

MAN01-09 – CRYO POSITIONING SYSTEMS CONTROLLER (CPSC) USER MANUAL

CRYO & NANO POSITIONING PRODUCTS

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RELEVANT DOCUMENTATION

Ref	Title, Author
[1]	CNP-Products_MAN00_Rxx_Getting-Started.pdf (JPE)
[2]	CNP-Products_MAN02_Rxx_Software-User-Manual.pdf (JPE)
[3]	C181055_APNo1_Rxx_yyyy-mm-dd_CPSC_Modes_Of_Operation.pdf (JPE)
[4]	
[5]	

DOCUMENT HISTORY

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JPE	2020-04-16	Ro1. Wiring clarification RSM / I1-RSM

DEFINITIONS

ABBREVIATIONS

1. INTRODUCTION

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

This *User Manual* describes the handling and use of Cryo Positioning Systems Controller (CPSC), from here on described as *controller*. This controller consists of a Base Cabinet (CAB) with one or more *plug-in modules* installed.



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

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

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

Please note that all content in this document is superseded by any new versions of this document. Visit the JPE website (www.jpe.nl) to obtain the most recent version¹. All images in this document are for illustrative purposes only.

1.1 Prerequisites

Before continuing with this user manual, please make sure to read and understand the contents of the (latest version of the) Cryo & Nano Positioning Products Getting Started Guide (MANoo).

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

2. CRYO ACTUATOR BASE CABINET (CAB)

This is a 19" desktop cabinet including a Power Supply, a USB/LAN Interface and six slots for up to six² plug-in modules (slot 1 = most left). The picture below shows an example of a typical configuration with 3x Cryo Actuator Driver Module 2 (CADM2) and 1x Resistive Sensor Module (RSM).



Figure 1: Controller - front side

At the back there is a Mains Power IEC inlet with ON/OFF switch, one USB port for a direct connection to a PC and one Ethernet connection for connection to a Local Area Network (LAN). By default the system is powered by 230VAC (European), but alternatively there is also an 115VAC (US) version available³.

Consult the *Cryo & Nano Positioning products Software User Manual (MANo2)* on how to use the controller with a PC or via LAN.



Figure 2: Controller - back side

At the back (either above the IEC inlet or above the USB port) there is also a label with the unique ID of the controller (in the format: **1038Eyyyyymm-xx**).

² The practical number of plug-in modules depends on the selected modules. Please consult JPE when ordering a controller.

³ Needs to be specified before ordering!

3. CRYO ACTUATOR DRIVER MODULE 2 (CADM2)

A Cryo Actuator Driver Module 2 (CADM2) can be used to drive piezo driven actuators like the Cryo Linear Actuator (CLA), Cryo Linear Drive (CLD) or Cryo Bearing Stage (CBS). Each CADM2 module has one drive output and one analog control input. In total there can be up to six CADM2 modules in one base cabinet (CAB), which enables driving up to 6 actuators in parallel.



Figure 3: CADM2

The 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 [V_{pp}] and high peak currents up to 10[A] for a short period of time (up to 30 [μsec])!

3.1 Output

The default Ambient Cables (ACL) can be connected directly to the output of this module (LEMO connectors). If any custom cabling is required, please consult the Getting Started Guide (MANo0).

Because of the high output voltages and peak currents, do not touch the pins of the output connectors!

3.2 Analog input

The module 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 (APNo1)*. To be able to use this external input, it is required to execute a software command to put the module in this mode (the analog input is inactive by default).

The differential input signal can be applied via a standard BNC connector.

Analog input (BNC)		
Input signal	Center pin	-10[V _{DC}] to +10[V _{DC}]
Reference	Outer	0[V _{DC}] (GND)

By varying the input signal, the output *frequency* and *direction* of movement can be set.

