

Software User Manual

## **CRYO & NANO POSITIONING PRODUCTS (PIEZOKNOB TECHNOLOGY)**



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**RELEVANT DOCUMENTATION**

Ref	Title (Author)	File name
[1]	Cryo & Nano Positioning products Hardware User Manual (JPE)	1036_MAN03_Rxx_yyyy-mm-dd_CNP_UM_HW.pdf
[2]	CPSC Modes of Operation (JPE)	1038_APNo1_Rxx_yyyy-mm-dd_CPSC_Modes_Of_Operation.pdf

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**DEFINITIONS**

Definition	Description

**ABBREVIATIONS**

Abbreviation	Description

## 1. ABOUT THIS MANUAL

This manual describes the control and operation via software of *Cryo & Nano Positioning Systems* (from here on described as systems) using JPE's *PiezoKnob Technology* cryogenic compatible actuators (from here on described as actuator). These actuators can be operated by using a (modular) Controller System (from here on described as controller).



Please read this User Manual carefully prior to installation and (initial) operation of the controller, (stand-alone) actuators and systems. Failure to observe the safety regulations results in a risk of mortal electric shock and/or damage to the controller(s), actuator(s) and/or system(s)!

JPE shall not be liable for damage or injury resulting from misuse of the controller system(s), actuator(s) and/or device(s) or unauthorized alterations to either of those.

**All products mentioned in this manual are intended for use in a laboratory and/or scientific research environment only** and may only be installed, maintained and used by higher educated, technical skilled personnel (from here on described as operators).

Consult the *Cryo & Nano Positioning products Hardware User Manual*<sup>1</sup> on how to install and setup systems and actuators using the controller and its function specific modules. For a quick reference on the various (software) control methods read the Application Note *CPSC Modes of Operation*<sup>2</sup>.

Please note that all content in this manual is superseded by any new versions of this manual (see file name). Visit the JPE website ([www.jpe.nl](http://www.jpe.nl)) to obtain the most recent version<sup>3</sup>. All images in this User Manual are for illustrative purposes only.

**For a quick-start at least read and follow the instructions in Chapters 2, 3 and 4.**

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<sup>1</sup> See reference [1]

<sup>2</sup> See reference [2]

<sup>3</sup> This manual is intended for products ordered and delivered from *October 2018 onwards*. For products ordered and delivered prior to this date, please refer to the previous User Manual(s), see also paragraph 7.

## 2. IMPORTANT SAFETY INFORMATION

### 2.1 User Manual Instructions

In this manual important (mostly safety related) information is shown inside a (red colored) bordered box, like this:

Important notes are shown inside a bordered box.

**Please note that it is obligatory to follow the instructions mentioned in these (red colored) bordered boxes! Failing to observe instructions may result in a risk of electric shock! Therefore follow all instructions carefully!**

### 2.2 General Safety Rules

- 1 Assembly and mounting of actuators and systems may only be carried out when not (electrically or optically) connected to the controller.
- 2 Always check all cabling, wiring and connectors (electrical as well as optical) on defects prior to connecting to actuators, systems or controllers.
- 3 Actuators and systems must only be connected to the controller when all actuators and systems have been placed in a safe environment towards the operator(s), i.e. out of reach by the operator(s) when driving them electrically (by using the controller).
- 4 Touching actuators and systems including all cabling and connectors while driving electrically, is not allowed and may result in a dangerous electrical shock! Avoid physically touching unconnected in- or outputs when the controller is powered ON (open voltage contacts present!).
- 5 Always place the controller(s), actuator(s) and system(s) on a sturdy surface or mount, the controller at level (and preferably) on a bench top, desk or 19" rack, and away from any wet or damp locations. Do not cover the top of the controller cabinet! In case of installing in a 19" rack, keep at least 2U height free above the cabinet.
- 6 Actuator(s) and system(s) can be used inside a vacuum chamber and/or cryogenic environment (cryostat). Actuator(s) and system(s) must only be operated when the environment is in a defined state. For instance: do not operate when cooling down procedure or vacuum pumping procedure is still in progress to reduce the risks of electric arcing (Paschen's Law).
- 7 Do not use the controller in any other way than to operate actuators and systems supplied by JPE and do not operate actuators and systems in any other way than by using the controller supplied by JPE.
- 8 The controller is designed to be powered by commonly used 230V AC / 50Hz (European version) or 115V / 60Hz (US version) via a socket with protective earth. Note that it is not possible to switch in between both (i.e. the ordered controller is either the 230V version or the 115V version). Always ensure proper grounding via the protective earth connection of the power inlet.



- 9 Do not turn ON the controller immediately after it has been brought from a cool into a warmer environment (risk of condensing water) or vice versa. After unpacking, wait at least 4 hours before using the controller.
- 10 Always keep metal screw on caps on the ends of unconnected (optical) cabling.

### 3. CONTROLLER DRIVER SETUP

#### 3.1 System requirements

To be able to control actuators and systems via software, use a PC system with (at least) Windows 7 (SP1) (32bit or 64bit) installed and make sure to have a free USB1.1/2.0 port available (for optimal performance it is best not use a hub device). Alternatively the controller can be connected to a Local Area Network (LAN) using a standard CAT5e (or comparable) cable.

*Currently the software is only natively available for Windows OS. Integration in third-party (control) software (like Matlab® or LabView®) is supported by the Command Line Interface (see chapter 5). Running the software in Linux is only possible when using the Windows-emulator "Wine".*

#### 3.2 Connection through USB

- 1 Log on to Windows with an account with (full) *Administrator* privileges.
- 2 Download a copy of the latest *Controller Software* at <http://www.jpe.nl/page/cryo-positioning-systems-controller/> (click on the drop down item "*Controller Software & User Manuals*") and unpack the .zip file in a folder of your choice.
- 3 Place the controller on an appropriate surface (for example a sturdy workbench) and make sure that no actuators or systems are connected to the controller!
- 4 Make sure that the *Mains Power Switch* on the back of the controller is in the "o" (OFF) position.
- 5 Connect the supplied USB cable to the back of the cabinet (connector labelled "USB") and on the other end in to a free USB port.
- 6 Power on the cabinet, switch the Mains Power Switch to the "1" (ON) position.
- 7 Windows will automatically detect new hardware. Because the controller uses a standard Human Interface Device (HID), a suitable driver should be found. Most likely this will result in (one or more of) the following message(s):



Figure 1: Installing software messages



*(Please note that the screenshots above may vary depending on the version of operating system that is being used)*

- 8 After successful installation, the *Device Properties* should look (similar) to this:

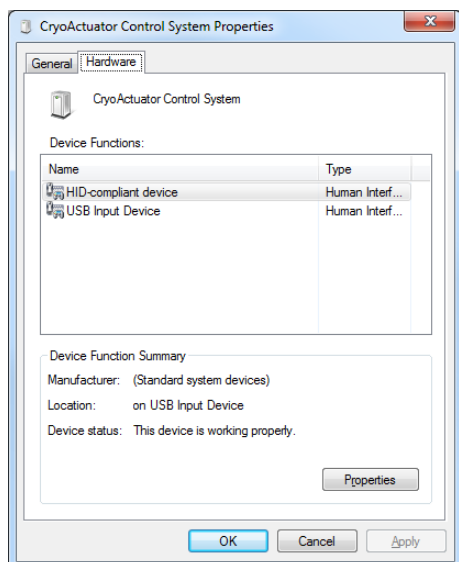


Figure 2: Driver properties

*(Go to Start > Devices and Printers > (right-click) on (Unspecified) Cryo Actuator Control System > select Properties > tab Hardware)*

- 9 Driver installation finished.

