MAN02 – SOFTWARE USER MANUAL

CRYO & NANO POSITIONING PRODUCTS

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RELEVANT DOCUMENTATION

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[1]	CNP-Products_MAN00_R01_Getting-Started.pdf (JPE)
[2]	C181055_APN01_Rxx_CPSC_Modes_Of_Operation.pdf (JPE)
[3]	C181055_APN02_Rxx_Using-Linux-OS.pdf (JPE)
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DOCUMENT HISTORY

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DEFINITIONS

ABBREVIATIONS

1. INTRODUCTION

Thank you for using JPE's Cryo & Nano Positioning products!

This manual describes the control and operation via software of *Cryo & Nano Positioning Systems* (from here on described as *systems*) using JPE's 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 document 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*).

Please note that all content in this document is superseded by any new versions of this document. Visit the JPE website (www.jpe.nl) to obtain the most recent version[1]. All images in this document are for illustrative purposes only.

1.1 Prerequisites

Before continuing with this user manual, please make sure to read and understand the contents of the (latest version of the) Cryo & Nano Positioning Products Getting Started Guide (MAN00) as well as the applicable Product User Manuals.

[1] This *User Manual* is intended for products ordered and delivered from **June 2019 onwards**. For products ordered and delivered prior to this date, please refer to the previous User Manual(s), see also Appendix A.

2. CONTROLLER DRIVER SETUP

2.1 System requirements

To be able to control actuators and systems via software, a PC system with (at least) Windows 7 (SP1) (32bit or 64bit) and one free USB2.0 port is required (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/CAT6 (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 4). Running the software in Linux is only possible when using the Windows-emulator "Wine"[2].

2.2 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.

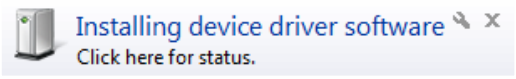
3 Place the controller on an appropriate surface (for example a sturdy workbench) and make sure that no actuators or systems are connected to the controller!

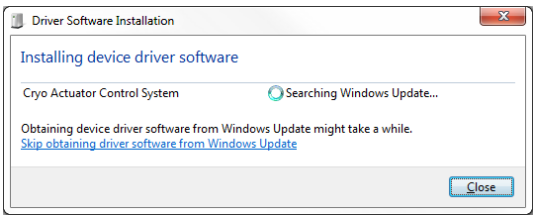
4 Make sure that the *Mains Power Switch* on the back of the controller is in the "0" (OFF) position.

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):





[2] Visit www.jpe.nl > Cryo & Nano Positioning > Cryo Positioning Systems Controller (CPSC)

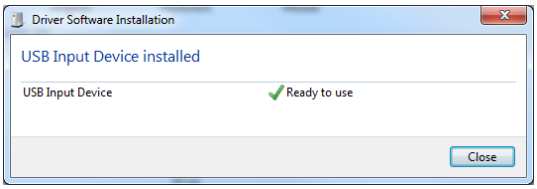


Figure 1: Installing software messages

(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:

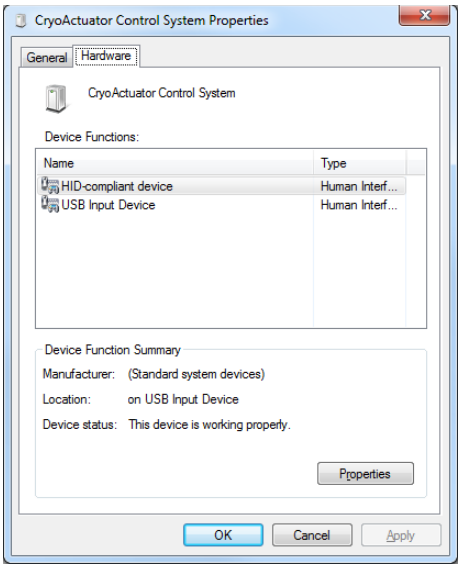


Figure 2: Driver properties

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

9 Driver installation finished.

2.3 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[3].