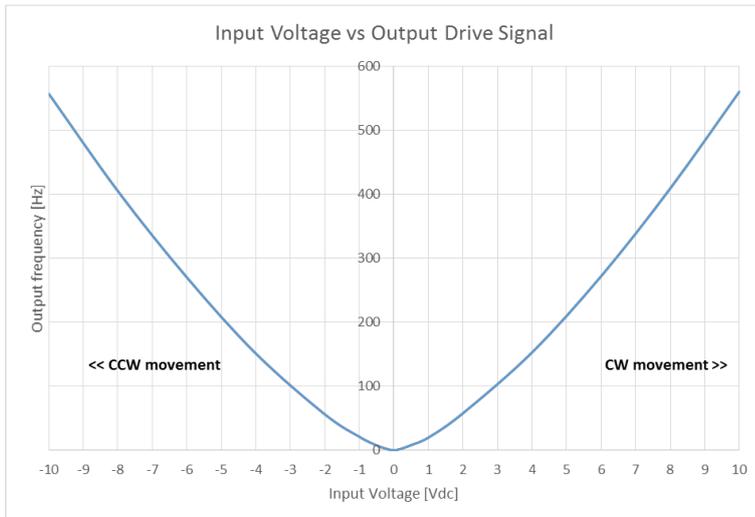


Figure 4: Input signal vs output frequency

Note that the curve is not completely linear; this to make sure that around $0 \pm 0.05[V]$ input, the actuator is not moving (dead point) 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 the *Software User Manual* for more information).

The module will perform an 'automatic zero calibration' upon power on to make sure the connected actuator will not move at an input voltage of 0 (zero) [V] (see above). However, this means that it is required to hold the input at 0 (zero) [V] during power on of the module (therefore, do not let the input float).

3.3 Scanner mode

The module can be operated in a (basic) piezo *scanner* mode by using the Graphical User Interface (GUI) or command line interface (CLI). In this mode a DC voltage can be set to the output instead of the default drive signal. This output voltage can vary between -20[V] and +130[V] (in respect to REF). Consult the software user manual for more detailed information on this option and how to use it in the GUI/CLI.

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

3.4 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. This also applies when the module is in <i>Analog Input mode</i> (see paragraph 3.2). Will start to blink when the module is in <i>Scanner mode</i> (see paragraph 3.3)
Error	Red	<p>Turns on when:</p> <ul style="list-style-type: none"> ▪ 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). ▪ (Cabinet) power supplies are not present. <p>If this led turns on, the output will be cut off from the amplifier inside the module to prevent damage to the electronics and for safety of the operator(s).</p> <p>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.</p> <p>Wait for at least 15 minutes for the module to cool down.</p>

3.5 Troubleshooting

3.5.1 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).

4. PIEZO SCANNING MODULE (PSM)

The Piezo Scanning Module (PSM) can be used to drive (single) *Scanner* piezo's (used in for example the CPSHR and CS02). 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 5: PSM

4.1 Outputs

This module can generate an (high voltage) output signal of -150VDC to +150VDC up to 100mA! Please be aware that the default scanner piezo's in for example CPSHR-S or CS02 cannot withstand these voltages in ambient conditions. 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!

Alternatively the PSM Input Limiter (PSMIL) add-on module is available that limits the inputs signals automatically.

Because of the high output voltages and peak currents, do not touch the pins of the output connectors!

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 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 output of this module (LEMO connectors). If any custom cabling is required, please consult the Getting Started Guide (MAN00).

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.

Analog input (BNC)		
Input signal	Center pin	-10[V _{DC}] to +10[V _{DC}]
Reference	Outer	0[V _{DC}] (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!

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. <i>This might occur if (multiple) outputs drive (multiple) load(s) at a high voltage and high frequency.</i> If the led turns on, the internal power supply to the amplifiers will be cut off and the output will go to 0[V]. Once the amplifiers have been cooled down significantly, the outputs will be reactivated and return to respond to the input signals.

4.4 Troubleshooting

4.4.1 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 continuously (> 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. RESISTIVE SENSOR MODULE (RSM)

The Resistive Sensor Module (RSM) can be used with actuators and systems equipped with Resistive Linear Sensors (product type option -RLS). Each module can read up to 3 sensors (simultaneous readout).



Figure 6: RSM

An RSM can only be used in conjunction with a Cryo Actuator Driver Module 2 (CADM2).

Typical CADM2 / RSM Configurations
1x CADM2 + 1x RSM
3x CADM2 + 1x RSM

5.1 Sensor inputs

Sensor inputs are *industry standard HDMI-type connectors* (3x).

For a quick and easy connection setup, it is recommended to use the Ambient Connector Kit for RSM (I1-RSM) (available separately, see chapter 9). The I1-RSM consists of 3x HDMI-type cables and a D-Sub Interface PCB that converts 3x HDMI-type connectors to a 1x 15p female D-Sub that can be connected directly to industry standard (vacuum) D-Sub (male) feedthroughs.