### 3.3 Connection through LAN

Alternatively the controller can be connected to a *Local Area Network* (LAN) using a standard CAT5e or comparable cable. By default the DHCP function is enabled, so that after connecting to a LAN, the controller can get an IP address automatically<sup>4</sup>.

- 1 Make sure that the *Mains Power Switch* on the back of the controller is in the "0" (OFF) position.
- 2 Connect a CAT5e (or comparable) cable to the back of the cabinet (connector labelled "LAN") and on the other end in to a free LAN port.
- 3 Power on the cabinet, switch the Mains Power Switch to the "1" (ON) position.

Should the controller not be able to get an IP address via DHCP, it is possible to manual enter an IP address using the Graphical User Interface (GUI). In that case it is required to connect the controller to a PC via USB first, to be able to store the IP address in the controller. Read Chapter 4.4 for further instructions.

Note that it is only possible to use one connection type at a time, so either USB or LAN. If the controller is connected to both, USB has the highest priority (and will be selected over LAN).

<sup>4</sup> This requires a DHCP Server to be active on the Local Area Network.

## 4. GRAPHICAL USER INTERFACE (GUI)

Before continuing, make sure to follow the proper setup and installation as described in the Cryo & Nano Positioning products Hardware User Manual<sup>5</sup>.

The stand-alone Graphical User Interface (GUI) can be used for basic movement control, parameter setting changes and diagnostics. The program is portable which means that it does not require installation and that it can run directly from within the folder containing the executable.

Please note that the GUI is a basic movement and control tool only and not a comprehensive motion control environment!

Note that the controller needs to be in External Control Mode. If a Manual Control Module (MCM) is installed, set the Channel knob to **EXT** before starting the GUI. When the controller is in the correct mode the LCD will display the text "EXTERNAL: USB" or "EXTERNAL: LAN" (in the latter case, followed by the IP address the controller uses).

If no MCM is present the controller is in the correct mode automatically, however please wait at least 10 seconds after all modules are powered on to give the controller time to boot (there is no visual indication).

Start the GUI by double-clicking the file **CAControlSystem.exe**. The program will automatically recognize the installed modules<sup>6</sup> and load the internally stored parameter settings for each output channel (if present). The GUI will check the USB port first, if none are found the GUI will ask to search for LAN connected controllers.

The screenshot below shows an example configuration with 1x CADM2 for driving *Cryo Linear Actuators* (products **CLA##xx**):

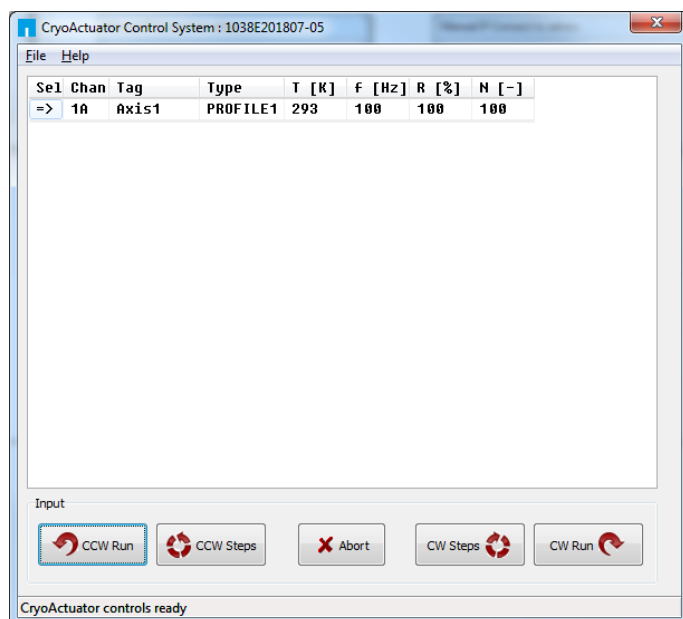


Figure 3: GUI with example configuration.

<sup>5</sup> See reference [1]

<sup>6</sup> CADM, CADM2 and OEM2 modules are supported by the GUI.

If the program cannot find the controller, a popup error message will be displayed. If necessary, go to: *File > Get Available Channels* to retrieve the available channels and settings again.

## 4.1 Controller IDs

In the top bar of the program window the ID of the connected controller is displayed when the controller is connected via USB. This ID must match the ID at the back of the controller cabinet<sup>7</sup>.

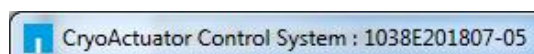


Figure 4: Controller ID display (USB)

This ID is useful to select (and distinguish) between controllers when multiple controllers have been connected to the same PC.

Note that when the controller is connected to a LAN, this top bar shows the controller's IP address instead. If an MCM is installed, this IP address will also be shown on the display.

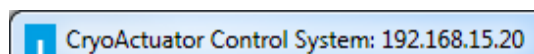



Figure 5: Controller IP address (LAN)

## 4.2 Channel List Box

The main part of the program is the channel list box displaying the (current) parameter settings for each available output channel. This box lists module slots 1 to 6 from top to bottom.

Se1	Chan	Tag	Type	T [K]	F [Hz]	R [%]	N [-]
=>	1A	Axis1	PROFILE1	293	100	100	100

Figure 6: Channel List Box

Select an output by clicking on the corresponding line in the channel list box. The selected channel is displayed in the "Sel" column with a -mark. The following parameters and options are available:

Parameter	Value	Notes
Chan	1A (, 1B, 1C) 2A (, 2B, 2C) 3A (, 3B, 3C) 4A (, 4B, 4C) 5A (, 5B, 5C) 6A (, 6B, 6C)	Channel number. In case of a CADM2 module only 1A (or 2A, 3A, 4A, 5A or 6A) is shown. In case of a CADM module the xB- and xC-channels are also listed.  <i>Display only - cannot be changed by the user.</i>
Tag	Max. 8 alphanumerical characters (space character is not allowed)	Identification parameter that can be chosen freely by the user and is displayed on the MCM (if installed) in between [ ]-brackets when in manual control mode.

