Hardware User Manual

CRYO & NANO POSITIONING PRODUCTS (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This user manual has been superseded by a newer version.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!

CONTENTS

RELEVANT DOCUMENTATION

Ref	Title (Author)	File name
[1]	Cryo & Nano Positioning products Software User Manual (JPE)	1036_MAN04_Rxx_yyyy-mm-dd_CNP_UM_SW.pdf
[2]	CPSC Modes Of Operation (JPE)	1038_APN01_Rxx_yyyy-mm-dd_CPSC_Modes_Of_Operation.pdf
[3]		
[4]		
[5]		

DOCUMENT HISTORY

Author	Date	Comment
JPE	2016-05-27	R01. Creation.
JPE	2016-06-01	R02. CADM/CADM2 update. Minor layout design changes.

DEFINITIONS

Definition	Description

ABBREVIATIONS

Abbreviation	Description

1. ABOUT THIS MANUAL

This manual describes the hardware installation and setup 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*).

Consult the *Cryo & Nano Positioning products Software User Manual* [Ref1] on how to operate systems and actuators using the controller and includes a detailed instruction list describing the user software.

Please note that all content in this manual is superseded by any new versions of this manual (see file name).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) to obtain the most recent version[1].

All images in this User Manual are for illustrative purposes only.

[1] This manual is intended for products ordered and delivered from *May 2016 onwards*. For products ordered and delivered prior to this date, please refer to the previous User Manual(s), see also paragraph 6.

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 <u>obligatory</u> to follow the instructions mentioned in these (red colored) bordered boxes! Failing to observe instructions may result in a risk of mortal electric shock! So please, follow <u>all</u> 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 2U 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.

3. AVAILABLE PRODUCTS

General note: please visit http://www.janssenprecisionengineering.com/cryo-nano-positioning/ for brochures and interface drawings with additional detailed (mechanical and electrical) specifications of all available products.

3.1 Cryo Linear Actuator (CLA##01 and CLA##02)

The Cryo Linear Actuator "PiezoKnob" (CLA) is developed for positioning in ambient, vacuum and cryogenic environment. There are a number of single linear actuator types available with different options.

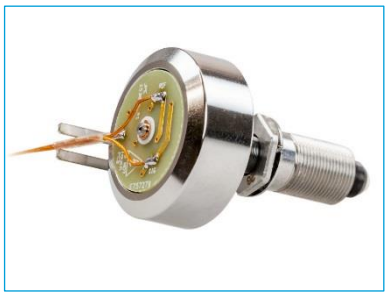

Figure 1: CLA2601

Figure 2: CLA1802HF-COE

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.

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 Electrical connections

All single actuators are assembled with ~150[mm] Kapton coated wire and a Connector Interface PCB at the end with a 2-pin 2.54mm pitch header mounted (*Molex KK 22-05-7028*). There are two mounting holes available for M2 (bolts not supplied).

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)

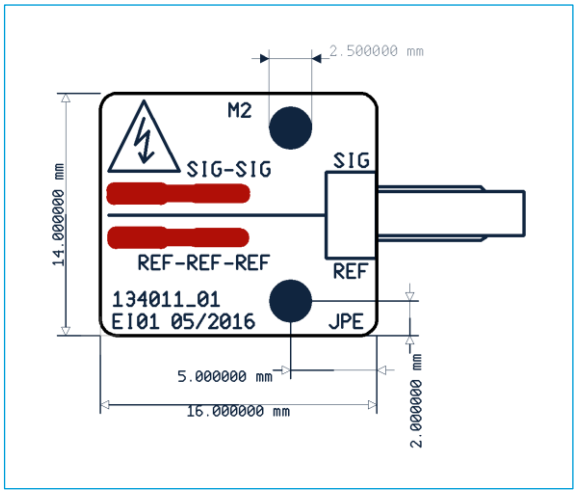

Figure 3: CLA Connector Interface PCB (top view)

Also make sure that there is 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 default Ambient Cable (ACL) can be connected directly to the Connector Interface PCB. If any custom cabling is required, please read paragraph 4.3 first!

3.1.3 Optical connections

If the actuator is equipped with a Cryo Optical Encoder (product type option **–COE**) an optical fiber with a length of ~200[mm] is fixed to the encoder bracket. On the end of the fiber is an *FC/APC narrow key (male)* connector.

The fiber cable and COE are delicate components that need to be handled very carefully. Take great care not to damage the encoder grid. Make sure that no force is applied to the fiber and fixate the FC/APC connector.

The default Ambient Fiber (AF5) cable can be connected to the FC/APC narrow key (male) connector only by using the supplied *FC/APC female/female adapter (Molex 106152-3000)*.


Figure 4: FC/APC female/female adapter
(image credit Molex)

If any custom cabling is required, please read paragraph 4.3 first!

3.1.4 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.

If the actuator is equipped with a Cryo Optical Encoder (product type option **-COE**) make sure that the encoder bracket is mounted correctly. Fixate the FC/APC (male) connector. Take great care not to damage the encoder grid!