1 Make sure that the *Mains Power Switch* on the back of the controller is in the "0" (OFF) position.

2 Connect a CAT5e/CAT6 (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.

[3] This requires a DHCP Server to be active on the Local Area Network.

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 set the IP address in the controller. Read Chapter 3.4 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).

3. GRAPHICAL USER INTERFACE (GUI)

***Important note**: A Graphical User Interface (GUI) for v6.x user software is not available. For the next major software upgrade (v7.x), an updated GUI will be released.*

***For basic movement functions only**, it is still possible to use the v5.3 GUI with the v6.x firmware and limited to the use of CADM2 modules. Do note that any other functions (for example related to the OEM2, RSM or diagnostics) will not work properly. The GUI executable is included in the download .zip file, but please refer to the v5.3 Software User Manual for information.*

[4] CADM2, RSM and OEM2 modules are supported by the GUI.

[5] See CNP-Products MAN01-09 (CPSC).

4. COMMAND LINE INTERFACE (CLI)

Before continuing, make sure to follow the proper setup and installation as described in the Getting Started Guide.

Please note that the controller can be used in different Modes of Operation: 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 or parameters combinations for the CLI will define the mode of operation the controller is in[8].

The 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) for example.

Note that the CLI cannot run at the same time as the GUI (or vice versa); only one can have control over the controller (the controller is always slave to the GUI or CLI).

Upon power on of the cabinet please wait for about 10 seconds for the controller to boot, before using the CLI.

The command line interface is a single file **(CAcli.exe)** that is called from the (Windows) command prompt and needs various arguments to work:

```
cacli COMMAND [parameters] {enter}
```

The screenshot below shows a few examples:

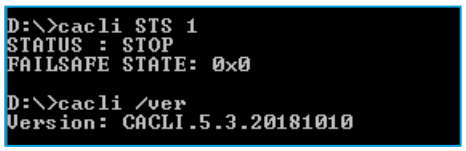


Figure 12: CLI examples

4.1 Addressing a specific controller

4.1.1 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 3.1). The first argument preceded with `@`, will define the target device. This argument needs to precede any other command arguments. For example:

```
cacli @1038E201807-05 COMMAND [parameters] {enter}
```

[8] See the document CPSC_Modes_Of_Operation.pdf (APN01)

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).