<sup>7</sup> See reference [1]

Parameter	Value	Notes
Type	NONE PROFILE1 <b>PROFILE2</b> PROFILE3	<p>Sets specific internal system parameters for the type of actuator attached to that particular channel output.</p> <p>PROFILE1 is used for all CA22xx(-COE) actuators with IDs up to #173xx-yyy as well as all CA26xx(-COE) actuators with IDs up to #172xx-yyy. Use this profile also for CBS, CLD and CRM and all stages that have the actuators with ID's listed above.</p> <p>PROFILE2 is used for CA22xx(-COE) actuators with IDs #174xx-yyy and upwards as well as CA26xx(-COE) actuators with IDs #18xxx-yyy and upwards.</p> <p>PROFILE3 is used for backwards compatibility with actuators delivered prior to 03/2013 (PKxxxx actuators).</p> <p><i>Right-click on the parameter to set / change the type.</i></p>
T [K]	0 to 300	Set this parameter to the temperature of the environment in which the actuator is used. Input is in Kelvin [K] (numerical values only).
F [Hz]	0 to 600	Frequency of operation input. Value is in Hertz [Hz] (numerical values only).
R [%]	0 to 100	<p>(Relative) Piezo step size parameter input. Value is a percentage [%] (numerical values only).</p> <p><i>See product datasheets for typical step size values for each actuator or system. Typical leave this at 100[%] unless small(er) steps are required.</i></p>

Parameter	Value	Notes
N [-]	1 to 50000	Number of actuation steps. This value is used when using the CW/CCW steps buttons (numerical values only).
inc []	(numerical value)	<p>Displays the current encoder counter value [Encoder Ticks<sup>8</sup>] if an actuator is equipped with a Cryo Optical Encoder (product type option -COE) and an OEM2 module is installed.</p> <p>Right-click any value will give the option to [Reset] the counter value or to get the current value [Get Position].</p> <p><i>Please note that the inc[] column will be visible only when one (or more) OEM2 modules have been installed. In case there is an (additional) CADM/CADM2 module installed without an accompanying OEM module, the rows for this module will display "ERROR".</i></p> <p><i>Please note that the encoder value will be reset after a power cycle (COE is a relative incremental encoder, current positions will not be stored).</i></p>

### 4.3 Input box

In the Input box, buttons can be used to drive the actuator(s) in 2 different ways.

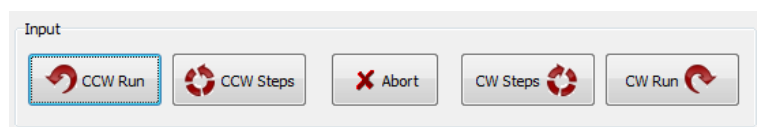


Figure 7: Input box

Use the CW (Clockwise) and CCW (Counter clockwise) buttons to drive the actuator connected to the output of the channel selected in the Channel List box:

- The **CCW Run** and **CW Run** buttons are to continuously move the actuator until the **Abort** button is pressed.
- The **CCW Steps** and **CW Steps** buttons are to move the actuator for a number of actuation steps ("N [-]" parameter, see previous paragraph).

Please note the following:

- Avoid physically touching unconnected outputs when the controller is turned ON.
- Channel or Parameter settings cannot be changed during movement.
- Do not select and actuate unconnected outputs.
- Power down the controller before disconnecting any actuator(s) or system(s).
- Encoder values will be reset after a power cycle (COE is a relative incremental encoder, positions will not be stored).

<sup>8</sup> The OEM2 encoder position readout is displayed in Encoder Ticks (pulses). Position resolution depends on type of encoder grid (PPR, Pulses Per Revolution - see brochures of each individual product).

## 4.4 File Menu

In the *File* menu (top of program window) some additional functions can be found.

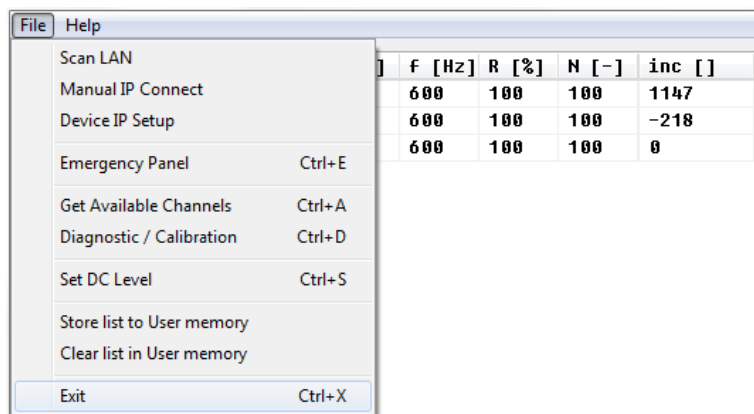


Figure 8: File menu

Function	Description
Scan LAN Manual IP Connect Device IP Setup	Settings for communication via LAN. Please read paragraph 4.5 for additional information.
Emergency Panel	Opens a pop-up window with a button to start moving the actuator on the <u>current selected channel</u> (!) in CCW direction with the maximum amount of torque possible. This can be useful in the case an actuator is stuck (locked) and doesn't seem to move using the regular commands and parameters.
Get Available Channels	Rescan all available channels and parameter settings stored.
Diagnostic / Calibration	Opens a pop-up windows with diagnostic and (COE) calibration functions.  <i>Only to be used when there are issues with actuators, systems or the controller (see paragraph 4.6).</i>
Set DC Level <sup>9</sup>	CADM/CADM2 Scanner function (mode).  Can be used to set a DC voltage level to the output (to be used with a scanner piezo for example) instead of the default drive signal. Can be set to a numerical value in between 0 and 1023, where zero represents ~0V output (-30V in respect to REF) and the maximum value represents ~150V output (+120V in respect to REF).  <i>Note that when active, the Output Active status LED on the CADM / CADM2 module will blink.</i>

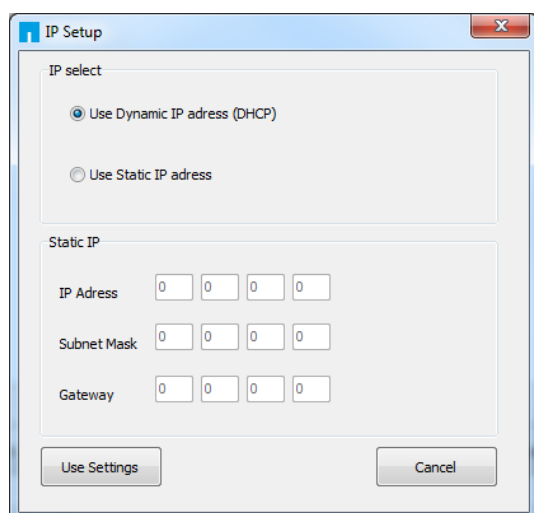
<sup>9</sup> Beta version. Functional, but not yet fully developed. See also reference [1].

Function	Description
Store list to User Memory Clear list in User Memory	If changes have been made to the parameter settings, use the Store List function to save these to the (internal) memory of the controller. This is also useful when using the MCM after disconnecting the controller from the PC. The <i>command line interface</i> (CLI) does not use any of the stored parameters. However, stored <i>Tag</i> and <i>Type</i> parameters can be requested from within the command line interface for information.

## 4.5 IP Setup

For this to work, the controller has to be connected to a PC via USB initially. Otherwise it is not possible to store the values in the controller.

Under normal circumstances it is most likely that the controller will get an IP address from a DHCP server on the Local Area Network (LAN). However, it is possible to set an IP address manually if the controller cannot obtain an IP address automatically. This can be done in *File > Device IP Setup*.



Option	Description
IP Select	Select between <i>Use Dynamic IP address (DHCP)</i> ( <b>default</b> ) or <i>Use Static IP address</i> .
Static IP	If <i>Use Static IP address</i> is selected, set the IP Address, Subnet Mask and Gateway. <b>Consult your IT department to obtain valid settings!</b>
Use Settings	Store and use the values set above. The controller will remember these settings even after power down.