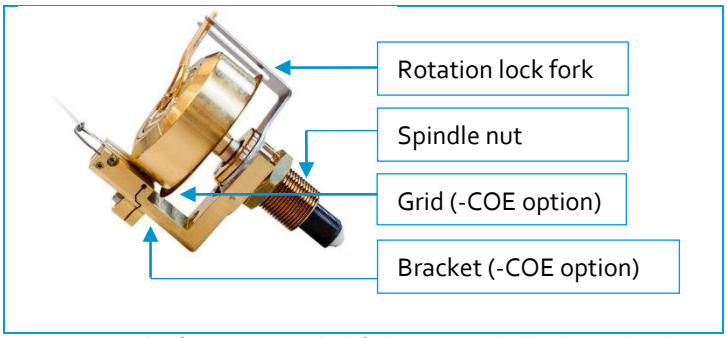

Figure 5: Example of a CLA rotation lock fork, COE encoder bracket and grid

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 Interface Drawings for additional (mechanical) information and detailed mounting instructions and dimensions.

3.1.5 Connecting to Controller

Controller with Plug-in Modules [2]	
CLA##01, CLA##02	CADM Output A or CADM2 Output
CLA##01-COE, CLA##02-COE	CADM Output A or CADM2 Output OEM2 Input A

[2] For available Modules see paragraph 3.6.

3.2 Cryo Positioning Stage High Resonance (CPSHR)

The Cryo Positioning Stage High Resonance (CPSHR) is a XYZ positioning stage developed for use in vacuum and cryogenic environment. Coarse and scanner actuation in series gives the CPSHR long range, high stability and dynamic positioning performance. Optional optical encoders on the coarse actuators offer feedback for predictable motion. There are a number of CPSHR types available with different options.

Figure 6: CPSHR1-S

Figure 7: CPSHR2-COE

3.2.1 Electrical connections

3.2.1.1 CPSHR1

The default CPSHR1-S with Scanner piezo (product type option **–S**) is assembled with (3x) ~150[mm] Kapton coated 4-way ribbon cables and a Connector Interface PCB at the end with (2x) 2-pin 2.54mm pitch headers mounted (*Molex KK 22-05-7028*). For each axis there is one Connector Interface PCB. There are two mounting holes available for M2 (bolts not supplied).

For each axis the pin configuration is as follows:

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

On each PCB there are 3 "marking" holes (indicated with "**#**" 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

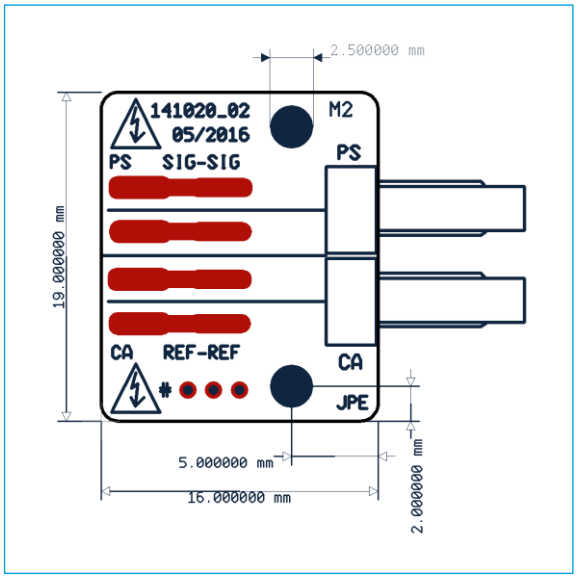

Figure 8: CPSHR1 Connector Interface PCB (top view)

Also make sure that there is no force applied to the Kapton coated wires connected to the system!

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 default Ambient Cable (ACL) can be connected directly to the Connector Interface PCB. If any custom cabling is required, please read paragraph 4.3 first!

3.2.1.2 CPSHR2

The default CPSHR2 is assembled with a fixed Connector Interface PCB with 2.54mm pitch headers mounted (*Molex KK 22-27-2021*). If the stage is equipped with a Cryo Optical Encoder (product type option **-COE**), this interface also houses fiber feedthrough adapters (see paragraph 3.2.2).

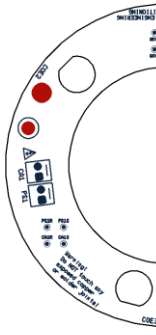
Figure 9: CPSHR2 Connector Interface PCB (top view)

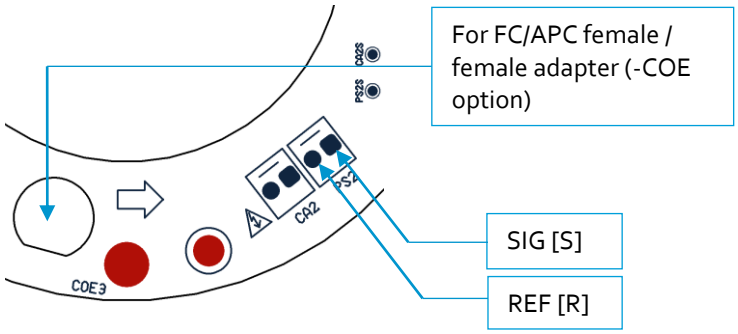

Figure 10: in detail (top view)

For each axis the pin configuration is as follows:

- PS Pin 1 : Piezo Scanner Signal (PS SIG)
- PS Pin 2 : Piezo Scanner REF (PS REF)
- CA Pin 1 : Cryo Actuator Signal (CA SIG)
- CA Pin 2 : Cryo Actuator REF (CA REF)

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 default Ambient Cable (ACL) can be connected directly to the Connector Interface PCB. If any custom cabling is required, please read paragraph 4.3 first!