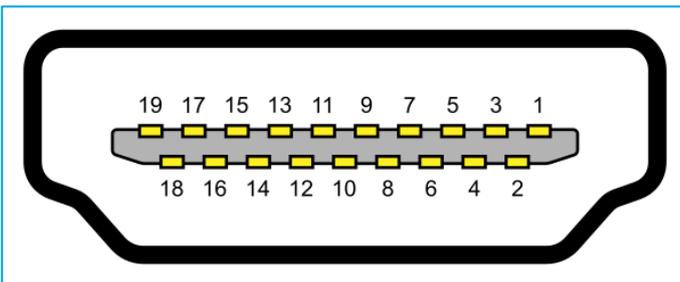


Figure 7: HDMI-type connector (front view)

Pin #	Description	Note
1	Excitation Positive	[A]
2	Shield	[B]
3	Sense Positive	[A]
4	Wiper Positive	
5	Shield	[B]
6	Wiper Negative	
7	Sense Negative	[A]
8	Shield	[B]
9	Excitation Negative	[A]
10-19	n/c	

The following signals should be wired as twisted pairs surrounded by a Shield [B]⁴

- 1 Excitation Positive + Sense Positive (with shield pin 2)
- 2 Excitation Negative + Sense Negative (with shield pin 8)
- 3 Wiper Positive + Wiper Negative (with shield pin 5)

[A] : The Excitation and Sense signals must be merged as close as possible to the RLS. To clarify: after merge, (Excitation Positive + Sense Positive) continue as "Excitation Positive" and (Excitation Negative + Sense Negative) continue as "Excitation Negative", while Wiper Positive and Wiper Negative must continue separately.

[B] : The shield should continue around a twisted pair for as long as possible.

*When using the **I1-RSM** (see chapter 9) this means the merge [A] will be done at the D-Sub Interface PCB. Shields [B] will be merged to each other as well on the D-Sub Interface PCB and end there.*

If any custom cabling is required, please consult the Getting Started Guide (MANo0).

5.2 Analog output

The analog output enables the option to use an external DAQ system to read out the sensor signals in order to setup an (external) control loop in combination with the analog input function of the CADM2 modules (see paragraph 3.2).

The analog output varies between $+5[V_{DC}]$ and $-5[V_{DC}]$ depending on the position of the (wiper of the) RLS connected to the actuator or stage.

It is important to understand that (zero) $0[V_{DC}]$ is the center position of the RLS and not by definition the center of the actuator or stage!

With the CBS10-RLS it is also important to know that $-5[V_{DC}]$ and $+5[V_{DC}]$ will not be reached, because the physical stroke of the CBS10 is shorter than the stroke of the RLS.

⁴ According to standard HDMI specification

That means that for the external control loop to work, the operator must define a signal offset in relation to the center of the connected actuator or stage first.

For each sensor there is a standard BNC-type connector available.

Analog output (BNC)		
Output signal	Center pin	-5[V _{DC}] to +5[V _{DC}]
Reference	Outer	0[V _{DC}] (GND)

5.3 Status LEDs

The module has 3 status LEDs on the front panel:

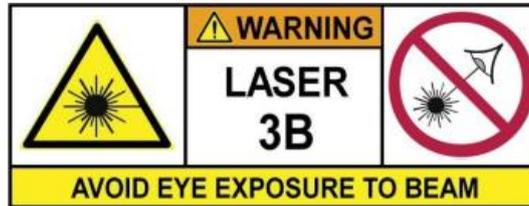
Function	LED Color	Note
Power	Green	Turns on when module is powered on and power supplies are OK.
Status1, Status2	Blue	Visual indication for the duty-cycle of the sensor excitation signal: Status1 = on, Status2 = on : Excitation Duty-cycle = 100% Status1 = off, Status2 = on : Excitation Duty-cycle = 10% - 99% Status1 = off, Status2 = off : Excitation Duty-cycle = 0%

6. 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).



Figure 8: OEM2



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

Typical CADM(2) / OEM2 Configurations

- | |
|--------------------|
| 1x CADM + 1x OEM2 |
| 1x CADM2 + 1x OEM2 |
| 3x CADM2 + 1x 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* and the *Software User Manual*⁵).

The laser used in the OEM2 is a Class 3B emitting invisible (infrared) light. According to the CE Directive 2006/25/EC it is required to take the following safety measures:

- 1 Prevent direct eye exposure. Always cover unconnected outputs with the supplied metal (screw-on) caps and never look at the open beam at the encoder itself.*
- 2 Always use a fully connected setup: all cabling must be present and connected from actuator or system to OEM2 before turning on the controller.*
- 3 Do not place a cabinet containing an OEM2 module at eye level.*
- 4 Wear safety glasses suitable for protection against Laser Class 3B infrared light.*

6.1 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 consult the Getting Started Guide (MAN00).