## 4.6 Diagnostic & Calibration

Typically only to be used when there are issues with actuators, systems or the controller. Please consult JPE when using this function!

When opening the Diagnostic & Calibration window the GUI will auto-detect the connected controller and installed modules. After auto-detection is completed one or more additional tabs will appear (depending on the controller module configuration).

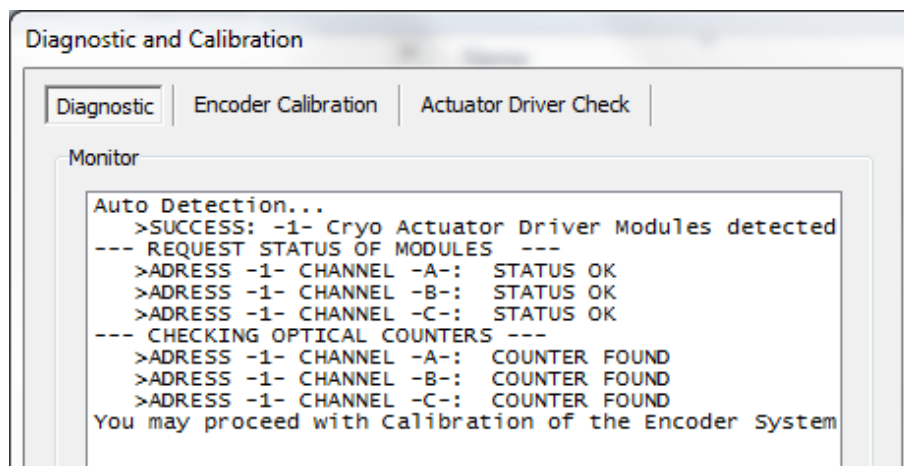


Figure 9: Diagnostic Auto Detection (example screenshot)



#### 4.6.1 Encoder Calibration

Note that this tab will only appear if the controller is equipped with one (or more) OEM2 modules.

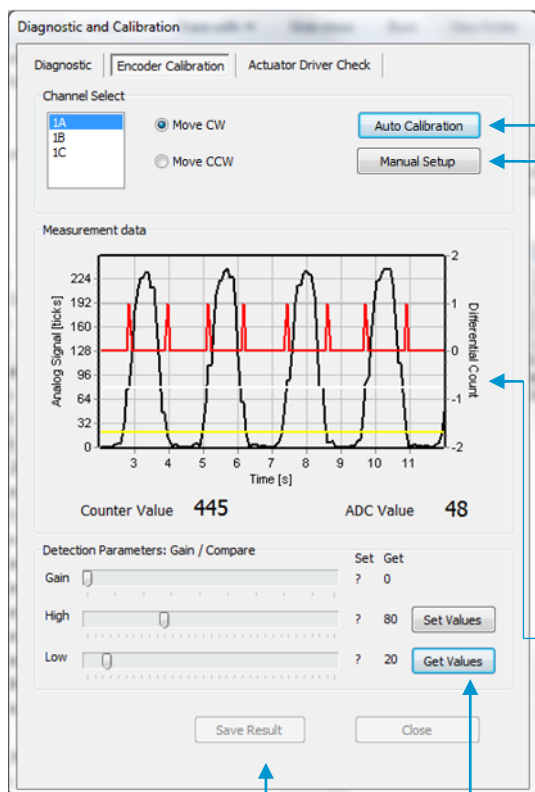


Figure 10: Encoder calibration window (example)

Select the appropriate output channel (*Channel Select*) and click the **Auto Calibration**<sup>10</sup> button to (re-) calibrate the connected Cryo Optical Encoder (-COE option).

**Make sure the actuator can run freely and is not near an end-stop**<sup>11</sup>.

A (black) command line box will pop-up; follow the on-screen instructions carefully!

Select **Manual Setup** to do a manual calibration. Move CW can be selected by default. As soon as the actuator starts to move a similar graph as shown here should appear.

The **black** line shows the **raw encoder signal**, while the **yellow** and **white** lines depict the set **Low** and **High Threshold** respectively. The **red** line are the actual measured encoder 'pulses' (= **counter value**). The raw analog encoder signal value (black line) should be as high as possible without clipping.

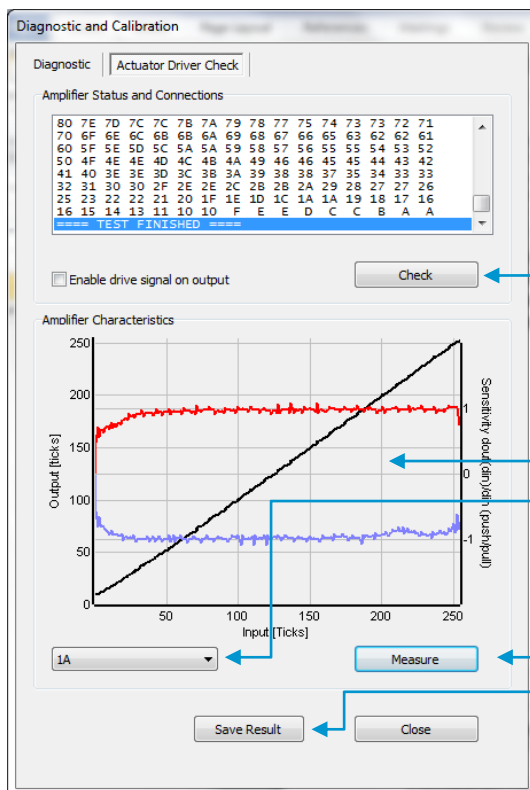
*Gain*, *Low* and *High Threshold* values can be set with the sliders. Current values can be looked up with the **Get Values** button. To set new (changed) values click the **Set Values** button.

To save measurement data (for example to send to JPE engineers), click the **Save Result** button (data can be saved as plain text file).

<sup>10</sup> The Auto Calibration requires the command line interface (cacli.exe) to be located in the same folder as the GUI executable.

<sup>11</sup> Auto Calibration may not work properly with the *Cryo Linear Drive* (CLD). Please use Manual Setup instead.

#### 4.6.2 Actuator Driver Check



Click the **Check** button to (re-) check the CADM/CADM2 status and connections (the option "Enable drive signal on output" can be left off by default).

To verify that the *amplifier characteristics* are still within normal operating range, select an output from the **dropdown menu** and click the **Measure** button to start the check. The result (graph) should be (very) similar to this screenshot.

To save *measurement data* (for example to send to JPE engineers), click the **Save Result** button (data can be saved as plain text file).

Figure 11: Amplifier Drive Check window (example)

## 5. COMMAND LINE INTERFACE (CLI)

Before continuing, make sure to follow the proper setup and installation as described in the Cryo & Nano Positioning products Hardware User Manual<sup>12</sup>.

Please note that the controller can be used in different Modes of Operation: Mdrive, Basedrive, Servodrive or Flexdrive. With the Command Line Interface (CLI) it is possible to set the controller in Servodrive or Flexdrive operation enabling the most dynamic operation modes available.

Specific commands / parameters combinations for the command line interface will define the mode of operation the controller is in. For a clear understanding of the different modes, please read the Application Note "CPSC Modes Of Operation"<sup>13</sup> before continuing!