3.2.2 Optical connections

If the CPSHR2 stage is equipped with a Cryo Optical Encoder (product type option **–COE**) an optical *FC/APC (female)* connector is mounted on the Connected Interface PCB. The default Ambient Fiber (AF5) cable can be connected directly to this connector. If any custom cabling is required, please read paragraph 4.3 first!

3.2.3 Mounting instructions

3.2.3.1 CPSHR1

By default the system is delivered with a standard interface plate (**I1-CPSHR1**) (M3 bolts not supplied). Make sure the wiring to the Connector Interface PCBs do not get damaged or stuck in the setup when mounting the CPSHR1. The Connector Interface PCBs must be mounted properly prior to driving the CPSHR1 electrically!

See the Interface Drawings for additional (mechanical) information and detailed mounting instructions and dimensions.

3.2.3.2 CPSHR2

By default the system is delivered with a mounting interface for M3 (bolts not supplied). Make sure the (electrical and optical) wiring to the Connector Interface PCB does not get damaged or stuck in the setup when mounting the CPSHR2.

See the Interface Drawings for additional (mechanical) information and detailed mounting instructions and dimensions.

3.2.4 Connecting to Controller

Controller with Plug-in Modules [3]				
	Recommended configuration		*Alternative configuration*	
	Module	Slot #	Module	Slot #
CA – Axis 1, Z1	CADM2 Output	1	CADM Output A	1
CA – Axis 2, Z2	CADM2 Output	2	CADM Output B	
CA – Axis 3, Z3	CADM2 Output	3	CADM Output C	
COE – Axis 1, Z1	OEM2 Input A	4	OEM2 Input A	2
COE – Axis 2, Z2	OEM2 Input B		OEM2 Input B	
COE – Axis 3, Z3	OEM2 Input C		OEM2 Input C	
PS – Axis 1, Z1	PSM Output A	5	PSM Output A	3
PS – Axis 2, Z2	PSM Output B		PSM Output B	
PS – Axis 3, Z3	PSM Output C		PSM Output C	

[3] For available Modules see paragraph 4.6.

3.3 Cryo Hexapod Positioning System (CHPS)

The Cryo Hexapod Positioning System (CHPS) is a 6 DoF positioning stage developed for use in vacuum and cryogenic environment. By default the system is equipped with a Scanner piezo and a Cryo Optical Encoders.

Figure 11: CHPS-S-COE

3.3.1 Electrical connections

Surrounding the hexapod is a Connector Interface PCB mounted which houses both electrical and optical connections. Each electrical connection uses a 2-pin 2.54mm pitch header (*Molex KK 22-27-2021*).

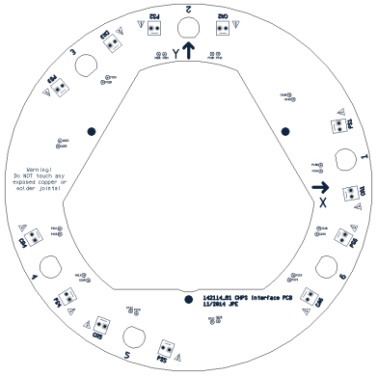

Figure 12: CHPS Connector Interface PCB (top view)

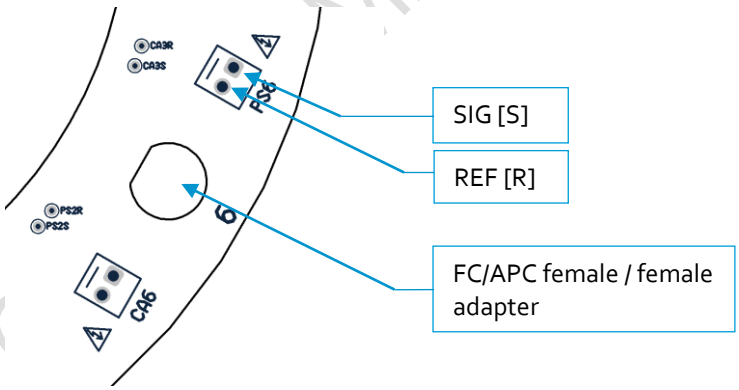

Figure 13: in detail (top view)

For each axis the pin configuration is as follows:

- PS Pin 1 : Piezo Scanner Signal (PS SIG)
- PS Pin 2 : Piezo Scanner REF (PS REF)
- CA Pin 1 : Cryo Actuator Signal (CA SIG)
- CA Pin 2 : Cryo Actuator REF (CA REF)

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 default Ambient Cable (ACL) can be connected directly to the Connector Interface PCB. If any custom cabling is required, please read paragraph 4.3 first!

3.3.2 Optical connections

An optical *FC/APC (female)* connector is mounted in between the electrical connections for each axis (for use with the Cryo Optical Encoders). The default Ambient Fiber (AF5) cable can be connected directly to this connector. If any custom cabling is required, please read paragraph 4.3 first!

