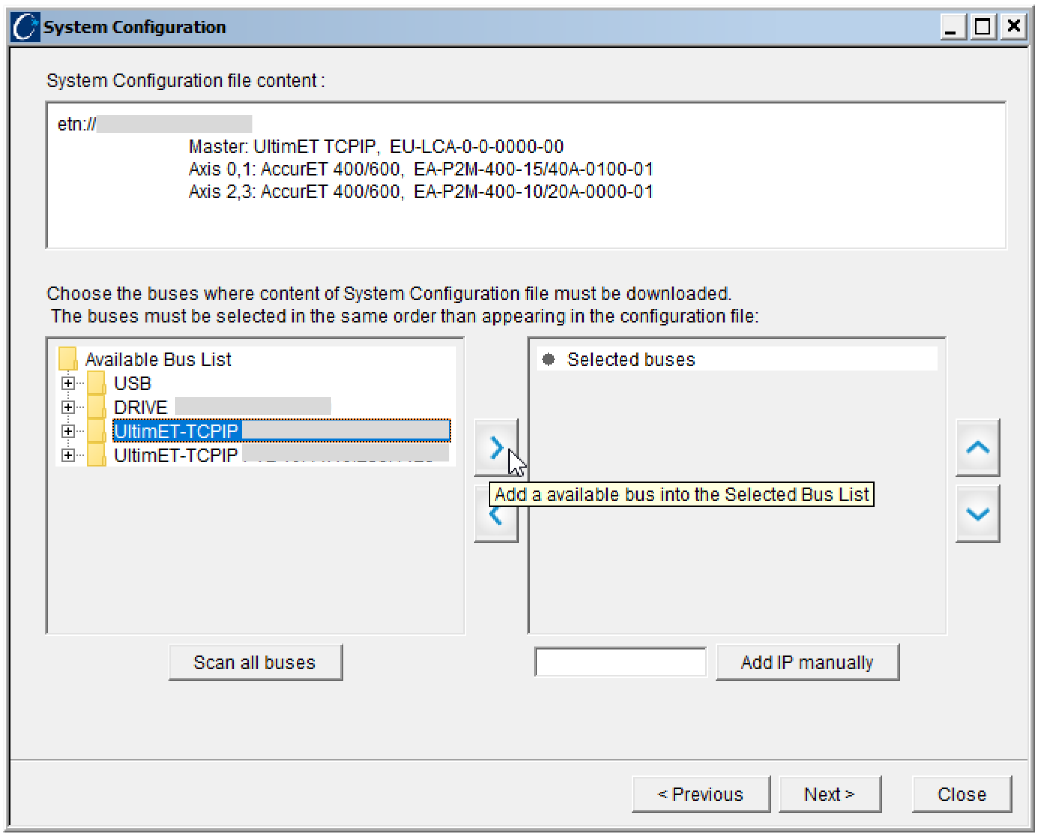
Selected buses

This panel is divided in three areas:

- In the top part appears a list of the contents of the system configuration backup file;
- On the left part appears a list of all available buses;
- On the right part appears the list of selected buses.

The user must select from the list of available buses the bus (or buses) on to which download the system configuration file.

To add a bus to the selected bus list, the user must first select the bus in the available bus list and then click on the arrow pointing to the right placed in between both lists (it is also possible to remove an item from the selected buses by selecting the bus to be removed in the selected bus list and then clicking on the arrow pointing to the left placed in between both lists).



System Configuration

System Configuration file content :

etn://[redacted]
Master: UltimET TCPIP, EU-LCA-0-0-0000-00
Axis 0,1: AccurET 400/600, EA-P2M-400-15/40A-0100-01
Axis 2,3: AccurET 400/600, EA-P2M-400-10/20A-0000-01

Choose the buses where content of System Configuration file must be downloaded.
The buses must be selected in the same order than appearing in the configuration file:

To change the order of the selected buses in the list, the user can use the arrows pointing up or down on the right of the panel.

Finally, the user can also enter an IP address manually:

›	Add a bus to the list of selected buses.
‹	Remove a bus from the list of selected buses.
˄	Move up a bus in the list of selected buses (the configuration backup starts from the bus on the top most of the list).
˅	Move down a bus in the list of selected buses.
☐ Add IP manually	Find a bus by introducing directly its IP address.

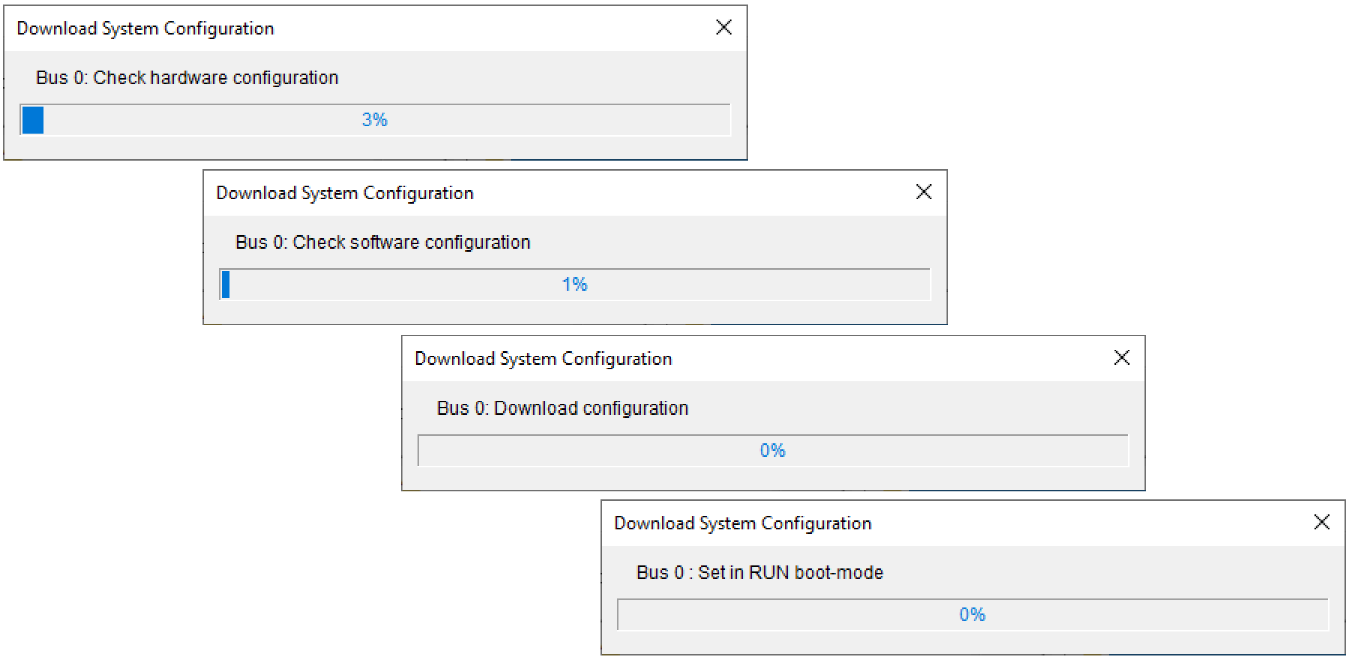
NOTE	The selected buses must be in the same order as listed in the system configuration file otherwise the *System Configuration Manager* tool will not be able to download the configuration.

Once the bus (or buses) has been selected matching the contents of the system configuration backup file, click on the **Next** button to start the downloading procedure.

The download procedure is executed with the following sequence of events:

- First, a verification is performed to the hardware compatibility between the system configuration backup file and the selected bus (or buses); if the selected bus (or buses) does not match to what is backed up in the system configuration file, an error is raised (refer to Section §10.6.3 for further information on how the hardware compatibility check is done);
- Second, the tool verifies if the software configuration (i.e. Firmware, Registers, Sequences…) running on the Controllers already matches with what is included in the system configuration file, in which case the download is needless (refer to Section §10.6.4 for further information on how the software configuration check is done);
- Finally, if the hardware matches and the software is not up to date, the real download is initiated.

A progress bar gives an indication of the status of the download.



Download System Configuration

Bus 0: Check hardware configuration

3%

Download System Configuration

Bus 0: Check software configuration

1%

Download System Configuration

Bus 0: Download configuration

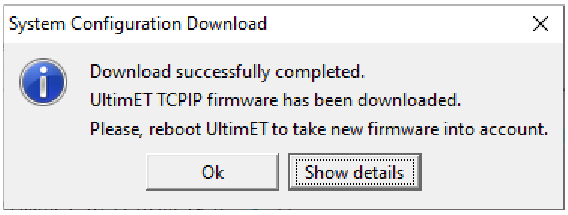
0%

Download System Configuration

Bus 0 : Set in RUN boot-mode

0%

And an information message is displayed once the download is successfully completed.



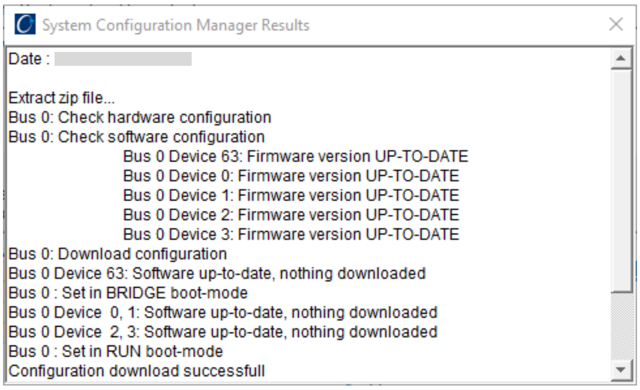
System Configuration Download

Download successfully completed.
UltimET TCPIP firmware has been downloaded.
Please, reboot UltimET to take new firmware into account.

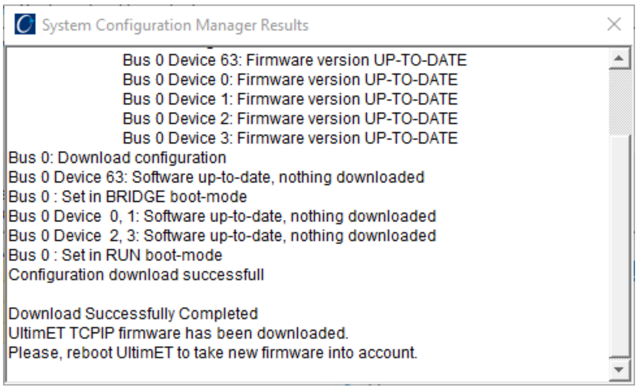
NOTE

A Controller must be rebooted after a firmware update. While in the case of ***AccurET*** position controllers, the rebooting is realized as part of the firmware downloading process, to properly reboot an ***UltimET Light PCI/PCIe*** motion controller it is mandatory to shut down the computer to ensure that the motherboard does not continue powering the Controller.

Click on the **Show details** button to view details of the system configuration download.



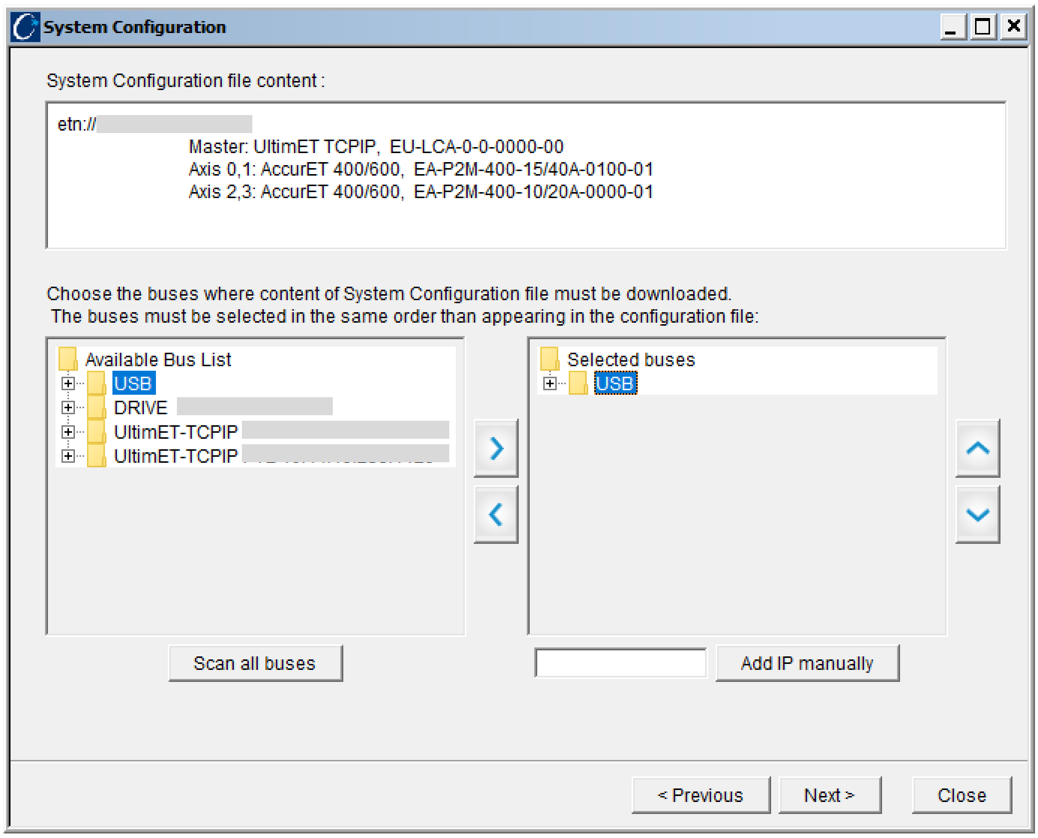
```
Date : [redacted]

Extract zip file...
Bus 0: Check hardware configuration
Bus 0: Check software configuration
            Bus 0 Device 63: Firmware version UP-TO-DATE
            Bus 0 Device 0: Firmware version UP-TO-DATE
            Bus 0 Device 1: Firmware version UP-TO-DATE
            Bus 0 Device 2: Firmware version UP-TO-DATE
            Bus 0 Device 3: Firmware version UP-TO-DATE
Bus 0: Download configuration
Bus 0 Device 63: Software up-to-date, nothing downloaded
Bus 0 : Set in BRIDGE boot-mode
Bus 0 Device  0, 1: Software up-to-date, nothing downloaded
Bus 0 Device  2, 3: Software up-to-date, nothing downloaded
Bus 0 : Set in RUN boot-mode
Configuration download successfull
```



```
            Bus 0 Device 63: Firmware version UP-TO-DATE
            Bus 0 Device 0: Firmware version UP-TO-DATE
            Bus 0 Device 1: Firmware version UP-TO-DATE
            Bus 0 Device 2: Firmware version UP-TO-DATE
            Bus 0 Device 3: Firmware version UP-TO-DATE
Bus 0: Download configuration
Bus 0 Device 63: Software up-to-date, nothing downloaded
Bus 0 : Set in BRIDGE boot-mode
Bus 0 Device  0, 1: Software up-to-date, nothing downloaded
Bus 0 Device  2, 3: Software up-to-date, nothing downloaded
Bus 0 : Set in RUN boot-mode
Configuration download successfull

Download Successfully Completed
UltimET TCPIP firmware has been downloaded.
Please, reboot UltimET to take new firmware into account.
```

In this particular example it is possible to see that the software configuration verification has detected that the firmware version was up to date, so the corresponding download was skipped.

Now, assuming the case where the user selects a bus (or buses) not matching the contents of the system configuration backup file.



System Configuration file content :

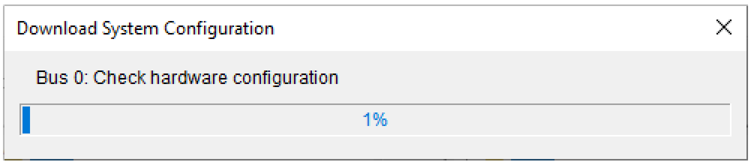
```
etn://[redacted]
            Master: UltimET TCPIP,  EU-LCA-0-0-0000-00
            Axis 0,1: AccurET 400/600,  EA-P2M-400-15/40A-0100-01
            Axis 2,3: AccurET 400/600,  EA-P2M-400-10/20A-0000-01
```

Choose the buses where content of System Configuration file must be downloaded.
The buses must be selected in the same order than appearing in the configuration file:

Available Bus List
- USB
- DRIVE [redacted]
- UltimET-TCPIP [redacted]
- UltimET-TCPIP [redacted]

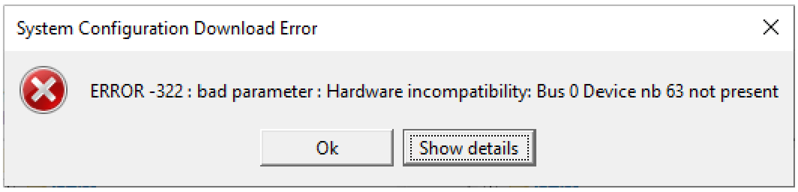
Selected buses
- USB

During the hardware compatibility check, it will be detected that the select bus (or buses) does not match the hardware description included in the system configuration backup file and an error is raised.



