

User Manual

## CRYOGENIC POSITIONING SYSTEMS (PIEZOKNOB TECHNOLOGY)

*This user manual has been superseded by a newer version. Use for information only. Most information in this document will still be valid, however follow only the General Safety Rules listed in the most recent user manual!*

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**DEFINITIONS**

Definition	Description

**ABBREVIATIONS**

Abbreviation	Description

## 1. ABOUT THIS MANUAL

This manual describes the setup and operation of *Cryogenic 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, (single) 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*).

All content in this manual is superseded by any new versions of this manual. Please visit the JPE website ([www.jpe.nl](http://www.jpe.nl)) to obtain the most recent version<sup>1</sup>.

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<sup>1</sup> This manual is intended for products ordered and delivered from July 2014 onwards. For products ordered and delivered prior to this date, please refer to the previous User Manual: 1036\_MAN01\_Rxx\_yyyy-mm-dd.pdf (visit [www.jpe.nl](http://www.jpe.nl) for a digital copy).

## 2. IMPORTANT SAFETY INFORMATION

### 2.1 User Manual Instructions

In this manual important (mostly safety related) information is shown inside a (orange 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 (orange colored) bordered boxes! Failing to observe instructions may result in a risk of mortal electric shock! So please, follow all instructions carefully!***

### 2.2 General Safety Rules

*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).*

*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.*

*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 1U height free above the cabinet.*

*It is allowed to place actuator(s) and system(s) 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).*

*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.*

*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 delivered controller is either the 230V version or the 115V version).*

*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.*

*Never open the controller cabinet (this will result in loss of warranty) or remove any modules while the controller is turned ON! Any other servicing, adjustment or repair works must only be carried out by JPE.*

### 3. AVAILABLE PRODUCTS

#### 3.1 Cryo (Linear) Actuator (CLA)

The Cryo Linear Actuator (CLA) is a piezo-ceramic based actuator developed for manipulation in ambient, vacuum and cryogenic environment. Currently, there are 2 single linear actuator types available (see pictures below<sup>2</sup>):

- CLA-1801: an actuator with a diameter of 18[mm].
- CLA-1801HF: an actuator with a diameter of 30[mm] for a higher axial load capacity.



Figure 1: CLA-1801

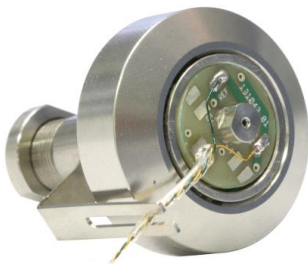


Figure 2: CLA-1801HF

Please visit <http://www.jpe.nl/products/cryo-actuator-piezoknob/> for brochures with additional detailed mechanical specifications of the most recent versions available.

##### 3.1.1 Principle of operation

The cryo (linear) actuator is developed for accurate positioning in vacuum environments from ambient down to cryogenic temperatures around a few Kelvin.

It is a spindle / nut drive concept for which the nut is attached to the frame and the spindle will be rotated by this piezo based actuator. The electrical wiring is attached to the rotating part, but decoupled for rotation by means of sliding contacts.

With the use of the controller it is possible to realize torque pulses in both directions on the spindle which enables the spindle to rotate with very small steps resulting in nanometer adjustability in a cryogenic environment.

<sup>2</sup> Images are for illustrative purposes only.

Since the working principle is based on inertia drives, the spindle always needs to be preloaded with a certain force (about 10 [N]).

It is important to know that the heat dissipation in the actuator as well as in the controller is proportional to the stepping frequency and proportional to the square of the applied voltage (step size). For full step size an estimate for the dissipated energy in the actuator is about 1.5 mJ / per step at ambient temperature but about 0.25 mJ per step at 4 Kelvin.

Please note that the actuators are driven with a set point profile with a maximum step size of 150 [V] and high peak currents!

### 3.1.2 Pin configuration

(Single) Actuators are assembled with ~150[mm] *Kapton coated wire* and a Connector Interface PCB at the end which contains a 2-pin 2.54mm pitch header (*Molex KK 22-27-2021*).

The pin configuration is as follows:

- Pin 1 : (Piezo) Signal (routes to the pad labeled "S" or "SIG" on the actuator)
- Pin 2 : (Piezo) REF (routes to the pad labeled "R" or "REF" on the actuator)

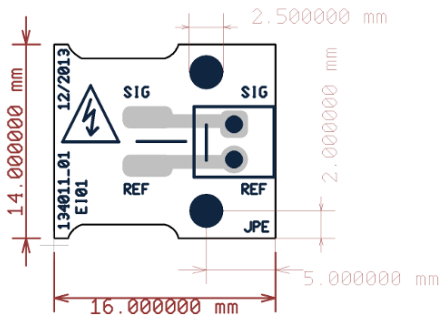


Figure 3: CLA Connector Interface PCB

There are two mounting holes available for M2 bolts (not supplied). Suitable spacers (supplied in delivery) must be used so that the header pins on the bottom pads do not touch any electrically conducting surfaces.

Make sure the Connector Interface PCB does **NOT** make any contact with an electrically conducting surface! Copper traces are exposed and the header pins soldered on the bottom side of the PCB are not isolated by default!

Also make sure that there will be no force applied to the Kapton coated wires connected to the actuator!



Please note that (Piezo) REF is NOT the same as (system) GND or PE, so do not connect these to each other and do not use standard oscilloscope probes!

The supplied *Ambient Cable* (ACL) can be connected directly to the Connector Interface PCB. If any custom cabling is required, please read paragraph 4.4 first!

### 3.1.3 Mounting instructions

By default the actuator is delivered with a spindle and spindle nut that can be mounted in a setup (thread on spindle nut). Additionally, a rotation lock “fork” is supplied that needs to be mounted with the spindle nut as well to lock the rotation of the (top) PCB on the actuator.