3.3.3 Mounting instructions

By default the system is delivered with a mounting interface for M5 (bolts not supplied). Make sure the (electrical and optical) wiring to the Connector Interface PCB does not get damaged or stuck in the setup when mounting the CHPS.

See the Interface Drawings for additional (mechanical) information and detailed mounting instructions and dimensions.

3.3.4 Connecting to Controller

Controller with Plug-in Modules [4]				
	Recommended configuration		*Alternative configuration*[5]	
	Module	Slot #	Module	Slot #
CA1	CADM2 Output	1.1	CADM Output A	1.1
CA2	CADM2 Output	1.2	CADM Output B	
CA3	CADM2 Output	1.3	CADM Output C	
COE1	OEM2 Input A	1.4	OEM2 Input A	1.2
COE2	OEM2 Input B		OEM2 Input B	
COE3	OEM2 Input C		OEM2 Input C	
PS1	PSM Output A	1.5	PSM Output A	1.5
PS2	PSM Output B		PSM Output B	
PS3	PSM Output C		PSM Output C	
CA4	CADM2 Output	2.1	CADM Output A	1.3
CA5	CADM2 Output	2.2	CADM Output B	
CA6	CADM2 Output	2.3	CADM Output C	
COE4	OEM2 Input A	2.4	OEM2 Input A	1.4
COE5	OEM2 Input B		OEM2 Input B	
COE6	OEM2 Input C		OEM2 Input C	
PS4	PSM Output A	2.5	PSM Output A	1.6
PS5	PSM Output B		PSM Output B	
PS6	PSM Output C		PSM Output C	

[4] For available Modules see paragraph 4.6.

[5] NOT recommended!

3.4 Cryo Tip / Tilt / Piston Stage (CTTPS)

The play-free Cryo Tip / Tilt / Piston Stage (CTTPS) accepts optical elements with various diameters and can be operated in vacuum and cryogenic environment. There are a number of CTTPS types available with different options.

Figure 14: CTTPS1-S

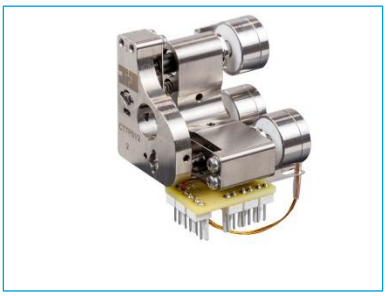

Figure 15: CTTPS-1/2-S

3.4.1 Electrical connections

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 axis the pin configuration is as follows:

- PS Pin 1 : Piezo Scanner Signal (PS SIG, red wire)
- PS Pin 2 : Piezo Scanner REF (PS REF, black wire)
- CA Pin 1 : Cryo Actuator Signal (CA SIG)
- CA Pin 2 : Cryo Actuator REF (CA REF)

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!

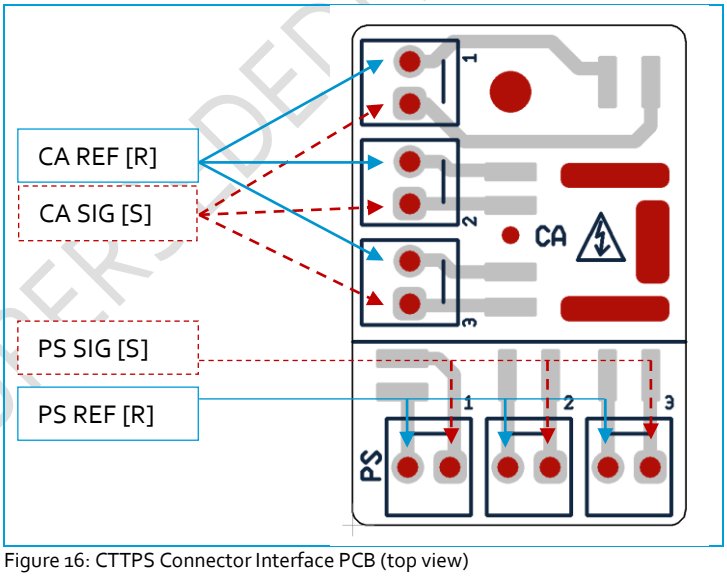

Figure 16: CTTPS Connector Interface PCB (top view)

The numbers (1, 2 and 3) next to each pin header indicates the axis number (which is engraved on the system as well).

The default Ambient Cables (ACL) can be connected directly to the Connector Interface PCBs. If any custom cabling is required, please read paragraph 4.3 first!

3.4.2 Mounting instructions

By default the system is delivered with a mounting interface for M4 (bolts 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. Also take care not to damage the wiring to the actuators (as these wires are not covered).

See the Interface Drawings for additional (mechanical) information and detailed mounting instructions and dimensions.

3.4.3 Connecting to Controller

Controller with Plug-in Modules [6]				
	Recommended configuration		*Alternative configuration*	
	Module	Slot #	Module	Slot #
CA – Axis 1	CADM2 Output	1	CADM Output A	1
CA – Axis 2	CADM2 Output	2	CADM Output B	
CA – Axis 3	CADM2 Output	3	CADM Output C	
PS – Axis 1	PSM Output A	4	PSM Output A	2
PS – Axis 2	PSM Output B		PSM Output B	
PS – Axis 3	PSM Output C		PSM Output C	

[6] For available Modules see paragraph 4.6.