Download System Configuration

Bus 0: Check hardware configuration



System Configuration Download Error

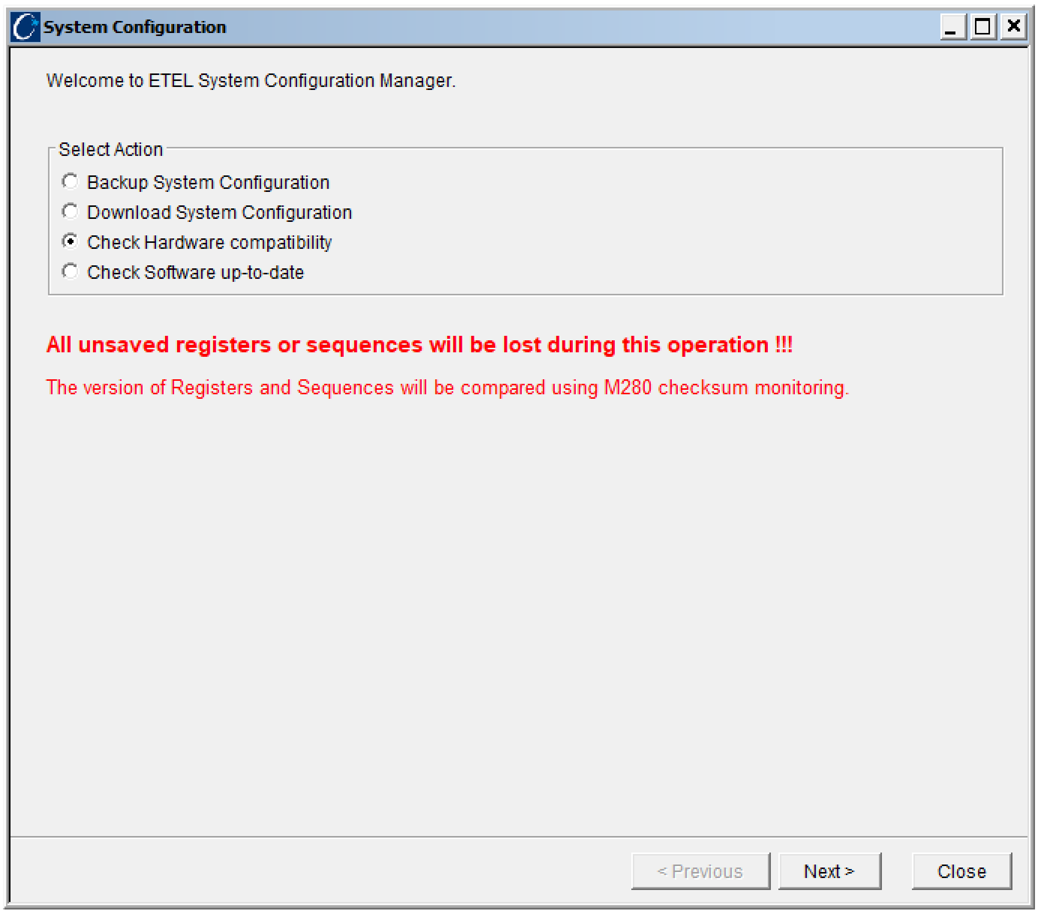
ERROR -322 : bad parameter : Hardware incompatibility: Bus 0 Device nb 63 not present

In this particular example, no Master device (corresponding to axis 63) is present in the selected bus connection. Click of the **Show details** button for additional information about the issue.

10.6.3. Check hardware

The hardware compatibility check will compare, for each Controller present on the selected bus (or buses), the Controller's part number (stored in monitoring `M85`) and axis number (stored in monitoring `M87`).

To perform this verification, the user must select the **Check Hardware compatibility** checkbox in the first panel of the *System Configuration Manager* wizard.



System Configuration

Welcome to ETEL System Configuration Manager.

Select Action

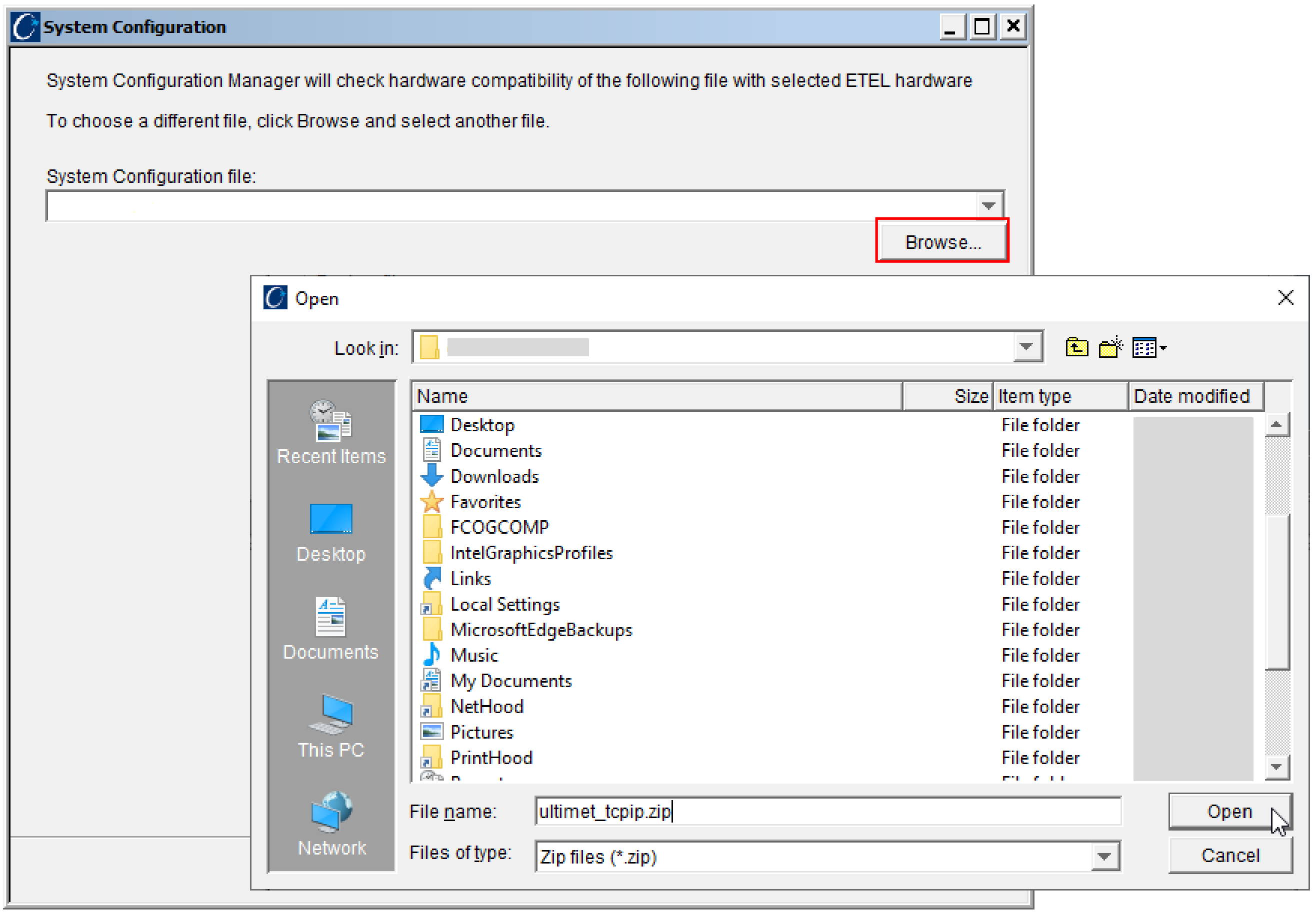
○ Backup System Configuration
○ Download System Configuration
● Check Hardware compatibility
○ Check Software up-to-date

All unsaved registers or sequences will be lost during this operation !!!

The version of Registers and Sequences will be compared using M280 checksum monitoring.

To proceed to the next panel, click on the **Next** button.

On the second panel, the user must select the system configuration backup file by clicking on the **Browse** button.



System Configuration Manager will check hardware compatibility of the following file with selected ETEL hardware

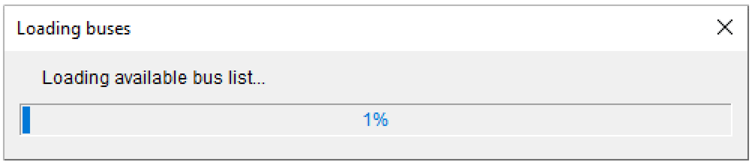
To choose a different file, click Browse and select another file.

System Configuration file:

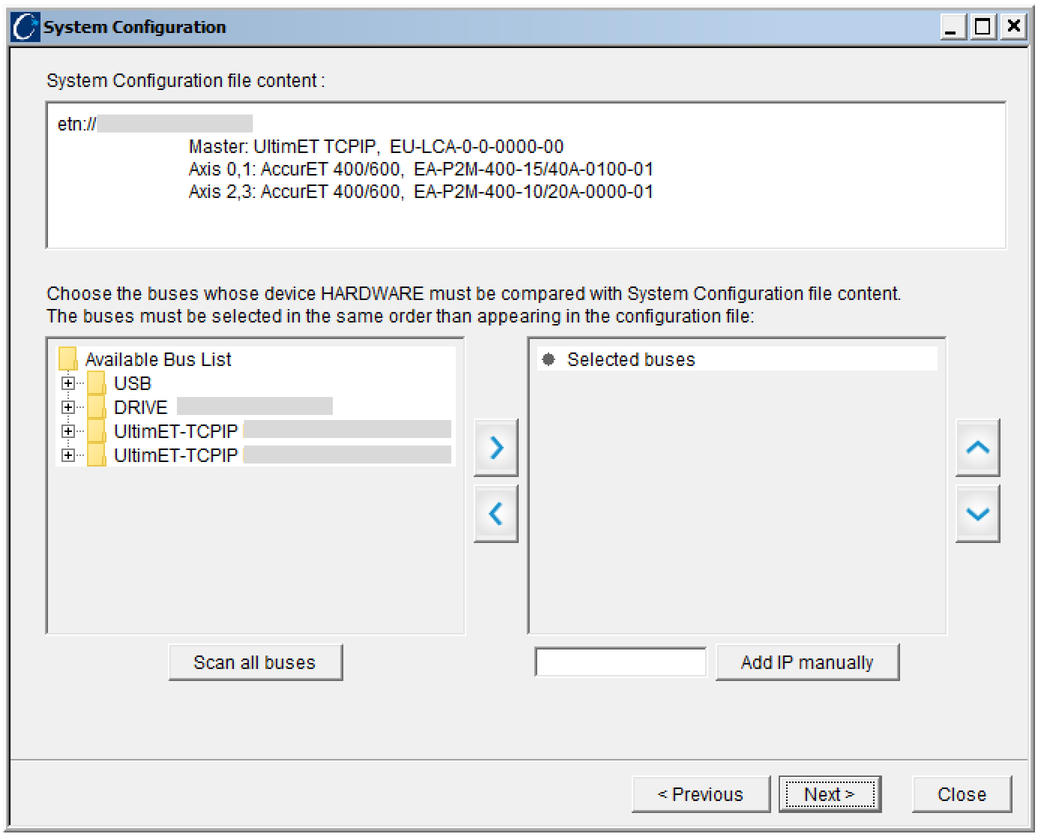
File name: ultimet_tcpip.zip

Files of type: Zip files (*.zip)

To proceed to the next panel, click on the **Next** button. The tool starts searching for the available connection buses and displays the ones found on the next panel. To scan for all available buses just click on the **Scan all buses** button.



Loading available bus list...



System Configuration file content :

etn://[redacted]
Master: UltimET TCPIP, EU-LCA-0-0-0000-00
Axis 0,1: AccurET 400/600, EA-P2M-400-15/40A-0100-01
Axis 2,3: AccurET 400/600, EA-P2M-400-10/20A-0000-01

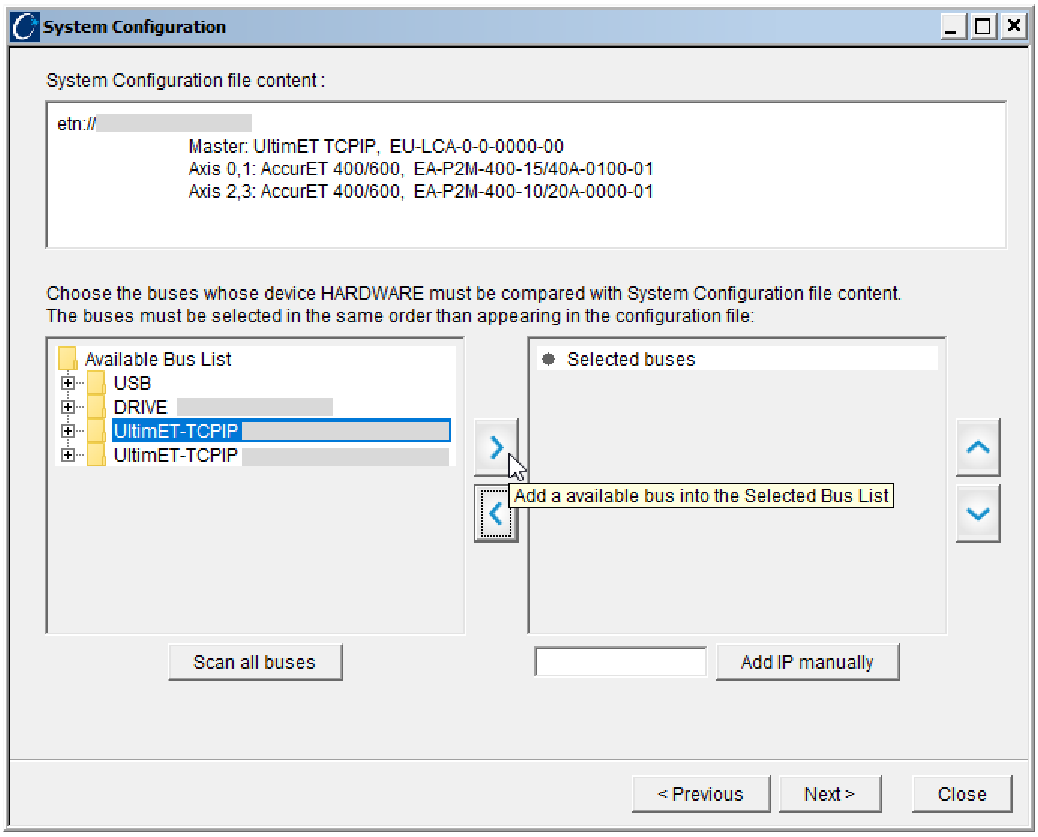
Choose the buses whose device HARDWARE must be compared with System Configuration file content.
The buses must be selected in the same order than appearing in the configuration file:

This panel is divided in three areas:

- In the top part appears a list of the contents of the system configuration backup file;
- On the left part appears a list of all available buses;
- On the right part appears the list of selected buses.

The user must select from the list of available buses the bus (or buses) to which perform a hardware compatibility check.

To add a bus to the selected bus list, the user must first select the bus in the available bus list and then click on the arrow pointing to the right placed in between both lists (it is also possible to remove an item from the selected buses by selecting the bus to be removed in the selected bus list and then clicking on the arrow pointing to the left placed in between both lists).



etn:// [redacted]
Master: UltimET TCPIP, EU-LCA-0-0-0000-00
Axis 0,1: AccurET 400/600, EA-P2M-400-15/40A-0100-01
Axis 2,3: AccurET 400/600, EA-P2M-400-10/20A-0000-01

Choose the buses whose device HARDWARE must be compared with System Configuration file content.
The buses must be selected in the same order than appearing in the configuration file:

To change the order of the selected buses in the list, the user can use the arrows pointing up or down on the right of the panel.