4.1.2 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 3.1). 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 COMMAND [parameters] {enter}
```

4.2 Command overview

A quick overview of all available commands (COMMAND) for all available modules and modes of operation.

Command	Description	Module	Mode of operation	Paragraph
DESC	Get information on installed module	CADM2	n/a	4.5.1
INFO	Get information on actuator types set		n/a	4.5.2
MOV	Move		Basedrive	4.5.3
STP	Stop			0
STS	Status			4.5.5
SDC	Scanner Mode			4.5.6
EXT	Use External Input		Flexdrive	4.5.7
PGV	Get Position	RSM	Basedrive	4.6.1
PGVA	Get Position of all 3 channels			4.6.2
EXS	Set excitation duty cycle			4.6.3
EXR	Read excitation duty cycle			4.6.4
MIS	Set negative end stop			4.6.5
MAS	Set positive end stop			4.6.6
MIR	Read negative end stop			4.6.7
MAR	Read positive end stop			4.6.8
MMR	Reset negative and positive end stop			4.6.9
HFM	Request buffered high frequency measurement			4.6.10
RSS	Save settings in non-volatile memory			4.6.11
INF	Request information about all settings			4.6.12
POS	Get Position	OEM2	Basedrive	4.7.1
RST	Reset Position			4.7.2
OEMC	Auto calibration procedure			4.7.3
FBEN	Enable Servodrive	{All modules}	Servodrive	4.8.1
FBXT	Disable Servodrive			4.8.2
FBCS	Go To setpoint			4.8.3
FBES	Emergency Stop			4.8.4
FBST	Get status position control			4.8.6

4.3 Common parameter arguments

The command line interface accepts `[parameters]` in a particular order. Depending on the first command `[COMMAND]` one of multiple other parameters are required.

Parameter	Value	Description
`[ADDR]`	`1 to 6`	Address of module corresponding to controller slot. *Address 1 => Slot 1 => the module on the leftmost position as seen from front of the cabinet.*
`[CH]`	`1 to 3`	Specific channel of a Module. Only applicable for modules with multiple input or output channels.
`[STAGE]`	`{VARIOUS}`	Sets specific internal system parameters for the type of actuator or system attached to that particular channel of that particular module set by `[ADDR]` and `[CH]`. Use command `/type` to get list of the available options.
`[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`	(Relative) Piezo step size parameter input. Value is a percentage [%] (numerical values only)[9].
`[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 (numerical values only).

4.4 General CLI commands

4.4.1 Get CLI version information

Command [followed by enter]	**(Example) Response**
`cacli /ver`	`Version: CACLI.5.3.20181010`

4.4.2 List of connected controllers

Command [followed by enter]	(Example) Response

`cacli /list`	`List of available devices:`
	`0) Cryo Actuator Control System (3057E201003-002)`
	`1) Cryo Actuator Control System (3057E201003-003)`

4.4.3 List of supported actuator and stage types

For use with the `[STAGE]` parameter.

[9] *See product brochures for typical step size values for each actuator or system. Typically leave this at 100[%] unless small(er) steps are required.*

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Command [followed by enter]	(Example) Response
cacli /type	List of Cryo Actuator types: CLA2201 CLA2201-COE CLA2201MK1 CLA2201MK1-COE ... ...

4.4.4 Get information about installed modules

Command to list the automatically detected modules in the controller.

Command [followed by enter]	(Example) Response
cacli modlist	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:4 SLOT 5 : SLOT 6 :

4.4.5 Scan for USB connected cabinets

If multiple controllers are connected to a PC using USB, use this command to retrieve a list of connected devices.

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

4.4.6 Scan for LAN connected cabinets

If one or more controllers are connected to a Local Area Network (LAN), use this command to retrieve a list of connected devices with their respective IP-addresses.

Command [followed by enter]	(Example) Response
cacli /LAN	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

4.5 CADM2 specific commands

4.5.1 Get information on installed module

Requests the module description and available output channels