Make sure the wiring does not get damaged or stuck in the setup when mounting the actuator. The Connector Interface PCB must be mounted properly prior to driving the actuator electrically! Make sure the actuator can be rotated by hand (carefully, and only if applicable and practical).

See the brochure (paragraph 3.1) for additional (mechanical) information.

### 3.1.4 Connecting to Controller

At the *Controller side*, connect as follows:

Controller with 1 Cryo Actuator Driver Module (CADM) <sup>3</sup> (sequential drive of Cryo Actuators)	
CLA1801(-HF)	CADM 1, Output A

## 3.2 Cryo Positioning Stage High Resonance (CPSHR)

The Cryo Positioning Stage High Resonance (CPSHR) is a XYZ positioning stage intended for cryogenic purposes insensitive for ground vibrations due to its high internal resonance frequency (> 1 kHz). The picture below shows the CPSHR<sup>4</sup>:



Figure 4: CPSHR

Please visit <http://www.jpe.nl/products/cryogenic-positioning-stage-high-resonance/> for brochures with additional detailed mechanical specifications of the most recent version available.

<sup>3</sup> For available Modules see paragraph o.

<sup>4</sup> Images are for illustrative purposes only.

### 3.2.1 Pin configuration

The CPSHR is assembled with (3x) ~150[mm] *Kapton coated 4w ribbon cables* and a Connector Interface PCB at the end which contains (2x) 2-pin 2.54mm pitch headers (*Molex KK 22-27-2021*). For each axis there is one Connector Interface PCB.

For each axis the pin configuration is as follows:

- Pin 1 : (PS SIG) Piezo Stack Signal
- Pin 2 : (PS REF) Piezo Stack REF
- Pin 3 : (CA SIG) Cryo Actuator Signal
- Pin 4 : (CA REF) Cryo Actuator REF

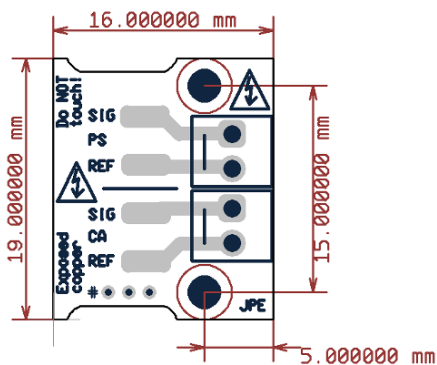


Figure 5: CPSHR Connector Interface PCB

There are two mounting holes available for M2 bolts (not supplied). Suitable spacers (supplied in delivery) must be used so that the header pins on the bottom pads do not touch any electrically conducting surfaces.

On each PCB there are 3 "marking" holes (indicated with a "#" next to it). These are 'soldered' to indicate the Axis number:

- 1 hole filled with solder: Axis 1
- 2 holes filled with solder: Axis 2
- 3 holes filled with solder: Axis 3

*Make sure that the Connector Interface PCBs do NOT make any contact with an electrically conducting surface! Copper traces are exposed and the header pins soldered on the bottom side of the PCBs are not isolated by default!*

*Also make sure that there will be no force applied to the Kapton ribbon cables connected to the system!*

*Please note that (PS or CA) REF is NOT the same as (system) GND or PE, so do not connect these to each other and do not use standard oscilloscope probes!*

The standard Ambient Cables (ACL) can be connected directly to the Connector Interface PCBs. If any custom cabling is required, please read paragraph 4.4 first!

### 3.2.2 Mounting instructions

By default the system is delivered with a mounting interface for M3 (not supplied).

Make sure the wiring to the Connector Interface PCBs do not get damaged or stuck in the setup when mounting the CPSHR. The Connector Interface PCBs must be mounted properly prior to driving the CPSHR electrically!

See the brochure (paragraph 3.2) for additional (mechanical) information.

### 3.2.3 Connecting to Controller

At the *Controller side*, connect as follows:

Controller with 1 Cryo Actuator Driver Module (CADM) (sequential drive of Cryo Actuators) and 1 Piezo Scanning Module (PSM) <sup>5</sup> (parallel drive of Piezo Stacks)	
CA – Axis 1, Z1	CADM 1, Output A
CA – Axis 2, Z2	CADM 1, Output B
CA – Axis 3, Z3	CADM 1, Output C
PS – Axis 1, Z1	PSM 1, Output A
PS – Axis 2, Z2	PSM 1, Output B
PS – Axis 3, Z3	PSM 1, Output C

## 3.3 Cryo Translation Stage (CTS)

The CTS is a translation stage for X, XY and XYZ manipulation, composed from up to 3 stacked single axis stages. The picture below shows the CTS(-XYZ)<sup>6</sup>:

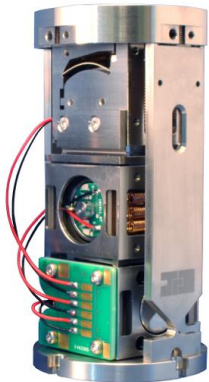


Figure 6: CTS-XYZ

Please visit <http://www.jpe.nl/products/cryo-translation-stage/> for brochures with additional detailed mechanical specifications of the most recent versions available.

### 3.3.1 Pin configuration

Wiring and connecting a CTS is somewhat different to connecting other systems. On the bottom part of the CTS a Connector Interface PCB is mounted to which cabling can be soldered.

<sup>5</sup> For available Modules see paragraph o.

<sup>6</sup> Images are for illustrative purposes only.