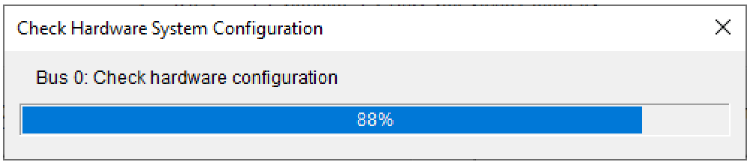
Finally, the user can also enter an IP address manually:

›	Add a bus to the list of selected buses.
‹	Remove a bus from the list of selected buses.
˄	Move up a bus in the list of selected buses (the configuration backup starts from the bus on the top most of the list).
˅	Move down a bus in the list of selected buses.
☐ Add IP manually	Find a bus by introducing directly its IP address.

NOTE	The selected buses must be in the same order as listed in the system configuration file otherwise the hardware compatibility check will fail.

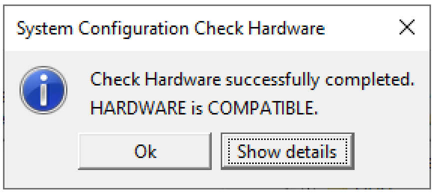
Once the bus (or buses) has been selected, click on the **Next** button to start the hardware compatibility check.

A progress bar gives an indication of the status of the check.



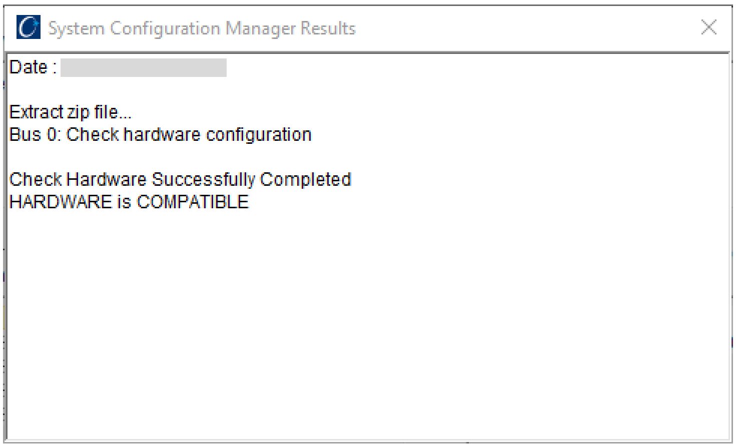
Bus 0: Check hardware configuration

And an information message is displayed once the hardware compatibility is verified.



Check Hardware successfully completed.
HARDWARE is COMPATIBLE.

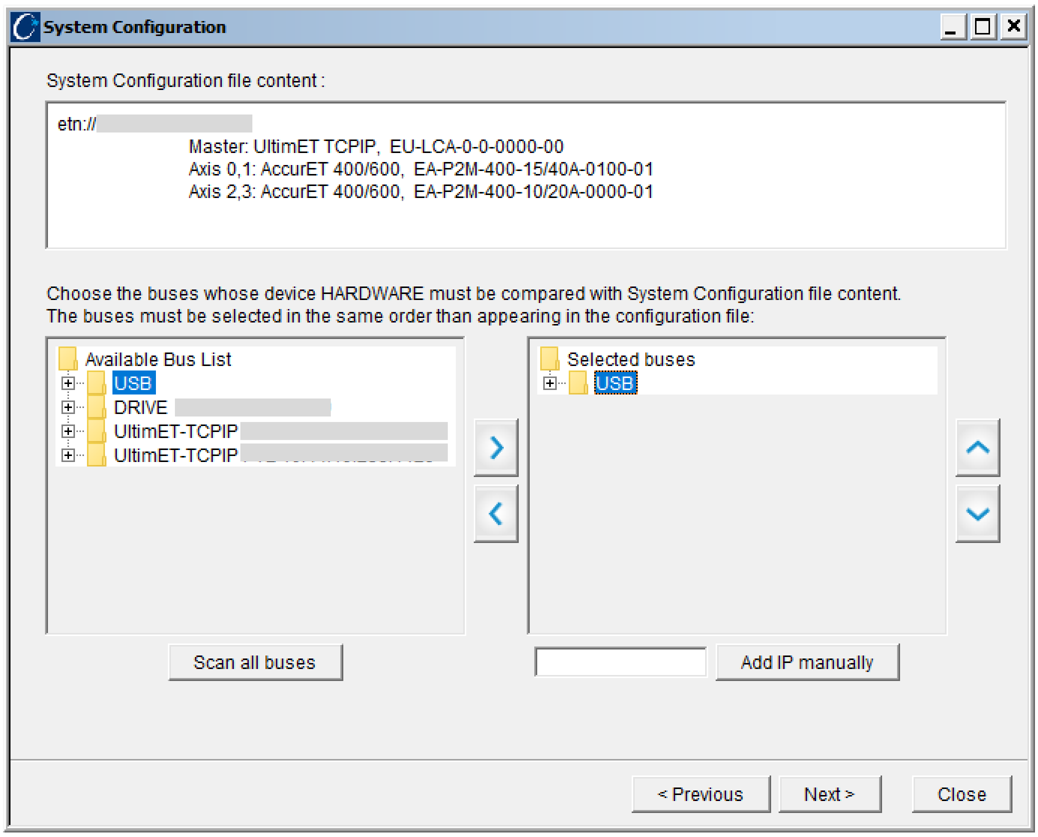
Click on the **Show details** button to view details of the hardware compatibility check.



```
Date :

Extract zip file...
Bus 0: Check hardware configuration

Check Hardware Successfully Completed
HARDWARE is COMPATIBLE
```

In this particular example the hardware is compatible.

Now, assuming the case where the user selects another bus (or buses) which is not compatible.

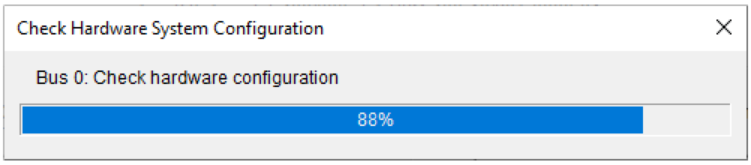


System Configuration file content :

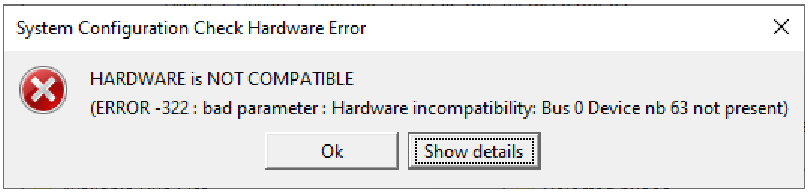
```
etn://[redacted]
                    Master: UltimET TCPIP,  EU-LCA-0-0-0000-00
                    Axis 0,1: AccurET 400/600,  EA-P2M-400-15/40A-0100-01
                    Axis 2,3: AccurET 400/600,  EA-P2M-400-10/20A-0000-01
```

Choose the buses whose device HARDWARE must be compared with System Configuration file content.
The buses must be selected in the same order than appearing in the configuration file:

During the hardware compatibility check, it will be detected that the select bus (or buses) does not match the hardware description included in the system configuration backup file and an error is raised.

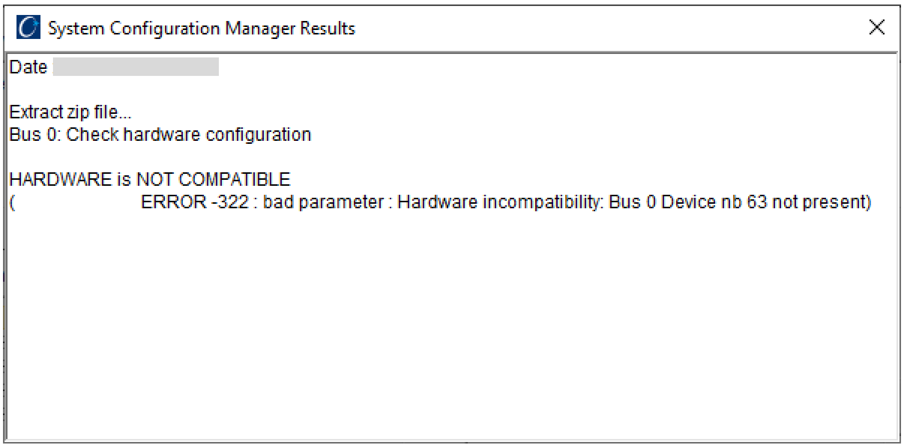


Bus 0: Check hardware configuration



HARDWARE is NOT COMPATIBLE
(ERROR -322 : bad parameter : Hardware incompatibility: Bus 0 Device nb 63 not present)

In this particular example, no Master device (corresponding to axis 63) is present in selected bus connection. Click of the **Show details** button for additional information about the issue.



```
Date

Extract zip file...
Bus 0: Check hardware configuration

HARDWARE is NOT COMPATIBLE
(                    ERROR -322 : bad parameter : Hardware incompatibility: Bus 0 Device nb 63 not present)
```

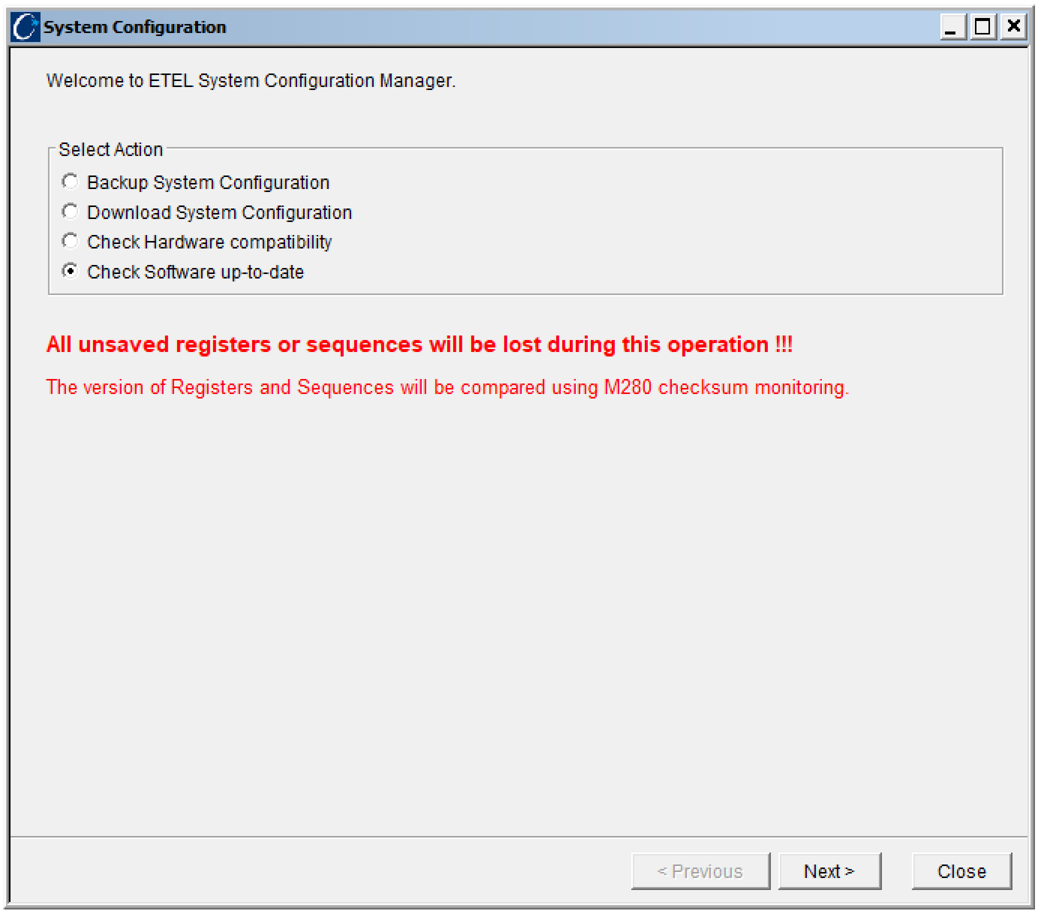
10.6.4. Check software

The software check consists of comparing the version of Registers and Sequences using the flash memory blocks checksums. These checksums are computed from the data present in the flash memory blocks and the value of monitoring `M282` which can be set by the version header of the downloaded Registers or Sequence file (refer to Sections §10.1 and §10.2 for further information on how to add version headers to Registers and Sequence files, respectively). If the flash memory blocks checksums match the checksums on the system configuration image backup, it means that the Controller's software is up to date and, therefore, a software download is not required.

NOTE	It is the user's responsibility to create the version headers for the Registers and Sequence files and update these according to his own traceability rules.

The software check is automatically preceded by a hardware compatibility check (refer to the previous Section §10.6.3 for information about the hardware compatibility check).

To perform this software verification, the user must select the **Check Software up-to-date** checkbox in the first panel of the *System Configuration Manager* wizard.



System Configuration

Welcome to ETEL System Configuration Manager.

Select Action

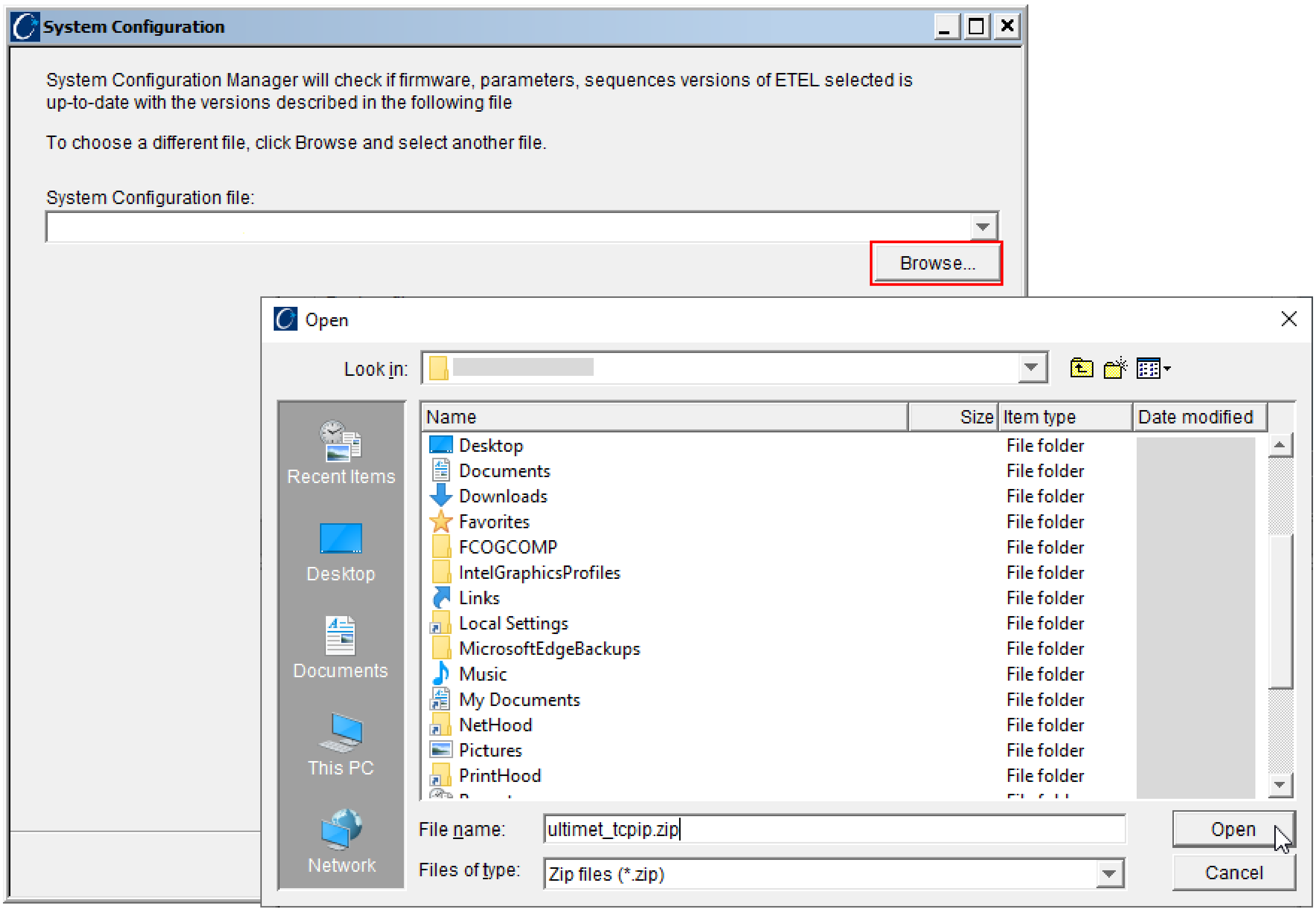
○ Backup System Configuration
○ Download System Configuration
○ Check Hardware compatibility
● Check Software up-to-date

All unsaved registers or sequences will be lost during this operation !!!