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

4.5.2 Get information on actuator types set

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

Command [followed by enter]	(Example) Response
cacli INFO [ADDR] example: cacli INFO 1	STAGE : CA2601 TAG : NONE

4.5.3 Move

Note: command specific for Basedrive mode of operation.

The move command starts moving an actuator with specified parameters. If an RSM or OEM2 is installed, the actuator position will be tracked automatically.

Command [followed by enter]	(Example) Response
cacli MOV [ADDR] [STAGE] [TEMP] [DIR] [FREQ] [REL] [STEPS] ([TRQFR])* (* optional) example: cacli MOV 1 CA2601 293 1 600 100 100	STATUS : MOVE

Please note the following:

- *Avoid physically touching unconnected outputs when the controller is turned ON.*
- *Do not select and drive unconnected outputs.*
- *Power down the controller before disconnecting any actuator(s) or system(s).*
- *OEM2 Encoder values will be reset after a power cycle (the Cryo Optical Encoder is a relative incremental encoder, current positions will not be stored).*

4.5.4 Stop

Note: command specific for Basedrive mode of operation.

Stops movement of an actuator.

Command [followed by enter]	(Example) Response

`cacli STP [ADDR]`
 	
`example:`
`cacli STP 1`
	`STATUS : STOP`

4.5.5 Status

Note: command specific for Basedrive mode of operation.

Requests the drive status: `MOVING` or `STOP`. In addition the `FAILSAFE STATE` (see paragraph 4.10) is being shown. If any error occurred (red status LED on module front panel has been lit), the cause of the error may be requested via this command.

Command [followed by enter]	(Example) Response

`cacli STS [ADDR]`
 	
`example:`
`cacli STS 1`
	`STATUS : STOP`
	`FAILSAFE STATE: 0x0`

4.5.6 Scanner Mode

The CADM2 can be used in a "scanner mode". In this mode the module will output a DC voltage level (to be used with a scanner piezo for example) instead of the default drive signal. `[VALUE]` can be set to a numerical value in between 0 and 1023 (10-bit value) where zero represents ~0[V] output (-30[V] in respect to REF) and the maximum value represents ~150[V] output (+120[V] in respect to REF). Use the `STP` (Stop) command to cancel this function.a

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

Command [followed by enter]	(Example) Response

`cacli SDC [ADDR] [VALUE]`
 	
`example:`
`cacli SDC 1 512`
	`STATUS : MOVE`

4.5.7 Use External Input

Note: command specific for Flexdrive mode of operation.

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]` argument now defines the step frequency at maximum (absolute) input signal. By default set this to 600 [Hz].
- With the `[DIR]` argument 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
cacli EXT [ADDR] [STAGE] [TEMP] [DIR] [FREQ] [REL] ([TRQFR])* (* optional) example: cacli EXT 1 CA2601 293 1 600 100	STATUS : USING EXTERNAL INPUT

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]. 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 drive unconnected outputs.*
- *Power down the controller before disconnecting any actuator(s) or system(s).*
- *OEM2 Encoder values will be reset after a power cycle (the Cryo Optical Encoder is a relative incremental encoder, current positions will not be stored).*

4.6 RSM specific commands

4.6.1 Get Position

Note: command specific for Basedrive mode of operation.

Request the position of a Resistive Linear Sensor (RLS) connected to a specific channel [CH] of the RSM module. Position value is in [m].

Command [followed by enter]	(Example) Response
cacli PGV [ADDR] [CH] [STAGE] example: cacli PGV 3 3 CBS10-RLS	RSM 3, channel 3 value: 0.004863806[m]

4.6.2 Get Position of all 3 channels

Note: command specific for Basedrive mode of operation.

Request the position of all three channels of the RSM simultaneously. Position value is in [m].

Command [followed by enter]	(Example) Response
cacli PGVA [ADDR] [STAGE] [STAGE] [STAGE] example: cacli PGVA 3 CBS10-RLS CBS10-RLS CBS10-RLS	RSM 3, channel 1 value: -0.000949055[m] RSM 3, channel 1 value: -0.000859404[m] RSM 3, channel 1 value: -0.004867325[m]