The pin configuration is as follows:

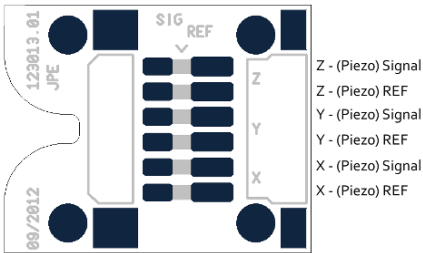


Figure 7: CTS Connector Interface PCB

The standard Ambient Cables (ACL) can NOT be connected directly to this Connector Interface PCB. If any custom cabling is required, please read paragraph 4.4 first!

*Customers are able to solder their own cabling to the CTS. Hereby it is vital to make sure that Signal and REF wires are not mixed up. Incorrect wiring will result in a risk of mortal electric shock and/or damage to the controller(s) and/or actuator(s). JPE does not assume liability for damages to property or personal injury!*

*Please note that (Piezo) REF is NOT the same as (system) GND or PE, so do not connect these to each other and do not use standard oscilloscope probes!*

**3.3.2 Mounting instructions**

By default the system is delivered with a mounting interface for M2.5 (not supplied).

Make sure the wiring to the Connector Interface PCB does not get damaged or stuck in the setup when mounting the CTS.

See the brochure (paragraph 3.3) for additional (mechanical) information.

**3.3.3 Connecting to Controller**

At the *Controller side*, connect as follows:

System with 1 Cryo Actuator Driver Module (CADM) <sup>7</sup> (sequential drive of actuators in CTS)	
X	CADM 1, Output A
Y	CADM 1, Output B
Z	CADM 1, Output C

System with 3 Cryo Actuator Driver Modules (CADM) (parallel drive of actuators in CTS)	
X	CADM 1, Output A
Y	CADM 2, Output A
Z	CADM 3, Output A

<sup>7</sup> For available Modules see paragraph o.

### 3.4 Cryo Tip / Tilt / Piston Stage (CTTPS)

There are 2 types currently available:

- CTTPS-1": a stage with an optical diameter of 1.0".
- CTTPS-2": a stage with an optical diameter of 2.0".

The picture below shows the 1" type<sup>8</sup>:

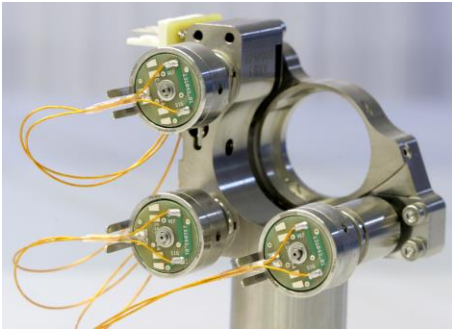


Figure 8: CTTPS-1"

Please visit <http://www.jpe.nl/products/cryo-tip-tilt-piston-stage/> for brochures with additional detailed mechanical specifications of the most recent versions available.

#### 3.4.1 Pin configuration

The CTTPS is assembled with a Connector Interface PCB already mounted onto the system. For each actuator in the CTTPS there is a 2-pin 2.54mm pitch header (*Molex KK 22-27-2021*) available.

For each actuator the pin configuration is as follows:

- Pin 1 : (Piezo) Signal (routes to the pad labeled "S" or "SIG" on the actuator)
- Pin 2 : (Piezo) REF (routes to the pad labeled "R" or "REF" on the actuator)

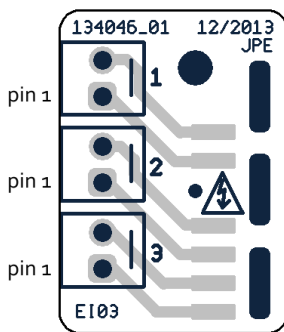


Figure 9: CTTPS Connector Interface PCB

The standard Ambient Cables (ACL) can be connected directly to this Connector Interface PCB. If any custom cabling is required, please read paragraph 4.4 first!

<sup>8</sup> Images are for illustrative purposes only.



Please note that (Piezo) REF is NOT the same as (system) GND or PE, so do not connect these to each other and do not use standard oscilloscope probes!

**3.4.2 Mounting instructions**

By default the system is delivered with a mounting interface for M4 (not supplied) at the optical center.

Make sure the wiring to the Connector Interface PCB does not get damaged or stuck in the setup when mounting the CTTPS.

See the brochure (paragraph 3.4) for additional (mechanical) information.

**3.4.3 Connecting to Controller**

At the *Controller side*, connect as follows:

System with 1 Cryo Actuator Driver Module (CADM) <sup>9</sup> (sequential drive of actuators in CTTPS)	
1	CADM 1, Output A
2	CADM 1, Output B
3	CADM 1, Output C

System with 3 Cryo Actuator Driver Module (CADM) (parallel drive of actuators in CTTPS)	
1	CADM 1, Output A
2	CADM 2, Output A
3	CADM 3, Output A

<sup>9</sup> For available Modules see paragraph o.

### 3.5 Controller

Actuators and systems can be operated with a (*Modular*) *Controller System*. This controller consists of a Base Cabinet (CAB) with one or more *plug-in modules* installed.

#### 3.5.1 Cryo Actuator Base Cabinet (CAB)

This is a 19" desktop cabinet including a Power Supply, a PC Interface for External Control Mode and six slots for up to six<sup>10</sup> plug-in modules. The picture below<sup>11</sup> shows an example configuration with 1x Cryo Actuator Driver Module (CADM), 1x Piezo Scanning Module (PSM) and 1x Manual Control Module (MCM).



Figure 10: Controller - front side

At the back there is a Mains Power IEC inlet with ON/OFF switch and 1 USB port for External Control (connection to PC). By default the system is powered by 230VAC (European), but alternatively there is also an 115VAC (US) version available<sup>12</sup>. For more information about using the controller with a PC (External Control Mode) see chapter 5.