The version of Registers and Sequences will be compared using M280 checksum monitoring.

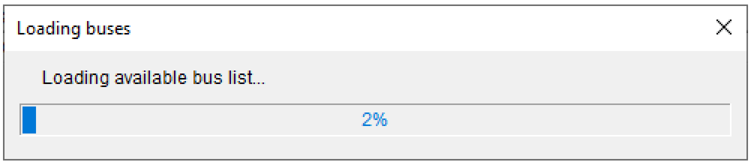
To proceed to the next panel, click on the **Next** button.

On the second panel, the user must select the system configuration backup file by clicking on the **Browse** button.

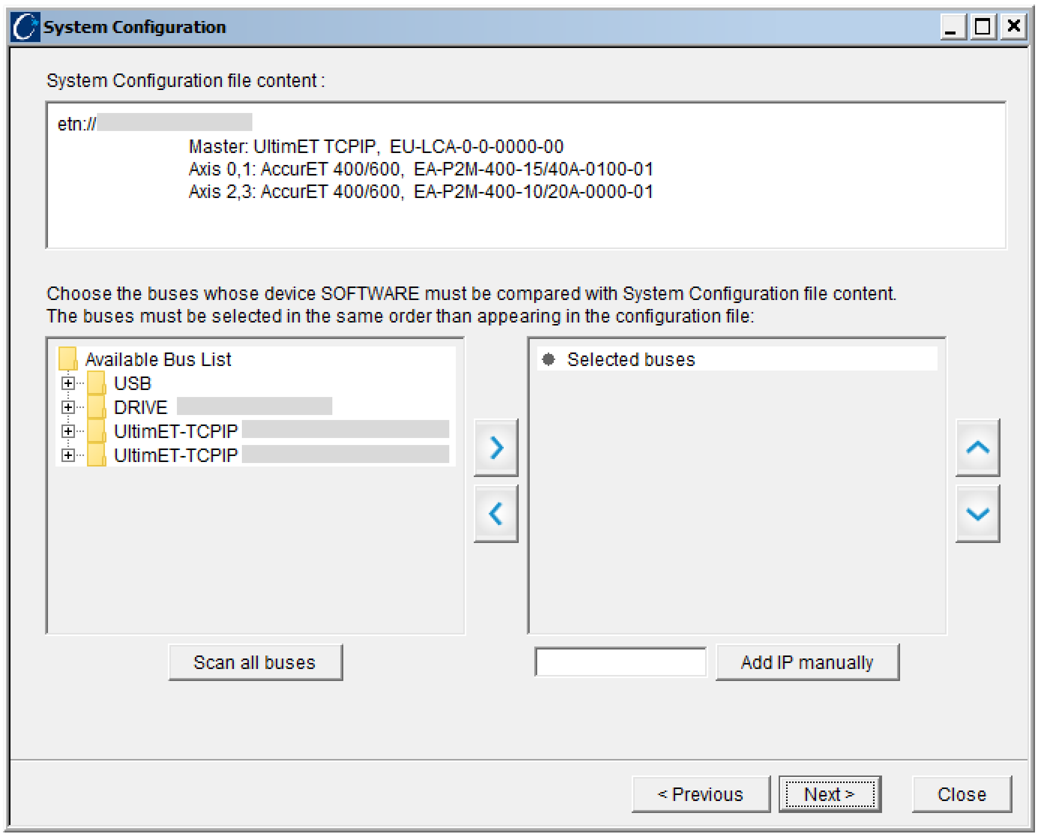


To proceed to the next panel, click on the **Next** button.

The tool starts searching for the available connection buses and displays the ones found on the next panel. To scan for all available buses just click on the **Scan all buses** button.



Loading available bus list...



System Configuration file content :

```
etn://[redacted]
        Master: UltimET TCPIP,  EU-LCA-0-0-0000-00
        Axis 0,1: AccurET 400/600,  EA-P2M-400-15/40A-0100-01
        Axis 2,3: AccurET 400/600,  EA-P2M-400-10/20A-0000-01
```

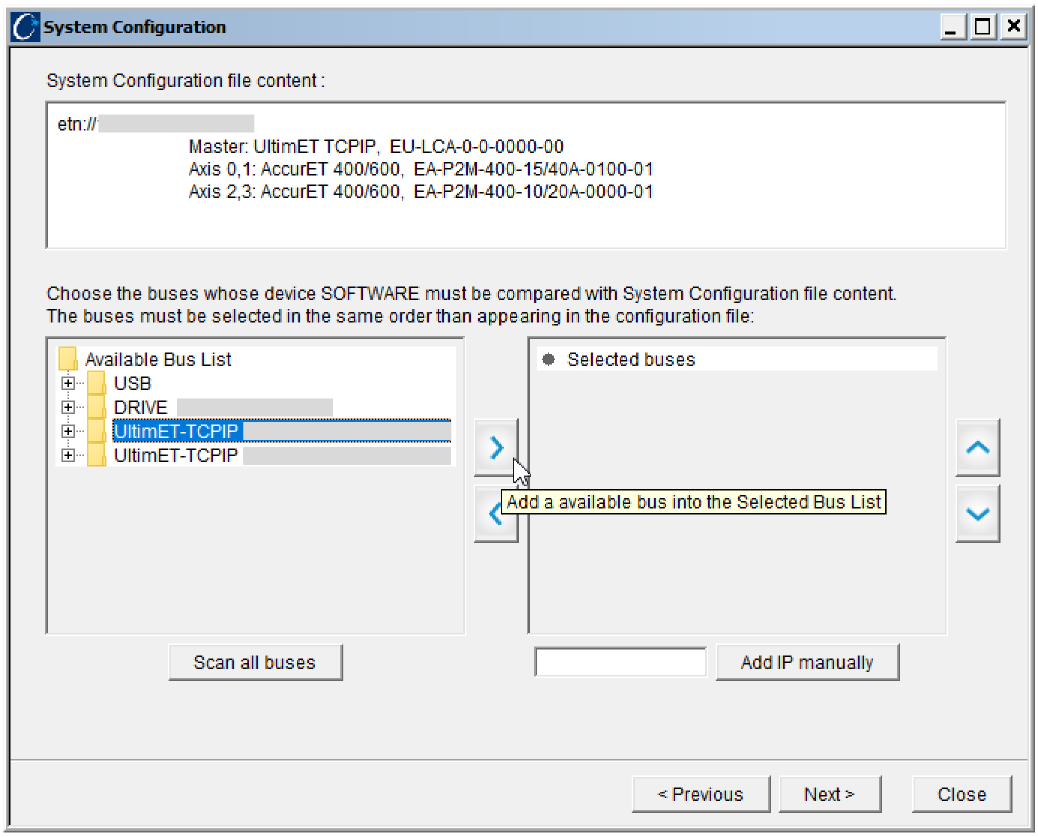
Choose the buses whose device SOFTWARE must be compared with System Configuration file content.
The buses must be selected in the same order than appearing in the configuration file:

This panel is divided in three areas:

- In the top part appears a list of the contents of the system configuration backup file;
- On the left part appears a list of all available buses;
- On the right part appears the list of selected buses.

The user must select from the list of available buses the bus (or buses) to which perform a software check.

To add a bus to the selected bus list, the user must first select the bus in the available bus list and then click on the arrow pointing to the right placed in between both lists (it is also possible to remove an item from the selected buses by selecting the bus to be removed in the selected bus list and then clicking on the arrow pointing to the left placed in between both lists).



System Configuration

System Configuration file content :

etn://[redacted]
Master: UltimET TCPIP, EU-LCA-0-0-0000-00
Axis 0,1: AccurET 400/600, EA-P2M-400-15/40A-0100-01
Axis 2,3: AccurET 400/600, EA-P2M-400-10/20A-0000-01

Choose the buses whose device SOFTWARE must be compared with System Configuration file content.
The buses must be selected in the same order than appearing in the configuration file:

To change the order of the selected buses in the list, the user can use the arrows pointing up or down on the right of the panel.

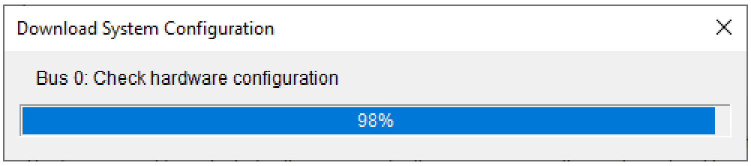
Finally, the user can also enter an IP address manually:

>	Add a bus to the list of selected buses.
<	Remove a bus from the list of selected buses.
^	Move up a bus in the list of selected buses (the configuration backup starts from the bus on the top most of the list).
v	Move down a bus in the list of selected buses.
☐ Add IP manually	Find a bus by introducing directly its IP address.

NOTE	The selected buses must be in the same order as listed in the system configuration file otherwise the software check will fail.

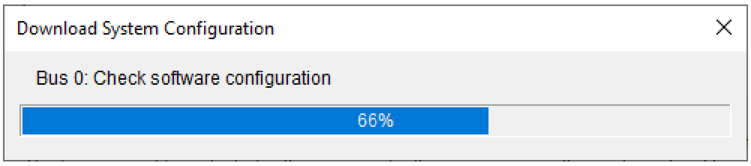
Once the bus (or buses) has been selected, click on the **Next** button to start the software check.

A progress bar gives an indication of the status of the software check.


Download System Configuration

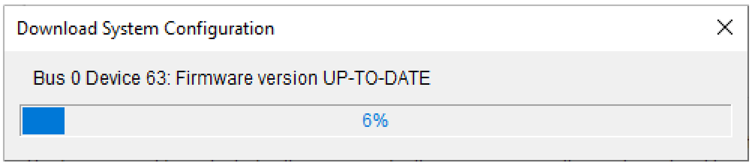
Bus 0: Check hardware configuration

98%


Download System Configuration

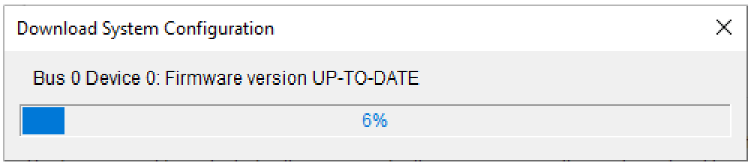
Bus 0: Check software configuration

66%


Download System Configuration

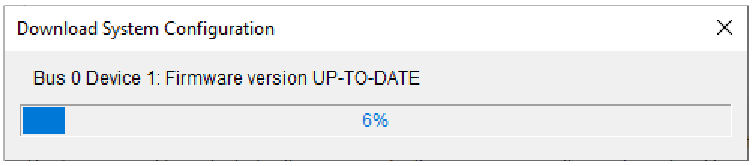
Bus 0 Device 63: Firmware version UP-TO-DATE

6%


Download System Configuration

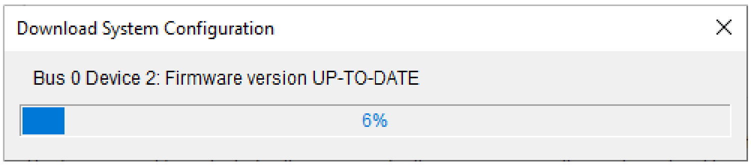
Bus 0 Device 0: Firmware version UP-TO-DATE

6%


Download System Configuration

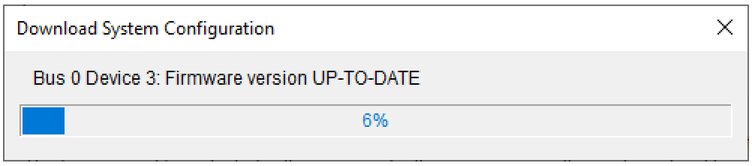
Bus 0 Device 1: Firmware version UP-TO-DATE

6%


Download System Configuration

Bus 0 Device 2: Firmware version UP-TO-DATE

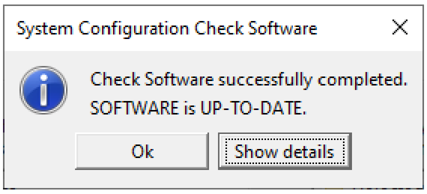
6%


Download System Configuration

Bus 0 Device 3: Firmware version UP-TO-DATE

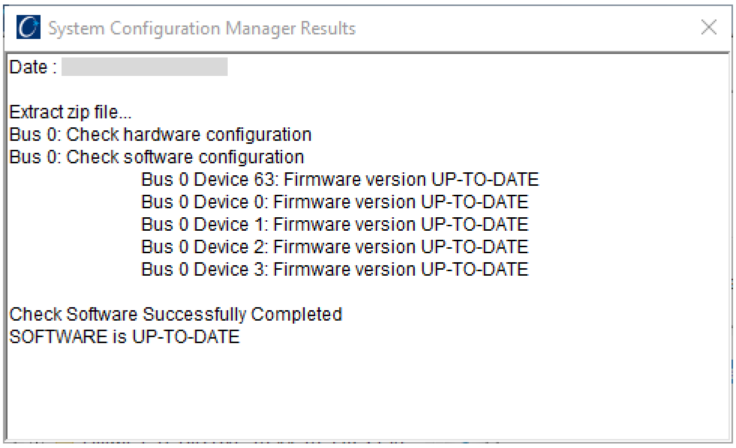
6%

And an information message is displayed once the software check is completed.


System Configuration Check Software

Check Software successfully completed.
SOFTWARE is UP-TO-DATE.

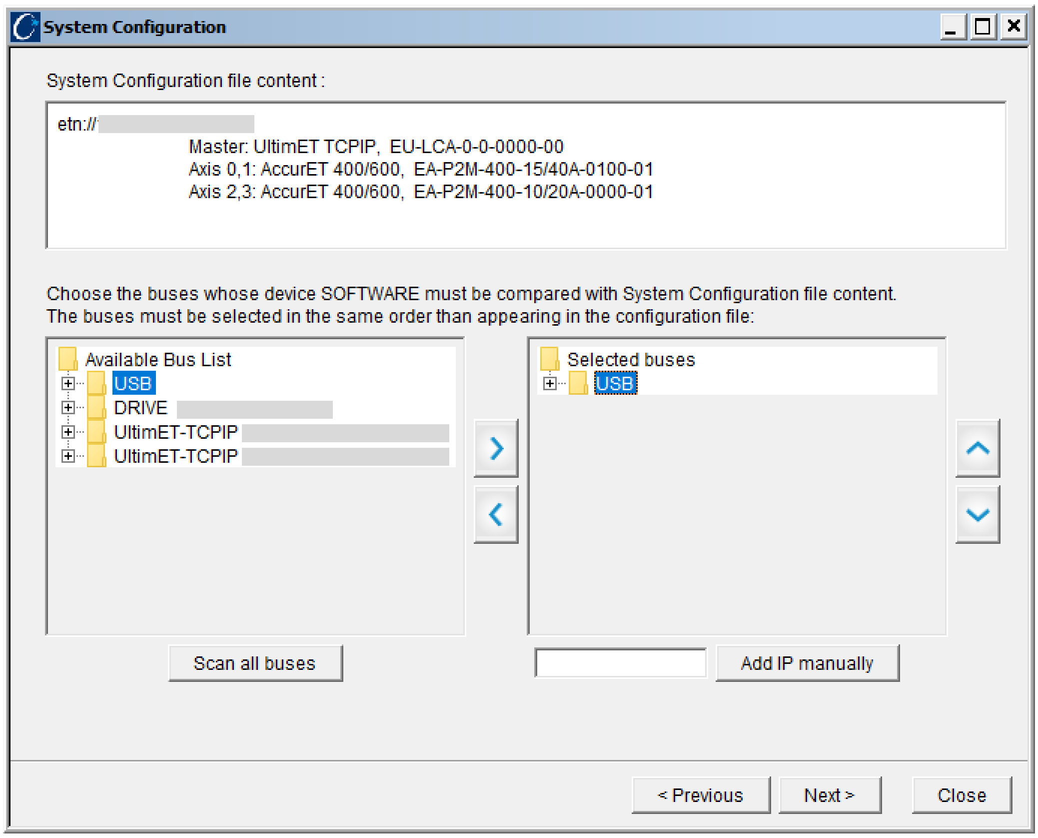
Click on the **Show details** button to view details of the software check.



```
Date :

Extract zip file...
Bus 0: Check hardware configuration
Bus 0: Check software configuration
                Bus 0 Device 63: Firmware version UP-TO-DATE
                Bus 0 Device 0: Firmware version UP-TO-DATE
                Bus 0 Device 1: Firmware version UP-TO-DATE
                Bus 0 Device 2: Firmware version UP-TO-DATE
                Bus 0 Device 3: Firmware version UP-TO-DATE

Check Software Successfully Completed
SOFTWARE is UP-TO-DATE
```

In this particular example the software is up to date.