4.6.3 Set excitation duty cycle

Note: command specific for Basedrive mode of operation.

Set the duty cycle of the sensor excitation signal of the RSM. Value is in [%] and can be set to 0 (zero) or from 10 to 100. The duty cycle is set for all channels of an RSM module (it is not possible to set the duty cycle for an individual channel).

Command [followed by enter]	(Example) Response
cacli EXS [ADDR] [DUTY] example: cacli EXS 3 20	Excitation frequency for RSM 3 has been set

4.6.4 Read excitation duty cycle

Note: command specific for Basedrive mode of operation.

Read the duty cycle of the sensor excitation signal of the RSM. Value is in [%]. The duty cycle is set equally for all channels of an RSM module.

Command [followed by enter]	(Example) Response
cacli EXR [ADDR] example: cacli EXS 3	RSM 3, excitation duty-cycle: 100[%]

4.6.5 Set negative end stop

Note: command specific for Basedrive mode of operation. To be used as part of the RLS Calibration process (see paragraph 4.6.13).

Set the current position of a Resistive Linear Sensor (RLS) connected to channel `[CH]` of the RSM to be the negative end-stop. Please follow the RLS Calibration process on how and when to use this command correctly.

Command [followed by enter]	(Example) Response
cacli MIS [ADDR] [CH] example: cacli MIS 3 3	Minimum value for RSM 3, channel 3 has been set

4.6.6 Set positive end stop

Note: command specific for Basedrive mode of operation. To be used as part of the RLS Calibration process (see paragraph 4.6.13).

Set the current position of a Resistive Linear Sensor (RLS) connected to channel `[CH]` of the RSM to be the positive end-stop. Please follow the RLS Calibration process on how and when to use this command correctly.

Command [followed by enter]	(Example) Response
cacli MAS [ADDR] [CH] example: cacli MAS 3 3	Maximum value for RSM 3, channel 3 has been set

4.6.7 Read negative end stop

Note: command specific for Basedrive mode of operation.

Read the current value of the negative end-stop parameter set for a specific channel `[CH]` of an RSM.

Command [followed by enter]	(Example) Response
cacli MIR [ADDR] [CH] [STAGE] example: cacli MIR 3 3 CBS10-RLS	RSM 3, channel 3 minimum value: -0.004864048 [m]

4.6.8 Read positive end stop

Note: command specific for Basedrive mode of operation.

Read the current value of the positive end-stop parameter set for a specific channel `[CH]` of an RSM.

Command [followed by enter]	(Example) Response
cacli MAR [ADDR] [CH] [STAGE] example: cacli MAR 3 3 CBS10-RLS	RSM 3, channel 3 maximum value: 0.004864049 [m]

4.6.9 Reset negative and positive end stop

Note: command specific for Basedrive mode of operation.

Reset the current values of the negative and positive end-stop parameters set for a specific channel `[CH]` of an RSM. Note that both parameters will be reset to the values stored in the non-volatile memory of the controller (see paragraph 4.6.11).

Command [followed by enter]	(Example) Response
cacli MMR [ADDR] [CH] example: cacli MMR 3 3	Minimum and maximum values for RSM 3, Channel 3 have been reset

4.6.10 Request buffered high frequency measurement

Note: command specific for Basedrive mode of operation.

To be used when there are issues with the Resistive Linear Sensor (-RLS option) or RSM module. Please consult JPE first before using this function!

Read a (buffered) set of sensor values of a Resistive Linear Sensor (RLS) connected to channel `[CH]` of the RSM. Data will be logged for 0.5[sec] with a sample frequency of ~5[kHz].

Command [followed by enter]	(Example) Response

`cacli HFM [ADDR] [CH] [STAGE]`
 	
`example:`
`cacli HFM 3 3 CBS10-RLS > HFMoutput.txt`
	`[list of data values]`

Note that by adding the greater-than character (>) after the parameter commands, the results will be written to a text file (with a name of choice).

4.6.11 Save settings to non-volatile memory

Note: command specific for Basedrive mode of operation.