Figure 11: Controller - back side

Please visit the JPE website for a brochure with detailed specifications of the most recent version available.

<sup>10</sup> The practical number of plug-in modules depends on the selected of modules. Please consult JPE when ordering a controller with plug-in modules.

<sup>11</sup> Images are for illustrative purposes only.

<sup>12</sup> Needs to be specified before ordering!

### 3.5.2 Cryo Actuator Driver Module (CADM)

A Cryo Actuator Driver Module (CADM) can be used to drive Cryo (Linear) Actuators (CLA). Each module can operate up to 3 actuators (in sequential mode). In total there can be up to 6 CADMs in one base cabinet (CAB), which enables driving up to 6 actuators in parallel or 18 actuators in sequential mode. The picture below shows a CADM module<sup>13</sup>:



Figure 12: CADM

The CADM generates a set point profile with a maximum step size of 150[V] and a maximum step frequency of 600[Hz]. This set point profile can be adjusted in *direction*, *step size* and *frequency* as well as be compensated for the operating temperature of the actuators.

*Please note that this module generates an (floating) output signal with a maximum of 150 [V] and high peak currents!*

Adjusting and operating these modules can be done via the External Control Mode (PC Interface connection, see chapter 5) or by using a Manual Control Module<sup>14</sup> (MCM, see paragraph 3.5.4).

The standard Ambient Cables (ACL) can be connected directly to the outputs of this module (LEMO connectors). If any custom cabling is required, please read paragraph 4.4 first!

Please visit the JPE website for a brochure with detailed specifications of the most recent version available.

<sup>13</sup> Images are for illustrative purposes only.

<sup>14</sup> The MCM can control up to 3x CADM (frequency, step size and direction only)



### 3.5.3 Piezo Scanning Module (PSM)

A Piezo Scanning Module (PSM) can be used to drive (single) Piezo Stacks (used in for example the CPSHR). Each module can operate up to 3 piezo stacks (in parallel mode). In total there can be up to 6 PSMs in one base cabinet (CAB) which enables driving up to 18 piezo stacks in parallel mode! The picture below shows a Piezo Scanning Module<sup>15</sup>.



Figure 13: PSM

The PSM generates a [10x] amplified output signal (in relation to an analog input signal). For each output, the input signal (A<sub>in</sub>) can be applied via a BNC connector according to the following pin configuration:

- Center : Input signal, -2[VDC] to +12[VDC]
- Outer : Ground (GND)

*Please note that Ground (GND) must **NOT** be connected to Protective Earth (PE). Keep this in mind if you would like to monitor the input signal on an oscilloscope (often the GND lug of a probe connection is connected to PE).*

*This module generates an (high voltage) output signal of -20VDC to +120VDC.*

The supplied *Ambient Cables* (ACL) can be connected directly to the outputs of this module (LEMO connectors). If any custom cabling is required, please read paragraph 4.4 first!

Please visit the JPE website for a brochure with detailed specifications of the most recent version available.

<sup>15</sup> Images are for illustrative purposes only.

### 3.5.4 Manual Control Module (MCM)

The Manual Control Module (MCM) can be used to operate (up to) 3 Cryo Actuator Driver Modules (CADM) without the need to connect the controller to a PC (External Control Mode). This enables a fast and easy way to drive up to 9 Cryo (Linear) Actuators (CLA) in sequential mode. The picture below shows a Manual Control Module<sup>16</sup>.



Figure 14: MCM

In each Base Cabinet (CAB) there is one slot (double width) available for a MCM.

#### 3.5.4.1 Knobs and switches

The following (CADM) parameters can be changed using knobs and switches on the front panel:

- Channel: 1 to 9 or External<sup>17</sup> (PC)
- Frequency: 1 to 600[Hz] (global setting for all channels)
- Step size: 1 to 100[%] (global setting for all channels)
- Direction: CW/CCW (only one channel can be controlled at the time).

Other CADM parameters available can only be changed/set in External Control Mode, see chapter 5.

#### 3.5.4.2 Display

The display shows the following information:

- Selected channel
- Frequency set
- Step size set
- Tag (this tag can only be set/changed in External Control mode using the GUI)

The picture below shows an example:



Figure 15: MCM Display

<sup>16</sup> Images are for illustrative purposes only.

<sup>17</sup> If no MCM is fitted, the base cabinet defaults to External Control Mode.

### 3.5.4.3 Select Channel

The table below shows a list of how channels are listed when one or more CADMs have been installed.

# CADM installed <sup>18</sup>	Available Channels
1 module	Channel 1A, 1B, 1C (= channels 1 – 3)
2 modules	Channel 1A, 1B, 1C, 2A, 2B, 2C (= channels 1 – 6)
3 modules	Channel 1A, 1B, 1C, 2A, 2B, 2C, 3A, 3B, 3C (= channels 1 – 9)

Please note that if the MCM channel is set to 1 – 9, it is not possible to operate the controller in External Control Mode (via PC). For this the channel knob needs to be set to EXT.

## 3.6 Ambient Cable (ACL)

The Ambient Cable (ACL) is the default way to connect actuator(s) and system(s) to plug-in modules.

The default length is 3.0[m]<sup>19</sup> and has a LEMO 1b.303 connector on one side (connects to CADM and PSM for example) and a 2-pin (crimp) socket connector (*Molex KK 22-01-2025* housing with *Molex KK 08-50-0032* crimp pins) on the other end to quickly interface to actuator(s) and system(s).