⁵ Visit www.jpe.nl > Cryo & Nano Positioning

6.2 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*). For more information about this feature, consult the Application Note *CPSC Modes of Operation (APNo1)*.

Pin #	Signal name	Note
1	[A] Quadrature (comparable) A	5V TTL compatible.
2	[A] Quadrature (comparable) B	
3	[A] Quadrature Direction	
4	[A] Analog detector signal	<i>For debug purposes</i>
5	[B] Quadrature (comparable) A	5V TTL compatible.
6	[B] Quadrature (comparable) B	
7	[B] Quadrature Direction	
8	[B] Analog detector signal	<i>For debug purposes</i>
9	[C] Quadrature (comparable) A	5V TTL compatible.
10	[C] Quadrature (comparable) B	
11	[C] Quadrature Direction	
12	[C] Analog detector signal	<i>For debug purposes</i>
13	5V _{opt(out)}	
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. This to ensure CW/CCW movement information in the output signal. Please note that this is only required when using an external DAQ system.

6.3 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.
Status1, Status2	Blue	<i>Reserved for future functionality.</i>

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.



Figure 9: Ambient Cable (ACL)

The default length is 3.0[m]⁶ and has a *LEMO 1b.303* connector on one side (connects to CADM2 and PSM for example) and a white colored 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).

Pin configuration on the (Molex) 2-pin (crimp) socket side		
Pin 1	Piezo SIG	Signal, White wire
Pin 2	Piezo REF	Reference, 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 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 Reference (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! Beware of any open voltage contacts!

If any custom cabling is required, please consult the Getting Started Guide (MANoo).

⁶ Shorter or longer cables (up to 6.0[m]) available on request.

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).



Figure 10: Ambient Fiber (AF₅)

The default length is 3.0[m]⁷ and has a *FC/APC (male)* connector both sides. To connect this side directly to (stand-alone) Cryo (Linear) Actuators (CLA) it is required to use the supplied FC/APC female/female adapter.



Figure 11: FC/APC female/female adapter

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

Always cover ends of unused cables and adapters with the supplied (screw-on) caps.

If any custom cabling is required, please consult the Getting Started Guide (MANoo).

⁷ Shorter or longer cables available on request.

9. AMBIENT CONNECTOR KIT FOR RSM (I1-RSM)

The Ambient Connector Kit for the RSM (I1-RSM) consist of 3x HDMI-type cables and an D-Sub Interface PCB that converts 3x HDMI-type connectors to a 1x 15p female D-Sub that can be connected directly to industry standard (vacuum) D-Sub (male) feedthroughs.

Included in the kit is a dummy feedthrough adapter (15p male-male D-Sub) for ambient testing, so it is not required to use an actual vacuum / cryostat feedthrough.

This cable set works best in combination with the Cryostat Cable for RLS (CCR). With this a complete (electrical) connection from RSM to RLS can be constructed without the need for any additional wiring.



Figure 12: I1-RSM

The default HDMI cable length is 3.0[m].

The D-Sub Interface PCB has 3x HDMI-type connectors and 1x standard 15p female D-Sub with screw locks to fix to standard D-Sub vacuum feedthroughs.

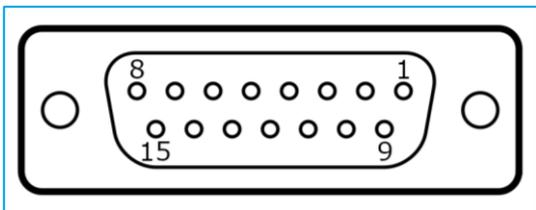


Figure 13: I1-RSM 15p female D-Sub (front view)

I1-RSM 15p female standard D-Sub			
Pin #	RLS #	XYZ conf.	Signal
1	1	X	Excitation Negative
2	1	X	Wiper Positive
3			n/c
4	2	Y	Wiper Negative
5	2	Y	Excitation Positive
6			n/c
7	3	Z	Wiper Negative
8	3	Z	Excitation Positive
9	1	X	Wiper Negative

10	1	X	Excitation Positive
11	2	Y	Excitation Negative
12	2	Y	Wiper Positive
13	n/c		
14	3	Z	Excitation Negative
15	3	Z	Wiper Positive

If any custom cabling is required, please consult the Getting Started Guide (MANoo).

10. CRYOSTAT CABLE FOR RLS (CCR)

The Cryostat Cable for RLS (CCR) is a cable set to connect up to 3x Resistive Linear Sensors (RLS) on the vacuum-cryo side.

This cable set works best in combination with the Ambient Connector Kit for the RSM (I1-RSM). With this a complete (electrical) connection from RLS to RSM can be constructed without the need for any additional wiring.