3.5 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. There are a number of CTS types available with different options.

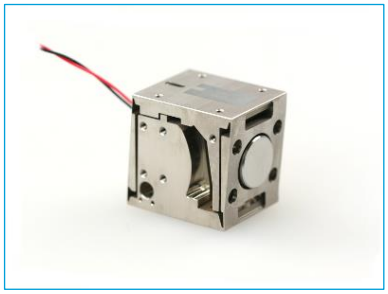

Figure 17: CTS

Figure 18: CTSXYZ-I

3.5.1 Electrical connections

3.5.1.1 CTS

Single CTS blocks use the same Connector Interface PCB as (single) CLA actuators, so see paragraph 3.1.2 for further instructions.

3.5.1.2 CTSXYZ-I

Wiring and connecting a CTSXYZ-I 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. The pin configuration is as follows:

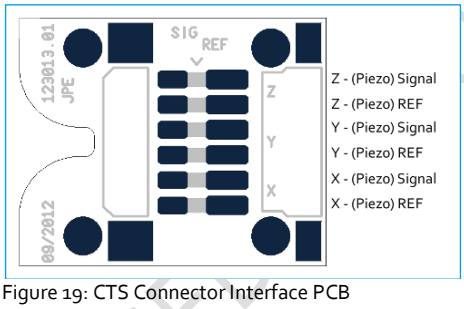

Figure 19: CTS Connector Interface PCB

The default Ambient Cables (ACL) can NOT be connected directly to this Connector Interface PCB. If any custom cabling is required, please read paragraph 4.3 first!

Customers are able to solder their own cabling to the CTSXYZ-I. 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!

3.5.2 Mounting instructions

By default the system is delivered with a mounting interface for M2 (CTS) or M2.5 (CTSXYZ-I) (bolts 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 Interface Drawings for additional (mechanical) information and detailed mounting instructions and dimensions.

3.5.3 Connecting to Controller

At the *Controller side*, connect as follows:

Controller with Plug-in Modules [7]				
	Recommended configuration		*Alternative configuration*	
	Module	Slot #	Module	Slot #
X	CADM2 Output	1	CADM Output A	1
Y	CADM2 Output	2	CADM Output B	
Z	CADM2 Output	3	CADM Output C	

[7] For available Modules see paragraph 4.6.

3.6 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.

3.6.1 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[8] plug-in modules (slot 1 = most left). The picture below shows an example configuration with 3x Cryo Actuator Driver Module 2 (CADM2), 1x Piezo Scanning Module (PSM) and 1x Manual Control Module (MCM).

Figure 20: Controller - front side

At the back there is a Mains Power IEC inlet with ON/OFF switch and 1 USB port for connection to a PC (External Control Mode). By default the system is powered by 230VAC (European), but alternatively there is also an 115VAC (US) version available[9]. Consult the *Cryo & Nano Positioning products Software User Manual* [Ref1] on how to use the controller with a PC (External Control Mode).

Figure 21: Controller - back side

At the back (either above the IEC inlet or above the USB port) there is also a label with the ID of the controller (starts with **1038E …**).

[8] The practical number of plug-in modules depends on the selected modules. Please consult JPE when ordering a controller.

[9] Needs to be specified before ordering!

3.6.2 Cryo Actuator Driver Module (CADM / CADM2)

A Cryo Actuator Driver Module (CADM) and Cryo Actuator Driver Module 2 (CADM2) can be used to drive Cryo Linear Actuators (CLA). Each CADM module can operate up to 3 actuators in serial mode whereas the CADM2 module only has one output. In total there can be up to six CADM or CADM2 modules in one base cabinet (CAB), which enables driving up to 6 actuators in parallel (CADM2) or 18 actuators in serial mode (CADM).

Figure 22: CADM

Figure 23: CADM2

The CADM/CADM2 generates a set point profile with a maximum step size of 150[V_{pp}] 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 [Vpp] and high peak currents!

Adjusting and operating these modules can be done via software (External Control Mode) or by using a Manual Control Module[10].

3.6.2.1 Outputs

The default Ambient Cables (ACL) can be connected directly to the outputs of this module (LEMO connectors). Please read paragraph 3.7 for the pinning reference. If any custom cabling is required, please read paragraph 4.3 first!

3.6.2.2 Analog input (CADM2 only)

The CADM2 has an additional differential analog input which enables the use of an external DAQ system. For more information about this feature, consult the Application Note *CPSC Modes of Operation* [Ref2]. To be able to use this external input, it is required to use External Control Mode in order to select this input via a software command (input is deselected by default).