The pin configuration on the (Molex) 2-pin (crimp) socket side is:

- Pin 1 : Piezo Signal (White wire)
- Pin 2 : Piezo REF (Black wire)

*Although not recommended, it is allowed to de-solder the Molex socket connector for final integration in the Customer's setup – however, any soldering must be carried out by qualified personnel only and please double-check correct pin wiring afterwards! JPE does not assume liability for damages to property or personal injury!*

*It is vital to make sure that Signal and REF wires are not mixed up when adding additional cabling. Incorrect wiring will result in a risk of mortal electric shock and/or damage to the controller (s), actuator(s) and/or system(s).*

*Please note that Piezo REF is NOT the same as (system) GND or PE, so do not connect these to each other and do not use standard oscilloscope probes!*

<sup>18</sup> Seen from left to right installed in cabinet

<sup>19</sup> Shorter or longer cables (up to 6.0[m]) available on request.

## 4. INSTALLATION AND SETUP

Before using any actuators, systems and/or controllers, carefully follow these installation and setup instructions.

### 4.1 Inside the box and unpacking

The following parts have to be inside the box:

- 1x Controller (Base Cabinet, CAB) with the ordered Modules.
- 1x (or more) Ambient Cables (ACL) depending on the number of actuators and/or systems ordered.
- 1x Mains Power chord
- 1x USB A to B cable.
- 1x (or more) (membrane) polypropylene Box with the ordered number of actuators and/or systems.

Carefully unpack everything and pay special attention to the (membrane) polypropylene box: the inner part of the polypropylene box can be taken out en bend in such way that the actuators and/or systems can be easily unpacked. **Do not cut the membrane plastic!** Keep the box in case products need to be returned.

*Each actuator and system comes with a Connector Interface PCB. Please refer to chapter 3 for important pin configuration and handling information - incorrect wiring will result in a risk of mortal electric shock and/or damage to the controller (s), actuator(s) and/or system(s)! It is not allowed to make any alterations to these Connector Interface PCBs!*

*Please note that all wires to actuators and (inside) systems are very fragile parts of the delivery and should always be handled with great care! Also, in general take great care in unpacking actuators and systems!*

*Actuators and systems can be used in special environments (for example a vacuum chamber or cryostat) that may require dedicated cabling. However, upon delivery only basic cabling (for use in ambient conditions) to connect to the (controller) modules is supplied. Please refer to chapter 4.4 for information on constructing additional cabling.*

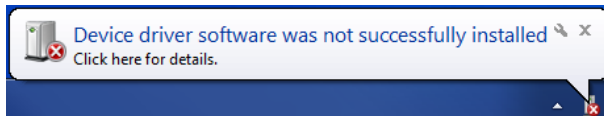
Before continuing, check all parts for any visible defects. If anything found or when in doubt, please contact JPE for further assistance.

### 4.2 Controller driver installation

To be able to control actuators and systems via a computer, use a PC system with (at least) Windows 7 (SP1) (both 32bit and 64bit) installed and make sure to have a free USB1.1/2.0 port available (do not use a hub device).

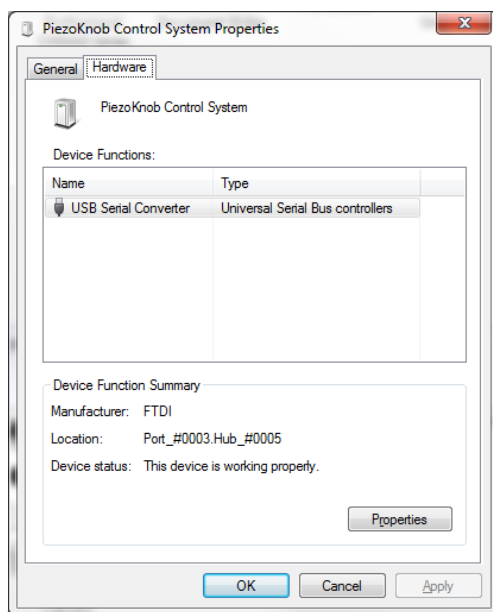
- 1 First, download a copy of the latest *Controller Software* at <http://www.jpe.nl/products/cryogenic-positioning-systems-controller/> and unpack the .zip file in a folder of your choice.
- 2 Place the controller on an appropriate surface (for example a sturdy workbench) and make sure that no actuators or systems are connected to the controller!
- 3 Make sure that the *Mains Power Switch* on the back of the controller is in the "o" (OFF) position.

- 4 Logon to Windows with an account with (full) *Administrator* privileges.
- 5 Connect the supplied USB cable to the back of the cabinet (USB connector labelled "EXT") and on the other end in to a free USB port.
- 6 Because the USB interface is bus powered, Windows will automatically detect new hardware (it is not required to power on the controller). Most likely this will result in the following message:



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

- 7 Click on the text "Click here for details" and let Windows search for a driver. Because the controller uses a standard FTDI interface, a suitable driver should be found. Another approach is to go to *Start > Devices and Printers > (right-click) on (Unspecified) PiezoKnob Control System > select Troubleshoot*.
- 8 After successful installation, the *Device Properties* should look (similar) like this:



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

- 9 Driver installation finished.

### 4.3 Setup for first time use

Depending if a Manual Control Module (MCM) is installed in the controller cabinet, first time use can be done in multiple ways. This paragraph assumes that the controller is fitted with (at least) a CADM for driving (single) Cryo (Linear) Actuators.

#### 4.3.1 General way of work setting up actuator(s) or system(s)

Please note that operating actuators or system may only be done when the actuators or systems have been placed in a safe environment towards the operator(s), i.e. out of reach by the operator(s) when operating them electrically (by using the controller).