The command line interface (CLI) enables easy integration with other control software (for example LabView® or MATLAB®) to be able to program movement sequences, to enable Servodrive or to set the CADM2 module in *analog input mode* (Flexdrive).

*Note that the CLI cannot run at the same time as the GUI (or vice versa); only one can have control over the controller. Also it is not possible to move an actuator manually by using the Manual Control Module (MCM) when in External Control Mode.*

If a Manual Control Module (MCM) is installed, set the Channel knob to **EXT** before starting the CLI. When the controller is in the correct mode the LCD will display the text "EXTERNAL: USB" or "EXTERNAL: LAN" (in the latter case, followed by the IP address the controller uses).

If no MCM is present the controller is in the correct mode automatically, however please wait at least 5-10 seconds after all modules are powered on to give the controller time to boot (there is no visual indication).

The command line interface is a single file (**CACli.exe**) that is called from the (Windows) command prompt and needs various arguments to work. The picture below shows a few examples:

```
D:\>caccli STS 1
STATUS : STOP
FAILSAFE STATE: 0x0

D:\>caccli /ver
Version: CACLI .5.3.20181010
```

Figure 12: CLI examples

### 5.1 Addressing a specific controller

#### 5.1.1 USB

If more than one controller is connected to the same PC via USB, the user has to define the target device for communication. Targets are defined by the controller ID# (see paragraph 4.1). The first argument preceded with @, will define the target device. This argument needs to precede any other command arguments. For example:

```
caccli @1038E201807-05 {followed by other command arguments}
```

<sup>12</sup> See reference [1]

<sup>13</sup> See reference [2]

Note that if only one controller is connected through USB, there is no need to define the target device (as it is selected by default).

```
D:\>cacli @1038E201807-05 STS 1
STATUS : STOP
FAILSAFE STATE: 0x0

D:\>cacli STS 1
STATUS : STOP
FAILSAFE STATE: 0x0
```

Figure 13: Communication through USB (one controller connected)

### 5.1.2 LAN

If one (or more) controller(s) is (are) connected via LAN, the user has to define the target device for communication. Targets are defined by the IP Address (see paragraph 4.1). The first argument preceded with @, will define the target device. This argument needs to precede any other command arguments. For example:

```
cacli @192.168.15.80 {followed by other command arguments}
```

```
D:\>cacli @192.168.15.80 STS 1
STATUS : STOP
FAILSAFE STATE: 0x0

D:\>cacli STS 1
ERROR: DEVICE NOT FOUND
```

Figure 14: Communication through LAN

## 5.2 Common argument parameters

The command line interface accepts parameters in a particular order. Depending on the first command argument one of multiple other arguments are required. See the following paragraphs for examples of all available user commands for the available modules.

Argument	Value	Description
[COMMAND]	MOV EXT STP STS INFO POS RST OEMC	First argument for the command line interface.  <i>CADM/CADM2</i> : MOV (Move), EXT (External mode input) <sup>14</sup> , STP (Stop movement), STS (Status) or INFO (Information).  <i>OEM2 specific</i> : POS (get Encoder position), RST (Reset encoder position) or OEMC (Encoder Auto calibration).
[ADDR]	1 to 6	Address of CADM or CADM2 corresponding to controller slot. <i>Address 1 =&gt; slot 1 =&gt; the module on the leftmost position as seen from front of the cabinet.</i>
[CH]	1 to 3	Module channel. Only applicable for the CADM module (which has 3 outputs), in case of a CADM2 module, this parameter should be set to 1.

<sup>14</sup> CADM2 only

Argument	Value	Description
[TYPE]	NONE PROFILE1 <b>PROFILE2</b> PROFILE3	<p>Sets specific internal system parameters for the type of actuator attached to that particular channel output.</p> <p><i>PROFILE1</i> is used for all CA22xx(-COE) actuators with IDs up to #173xx-yyy as well as all CA26xx(-COE) actuators with IDs up to #172xx-yyy. Use this profile also for CBS, CLD and CRM and all stages that have the actuators with ID's listed above.</p> <p><i>PROFILE2</i> is used for CA22xx(-COE) actuators with IDs #174xx-yyy and upwards as well as CA26xx(-COE) actuators with IDs #18xxx-yyy and upwards.</p> <p><i>PROFILE3</i> is used for backwards compatibility with actuators delivered prior to 03/2013 (PKxxxx actuators).</p> <p>Use command <code>/type</code> to get list of the available options.</p>
[TEMP]	0 to 300	Set this parameter to the temperature of the environment in which the actuator is used. Input is in Kelvin [K] (numerical values only).
[DIR]	0 to 1	Direction of movement: set to 1 for clockwise (CW) movement and 0 (zero) for counter-clockwise (CCW).
[FREQ]	0 to 600	Frequency of operation input. Value is in Hertz [Hz] (numerical values only).
[REL]	0 to 100	<p>(Relative) Piezo step size parameter input. Value is a percentage [%] (numerical values only).</p> <p><i>See product datasheets for typical step size values for each actuator or system. Typical leave this at 100[%] unless small(er) steps are required.</i></p>
[STEPS]	0 to 50000	Number of actuation steps. Range 0 to 50000, where 0 is used for infinite move (use STP command to stop actuator movement).
[TRQFR]	1 to 30	Optional torque factor to apply (numerical values only).

## 5.3 General CLI commands

### 5.3.1 Get CLI version information

Command [followed by enter]	(Example) Response
<code>cacli /ver</code>	Version: CACLI.5.3.20181010

### 5.3.2 List supported cryo linear actuator (CLA) types

Command [followed by enter]	(Example) Response
<code>cacli /type</code>	List of Cryo Actuator types: PROFILE1 PROFILE2 PROFILE3

### 5.3.3 Get information about installed modules

Command to list the automatically detected modules in the controller.

Command [followed by enter]	(Example) Response
<code>cacli modlist</code>	STATUS : INQUIRY OF INSTALLED MODULES Configuration:3 SLOT 1 : Cryo Actuator Driver Module (CADM)      ADR:1 SLOT 2 : Cryo Actuator Driver Module (CADM)      ADR:2 SLOT 3 : Cryo Actuator Driver Module (CADM)      ADR:3 SLOT 4 : Optical Encoder Module                    (OEM )      ADR:3 SLOT 5 : SLOT 6 :

### 5.3.4 Scan for USB connected cabinets

Command [followed by enter]	(Example) Response
<code>cacli /USB</code>	List of available devices: 0) CryoActuator Control System (1038E201807-05)

### 5.3.5 Scan for LAN connected cabinets

Command [followed by enter]	(Example) Response
<code>cacli /LAN</code>	Probing 192.168.15.255 for available devices ...  Reply from 192.168.15.20:JPE CryoActuator Control System  Probe statistics for 192.168.15.255: Unique devices = 1, Rounds = 4

## 5.4 CADM / CADM2 specific commands

### 5.4.1 Get information on installed modules

Requests the module description and available output channels

Command [followed by enter]	(Example) Response
<code>cacli DESC [ADDR]</code>  example: <code>cacli DESC 1</code>	Version : CADM2 Available Channels: 1

### 5.4.2 Get information on actuator types set

Request information about a user defined *Tags* (name) or set actuator *Types*.