Now, assuming the case where the user selects another bus (or buses) which is not compatible.

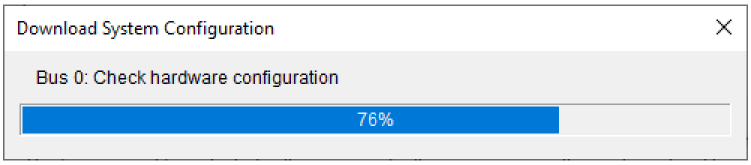


System Configuration file content :

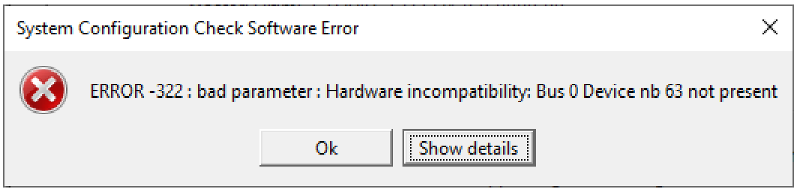
```
etn://
                Master: UltimET TCPIP,  EU-LCA-0-0-0000-00
                Axis 0,1: AccurET 400/600,  EA-P2M-400-15/40A-0100-01
                Axis 2,3: AccurET 400/600,  EA-P2M-400-10/20A-0000-01
```

Choose the buses whose device SOFTWARE must be compared with System Configuration file content.
The buses must be selected in the same order than appearing in the configuration file:

During the hardware compatibility check, it will be detected that the select bus (or buses) do not match the hardware description included in the system configuration backup file and an error is raised.

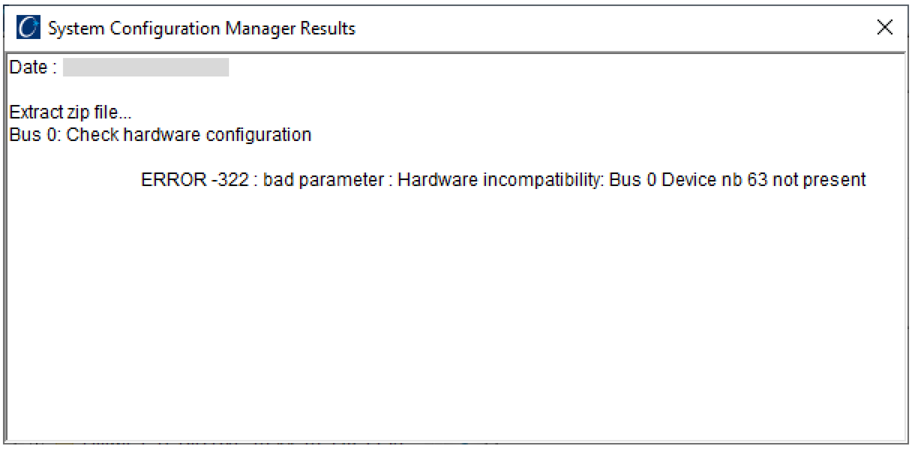

Download System Configuration

Bus 0: Check hardware configuration


System Configuration Check Software Error

ERROR -322 : bad parameter : Hardware incompatibility: Bus 0 Device nb 63 not present

In this particular example, no Master device (corresponding to axis 63) is present in selected bus connection. Click of the **Show details** button for additional information about the issue.


System Configuration Manager Results

Date :

Extract zip file...
Bus 0: Check hardware configuration

ERROR -322 : bad parameter : Hardware incompatibility: Bus 0 Device nb 63 not present

11. Utilities

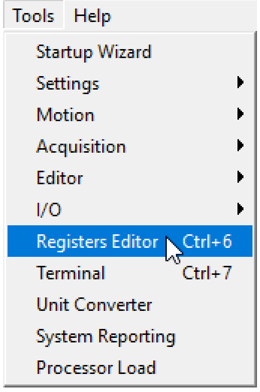
ComET4 disposes of a few useful utilities that are presented in this Chapter.

11.1. Registers Editor

The *Registers Editor* tool allows the user to view and edit the Registers of a Controller. To launch this tool, follow one of two possible options:

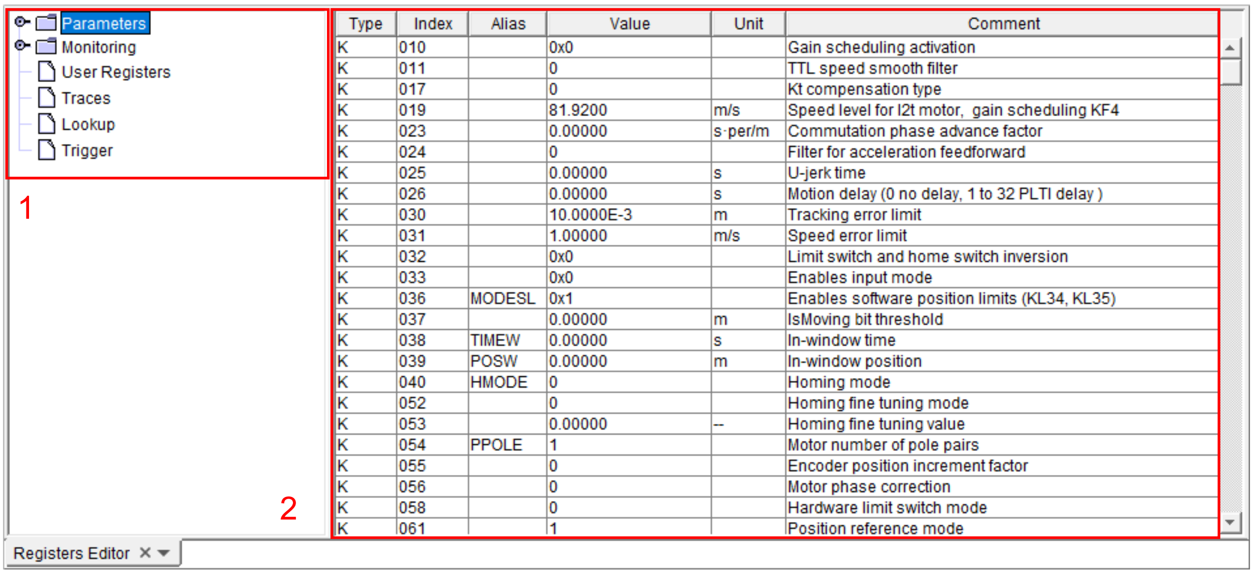
1. On the **Toolbar Tools** group, click on the button , or

2. Select the Menu option **Tools → Registers Editor**.



The *Registers Editor* tool main window is divided in 2 areas:

1. **TreeView** control;
2. **Registers** listing;



Type	Index	Alias	Value	Unit	Comment
K	010		0x0		Gain scheduling activation
K	011		0		TTL speed smooth filter
K	017		0		Kt compensation type
K	019		81.9200	m/s	Speed level for I2t motor, gain scheduling KF4
K	023		0.00000	s·per/m	Commutation phase advance factor
K	024		0		Filter for acceleration feedforward
K	025		0.00000	s	U-jerk time
K	026		0.00000	s	Motion delay (0 no delay, 1 to 32 PLTI delay)
K	030		10.0000E-3	m	Tracking error limit
K	031		1.00000	m/s	Speed error limit
K	032		0x0		Limit switch and home switch inversion
K	033		0x0		Enables input mode
K	036	MODESL	0x1		Enables software position limits (KL34, KL35)
K	037		0.00000	m	IsMoving bit threshold
K	038	TIMEW	0.00000	s	In-window time
K	039	POSW	0.00000	m	In-window position
K	040	HMODE	0		Homing mode
K	052		0		Homing fine tuning mode
K	053		0.00000	--	Homing fine tuning value
K	054	PPOLE	1		Motor number of pole pairs
K	055		0		Encoder position increment factor
K	056		0		Motor phase correction
K	058		0		Hardware limit switch mode
K	061		1		Position reference mode

In the **TreeView** control, the Registers are grouped according to the following classification:

Parameters	`K` register type and sub-types. `C` register type and sub-types (only available on the ***AccurET*** position controllers).
Monitoring	`M` register type and sub-types.
User Registers	`X` register type and sub-types.
Traces	`T` register type and sub-types.
Lookup	`L` register type and sub-types.
Trigger	`E` register type (`EL` sub-type, only available on the ***AccurET*** position controllers).

NOTE

These register types are not available in the *Registers Editor* tool: `P`, `Y`, `W` and `R`.
Refer to Section §10.1 for further information about Registers.

In addition, to further assist the user finding the right Register to view/edit, the **Parameters** and **Monitoring** Registers have been further classified according to categories that are representative of their function.

When the connection is established with an ***AccurET*** position controller, these are the categories used to classify the **Parameters** and **Monitoring**:

Category	Parameters	Monitoring
Cogging Configuration	✓	✓
Communication	✓	✓
Commutation	✓	
Configuration	✓	✓
Controller Status	✓	✓
Dual Encoder Feedback	✓	✓
Errors & Warnings	✓	✓
Feedback	✓	✓
Force Control	✓	✓
Gantry Function	✓	✓
I/O Registers	✓	✓
Identification	✓	✓
Indexation	✓	✓
Internal	✓	✓
Mappings Configuration	✓	✓
Motor	✓	✓
Motor Brake	✓	✓

Motor And Commutation		✓
Optional Board I/O Registers		✓
Phasing	✓	✓
Position Capture	✓	✓
Power Multiplicator Function	✓	✓
QUIET Parameters	✓	
Real Time Value	✓	✓
Regulation	✓	✓
SPI Communication	✓	✓
Protection	✓	✓
Save And Restore Functions		✓
Sequence & CSM Handling	✓	✓
Set Point Generator	✓	✓
Trace Acquisition	✓	✓
Trigger Registers	✓	✓
Wait Functions		✓

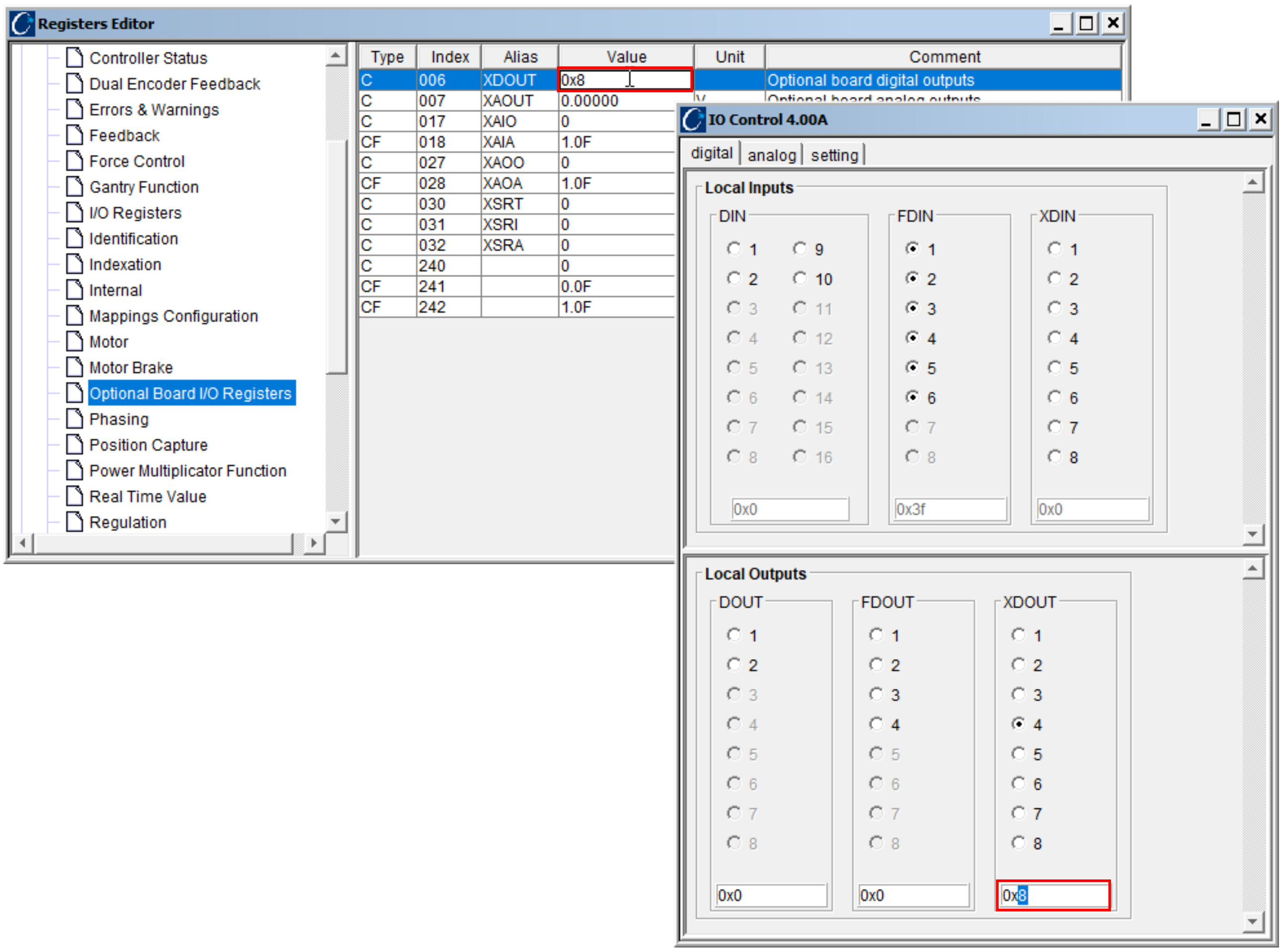
When the connection is established with an ***UltimET Light/ADVANCED*** motion controller, these are the categories used to classify the **Parameters** and **Monitoring**:

Category	**UltimET Light**		**ULTIMET ADVANCED**	
	Parameters	**Monitoring**	**Parameters**	**Monitoring**
Communication	✓	✓	✓	✓
Configuration	✓	✓	✓	✓
Controller Info Registers				✓
Controller Status		✓		✓
Errors & Warnings	✓	✓	✓	✓
External I/O Registers On WAGO	✓	✓		
I/O Registers	✓	✓	✓	✓
Internal	✓	✓		✓
Interpolation Functions	✓	✓	✓	✓
Motion System Specific	✓	✓	✓	
Real Time Value		✓		✓
SPI Communication			✓	✓
Protection	✓		✓	✓
Save And Restore Functions		✓		✓
Sequence & CSM Handling	✓	✓	✓	✓

Trace Acquisition	✓	✓	✓	✓
Wait Functions		✓		

The user can modify a Register by simply changing its value in the **Value** column in the Register listing area and hitting the `Enter` key.

The example below depicts how to modify the optional board digital outputs (register `XDOUT`) value to 0x8. The resulting effect can be visualized with the *I/O Control* tool.