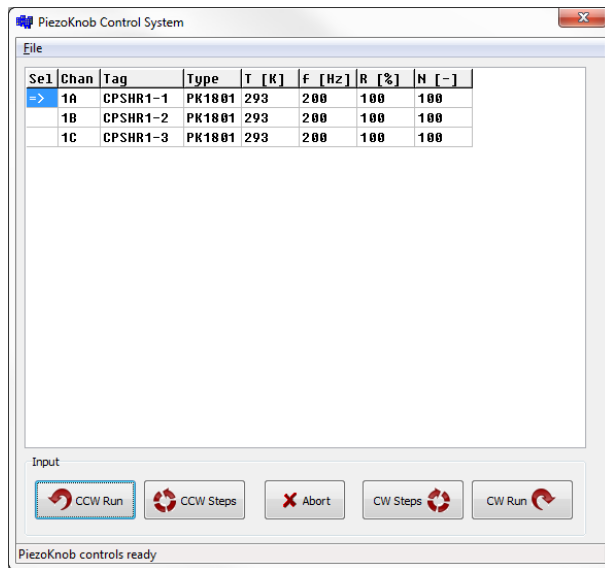
- 1 Mount the actuator(s) or system(s) according to the instructions mentioned in the appropriate paragraphs (*Mounting Instructions*) in chapter 3. For the initial test run, use only the supplied Ambient Cabling (ACL).
- 2 Connect the supplied mains power chord to the back on the controller cabinet (IEC inlet) and plug the power chord into a protective contact power socket. Make sure the mains power match the rated input voltage (label on back panel). Make sure that the top of the cabinet is not covered! (When installed in a 19" rack, make sure at least 1U above is free.)
- 3 Connect each actuator or system to the controller modules according to the instructions mentioned in the appropriate paragraphs (*Connecting to Controller*) in chapter 3. For easy reference, make a note which actuator or system in connected to which output!

#### 4.3.2 Without Manual Control Module (MCM)

If no Manual Control Module (MCM) is installed, driving actuator(s) or system(s) is only possible via a PC (External Control Mode).

- 1 Power on the controller by switching the *Mains Power Switch* on the back to the "1" (ON) position.
- 2 (If applicable) LEDs on the installed modules will light up. See chapter 3 for additional information on each module or chapter 6 for the troubleshooting section if any of the LEDs lights red or no LEDs light up at all.
- 3 In the downloaded Controller Software folder (see paragraph 4.2) go to the folder *pzknb\_GUI* and start the stand-alone GUI program (*pzknb\_GUI.exe*). Upon loading the application, all available modules will be loaded in a list box.

The screenshot below shows an example configuration with one CADM for driving Cryo (Linear) Actuators:



(For more detailed information about the GUI and other software tools, see chapter 5)

- Select a channel by clicking in the appropriate "Sel" row (blue box with white arrow) and click the CCW Steps or CW Steps button once. If everything is setup as it should, the actuator connected to that channel will do 100 steps (N-parameter) with a frequency of 200Hz (f-parameter) and at full step-size (R-parameter) (note that actual parameter setting may vary).

Please note the following:

- Avoid physically touching unconnected outputs when the controller system 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).

#### 4.3.3 With Manual Control Module (MCM)

If a Manual Control Module (MCM) is installed, driving actuator(s) or system(s) can be done without connecting the controller to a PC. This enables an easy and quick way to check if everything works as expected.

- Power on the controller by switching the *Mains Power Switch* on the back to the "1" (ON) position.
- (If applicable) LEDs on the installed modules will light up. See chapter 3 for additional information on each module or chapter 6 for the troubleshooting section if any of the LEDs lights red or no LEDs light up at all.
- Select the output channel to which an actuator or system is attached by using the *Channel* knob (see example picture below). Most likely set it to channel 1 (1A).



(For more detailed information about the MCM, see paragraph 3.5.4)

- 4 Set the *Frequency* to about 200Hz and *Step Size* to 100%.
- 5 Now move the actuator by pushing and holding the *Move* switch for a couple of seconds. Apart from the frequency and step size setting, the controller system is using factory default settings which are suitable for use in an ambient environment.

*Please note the following:*

- Avoid physically touching unconnected outputs when the controller system 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).

#### 4.4 Guide for additional cabling

This paragraph can be used as a reference for connecting and constructing additional cabling in between actuator(s) or systems(s) and the (controller) module(s) (if required).

Please note that any soldering must be carried out by qualified personnel only and please double-check correct pin wiring afterwards! JPE does not assume liability for damages to property or personal injury!



*It is not allowed to make any alterations to the actuator's and/or system's Connector Interface PCBs.*

*Make sure to test all actuators and systems with only the supplied cabling first, before connecting any additional cabling for the intended setup in which the actuators and systems are to be used.*

*Visually check for cable faults and check for possible shorts in between wires and/or in between wires and the actuator or system itself (using a multi-meter) after connecting any additional cabling.*

#### 4.4.1 Altering Ambient Cables (ACL)

Although not recommended, it is allowed to de-solder the Molex socket connector for final integration in the Customer's setup (for example for a feed through). It is vital to make sure that Signal and REF wires are not mixed up when soldering the cable to a different connector!

It is not allowed to alter the LEMO connector on the Ambient Cable.

#### 4.4.2 Recommendations for additional cabling for CLA

The total DC resistance of all cabling per actuator (CADM output to actuator) should not exceed 10[Ω]. The supplied Ambient Cable (ACL) has a resistance of less than 0.5Ω/m.

If any other cabling is to be used, make sure to use wires with a rated voltage of (at least) 200[V] and a rated current of (at least) 1[A] continuously.

Always check visually for cable or wire faults or possible shorts in between wires and/or in between wires and the actuator(s) / system(s) itself (by using a multi-meter) after installation in the final setup and before connecting the actuator(s) / system(s) to the controller module(s).

## 5. EXTERNAL CONTROL MODE (CONTROLLER SOFTWARE)

Before continuing, make sure to follow the proper setup and installation as described in chapter 4!