Command [followed by enter]	(Example) Response
<code>cacli INFO [ADDR] [CH]</code>  example: <code>cacli INFO 1 1</code>	TYPE : CA1801 TAG : NONE

### 5.4.3 Move

The move command starts moving an actuator with specified parameters. If an OEM2 is installed, the CLA-COE position will be tracked automatically. *Note: command specific for Basedrive mode of operation.*

Command [followed by enter]	(Example) Response
-----------------------------	--------------------

<pre>cacli MOV [ADDR] [CH] [TYPE] [TEMP] [DIR] [FREQ] [REL] [STEPS] [TRQFR]* (* optional)  example: cacli MOV 1 1 CA1801 293 1 600 100 100</pre>	<pre>STATUS : MOVE</pre>
--	--------------------------

Please note the following:

- Avoid physically touching unconnected outputs when the controller is turned ON.
- Do not select and actuate unconnected outputs.
- Power down the controller before disconnecting any actuator(s) or system(s).
- Encoder values will be reset after a power cycle (COE is a relative incremental encoder, current positions will not be stored).

#### 5.4.4 Stop

Stops movement of an actuator. *Note: command specific for Basedrive mode of operation.*

Command [followed by enter]	(Example) Response
<pre>cacli STP [ADDR]  example: cacli STP 1</pre>	<pre>STATUS : STOP</pre>

#### 5.4.5 Status

Requests the amplifier status: Moving or Stop. In addition the amplifier Failsafe State (see paragraph 5.8) is being shown. If any error of the amplifier occurred (red status LED on front panel), the cause of the error may be requested via this command. *Note: command specific for Basedrive mode of operation.*

Command [followed by enter]	(Example) Response
<pre>cacli STS [ADDR]  example: cacli STS 1</pre>	<pre>STATUS : STOP FAILSAFE STATE: 0x0</pre>

#### 5.4.6 Set Output to DC

*Note: Scanner function (mode).*

Can be used to set a DC voltage level to the output (to be used with a scanner piezo for example) instead of the default drive signal. Can be set to a numerical value in between 0 and 1023 (10-bit value) where zero represents ~0V output (-30V in respect to REF) and the maximum value represents ~150V output (+120V in respect to REF). Use the STP (Stop) command to cancel this function.

*Note that when active, the Output Active status LED on the CADM / CADM2 module will blink.*

Command [followed by enter]	(Example) Response
<pre>cacli SDC [ADDR] [CH] [VALUE]  example: cacli SDC 1 1 512</pre>	<pre>STATUS : MOVE</pre>

#### 5.4.7 Select Analog Input (CADM2 only)

*Note: command specific for CADM2 and Flexdrive mode of operation only.*

To use the CADM2 in Flexdrive mode, it is required to set the module in analog input mode prior to using Flexdrive. The `EXT` command basically works similar to the `MOV` command, however there are a few differences:

- The `[FREQ]` parameter now defines the step frequency at maximum (absolute) input signal. By default set this to 600 [Hz].
- With the `[DIR]` parameter it is possible to reverse the input <> direction of movement relation. By default this parameter is set to 1 so that a positive input voltage results in a CW movement.

Command [followed by enter]	(Example) Response
<pre> cacli EXT [ADDR] [CH] [TYPE] [TEMP] [DIR] [FREQ] [REL] [TRQFR]* (* optional)  example: cacli EXT 1 1 CA1801 293 1 600 100 </pre>	<pre> STATUS : USING EXTERNAL INPUT </pre>

Please note that the relative step size needs to be set within the `EXT` command! If a different step size is required in Flexdrive mode, this command needs to be executed again with a different `[REL]` value! The analog input only directs Frequency and Direction (CW/CCW) of movement.

Note that the CADM2 module will perform an 'automatic zero calibration' upon power on to make sure the connected actuator will not move at an input voltage of 0 (zero) [V]<sup>15</sup>. However, this means that it is required to hold the input at 0 (zero) [V] during power on of the module (do not let the input float).

Also be aware of:

- Avoid physically touching unconnected outputs when the controller is turned ON.
- Do not select and actuate unconnected outputs.
- Power down the controller before disconnecting any actuator(s) or system(s).
- The (blue) Output Active LED will turn to indicate the module output is active.

<sup>15</sup> See reference [1]



## 5.5 OEM2 specific commands

### 5.5.1 Get Position

Request the position of an encoder channel. Please note that the [ADDR] and [CH] parameters relate to the accompanying CADM or CADM2 module! Position value is in [Encoder Ticks<sup>16</sup>]. *Note: command specific for Basedrive mode of operation.*

Command [followed by enter]	(Example) Response
<pre>cacli POS [ADDR] [CH]</pre> <p>example: cacli POS 1 1</p>	<pre>POS: 2 RVL: 0</pre>

Encoder values will be reset after a power cycle (COE is a relative incremental encoder, current positions will not be stored).

### 5.5.2 Reset Position to Zero

To reset the position to zero for a specific encoder channel. Please note that the [ADDR] and [CH] parameters relate to the accompanying CADM or CADM2 module! *Note: command specific for Basedrive mode of operation.*

Command [followed by enter]	(Example) Response
<pre>cacli RST [ADDR] [CH]</pre> <p>example: cacli RST 1 1</p>	<pre>Counter for CH1 has been reset to zero</pre>

### 5.5.3 Start Auto Calibration Procedure

Only to be used when there are issues with the Cryo Optical Encoder (-COE option) or OEM2 module<sup>17</sup>. Please consult JPE first before using this function!

To start a calibration procedure for a specific channel. Please note that the [ADDR] and [CH] parameters relate to the accompanying CADM or CADM2 module!

Command [followed by enter]	(Example) Response
<pre>cacli OEMC [ADDR] [CH] [TYPE] [TEMP] [DIR] [FREQ]</pre> <p>example: cacli OEMC 1 1 CA1801 293 0 600</p>	<pre>=== OEM Calibration Procedure === Progress Count: 400\400 Using 800 pulses for process CALIBRATION QUALITY: 4/4 Summary of determined values: SWG: 25 TH: 67 TL: 27 Do you want to use the determined values for module:1 channel:1 (y/n)?</pre>

<sup>16</sup> The OEM2 encoder position readout is displayed in Encoder Ticks (pulses). Position resolution depends on type of encoder grid (PPR, Pulses Per Revolution - see brochures of each individual product).

<sup>17</sup> Auto Calibration may not work properly with the Cryo Linear Drive (CLD). Please use Manual Setup instead using the GUI (see paragraph 4.6.1).

The result of the calibration procedure are new detector settings: *gain* (SWG) and two-level *threshold* values (TH and TL). The user will be asked to store or cancel the calibration once new values have been determined.

## 5.6 Servodrive specific commands

Once in Servodrive mode do not mix with other (non-servodrive) CADM/CADM<sub>2</sub> commands (for example do not use the MOV command while in Servodrive mode). Only OEM<sub>2</sub> specific commands are allowed.

### 5.6.1 Enable Servodrive

Enable the internal position feedback control and start operating in servo mode. [PGAIN] is the Controller Proportional gain in (Frequency/error) [Hz/Tick] (by default set to 300).