Type	Index	Alias	Value	Unit	Comment
C	006	XDOUT	0x8		Optional board digital outputs
C	007	XAOUT	0.00000	V	Optional board analog outputs
C	017	XAIO	0		
CF	018	XAIA	1.0F		
C	027	XAOO	0		
CF	028	XAOA	1.0F		
C	030	XSRT	0		
C	031	XSRI	0		
C	032	XSRA	0		
C	240		0		
CF	241		0.0F		
CF	242		1.0F		

If a modification has been made, the user must save the configuration to the Controller otherwise it will be lost at the next reboot. For this, select the Menu **Controller → Save Configuration to Controller** or click on the **Save configuration to controller** toolbar button 💾. On the **Save on Controller** dialog box that pops-up, select which axis to save, select the radio button control that best fits to configuration to be saved and finally click on the **Save** button.

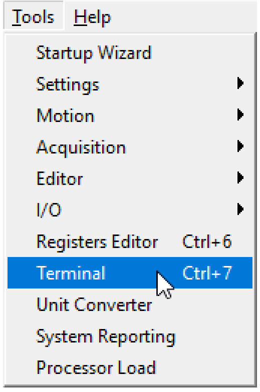
Alternatively, the corresponding command can also be typed in the *Terminal* tool. Refer to Section §10.3 for more information about saving a Controller's configuration.

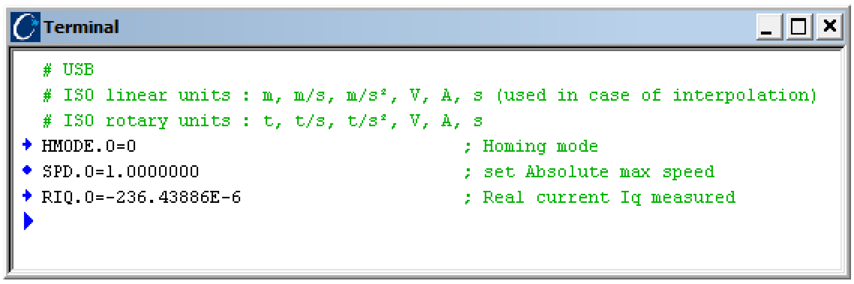
11.2. Terminal

The *Terminal* tool allows the user to send commands to a Controller and to inquire or modify the values of Registers. To launch this tool, follow one of two possible options:

1. On the **Toolbar Tools** group, click on the button , or

2. Select the Menu option **Tools → Terminal**.





```
  # USB
  # ISO linear units : m, m/s, m/s², V, A, s (used in case of interpolation)
  # ISO rotary units : t, t/s, t/s², V, A, s
► HMODE.0=0                             ; Homing mode
► SPD.0=1.0000000                       ; set Absolute max speed
► RIQ.0=-236.43886E-6                   ; Real current Iq measured
►
```

The *Terminal* tool is a command line alike utility. To send a command, the user must type it in the *Terminal* window respecting the following syntax:

`<cmd_name>.<axis>[=<P1>][,<P2>]`	
`<cmd_name>`	Command name
`<axis>`	Axis number
`<P1>`	Parameter #1
`<P2>`	Parameter #2

Press ’`Enter`’ to send the command to the Controller.

NOTE	The fields in between 'square brackets' are optional and certain commands might require more than 2 parameters. Refer to the *AccurET Modular Position Controller Operation & Software Manual* and *UltimET Light/ADVANCED Motion Controllers User's Manuals* for more information about the commands and their syntaxes.

The icon displayed on the left margin of the command line provide feedback to the user:

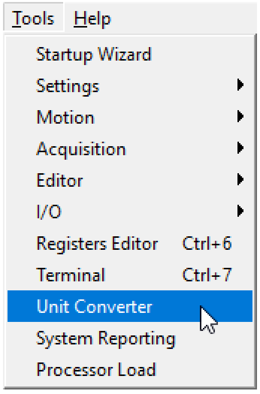
Icon	Example	Meaning
▶		Command line default prompt. User can type in a command.
◆	◆ PWR.0=1 , ◆ X0.0=1	Command to execute an action/modify a Register executed by the Controller.
◆	◆ PWR.0=1	Command to execute an action/modify a Register not executed by the Controller (e.g. certain commands, like the power on, cannot be executed when the Controller is in error).
➧	➧ X0.0=0	Command to read a Register executed by the Controller. The Register value is returned and displayed in the command line.
✕	✕ RSD.0=255	Reply from the Controller to a command not received (usually because the connection with the Controller is broken).
⧗	⧗ PWR.0=1	Reply from the Controller to a command still pending.

11.3. Unit Converter

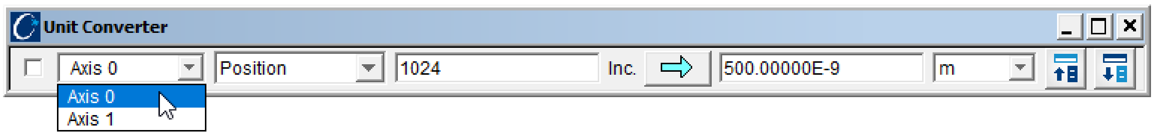
The *Unit Converter* tool is a simple utility for converting values of the kinematic quantities position, speed, acceleration and jerk from the Controller's internal units (designated increments) to ISO units and vice versa.

NOTE	Refer to the *AccurET Modular Position Controller Operation & Software Manual* for further information about units conversion.

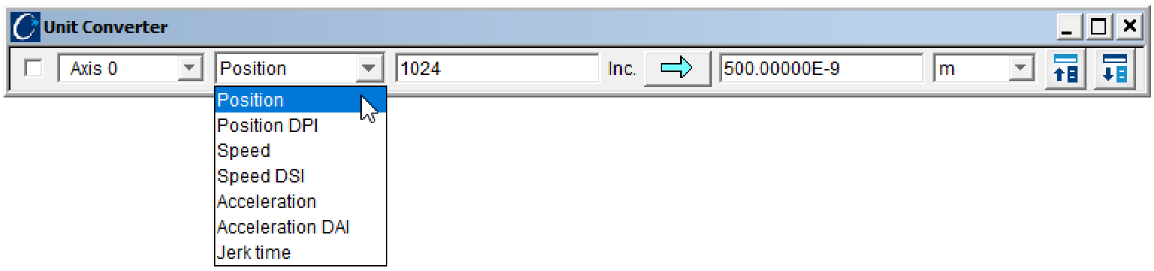
To launch this tool, go to the Menu option **Tools → Unit Converter**:



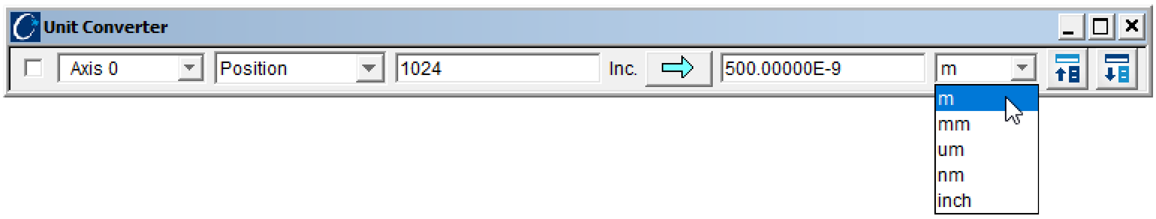
Start by selecting the axis from the left-most drop-down list.



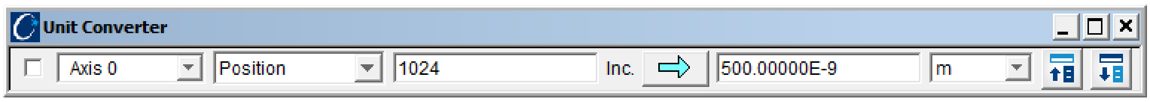
Then, choose the kinematic quantity from the second drop-down list



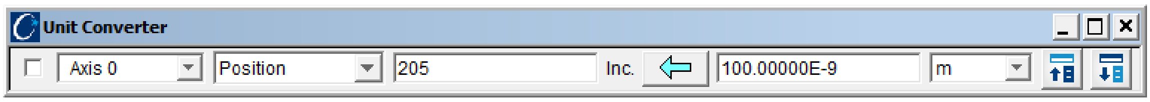
and select the ISO units from the right-most drop-down list.



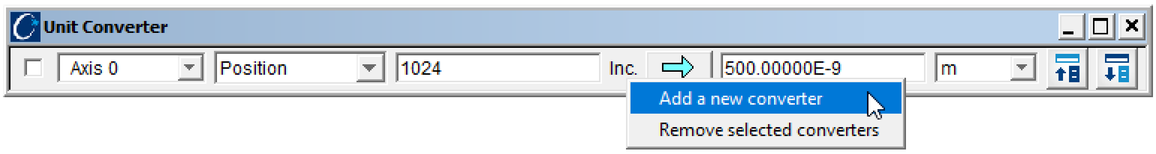
Finally, input the value in increments and get the equivalent conversion in ISO units



or vice-versa

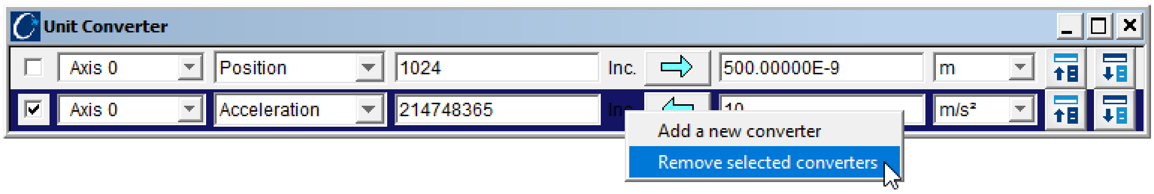


To add a new conversion, simply right-click on the tool's window and select the **Add a new converter** option from the context menu.



NOTE	The *Unit Converter* tool can display as many units as wanted. But, there is a practical limit since the tool window size is constrained to ***ComET4***'s desktop area and there is no vertical scrollbar.

For the inverse operation, first select which physical quantities(s) to remove by checking the correspondent checkbox control to the left of the axis drop-down list, then right-click and select the option **Remove selected converters** from the context menu.



☐ Axis 0 | Position | 1024 | Inc. | ⇨ | 500.00000E-9 | m

☑ Axis 0 | Acceleration | 214748365 | Inc. | ⇦ | 10 | m/s²

With the button controls, the user can:

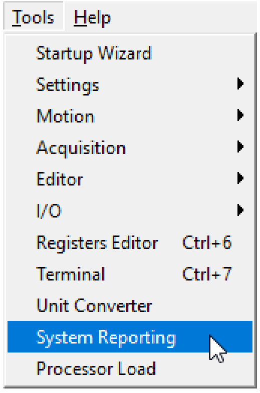
⇨	Specify the direction of the conversion from increments to ISO units.
⇦	Specify the direction of the conversion from ISO units to increments.
↑	Get from the Controller the value of the Registers: `M6` or `ML6` (theoretical position in user scale) and apply to the kinematic quantity position (if selected); `KL211` (absolute maximum speed) and apply to the kinematic quantity speed (if selected); `KL212` (absolute maximum acceleration) and apply the kinematic quantity acceleration (if selected).
↓	Set the Controller's Registers: `KL210` (target position) with the value of the kinematic quantity position (if selected); `KL211` (absolute maximum speed) with the value of the kinematic quantity speed (if selected); `KL212` (absolute maximum acceleration) with the value of the kinematic acceleration (if selected).

11.4. System Reporting

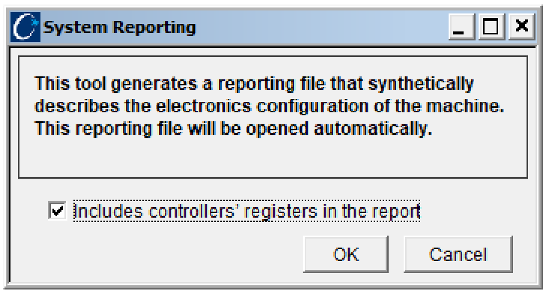
The *System Reporting* tool generates an HTML report file with a description of the electronics setup of a given motion system.

TIP	Consider generating a System Reporting file whenever contacting ETEL's Support team for support on troubleshooting an issue with an application.

To launch this tool, go to the Menu option **Tools → System Reporting**:



The user can choose to include in the report a listing of the Controllers' `M` (Monitoring) and `K` (Parameters) Registers by checking the option **Includes controller's registers in the report**.

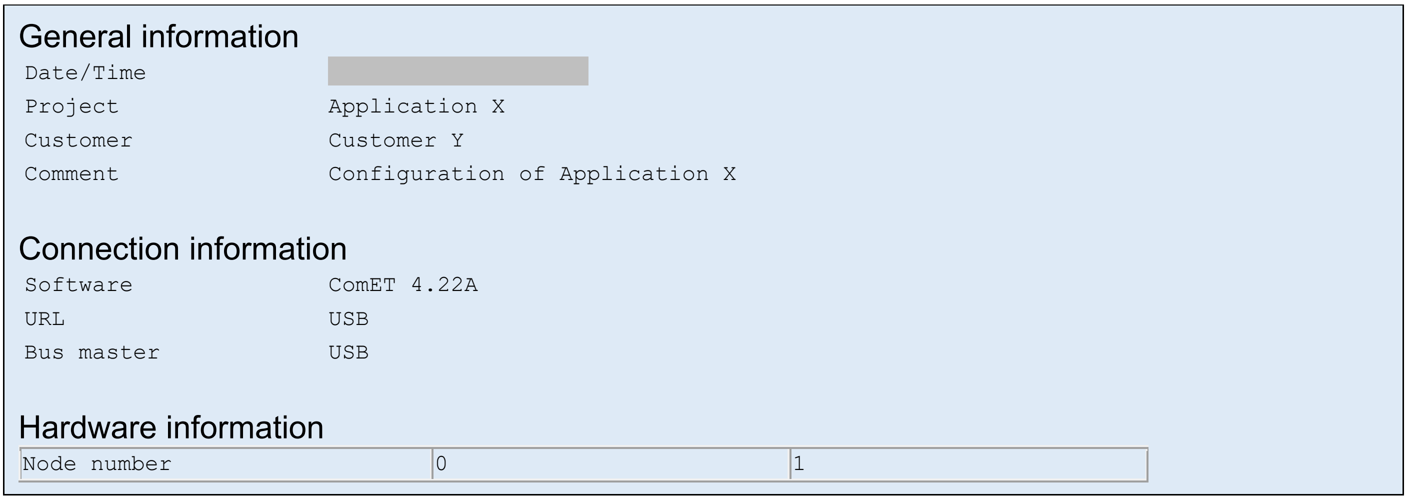


This tool generates a reporting file that synthetically describes the electronics configuration of the machine. This reporting file will be opened automatically.

☑ Includes controllers' registers in the report

An excerpt of a generated HTML report file is presented below. It is composed of the following 4 sections:

- General information: includes the date/time the report was generated and information about the project and customer;
- Connection information: includes information about the type of connection used;
- Hardware information: includes information about the electronics setup;
- Parameters information: includes the listing of the Controllers' `M` and `K` Registers. This section only appears if the user has selected the option to include these Registers in the report.