In External Control Mode, the controller is connected via an USB cable to a PC running (at least) Windows 7 SP1 (32bit or 64bit). A copy of the latest Controller Software can be downloaded at the JPE website (<http://www.jpe.nl/products/cryogenic-positioning-systems-controller/>). See paragraph 4.2 for driver installation.

A **stand-alone** Control Program (**pzknb\_GUI.exe**) has an easy to use GUI that can be used to move Cryo (Linear) Actuators (or Cryo (Linear) Actuators in systems) by using CADMs. There is also a basic **command line** version of this program available for easy integration with other programs (for example MATLAB) to be able to program movement sequences.

Note that both programs cannot be running at the same time; only one can have control over the controller.

*Please note that both are only basic movement control tools and not comprehensive motion control environments!*

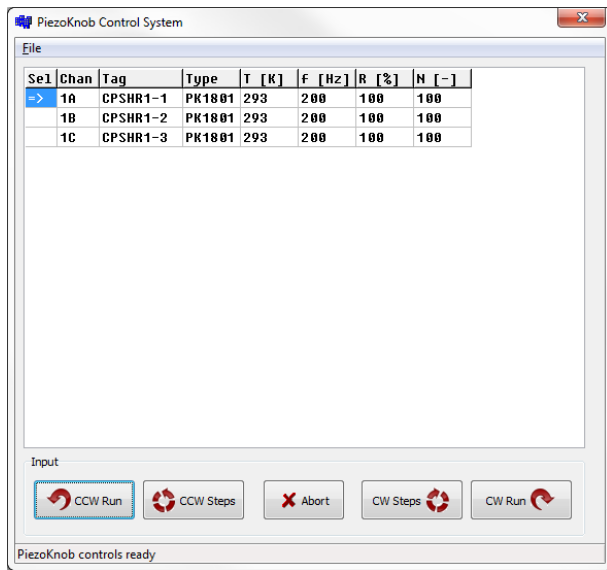
Each CADM output can be programmed with different settings. Actuators can be moved for a number of steps or continuously and of course for both directions. Please note that it is not possible to move an actuator manually by using the Manual Control Module (MCM) when in computer controlled mode.

### 5.1 Stand-alone GUI

*Note: if a Manual Control Module (MCM) is installed: turn the Channel knob on the MCM to the "EXT" position. The LCD displays the text "EXTERNAL CONTROL INPUT SELECTED".*

Start the program by double-clicking the file **pzknb\_GUI.exe** from within (Windows) Explorer (no installation required). When the appropriate USB driver is installed, the program will automatically recognize the number of available output channels and load the internally stored parameter settings for each output channel (if present!).

The picture below shows an example:



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.

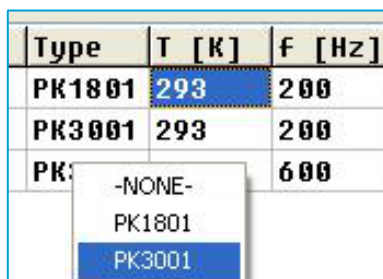
### 5.1.1 Channel List Box

The main part of the program is the channel list box displaying the (current) parameter settings for each output channel available:

Se1	Chan	Tag	Type	T [K]	f [Hz]	R [%]	N [-]
=>	1A	CPSHR1-1	PK1801	293	200	100	100
	1B	CPSHR1-2	PK1801	293	200	100	100
	1C	CPSHR1-3	PK1801	293	200	100	100

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 columns are available:

- **Chan:** channel number (display only; cannot be changed by the user).
- **Tag:** an 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 (may contain alphanumerical characters with a maximum of 8 characters).
- **Type:** sets specific internal system parameters to correspond with the type of actuator attached to that particular channel output. Right-click on the parameter to set / change the type, see picture below.

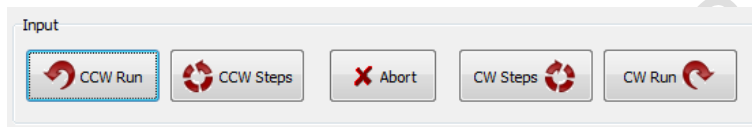


*For now this to PK1801 when using any type of CLA. Other types are for future use only.*

- **T [K]:** set this parameter to the temperature of the environment in which the actuator is used. Input is in [K] (degrees Kelvin) and limited from 0 to 300 (numerical values only).
- **F [Hz]:** frequency of operation input. Value is in [Hz] (Hertz) and limited from 0 to 600 (numerical values only).
- **R [%]:** (relative) piezo step size parameter input. Value a percentage [%] and can be set from 0 to 100 (numerical values only).
- **N [-]:** number of actuation steps. This value is used when using the **(C)CW steps** buttons. Value is limited from 1 to 50000 (numerical values only).

### 5.1.2 Input box

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



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

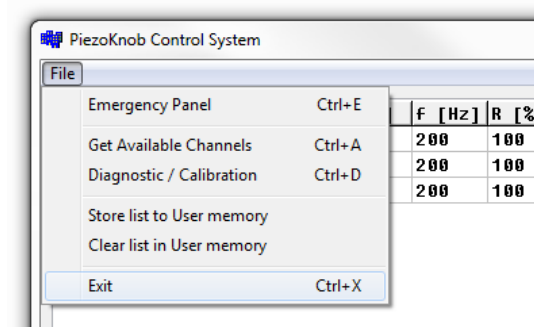
- The **CCW Run** and **CW Run** buttons are to continuously move the actuator until the **Abort** button is pressed.
- The **CCW Steps** and **CW Steps** buttons are to move the actuator for a number of steps ("N [-]" parameter, see previous paragraph).

*Please note the following:*

- Avoid physically touching unconnected outputs when the controller system 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).