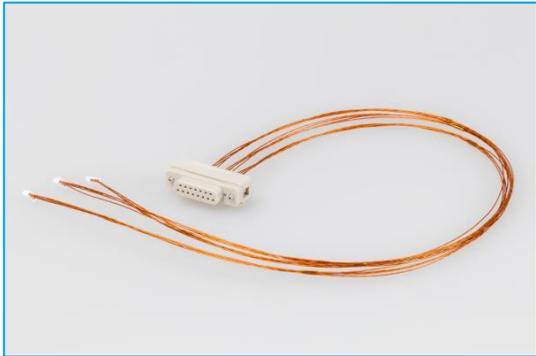


Figure 14: CCR

The default length is 0.5[m] and has [3x] 4p female terminal housing with female crimp contacts (*Würth WR-WTB 1.25mm*) on one end and a 15p female PEEK UHV D-Sub with screw locks (*LewVac D15-PCONF with DPINF-25-S crimp contacts*) on the other side. This D-Sub can be connected directly to industry standard (vacuum) D-Sub (male) feedthroughs.

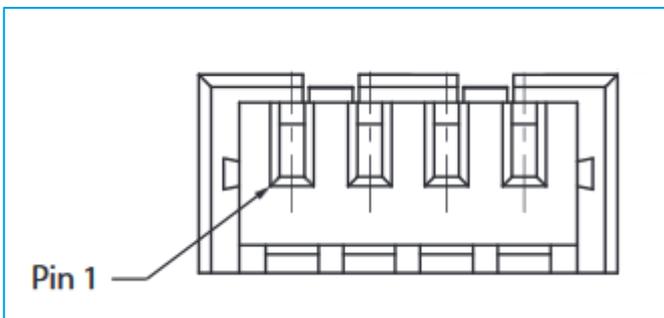


Figure 15: 4-pin WR-WTB 1.25mm Female (front view)

4-pin WR-WTB female terminal (3x)		
Pin #	Description	RLS PCB Ref.
1	Wiper Negative	A
2	Excitation Positive	B
3	Wiper Positive	C
4	Excitation Negative	D

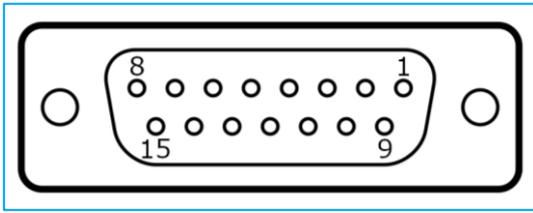


Figure 16: CCR 15p female D-Sub (front view)

CCR 15p female PEEK UHV D-Sub			
Pin #	RLS #	XYZ Conf.	Signal
8	1	X	Excitation Negative
7	1	X	Wiper Positive
6			n/c
5	2	Y	Wiper Negative
4	2	Y	Excitation Positive
3			n/c
2	3	Z	Wiper Negative
1	3	Z	Excitation Positive
15	1	X	Wiper Negative
14	1	X	Excitation Positive
13	2	Y	Excitation Negative
12	2	Y	Wiper Positive
11			n/c
10	3	Z	Excitation Negative
9	3	Z	Wiper Positive

Note that most (D-Sub) vacuum feedthroughs are "male-male" type. This means that the pinning will be mirrored from one side to the other. The pinning of the 15p female PEEK UHV D-Sub is defined such that it works correctly by default with the I1-RSM and a male-male feedthrough (!).

If any custom cabling is required, please consult the Getting Started Guide (MANoo).

11. TROUBLESHOOTING

11.1 Cabinet does not power on

Unplug the power supply cable and check that the input fuse is still undamaged. If the fuse is still okay, make sure that the power supply cable is fully inserted into the IEC inlet.

11.2 RSM doesn't read RLS values

Check that the HDMI connectors are fully inserted into the inputs.

12. DECLARATION OF CONFORMITY

Manufacturer : JPE B.V.
Address : Aziëlaan 12
6199 AG Maastricht-Airport
The Netherlands

The manufacturer hereby declares that the product:

Product Name : **Cryo Positioning Systems Controller (CPSC)**
Product Description : **Modular electronics system consisting of a 19" cabinet including function specific modules and add-on components.**
Product Number : **C181055**

Complies with the following European directives:

2014/35/EU Low Voltage Directive
2014/30/EU EMC Directive
2006/25/EC Artificial Optical Radiation
2011/65/EU RoHS

A copy of the Technical file for this equipment is available at JPE.

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