General information

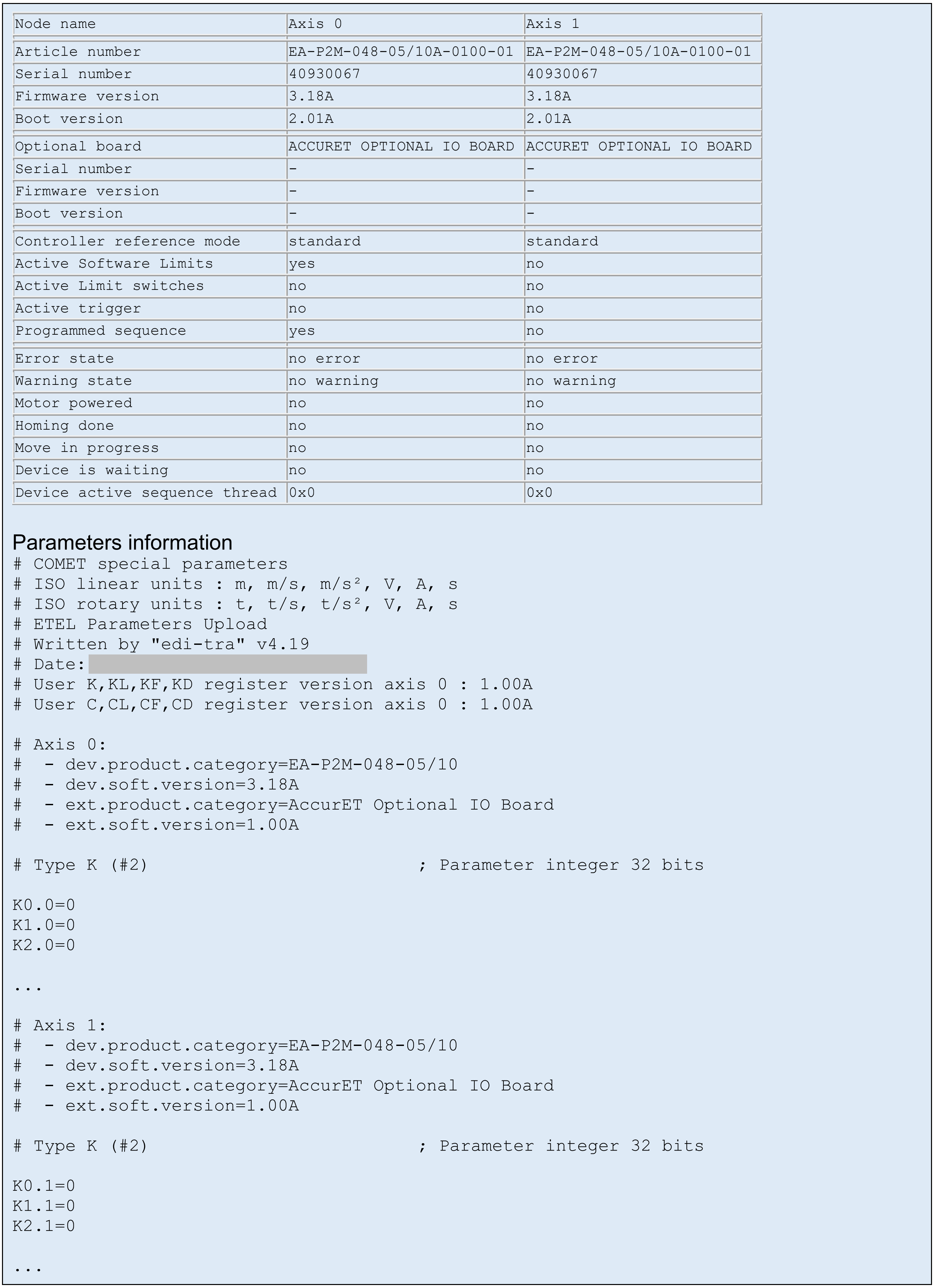
Date/Time	[redacted]
Project	Application X
Customer	Customer Y
Comment	Configuration of Application X

Connection information

Software	ComET 4.22A
URL	USB
Bus master	USB

Hardware information

Node number	0	1



Node name	Axis 0	Axis 1
Article number	EA-P2M-048-05/10A-0100-01	EA-P2M-048-05/10A-0100-01
Serial number	40930067	40930067
Firmware version	3.18A	3.18A
Boot version	2.01A	2.01A
Optional board	ACCURET OPTIONAL IO BOARD	ACCURET OPTIONAL IO BOARD
Serial number	-	-
Firmware version	-	-
Boot version	-	-
Controller reference mode	standard	standard
Active Software Limits	yes	no
Active Limit switches	no	no
Active trigger	no	no
Programmed sequence	yes	no
Error state	no error	no error
Warning state	no warning	no warning
Motor powered	no	no
Homing done	no	no
Move in progress	no	no
Device is waiting	no	no
Device active sequence thread	0x0	0x0

Parameters information

```
# COMET special parameters
# ISO linear units : m, m/s, m/s², V, A, s
# ISO rotary units : t, t/s, t/s², V, A, s
# ETEL Parameters Upload
# Written by "edi-tra" v4.19
# Date: [redacted]
# User K,KL,KF,KD register version axis 0 : 1.00A
# User C,CL,CF,CD register version axis 0 : 1.00A

# Axis 0:
#  - dev.product.category=EA-P2M-048-05/10
#  - dev.soft.version=3.18A
#  - ext.product.category=AccurET Optional IO Board
#  - ext.soft.version=1.00A

# Type K (#2)                       ; Parameter integer 32 bits

K0.0=0
K1.0=0
K2.0=0

...

# Axis 1:
#  - dev.product.category=EA-P2M-048-05/10
#  - dev.soft.version=3.18A
#  - ext.product.category=AccurET Optional IO Board
#  - ext.soft.version=1.00A

# Type K (#2)                       ; Parameter integer 32 bits

K0.1=0
K1.1=0
K2.1=0

...
```

NOTE The HTML report file is automatically presented in an Internet Explorer window after generation.

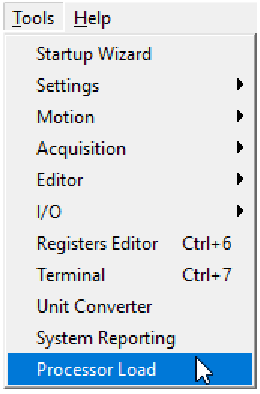
11.5. Processor Load

The *Process Load* tool allows the user to:

- Estimate the load of a Controller's processor for a given configuration;
- Measure the real load of a Controller's processor for a given configuration.

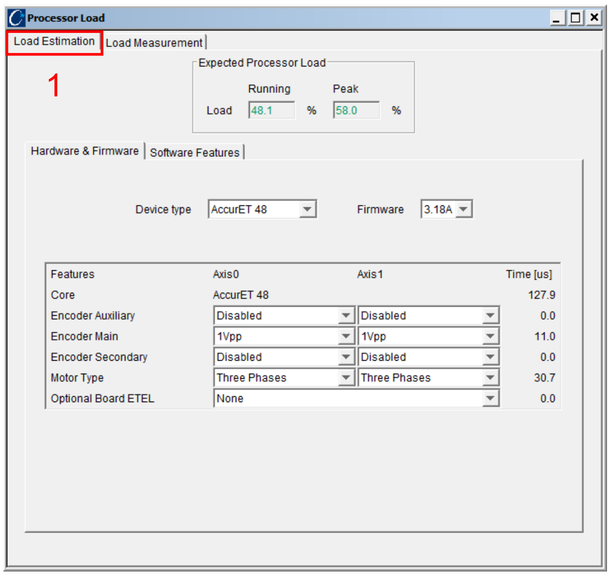
NOTE The ***ACCURET+*** position controllers are not supported.

To launch this tool, go to the Menu option **Tools → Processor Load**:



The tool is divided in two panels:

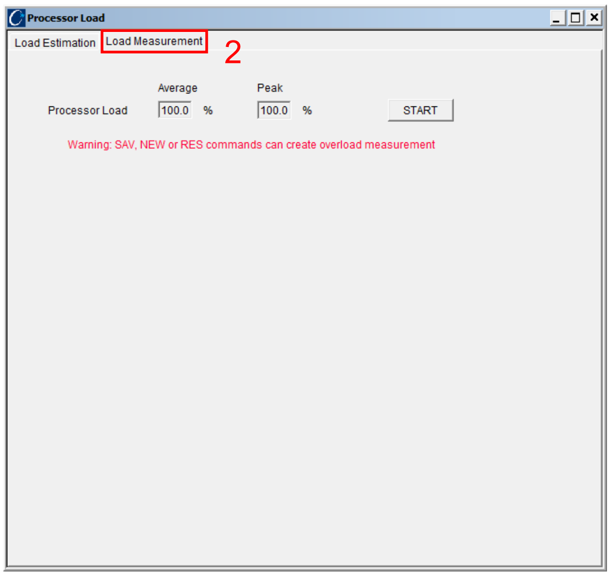
3. Load Estimation; and
4. Load Measurement.



	Running		Peak	
Load	48.1	%	58.0	%

Device type: AccurET 48
Firmware: 3.18A

Features	Axis0	Axis1	Time [us]
Core	AccurET 48		127.9
Encoder Auxiliary	Disabled	Disabled	0.0
Encoder Main	1Vpp	1Vpp	11.0
Encoder Secondary	Disabled	Disabled	0.0
Motor Type	Three Phases	Three Phases	30.7
Optional Board ETEL	None		0.0



	Average		Peak	
Processor Load	100.0	%	100.0	%

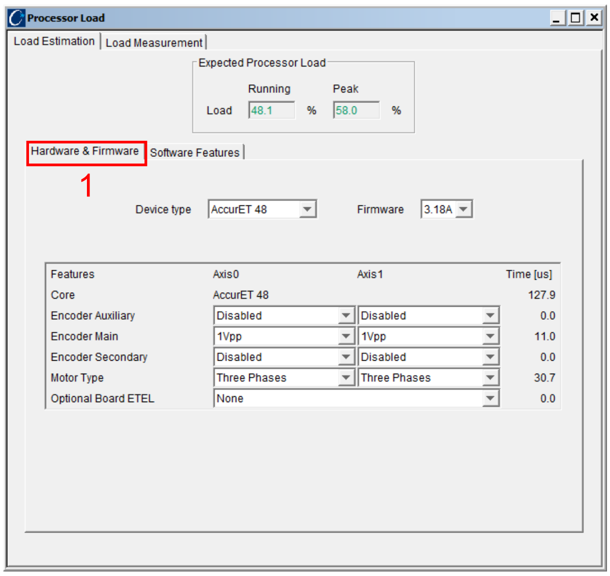
Warning: SAV, NEW or RES commands can create overload measurement

11.5.1. Load estimation

The estimation of the load of a Controller's processor can be very helpful when designing a new application. The load estimation provided by the *Processor Load* tool gives an indication to the user about the Controller's ability to handle in a "timely" manner all the features enabled for the given hardware and firmware. This part of the tool can be used off-line.

The **Load estimation** panel is further sub-divided in two other panels:

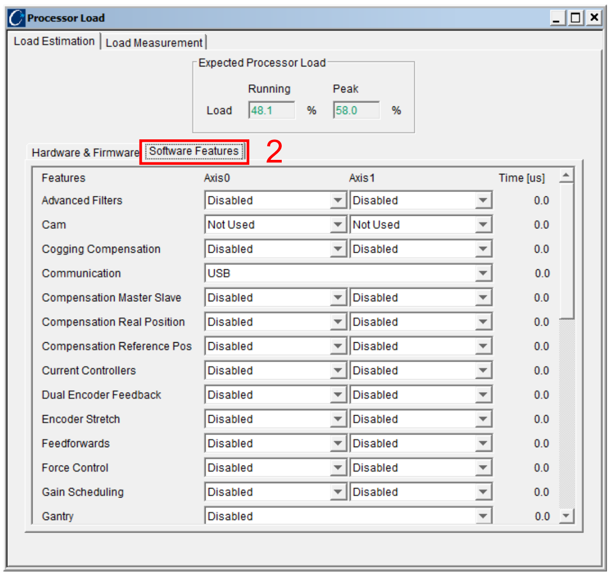
1. Hardware & Firmware; and
2. Software Features.



	Running		Peak	
Load	48.1	%	58.0	%

Device type: AccurET 48
Firmware: 3.18A

Features	Axis0	Axis1	Time [us]
Core	AccurET 48		127.9
Encoder Auxiliary	Disabled	Disabled	0.0
Encoder Main	1Vpp	1Vpp	11.0
Encoder Secondary	Disabled	Disabled	0.0
Motor Type	Three Phases	Three Phases	30.7
Optional Board ETEL	None		0.0

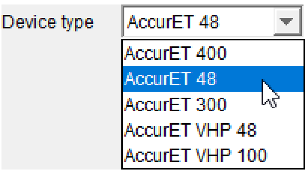


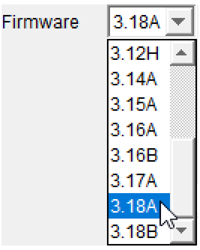
	Running		Peak	
Load	48.1	%	58.0	%

Features	Axis0	Axis1	Time [us]
Advanced Filters	Disabled	Disabled	0.0
Cam	Not Used	Not Used	0.0
Cogging Compensation	Disabled	Disabled	0.0
Communication	USB		0.0
Compensation Master Slave	Disabled	Disabled	0.0
Compensation Real Position	Disabled	Disabled	0.0
Compensation Reference Pos	Disabled	Disabled	0.0
Current Controllers	Disabled	Disabled	0.0
Dual Encoder Feedback	Disabled	Disabled	0.0
Encoder Stretch	Disabled	Disabled	0.0
Feedforwards	Disabled	Disabled	0.0
Force Control	Disabled	Disabled	0.0
Gain Scheduling	Disabled	Disabled	0.0
Gantry	Disabled		0.0

11.5.1.1. Hardware & Firmware sub-panel

On the **Hardware & Firmware** panel, the user must select the Controller model and firmware version from the **Device type** and **Firmware** drop-down lists, respectively.


Device type AccurET 48

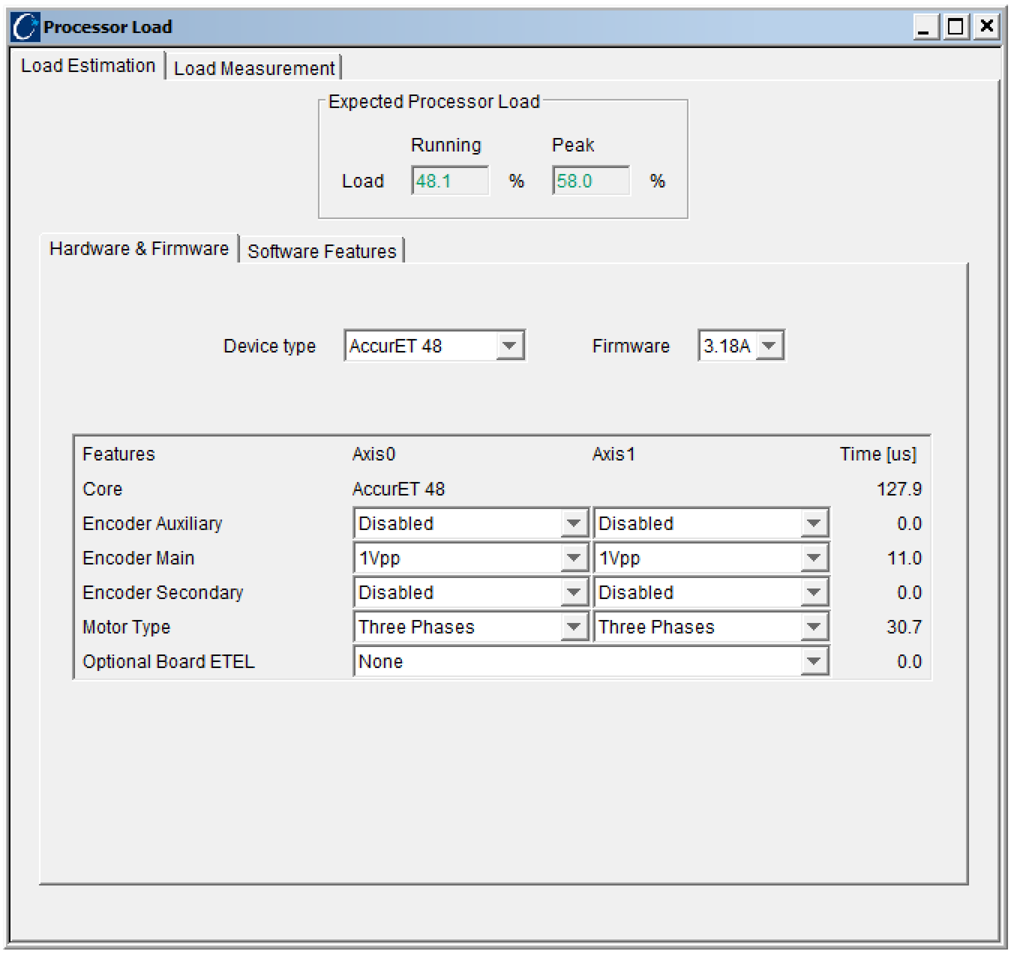

Firmware 3.18A

NOTE	The *Processor Load* tool will use the firmware located in ***ComET4***'s firmware pool. It is only compatible with firmware versions 3.12A and above.