Store the current values of the following parameters of the RSM to the non-volatile memory of the controller: *excitation duty cycle* (`EXS`), *negative end stop* (`MIS`) and *positive end-stop* (`MAS`).

Command [followed by enter]	(Example) Response

`cacli RSS [ADDR]`
 	
`example:`
`cacli RSS 3`
	`Settings for RSM 3 have been stored in flash`

Note that when resetting the negative and positive end stop values (see paragraph 4.6.9), these settings will be (re-)loaded. Also note that any previously stored values will be overwritten.

Factory default settings are:
- *EXS: 100%*
- *MIS and MAS: factory calibrated values for the ordered actuator or system.*

4.6.12 Request information about all settings

Note: command specific for Basedrive mode of operation.

Read the current values of the following parameters of the RSM: excitation duty cycle (in [%]), negative and positive end stops of each channel (in [m]).

Command [followed by enter]	(Example) Response

`cacli INF [ADDR]`
 	
`example:`
`cacli INF 3`
	`RSM 3, excitation duty-cycle: 50[%]`
	`RSM 3, channel 1 minimum value: -0.004844467 [m]`
	`RSM 3, channel 1 maximum value: 0.004844467 [m]`
	`RSM 3, channel 2 minimum value: -0.004857395 [m]`
	`RSM 3, channel 2 maximum value: 0.004857396 [m]`
	`RSM 3, channel 3 minimum value: -0.004864835 [m]`
	`RSM 3, channel 3 maximum value: 0.004864836 [m]`

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4.6.13 How to calibrate a Resistive Linear Sensor (RLS)

Follow the instructions below to (re-)calibrate a Resistive Linear Sensor (RLS) connected to one of the sensor inputs of an RSM using the commands listed in previous paragraphs.

1 Make sure the actuator is not moving. Run the `MIR` and `MAR` command to get the current values stored in the controller for the negative and positive end stop respectively. Write these values down in case it is required to restore these values.

2 Move the connected actuator to the negative end stop position. This can be done manually *(with great care and only if physically possible)* or by using the `MOV` command (see paragraph 4.5.3). When using the `MOV` command, get up to date position values with the `PGV` (see paragraph 4.6.1) or `PGVA` command (see paragraph 4.6.2) to determine when the negative end stop position has been reached.

3 Make sure the actuator is not moving. Use the `MIS` command (see paragraph 4.6.5) to set the current position value to be the negative end stop.

4 Move the connected actuator to the positive end stop position. This can be done manually *(with great care and only if physically possible)* or by using the `MOV` command (see paragraph 4.5.3). When using the `MOV` command, get up to date position values with the `PGV` (see paragraph 4.6.1) or `PGVA` command (see paragraph 4.6.2) to determine when the positive end stop position has been reached.

5 Make sure the actuator is not moving. Use the `MAS` command (see paragraph 4.6.6) to set the current position value to be the positive end stop.

6 Save the calibration values to the non-volatile memory using the `RSS` command so they will be stored even if the controller has been powered down.

7 Repeat steps #1 to #6 for any other sensors connected to the RSM.

8 (Re-)Calibration is now completed.

4.7 OEM2 specific commands

4.7.1 Get Position

Note: command specific for Basedrive mode of operation.

Request the position of an encoder connected to channel `[CH]` of an OEM2. Position value is in [Encoder Ticks[10]].

Command [followed by enter]	(Example) Response

`cacli POS [ADDR] [CH]`
 	
`example:`
	`POS: 2`

[10] 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).

`cacli POS 1 1`	`RVL: 0`

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

4.7.2 Reset Position to Zero

Note: command specific for Basedrive mode of operation.

To reset the position to zero for a specific encoder connected to channel `[CH]` of an OEM2.

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

`cacli RST [ADDR] [CH]`
 	
`example:`
`cacli RST 1 1`
	`Counter for CH1 has been reset to zero`

4.7.3 Auto Calibration Procedure