The differential input signal can be applied via a BNC connector according to the following pin configuration:

- Center : Input signal, -10[V_{DC}] to +10[V_{DC}]
- Outer : Ground (GND)

[10] The MCM can control up to 3x CADM/CADM2 (frequency, step size and direction only)

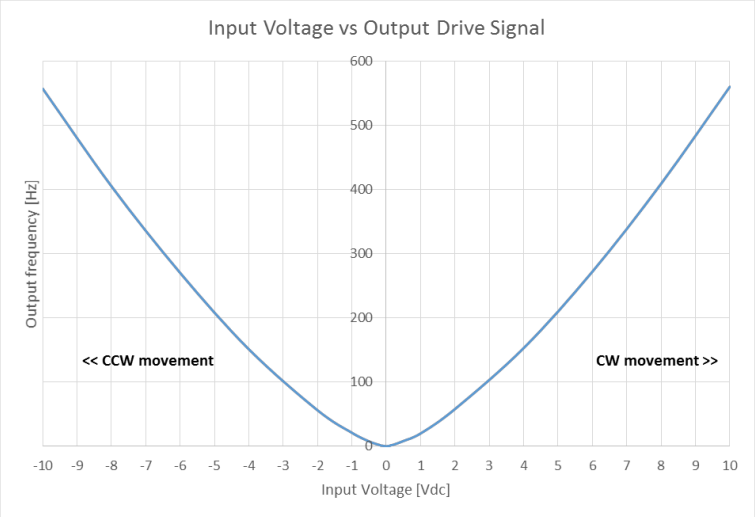

Figure 24: CADM2 input signal vs output frequency

Note that the curve is not completely linear; this to make sure that around 0 ± 0.05[V] input, the actuator is not moving and that it is possible to easily set a 1-2Hz step frequency (comparable with single stepping). Use the graph as general guide only; the exact values may vary slightly depending on component tolerances in the modules.

Please note that the *step size* parameter cannot be adjusted with the analog input control. This value needs to be set before selecting the analog input (see [Ref1]).

3.6.2.3 Status LEDs

The module has 3 status LEDs on the front panel:

Function	LED Color	Note
Power	Green	Turns on when module is powered on and power supplies are OK
Output Active	Blue	Turns on when (one of the) output(s) is (are) activated
Error	Red	Turns on when: ▪ An overcurrent has occurred. Possibly caused by a (cabling) fault or short circuit. ▪ Temperature overload of the module occurred (amplifier in module gets too hot). If this led turns on, the output will be cut off from the amplifier inside the module to prevent damage to the electronics and operator(s). In either case, power down the controller immediately and disconnect all actuators and systems. Investigate all wiring and cabling and check for faults or short circuits. Wait for at least 15 minutes for the module to cool down.

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

3.6.3 Optical Encoder Module 2 (OEM2)

A (laser operated) Optical Encoder Module 2 (OEM2) can be used with actuators and systems equipped with Cryo Optical Encoders (product type option **–COE**). Each module can read up to 3 encoders (simultaneous readout).

An OEM2 can only be used in conjunction with a Cryo Actuator Driver Module (CADM / CADM2). Typical configurations are:

- 1x CADM + 1x OEM2
- 1x CADM2 + 1x OEM2
- 3x CADM2 + 1x OEM2

Figure 25: OEM2

To read out encoders with this module it is required to use the External Control Mode or via an external DAQ system (consult the Application Note *CPSC Modes of Operation* [Ref2]).

The laser used in the OEM2 is a Class 3R. According to the Directive 2006/25/EC is it required to take the following safety measures:

- *Prevent direct eye exposure. Always cover unconnected outputs with the (screw on) dust caps and do not look at the open beam at the encoder itself.*
- *Always use a fully connected setup: all cabling must be present and connected from actuator or system to OEM2 before turning on the controller.*
- *Training is required. Only qualified personnel is allowed to operate the OEM2 (IEC TR 60825-14: 2004).*

3.6.3.1 Optical outputs

The default Ambient Fiber (AF5) cable can be connected directly to the outputs of this module (*FC/APC narrow key female connectors*). If any custom cabling is required, please read paragraph 4.3 first!

3.6.3.2 Electrical in-/ outputs

To connect the OEM2 to an external DAQ system, a standard 25-pin D-Sub male connector is available for optical isolated user in-/outputs *(required cabling is not supplied)*.

Pin #	Signal name	Note	
1	[A] Quadrature A		*5V TTL compatible.*
2	[A] Quadrature B		
3	[A] Quadrature Direction	*Required user input!*	
4	[A] Analog detector signal		
5	[B] Quadrature A		*5V TTL compatible.*
6	[B] Quadrature B		
7	[B] Quadrature Direction	*Required user input!*	
8	[B] Analog detector signal		
9	[C] Quadrature A		*5V TTL compatible.*
10	[C] Quadrature B		
11	[C] Quadrature Direction	*Required user input!*	
12	[C] Analog detector signal		
13	$5V_{opt}$	*Input supply for the optical in-/outputs*	
14-25	GND_{opt}		

The OEM2 quadrature-comparable output requires a user supplied Direction input. This means that the user has to instruct the OEM2 the direction of movement before actual movement of the actuators. Otherwise it is not possible to output CW/CCW movement information in the output signal. Please note that this is only required when using an external DAQ system.

3.6.3.3 Status LEDs

The module has 4 status LEDs on the front panel:

Function	LED Color	Note
Power	Green	Turns on when module is powered on and power supplies are OK.
Status1, Status2	Blue	*Reserved for future functionality.*

3.6.4 Piezo Scanning Module (PSM)

A Piezo Scanning Module (PSM) can be used to drive (single) Scanner piezo's (used in for example the CHPS and CPSHR). Each module can operate up to 3 scanner piezo's (in parallel mode). In total there can be up to 6 PSMs in one base cabinet (CAB) which enables driving up to 18 scanner piezo's in parallel mode!