Command [followed by enter]	(Example) Response
<pre>caccli FBEN [PGAIN] [TYPE] [TEMP] [TRQFR]</pre> <p>example:</p> <pre>caccli FBEN 300 CA1801 293</pre>	STATUS : POSITION CONTROL ENABLED

### 5.6.2 Disable Servodrive

Disable the internal position feedback control.

Command [followed by enter]	(Example) Response
<pre>caccli FBXT</pre> <p>example:</p> <pre>caccli FBXT</pre>	STATUS : POSITION CONTROL DISABLED

### 5.6.3 Go to Set Point

When Servodrive has been enabled use this command to move actuators to the set point position. After the FB<sub>CS</sub> command has been send, the controller will react immediately by moving the actuators towards the set points [SP1], [SP2] and [SP3] [in Encoder Ticks<sup>18</sup>].

Command [followed by enter]	(Example) Response
<pre>caccli FB<sub>CS</sub> [SP1] [SP2] [SP3]</pre> <p>example:</p> <pre>caccli -100 -100 -100</pre>	STATUS : POSITION CONTROL SET

Note that if an actuator is not connected to one of the outputs, enter 0 (zero) as position set point.

Please note the following:

- Avoid physically touching unconnected outputs when the controller is turned ON.
- Do not select and actuate unconnected outputs.
- Power down the controller before disconnecting any actuator(s) or system(s).
- Servodrive with a CADM module only works with output A of that CADM module! In that

<sup>18</sup> The OEM<sub>2</sub> encoder position readout is displayed in Encoder Ticks (pulses). Position resolution depends on type of encoder grid (PPR, Pulses Per Revolution - see brochures of each individual product).

case only use [SP1] and leave the others at zero (0).

- Encoder values will be reset after a power cycle (COE is a relative incremental encoder, current positions will not be stored).

#### 5.6.4 Emergency stop

When Servodrive has been enabled and actuators are moving use this command for an immediate stop (of all actuators).

Command [followed by enter]	(Example) Response
cacli FBES	STATUS : POSITION CONTROL STOPPED

#### 5.6.5 Find end stops

When Servodrive has been enabled use this command to move actuators to a (hard) end stop.

Please note that this function is defined to be used with systems like the **CPSHR**. Consult the interface drawings to get detailed information about the availability of (hard) end stops in systems!

Encoder values will be reset after a power cycle (COE is a relative incremental encoder, current positions will not be stored).

Command [followed by enter]	(Example) Response
cacli FBFE [DIR] [FILTER] [ZERO]  example: cacli FBFE 1 20 1	STATUS : POSITION CONTROL FIND ENDSTOP

Command	Description
[DIR]	Direction to hit end stop: 1 = CW, 0=CCW
[FILTER]	Velocity polling delay (relative) in range 1 to 20.
[ZERO]	Reset position after completion (1=yes, 0=no)

#### 5.6.6 Get status position control

Get status position and position error information of the controller.

Command [followed by enter]	(Example) Response
cacli FBST	STATUS : POSITION CONTROL INQUIRY ENABLED:1 BUSY:0 POS1:-100 POS2:-100 POS3:-100 ERR1:0 ERR2:0 ERR3:0

Return	Description
--------	-------------

Return	Description
[ENABLED]	0 when position control is disabled 1 when position control is enabled 2 when the find end stop procedure is activated
[BUSY]	If 1 the controller is busy minimizing the error between the set point end the current position. When this flag is 0 (zero), the position error is 0 (zero).
[POSx]	Current position information [Encoder Ticks <sup>19</sup> ].
[ERRx]	Current position error information [Encoder Ticks <sup>19</sup> ].

## 5.7 Pipe server for USB communication (optional)

Every time a new command is entered into the CLI the USB port is opened, the command is processed and transferred, then the USB port is closed again. This procedure for communicating with the controller is time consuming. In order to leave the USB communication port open, the CLI can be opened as a *pipe server* and *-client* to relay command messages from application specific interfaces (MATLAB® e.g.).

### 5.7.1 Opening and closing the pipe server

The pipe server can be opened **automatically** (in a new terminal window) with the first USB connection available by using:

```
cacli @SERV
```

The pipe will be named "SamplePipe".

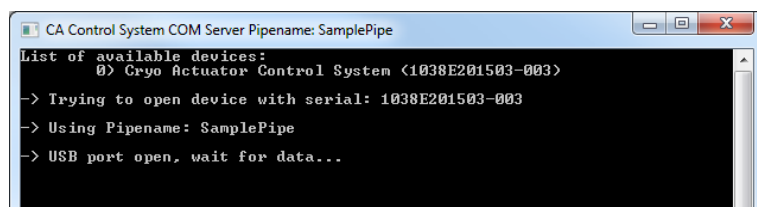


Figure 15: automatic opening of pipe server (with name "SamplePipe")

If another controller or USB connection is desired, then the user can open the pipe server **manually**:

```
cacli SERV
```

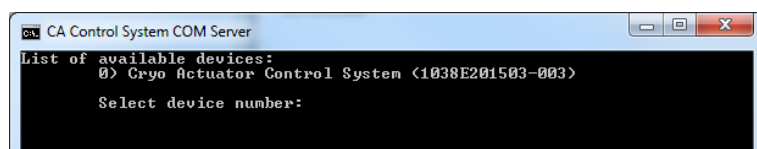


Figure 16: select the controller by number

<sup>19</sup> The OEM2 encoder position readout is displayed in Encoder Ticks. Position resolution depends on type of encoder grid (PPR, Pulses Per Revolution - see brochures of each individual product).

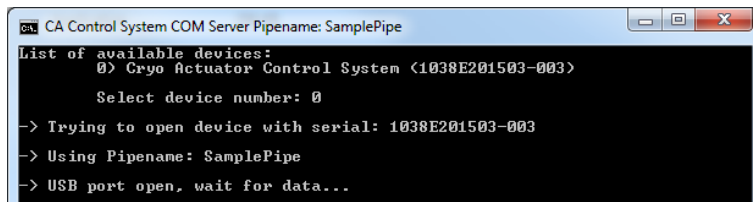


Figure 17: manual selected controller number. Pipe name: "SamplePipe".

Or by directly entering the controller ID#:

```
cacli SERV:[SERIALNUMBER]
```

Where [SERIALNUMBER] is the controller ID# (see paragraph 4.1). Note that in this case the pipe will be named after the controller ID#.

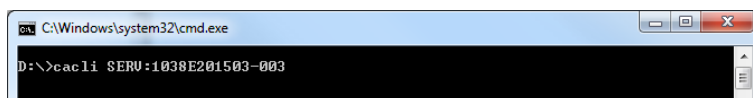


Figure 18: select by controller ID#

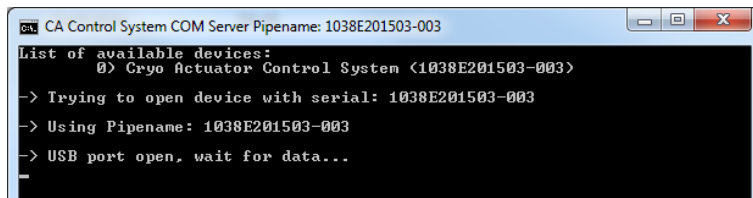


Figure 19: selected by controller id#. Pipe name: "1038E201503-003".