To be used when there are issues with the Cryo Optical Encoder (-COE option), OEM2 module or if the Cryo Optical Encoder requires re-calibration. Please consult JPE first before using this function!

To start a calibration procedure for a specific encoder connected to channel `[CH]` of an OEM2.

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

`cacli OEMC [ADDR] [CH] [STAGE] [TEMP] [DIR] [FREQ]`
 	
`example:`
`cacli OEMC 1 1 CA2601 293 0 600`
	`=== 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)?`

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.

Note: the calibration can be stopped prematurely by pressing the Enter-key; the calibration procedure then uses data gathered up to that point (might be required when calibrating a CLD-COE for example).

4.8 Servodrive specific commands

Once in Servodrive mode do not mix with other non-Servodrive commands (for example do not use the `MOV` command while in Servodrive mode). In general, Servodrive commands are 4-characters long starting with the letters `FB`.

4.8.1 Enable Servodrive

Enable the internal position feedback control and start operating in servo mode with the connected `[STAGE]`.

- RLS/RSM: `[CLEARANCE]` defines the distance the `[STAGE]` must keep in respect to the end stop (set with `MIS` and `MAS`). Value in [m].
- COE/OEM2: set `[CLEARANCE]` to 0 (zero).

Command [followed by enter]	(Example) Response

`cacli FBEN [STAGE] [CLEARANCE] [STAGE] [CLEARANCE] [STAGE] [CLEARANCE] [TEMP] ([TRQFR])*`
 	
`(* optional)`
 	
`example:`
`cacli FBEN CS021-RLS.X 0 CS021-RLS.Y 0 CS021-RLS.Z 0 300`
	`STATUS : POSITION CONTROL ENABLED`

Note that Servodrive control will not be updating the setpoints once control has been disabled (see paragraph 4.8.2). This means that if the sensor position value changes, `FBEN` will move the actuators back to its last known (setpoint) position when re-enabling Servodrive! (Initially this will be setpoint `SPx=0`).

4.8.2 Disable Servodrive

Disable the internal position feedback control.

Command [followed by enter]	(Example) Response

`cacli FBXT`
 	
`example:`
`cacli FBXT`
	`STATUS : POSITION CONTROL DISABLED`

4.8.3 Go To Setpoint

When Servodrive has been enabled (`FBEN`) use this command to move actuators to a set point position. After the `FBCS` command has been send, the controller will react immediately by moving the actuators towards the set points `[SP1]`, `[SP2]` and `[SP3]`. `[SPx]` values need to be entered in [m]. Set `[ABS]` to 1 to enable absolute positioning (`[SPx]` values will be relative to the center of the stage), otherwise set to 0 (zero).

Command [followed by enter]	(Example) Response

`cacli FBCS [SP1] [ABS] [SP2] [ABS] [SP3] [ABS]`
 	
`example:`
`cacli -1e-3 1 -1e-3 1 -1e-3 1`
	`STATUS : POSITION CONTROL SET`

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Note that if an actuator / stage 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).*
- *Cryo Optical Encoder (COE) values will be reset after a power cycle (COE is a relative incremental encoder, current positions will not be stored).*

4.8.4 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

4.8.6 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 FINISHED:1 TIME-OUT1:0 TIME-OUT2:0 TIME-OUT3:0 INVALID_SETPOINT1:0 INVALID_SETPOINT2:0 INVALID_SETPOINT3:0 POSITION_ERROR1:268 POSITION_ERROR2:107 POSITION_ERROR3:-58

Return	Description
[ENABLED]	0 : position control is disabled. 1 : position control is enabled. 2 : find end stop procedure is activated.
[FINISHED]	0 : controller is moving the [stage] towards setpoint [SPx]. 1 : controller has completed most recent positioning sequence.
[TIME-OUTx]	0 : setpoint reached within time limit. 1 : setpoint has not been reached within a time limit (system time out).
[INVALID_SETPOINTx]	0 : entered setpoint is valid. 1 : entered setpoint is not within range of the stage.
[POSITION_ERRORx]	Position error value in [bits]. Mainly used to confirm (correct) direction of movement of [stage].

4.9 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.).

4.9.1 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 {enter}
```