Figure 26: PSM

3.6.4.1 Outputs

This module can generate an (high voltage) output signal of -150VDC to +150VDC! Please be aware that the default scanner piezo's in for example CHPS, CPSHR-S or CTTPS-S can NOT withstand these voltages. Therefore make sure to limit the output voltage to -20VDC to +130VDC (see also product brochures) by limiting the applied input voltage to the PSM!

Each output is fused with a 100mA fast acting 5x20mm glass fuse to protect the amplifier for short circuits. These fuses can be replaced by the operator(s) by unscrewing the (bayonet) fuse holder by hand.

Always power down the controller first before replacing any fuses! Make sure to replace the blown fuse with the same type and value.

The default Ambient Cables (ACL) can be connected directly to the outputs of this module (LEMO connectors). Please read paragraph 3.7 for the pinning reference. If any custom cabling is required, please read paragraph 4.3 first!

3.6.4.2 Analog inputs

The PSM generates a [15x] amplified output signal (in relation to an analog input signal). For each output, the (analog) input signal can be applied via a BNC connector according to the following pin configuration:

- Center : Input signal, -10[V_{DC}] to +10[V_{DC}]
- 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).

Make sure not to exceed the maximum input voltage range!

This module can generate an (high voltage) output signal of -150VDC to +150VDC! Please be aware

that the default scanner piezo's in for example CHPS, CPSHR-S or CTTPS-S can NOT withstand these voltages. Therefore make sure to limit the output voltage to -20VDC to +130VDC (see also product brochures) by limiting the applied input voltage to the PSM!

3.6.4.3 Status LEDs

The module has 4 status LEDs on the front panel:

Function	LED Color	Note
Power	Green	Turns on when module is powered on and power supplies are OK
A/B/C Thermal Overload	Red	Turns on when (one or more) amplifiers inside the module get too hot. *This might occur if (multiple) outputs drive (multiple) load(s) at a high voltage and high frequency.* If the led turns on, the internal power supply to the amplifiers will be cut off and the output will go to 0V. Once the amplifiers have been cooled down significantly, the outputs will be reactivated and return to respond to the input signals.

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

3.6.5 Manual Control Module (MCM)

The Manual Control Module (MCM) can be used to operate (up to) three Cryo Actuator Driver Modules (CADM / CADM2) 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.

Figure 27: MCM

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

3.6.5.1 Knobs and switches

The following (CADM/CADM2) parameters can be changed using knobs and switches on the front panel:

- Channel: 1 to 9 or External Control Mode (EXT)[11]
- 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/CADM2 parameters available can only be changed/set in External Control Mode [Ref1].

3.6.5.2 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)

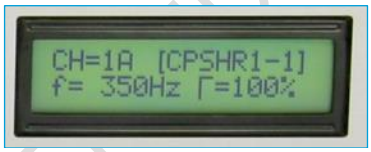

Figure 28: MCM Display (example)

[11] If no MCM is fitted, the base cabinet defaults to External Control Mode.

3.6.5.3 Select Channel

The table below shows a list of how channels are listed when one or more CADM/CADM2 have been installed[12].

# CADM installed	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)

# CADM2 installed	Available Channels
1 module	Channel 1A (= channel 1)
2 modules	Channel 1A, 2A (= channels 1 & 4)
3 modules	Channel 1A, 2A, 3A (= channels 1, 4 & 7)

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

[12] Seen from left to right installed in cabinet

3.7 Ambient Cable (ACL)

The Ambient Cable (ACL) is the default way to connect actuator(s), scanner piezo's (product type option **–S**) and system(s) to plug-in modules.

The default length is 3.0[m][13] and has a *LEMO 1b.303* connector on one side (connects to CADM, CADM2 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 (SIG) 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!

If any custom cabling is required, please read paragraph 4.3 first!

[13] Shorter or longer cables (up to 6.0[m]) available on request.

3.8 Ambient Fiber (AF5)

The Ambient Fiber (AF5) is a hybrid patch cable and is the default way to connect Cryo Optical Encoder(s) (product type option **-COE**) to Optical Encoder Module(s) (OEM2).

The default length is 3.0[m][14] and has a *FC/APC (male)* connector both sides. To connect this side directly to Cryo (Linear) Actuators (CLA) it is required to use the supplied FC/APC female/female adapter.

Figure 29: FC/APC female/female adapter

Some systems already have this adapter mounted, so these do not require to use an additional adapter.

If any custom cabling is required, please read paragraph 4.3 first!

[14] Shorter or longer cables 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 (or more) white-colored (membrane) Polypropylene Box(es) with the ordered number of actuators and/or systems.

- 1x Base Cabinet (CAB) with the ordered plug-in modules.
- 1x (or more) Ambient Cables (ACL) depending on the number of actuators and/or systems ordered.
- 1x (or more) Ambient Fiber (AF5) cables depending if Cryo Optical Encoders have been ordered.
- 1x Mains Power chord
- 1x USB A to B cable.

Carefully unpack everything and pay special attention to the white-colored (membrane) polypropylene box: the inner part of the polypropylene box can be taken out and 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 4 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 electrical wires and optical fibers 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 5.4 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 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.