In the two latter cases the user has to open a new terminal window to be able send commands via the pipe to the controller.

Close the Pipe Server by simply closing the terminal window that is running the pipe or to enter **CTRL+C** in this terminal window.

### 5.7.2 Using the pipe client

If the Pipe Server is opened **automatically** (and has the name *SamplePipe*) the user can address the pipe by using the argument:

```
cacli @SERV {followed by other command arguments}
cacli @SERV:SamplePipe {followed by other command arguments} (optional)
```

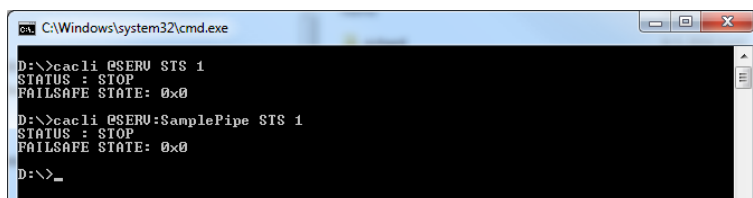
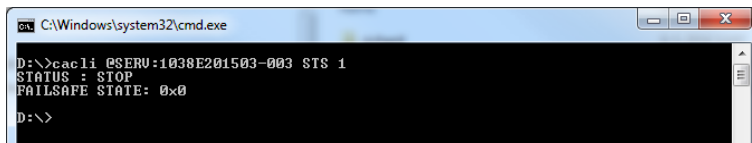


Figure 20: pipe client (automatic)

If the Pipe Server is opened **manually** (or might have a different name) the user can address it like this:

```
cacli @SERV:[pipename] {followed by other command arguments}
```



```

C:\Windows\system32\cmd.exe
D:\>cac1i ESERU:1038E201503-003 STS 1
STATUS : STOP
FAILSAFE STATE: 0x0
D:\>

```

Figure 21: pipe client (manual)

## 5.8 Error codes

### 5.8.1 Command error codes

In case the controller receives an invalid command, an error response [err] will be sent back displaying the expected command arguments.

Error code	Description
err 1.x	Invalid parameter used.
err 3.x	Indicates that the CADM/CADM2 parameter argument string is not complete; so for example if the following command is send: MOV 1 1 CA1801, the controller system will respond with this error number (because the MOV parameter requires values for DIR, FREQ, REL and STEPS as well).
err 4.x	Like err 3 but for OEM2 specific parameter argument strings.
err 5.x	Like err 3 but for ServoDrive specific parameter argument strings.
ERROR: time out	Communication error between PC and controller.
ERROR: DEVICE NOT FOUND	The controller is not connected to the PC.
ERROR: COUNTER NOT FOUND	There is no Cryo Optical Encoder connected to an OEM2 channel.

### 5.8.2 Failsafe State


When using the Status command (STS) in the command line interface (See paragraph 5.4.5), the controller will display a Failsafe State value. In normal operation this value should be 0x0, however if there is an issue (amplifier status LED on front panel will light up red), the cause of the error may be requested via this command.

Failsafe State code	Description
0x01	FAILURE: *UPPER* VOLTAGE RAIL IS MISSING INSPECTION OF UNIT IS REQUIRED
0x02	FAILURE: *LOWER* VOLTAGE RAIL IS MISSING INSPECTION OF UNIT IS REQUIRED
0x04	THERMAL OVERLOAD OF AMPLIFIER STAGE CAPACITIVE LOAD IS TOO LARGE, LET UNIT COOL DOWN
0x40	FAILURE: OVERCURRENT DETECTED on UPPER RAIL: I>10A t>100us: POSSIBLE CAUSES: 1) SHORT CIRCUIT TO PROTECTED EARTH OR REFERENCE 2) CAPACITIVE LOAD OR DRIVE PARAMETERS NOT CORRECT RESET REQUIRED

Failsafe State code	Description
0x20	FAILURE: OVERCURRENT DETECTED on UPPER RAIL: $I > 0.15A$ $t > 1ms$ : POSSIBLE CAUSES: 1) SHORT CIRCUIT TO PROTECTED EARTH OR REFERENCE 2) CAPACITIVE LOAD OR DRIVE PARAMETERS NOT CORRECT RESET REQUIRED
0x10	FAILURE: OVERCURRENT DETECTED on LOWER RAIL: $I > 10A$ $t > 100\mu s$ : POSSIBLE CAUSES: 1) SHORT CIRCUIT TO PROTECTIVE EARTH 2) CAPACITIVE LOAD OR DRIVE PARAMETERS NOT CORRECT RESET REQUIRED
0x08	FAILURE: OVERCURRENT DETECTED on LOWER RAIL: $I > 0.15A$ $t > 1ms$ : POSSIBLE CAUSES: 1) SHORT CIRCUIT TO PROTECTIVE EARTH 2) CAPACITIVE LOAD OR DRIVE PARAMETERS NOT CORRECT RESET REQUIRED

## 6. TROUBLESHOOTING & KNOWN ISSUES

### 6.1 (GUI) Floating Point Error when moving actuator

Make sure the row is selected for the particular actuator. The row is correctly selected when the  - mark is visible. If that is not the case, this error may pop up.

### 6.2 Unable to detect available channels

If the GUI or CLI is unable to find the available (CADM/CADM2/OEM2) channels, try the following:

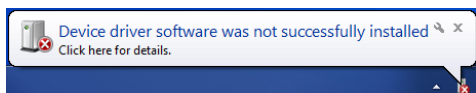
- 1 Close the GUI or CLI application
- 2 Disconnect the USB and/or LAN cable
- 3 Power cycle the controller cabinet
- 4 (If applicable) Make sure the *Channel* knob on the MCM is set to "EXT"
- 5 Reconnect the USB and/or LAN cable
- 6 Start the GUI application or CLI again

### 6.3 Windows cannot find driver

If Windows is not able to find a suitable FTDI driver itself, select a driver from the downloaded software zip file. You can find the drivers in the (sub-) folder `\USBdriver\`.

### 6.4 Unable to install driver in Windows 7

In a rare case it may happen that the Controller Software driver cannot be installed in Windows 7 (64bit version) because of a driver sign issue. In this case, because the software driver is not signed by Microsoft, Windows refuses to install the driver.



A workaround is to do the following:

- 1 Launch a Command Prompt under Administrative privileges by clicking the *Start > Search for "cmd"* (without quotes).
- 2 Right-click on the search results and choose *Run as administrator*. Click through the UAC prompt.
- 3 In the command prompt window execute the following two commands:

```
bcdedit.exe -set loadoptions DDISABLE_INTEGRITY_CHECKS [enter]
bcdedit.exe -set TESTSIGNING ON [enter]
```

- 4 Now restart the computer to disable digital driver signing in Windows 7.





## 7. USER MANUAL VERSION

This User Manual assumes using the latest products and controller software:

CPS\_v5.3.201810xx

If you are using older products you might require consulting a different User Manual. Please visit the JPE website: <http://www.janssenprecisionengineering.com/page/cryo-positioning-systems-controller/> and click on the drop down item "Controller Software & User Manuals".

Fill in the Contact form on <http://www.janssenprecisionengineering.com/contact/> to request older User Manuals or software versions.