The pipe will be named "SamplePipe".

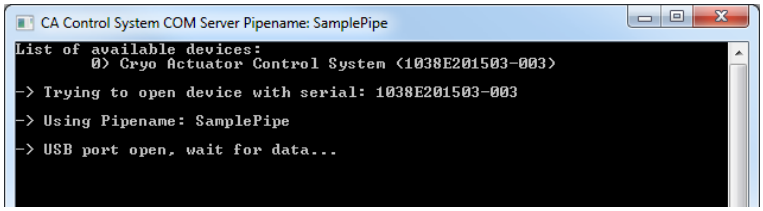

Figure 13: automatic opening of pipe server (with name "SamplePipe")

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

```
cacli SERV {enter}
```

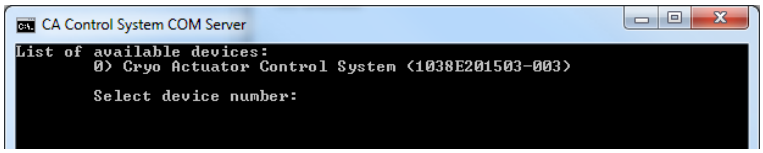

Figure 14: select the controller by number

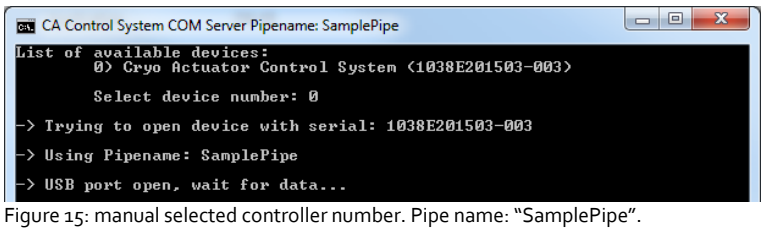

Figure 15: manual selected controller number. Pipe name: "SamplePipe".

Or by directly entering the controller ID#:

```
cacli SERV:[SERIALNUMBER] {enter}
```

Where `[SERIALNUMBER]` is the controller ID# (see paragraph 3.1). Note that in this case the pipe will be named after the controller ID#.

Figure 16: select by controller ID#

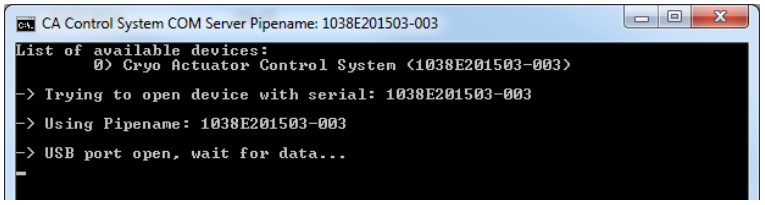

Figure 17: selected by controller id#. Pipe name: "1038E201503-003".

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.

4.9.2 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 [COMMAND] <parameters> {enter}
cacli @SERV:SamplePipe [COMMAND] <parameters> {enter} (optional)
```

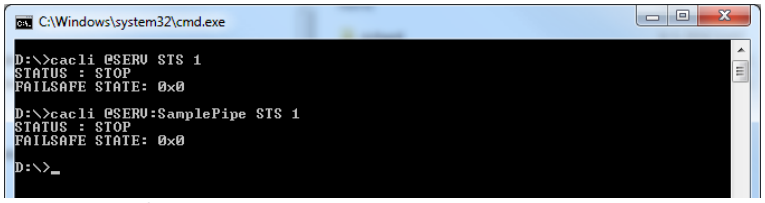

Figure 18: pipe client (automatic)

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

```
cacli @SERV:[pipename] [COMMAND] <parameters> {enter}
```

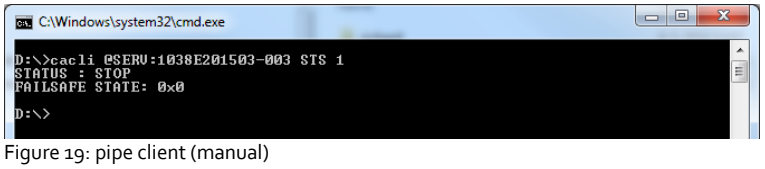

Figure 19: pipe client (manual)

4.10 Error codes

4.10.1 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 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.
`err 6.x`	Like `err 3` but for RSM 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.

4.10.2 Failsafe State

When using the Status command (STS) in the command line interface (See paragraph 4.5.5), 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 CAPACATIVE 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
`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

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Failsafe State code	Description
0x10	FAILURE: OVERCURRENT DETECTED on LOWER RAIL: I>10A t>100us: 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

5. TROUBLESHOOTING & KNOWN ISSUES

5.1 (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.

5.2 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

Appendix A. Document Version

This *Software User Manual* assumes using the latest products and controller software: **v6.0.20200224**

If you are using older products you might require to consult a different User Guide / 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"*.