4.2.1 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 standard 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 2U 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!

4.2.2 Using the 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.

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 5 for the troubleshooting section if any of the LEDs light red or no LEDs light up at all. The display on the MCM will display a boot message.

3 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).

Figure 30: MCM Front Panel

4 Set the *Frequency* to about 100Hz 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.

Observe that on the CADM module the LED "Output Active" will light up.

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).*
- *Read out of Cryo Optical Encoders (product type option -COE) with the Optical Encoder Module (OEM) is not possible with the MCM.*

4.2.3 Without using the Manual Control Module (MCM)

If no Manual Control Module (MCM) is installed, driving actuator(s) or system(s) is only possible via External Control Mode, please refer to the *Cryo & Nano Positioning products Software User Manual* [Ref1] on how to operate systems and actuators via software.

4.3 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.

4.3.1 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.

4.3.2 Recommendations for additional cabling for CLA

The total DC resistance of all cabling per actuator (CADM/CADM2 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).

4.3.3 Adding additional fiber cabling

If additional fiber cabling is required, make sure to use FC/APC patch cables only. The default connection scheme, using standard Ambient Fibers (AF5) can be seen in the schematic overview below:

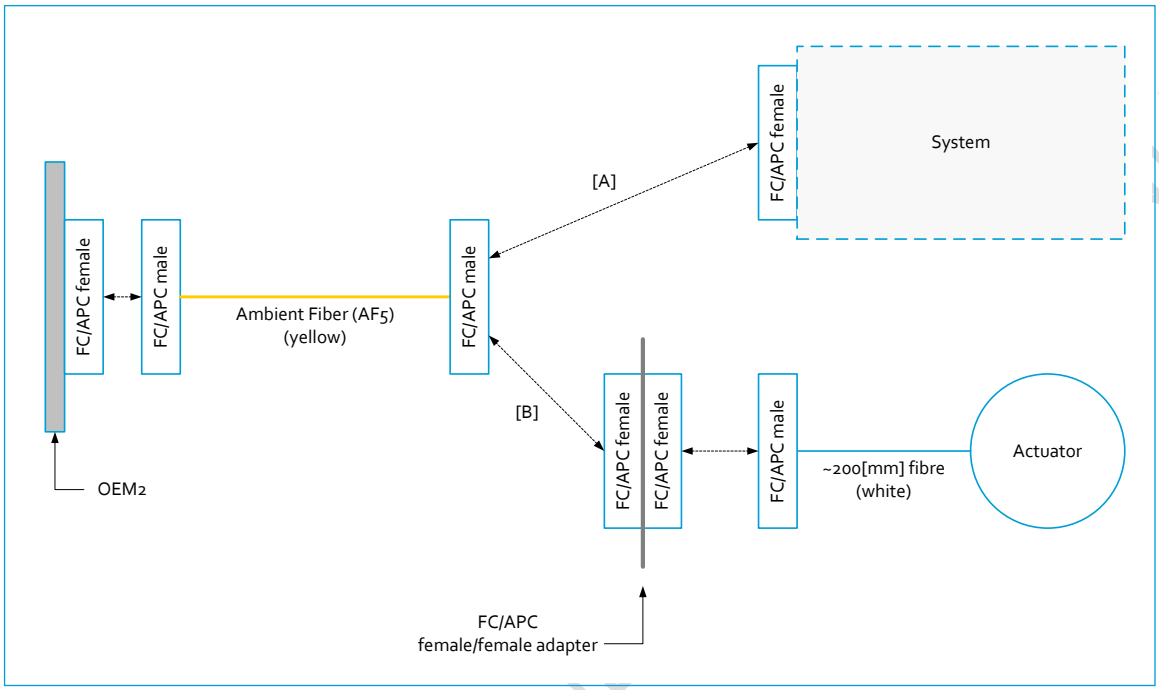

Figure 31: Default optical connections

- Case [A]: when connecting systems like CPSHR, CHPS.
- Case [B]: when connecting single CLA actuators, it is required to insert the FC/APC female/female adapter (supplied).

5. TROUBLESHOOTING

5.1 CADM/CADM2

5.1.1 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).

5.1.2 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.

5.2 PSM

5.2.1 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.

If the module is contentiously (> 5 minutes) driving loads at a high voltage and high frequency in ambient conditions, the module will warm up considerably and might go into thermal overload protection.

5.2.2 Error LED (red) turns on

Turns on when (one or more) amplifiers inside the module get too hot, see paragraph 3.6.4.3.

5.3 MCM

5.3.1 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.

6. USER MANUAL VERSION

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

CPS_v5.1b

If you are using products delivered prior to 05/2016 you might require consulting a different User Manual:

Deliveries	User Manual	S/W version
All hardware **delivered** 02/2015 – 04/2016	1036_MAN02_R02_yyyy-mm-dd.pdf	CPS_v5.0
All hardware **delivered** 07/2014 – 01/2015	1036_MAN02_R01_yyyy-mm-dd.pdf	CPS_v4.0
All hardware **delivered** 01/2012 – 06/2014	1036_MAN01_R01_yyyy-mm-dd.pdf	PKC_v2.3

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