Then, define for both Controller axis which hardware features are being used:

Hardware features	
Encoder Auxiliary	Type of position feedback used for the main, secondary and auxiliary encoders. The options are: - Disabled; - 1 Vpp; - TTL and TTL with smoothed filter (only available for the main encoder); - EnDat 2.1 and 2.2; - Any register of type int32, float and int64.
Encoder Main	
Encoder Secondary	
Motor Type	Type of motor being controlled. The options are: - 1-phase; - 2-phases; - 3-phases.
Optional Board ETEL	Is there an option I/O board installed? The options are: None; Installed: XAOUT directly set; XAOUT indirectly set through a 32-bit and 64-bit Register.

An estimation of the load expressed in µs for any hardware feature enabled is displayed on the right side. The result after configuration might look like this.



	Running		Peak	
Load	48.1	%	58.0	%

Device type: AccurET 48
Firmware: 3.18A

Features	Axis0	Axis1	Time [us]
Core	AccurET 48		127.9
Encoder Auxiliary	Disabled	Disabled	0.0
Encoder Main	1Vpp	1Vpp	11.0
Encoder Secondary	Disabled	Disabled	0.0
Motor Type	Three Phases	Three Phases	30.7
Optional Board ETEL	None		0.0

11.5.1.2. Software Features sub-panel

On the **Software Features** panel, the user has to define which software features are going to be used in his application. The list of features is extensive (refer to the *AccurET Modular Position Controller Operation & Software Manual* for further information):

Software features	
Advanced Filters	Are there any Regulator filters being used? The options are: - Disabled; - Enabled: 1 up to 7 filters used.
Cam	Is the CAM feature being used? The options are: - Not used; - Used.
Cogging Compensation	Is the cogging compensation being used? The options are: - Not used; - Used: linear (i.e. enabled for a linear axis) or rotary correction (i.e. enabled for a rotary axis).
Communication	Which type of connection is being used by the Controller? The options are: - USB only; - ***TransnET*** only or with USB as well; - Ethernet only or with USB as well; - EtherCAT only or with USB as well.
Compensation Master Slave	Is the Master/Slave position compensation being used? The options are: - Disabled; - Enabled: on int32, float, int64 or double.
Compensation Real Position	Is the compensation on real position being used? The options are: - Disabled;

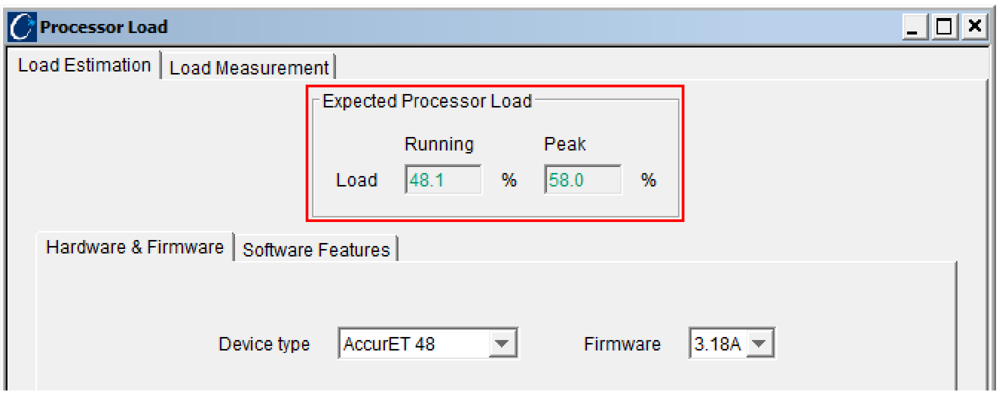
	- Enabled: on int32, float, int64 or double.
Compensation Reference Pos	Is the position external reference mode being used? The options are: - Disabled; - Enabled: filtered or not filtered on int32, float, int64 or double.
Dual Encoder Feedback	Is the dual encoder feedback feature being used? The options are: - Disabled; - Enabled: Permanent or Intermittent modes.
Dynamic Braking	Is the dynamic braking feature being used? The options are: - Disabled; - In case of error; - When motor power off.
Encoder Stretch	Is the encoder stretch feature being used? The options are: - Disabled; - Enabled.
Feedforwards	Is feedforward compensation being used? The options are: - Disabled; - Enabled: including dry friction with or without hysteresis.
Force Control	Is the Controller being used for force control? The options are: - Disabled; - Enabled.
Gain Scheduling	Is the gain scheduling feature being used? The options are: - Disabled; - Enabled: Kdp and/or Kip gain scheduling; - Enabled: Advanced gain scheduling.
Gantry	Is the Controller configured for Gantry control? The options are: - Disabled; - Enabled: Gantry levels 1 or 2.
Gantry Advanced Feedforward	Is advanced gantry feedforward being used? The options are: - Disabled; - Enabled: Gantry levels 1 or 2.
Motor Brake	Is the external motor braking control through digital output (`DOUT`) being used? The options are: - Disabled; - Enabled.
Motor Protection	Is motor protection being used? The options are: - Disabled; - Enabled: temperature check on digital inputs.
Movements	Is a motion being executed? The options are: - Disabled; - Not moving; - Moving (Linear S-Curve); - Moving (Rotary S-Curve).
Movements Hardware Limits	Is movement limit control enabled? The options are: - Disabled; - Enabled: limit switches on DIN, L1/L2 or L/H pin signals.
Movements Software Limits	Is movement limit control enabled? The options are: - Disabled; - Enabled: K36 =1, 2 or 4.
Position Controller	Which type of position controller is being used? The options are: - Disabled; - Enabled: state regulator or stepper.
Position Capture	Is the position capture feature being used? The options are: - Disabled; - Enabled: main, secondary or auxiliary encoders.
Power Consumption	Is the calculation of the power consumption enabled? The options are: - Disabled;

	- Enabled.
Power Sag Detection	Is the power sag detection feature being used? The options are: - Disabled; - Enabled without power sag; - Enabled with power sag.
RTV Read	Is the Controller reading Real-Time Values (RTV)? The options are: - Disabled; - Enabled: 1 to 16 slots used.
RTV Write	Is the Controller writing Real-Time Values (RTV)? The options are: - Disabled; - Enabled: 1 to 15 slots used.
Scale Mapping	Is scale mapping being used? The options are: - Disabled; - Enabled: linear or rotary scale.
Sequences	Are Sequences being used? The options are: - Disabled; - Enabled: default allocation time, one or two threads, running on external or internal stack; - Enabled: maximum allocation time, one or two threads, running on external or internal stack;
SPI	Is the Serial Peripheral Interface (SPI) bus being used? The options are: - Disabled; - Enabled.
Stage Mapping	Is stage mapping being used? The options are: - Disabled; - Enabled: 1D, 2D or 3D mapping.
Stage Protection	Is the stage protection feature being used? The options are: - Disabled; - Enabled: with step or ramp brake on the speed.
Trajectory Filters	Are there any trajectory filters being used? The options are: - Disabled; - Enabled: linear movement, 1 up to 4 filters defined; - Enabled: rotary movement, 1 up to 4 filters defined.
Trigger 1D	Is the application using 1D triggers? The options are: - Disabled; - Enabled: trigger, trigger status, trigger with missed event, publish position for trigger, trigger with missed event and/or position from any register.
Trigger 2D	Is the application using 2D triggers? The options are: - Disabled; - Enabled: trigger, trigger with missed event and/or position from any register.

On the right side is displayed an estimation of the load (in µs) for any software feature enabled.

If a feature is not available in the list, it is possible to enter manually the estimated processor load time using **Other Function(s) Time** edit control.

On the top section of the Load Estimation panel is displayed the estimated load (average and peak) for the given configuration as a percentage of the total capacity.



Expected Processor Load

	Running		Peak	
Load	48.1	%	58.0	%

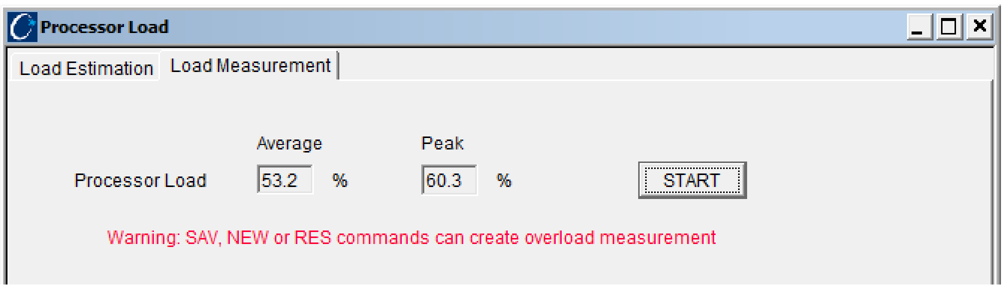
Device type: AccurET 48

Firmware: 3.18A

NOTE This tool performs only an estimation of the load. Depending on the synchronization between different functions, the value estimated may vary from the real value.

11.5.2. **Load measurement**

The load of Controller's processor can actually be measured with the *Processor Load* tool as well. Just select the second panel **Load Measurement** and click on the **START** button. The average and peak load values are measured for a moment and then displayed.



	Average		Peak	
Processor Load	53.2	%	60.3	%

Warning: SAV, NEW or RES commands can create overload measurement

12. Service & Support

For any inquiry regarding technical, commercial and service information relating to ETEL products, please contact your ETEL representative.

HEADQUARTER / SWITZERLAND	**BELGIUM**	**CHINA**
ETEL S.A. Zone industrielle CH-2112 Môtiers Phone: +41 (0)32 862 01 00 E-mail: etel@etel.ch http://www.etel.ch	HEIDENHAIN nv/sa Pamelse Klei 47 1760 Roosdaal Phone: +32 54 34 31 58 E-mail: sales@heidenhain.be	DR. JOHANNES HEIDENHAIN (CHINA) Co., Ltd No. 6, Tian Wei San Jie, Area A, Beijing Tianzhu Airport, Industrial Zone Shunyi District, Beijing 101312 Phone: +86 400 619 6060 E-mail: sales@heidenhain.com.cn
CZECH Republic	**FRANCE**	**GERMANY**
HEIDENHAIN s.r.o. Dolnomecholupská 12b 102 00 Praha 10 - Hostivar Phone: +420 272 658 131 E-mail:heidenhain@heidenhain.cz	HEIDENHAIN FRANCE SARL 2 avenue de la cristallerie 92310 Sèvres Phone: +33 (0)1 41 14 30 09 E-mail: sales@heidenhain.fr	DR. JOHANNES HEIDENHAIN GmbH Technisches Büro Südwest II Verkauf ETEL S.A. Schillgasse 14 78661 Dietingen Phone: +49 (0)741 17453-0 E-mail: tbsw.etel@heidenhain.de
GREAT-BRITAIN	**ISRAEL (Representative)**	**ITALY**
HEIDENHAIN (GB) Ltd. 200 London Road, Burgess Hill, West Sussex RH 15 9RD Phone: +44 (0)1444 247711 E-mail: sales@heidenhain.co.uk	MEDITAL COMOTECH Ltd. 36 Shacham St., P.O.B 7772, Petach Tikva Israel 4951729 Phone: +972 3 923 3323 E-mail: comotech@medital.co.il	ETEL S.A. Piazza della Repubblica 11 28050 Pombia Phone: +39 0321 958 965 E-mail: etel@etelsa.it
JAPAN	**KOREA**	**SINGAPORE**
HEIDENHAIN K.K. Hulic Kojimachi Bldg. 9F 3-2 Kojimachi, Chiyoda-ku Tokyo - 102-0083 Phone: +81 3 3234 7781 E-mail: sales@heidenhain.co.jp	HEIDENHAIN KOREA Ltd. 2F Namsung Plaza (9th Ace Techno Tower), 130, Digital-ro, Geumcheon-Gu, Seoul, Korea 08589 Phone: + 82 2 2028-7430 E-mail: etelsales@heidenhain.co.kr	HEIDENHAIN PACIFIC PTE. LTD 51 Ubi Crescent, Singapore 408593 Phone: +65 6749 3238 E-mail: info@heidenhain.com.sg
SPAIN (Representative)	**SWEDEN**	**SWITZERLAND**
Farresa Electronica, S.A. C/ Les Corts, 36 bajos ES-08028 Barcelona Phone: +34 93 409 24 91 E-mail: farresa@farresa.es	HEIDENHAIN Scandinavia AB Storsätragränd 5 127 39 Skärholmen Phone: +468 531 93 350 E-mail: sales@heidenhain.se	ETEL S.A. Zone industrielle CH-2112 Môtiers Phone: +41 (0)32 862 01 33 E-mail: sales@etelsa.ch
TAIWAN	**THE NETHERLANDS**	**UNITED STATES**
HEIDENHAIN CO., LTD. No. 29, 33rd road, Taichung Industrial Park Taichung 40768, Taiwan, R.O.C. Phone: +886 4 2358 8977 E-mail: info@heidenhain.tw	HEIDENHAIN NEDERLAND B.V. Copernicuslaan 34 6716 BM Ede Phone: +31 (0)318 581800 E-mail: verkoop@heidenhain.nl	HEIDENHAIN CORPORATION 333 E. State Parkway Schaumburg, IL 60173 Phone: +1 847 490 1191 E-mail: info@heidenhain.com

The technical hotline based at ETEL S.A.'s headquarters can be reached by:

- Phone: +41 (0)32 862 01 12
- Fax: +41 (0)32 862 01 01
- E-mail: support@etel.ch

Refer to your corresponding ETEL S.A. representative for more information about the technical documentation.

ETEL S.A. organizes training courses for customers on request, including theoretical presentations of our products and practical demonstrations at our facilities.

13. Frequently Asked Questions

How to establish the communication?
Refer to Section §3.1.

How to setup a system?
Refer to Sections §3.2 and §4.1.

How to check the status of the user's application?
Refer to Section §2.3.

How to make a simple movement?
Refer to Section §3.4.

How to adjust the encoder signals?
Refer to Section §4.1.5.

How to know the electronics configuration?
Refer to Section §11.4.

How to edit, modify and save the registers of the controller?
Refer to Sections §10.1, §11.1 and §11.2.

How to make an emergency stop?
Refer to Section §3.5.

How to monitor the controller's registers?
Refer to Sections §7.1, §7.2 and §7.4.

How to define the protections?
Refer to Section §4.1.9.

How to monitor and manage the I/Os?
Refer to Section §9.

How to generate an S-curve profile?
Refer to Section §6.1.

How to send a command?
Refer to Sections §3.3 and §11.2.

How to write and execute a Sequence?
Refer to Sections §8.1.1 and §8.1.2.

How to debug a Sequence?
Refer to Section §8.1.3.

How to pre-compile a Sequence?
Refer to Section §8.1.4.

How to select the units?
Refer to Sections §2.5.3, §7.1 and §7.2.

How to know the events occurred on a controller?
Refer to Section §7.5.

How to download a new firmware?
Refer to Section §10.4.

How to backup and restore the controller configuration?
Refer to Section §10.5.

How to customize the ComET interface?
Refer to Section §10.6.

How to adjust the regulation of the system?
Refer to Section §4.2.

How to configure the analog I/Os?
Refer to Section §9.2.

How to manage the system configuration?
Refer to Section §10.6.

How to do a scale mapping?

Refer to Section §4.2.5.

How to make a stage mapping?
Refer to Section §4.2.6.

How to tune the advanced feedforward parameters?
Refer to Section §4.2.4.

How to make a frequency analysis of the system?
Refer to Section §7.3.

How to visualize scope acquisition?
Refer to Sections §7.1 and §7.2.

How to measure the processor load?
Refer to Section §11.5.

How to configure the force control?
Refer to Section §5.1.

How to set the *QuiET* active isolation system?
Refer to Section §5.2.

How to set up a *ZxT* module?
Refer to Section §5.3.

How to download a Customer Software Module?
Refer to Section §8.2.2.

How to upload log files from the *ULTIMET ADVANCED* motion controller?
Refer to Section §7.6.

Index