### 5.1.3 File Menu

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



- **Emergency Panel:** opens a pop-up window with a button to start moving the actuator on the current selected channel (!) 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:** only to be used when having issues with the controller. Please consult JPE first!
- **Store list and Clean list:** 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 command line interface (see paragraph 5.2) does not use any of the stored parameters. However, stored Tag and Type can be requested from within the command line tool for information.

## 5.2 Command Line Interface

*Note: if a Manual Control Module (MCM) is installed: turn the Channel knob on the MCM to the "EXT" position. The LCD displays the text "EXTERNAL CONTROL INPUT SELECTED".*

A different method of controlling actuators via the PC is by using a command line interface version of the Control program. The command line tool is a single file (**pzknb.exe**) that is called from the command prompt and needs various arguments to work. The picture below shows an example:

```
U:\>pzknb M 1 1 PK1801 300 0 150 100 4000
```

### 5.2.1.1 Command Line arguments

The command line tool has the following arguments (space separated):

```
pzknb[CMD][ADDR][CH][TYPE][TEMP][DIR][FREQ][REL][STEPS][TROFR]
```

Where:

- **[CMD]:** must be set to: M (move), X (stop), S (status) or i (information). Argument is case sensitive!
  - **Move:** enables actuation of an actuator.
  - **Stop:** disables actuation of an actuator.
  - **Status:** get the actual status of the amplifier module. Status feedback can be: STOP, MOVE or ERROR.
  - **Information:** read the stored parameters of [Type] and [Tag] from the controller. This argument is only a help to let the user retrieve the type and description of the requested

channel as it is set in the GUI. *Please note that the move command does not use any of the parameters displayed by the information command; the move command uses the parameters which are being used in the function argument of the command line tool.*

- [ADDR]: select CADM installed in controller. Must be set to: 1, 2 or 3.
- [CH]: select output channel number on selected CADM. Must be set to 1 (channel A), 2 (channel B) or 3 (channel C).
- [TYPE]: select actuator type. Must be set to PK1801. Note correct writing, argument is case sensitive!
- [TEMP]: set the environmental temperature (in [K]) in which the actuator is used. Must be set from 0 to 300 (integer values only).
- [DIR]: set the direction of movement. Must be set to 1 (CW) or 0 (CCW) (integer values only).
- [FREQ]: set the frequency of operation in Hertz [Hz]. Must be set from 1 to 600 (integer values only).
- [REL]: set the (relative) piezo step size as a percentage [%] in between 1 to 100 (integer values only).
- [STEPS]: number of actuation steps. Must be set from 0 to 50000 (integer values only). If set to zero ("0") it means that the actuator will run continuously until a stop command is given.
- [TROFR]: **(optional)** Torque multiplication factor. To be used to force an actuator out of a "locked" position. Can be set from 1 to 30 (integer values only). *Please note that if the system is unable generate the corresponding drive signal with respect to the entered value (=value entered too high), the program will return a warning message. In this case, the maximum available factor that can be realized will be used.*

The requested arguments for correct operation of the command line depend on the given [CMD].

In case of the following commands the following arguments are mandatory:

- **move** command ([CMD] = 'M') : M[ADDR][CH][TYPE][TEMP][DIR][FREQ][REL][STEPS].
- **stop** command ([CMD] = 'X') : X[ADDR]
- **status** command ([CMD] = 'S') : S[ADDR]
- **information** command ([CMD] = 'i') : i[ADDR][ch]

#### 5.2.1.2 Response messages

After sending one of the commands {move, stop or status}, the system will answer with a response message indicating the status of the command (MOVE, STOP, ERROR). In case the system receives an invalid command, an error response (err) will be send back displaying the expected command arguments.

Possible error codes are:

- **err 3(a/b/c/d)**: indicates that the parameter string is not complete; so for example if the following command is send: M 1 1 PK1801, the controller system will respond with this error number (because the M parameter requires values for Dir, Freq, Rel and Steps as well).
- **err 5**: indicates that the parameter string is incorrect (typing error for example).
- **error - time out**: communication error between PC and controller system.
- **DEVICE NOT FOUND**: the controller system is not connected to the PC.

## 6. TROUBLESHOOTING

### 6.1 CADM

#### 6.1.1 Heat dissipation

When the module is powered on (but in idle), the plug-in unit's front panel might feel warm to the touch after a while. This is normal behavior.

If the module is continuously (> 15 minutes) driving an actuator at full step size and at the highest frequency in ambient conditions, the module will warm up considerably. The module has a built-in temperature overload safety, which will turn off the outputs as soon as it will reach a certain temperature (red error led will light up). If that is the case, the operator must wait until the module is cooled down significantly. It is recommended to turn off the controller and to wait for at least 15 to 20 minutes before turning it back on again (if the module is still too hot, the red error led will turn on again after power on).

#### 6.1.2 Error LED (red) turns on

Most likely an overcurrent has occurred. Please power down the controller and disconnect all actuators and systems. Investigate all wiring and cabling and check for faults or short circuits.

### 6.2 PSM

#### 6.2.1 Heat dissipation

When the module is powered on (even in idle), the plug-in unit's front panel might feel warm to the touch after a while. Also the top cover of the cabinet will feel quite warm at the spot where the module is placed. This is normal behavior.

### 6.3 External Control Mode

#### 6.3.1 Cannot see available channels

If the Controller Software is unable to find the available (CADM) channels, try the following:

- 1 Close the GUI application
- 2 Disconnect the USB 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 cable
- 6 Start the GUI application again

#### 6.3.2 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.

## 6.4 MCM

### 6.4.1 Back light display off

In some cases the back light of the display on the controller system stays off at power on. Mostly this happens when the controller system is switched on again immediately after a power off action. If this issue happens, power off the controller system and wait for about 5 minutes before powering the controller system again.

SUPERSEDED! FOR INFORMATION ONLY