

**Introduction**

This document describes the different modes of operation when using the *Cryo Positioning Systems Controller (CPSC)*. This controller is needed to operate JPE's *Cryo Linear Actuator (CLA)* and positioning stages that contain such actuators.

The CPSC *Base Cabinet (CAB)* with standard integrated *power supply (PSU)* and *communications interface (PCI)* has 6 free slots. Modules can be inserted upon customer requirements. These modules cannot be randomly placed in the CPSC, certain configuration boundary conditions need to be followed. For detailed information download *-Module Configurations-* from <http://www.janssenprecisionengineering.com/page/cryo-positioning-systems-controller/>.

Communication between PC<sup>[1]</sup> and CPSC is possible by using an easy to use *Graphical User Interface (GUI)* or a more extensive *Command Line Interface (CLI)*. While the GUI can be used to get diagnostic information as well, the CLI enables easy integration with other control software, like for example MATLAB. The latest *-Controller Software Windows-* can be downloaded from <http://www.janssenprecisionengineering.com/page/cryo-positioning-systems-controller/>



More information can be found on <http://www.janssenprecisionengineering.com/cryo-nano-positioning/>

**Modes of operation**

There are 4 different modes of operation available:

- Mdrive : manual toggle, no PC needed, open loop only
- BaseDrive : low frequent / set-and-forget positioning, requires motion programming, can be used open loop or closed loop using the Cryo Optical Encoder
- Servodrive : addressing multiple points in a short time, uses a CPSC internal controller, closed loop only, requires a Cryo Optical Encoder
- Flexdrive : most dynamic operation mode, requires a customer supplied external data acquisition system

Detailed information how to use these modes of operation can be found in the CPSC manual, which can be downloaded from <http://www.janssenprecisionengineering.com/page/cryo-positioning-systems-controller/>

Throughout this document the following modules are used:

- MCM : Manual Control Module always used in combination with up to three CADM or CADM2 modules
- CADM : Cryo Actuator Driver Module outputs the drive profile for a CLA, 3 axes but only 1 active axis at a time
- CADM2 : Cryo Actuator Driver Module 2 outputs the drive profile for a CLA, 1 axis
- OEM2 : Optical Encoder Module 2 readout of the Cryo Optical Encoder, 3 axes simultaneous position output

Compatibility of CPSC modules with the various drive methods						
	Mdrive	Basedrive	Servodrive	Flexdrive	Run axes in parallel	Number of axes per module*
MCM	✓	✗	✗	✗	✗	3-9**
CADM	✓	✓	✗	✗	✗***	3
CADM2	✓	✓	✓	✓	✓	1
OEM2	✗	✓	✓	✓	✓	3

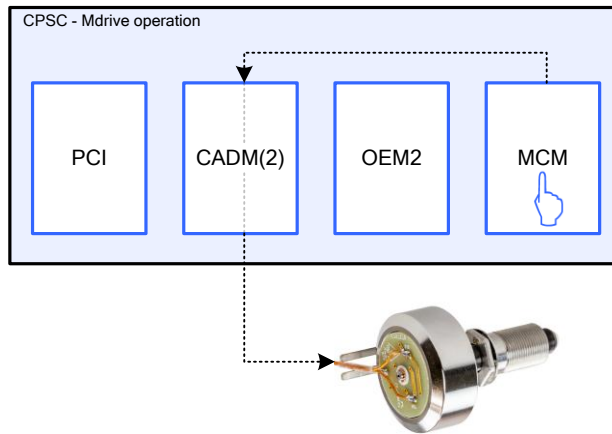
\* If more axes are needed more modules must be used. This could also imply the use of more than one CPSC  
 \*\* 3 in combination with 1x CADM or 3x CADM2, 9 in combination with 3x CADM  
 \*\*\* In principle multiple axes can run in parallel when using multiple CADM modules. Advised is the use of multiple single axis CADM2 modules as a more cost effective solution

Note: if the CPSC contains a MCM module, it is always possible to switch to Mdrive.

[1] : Connection via USB on Windows OS.

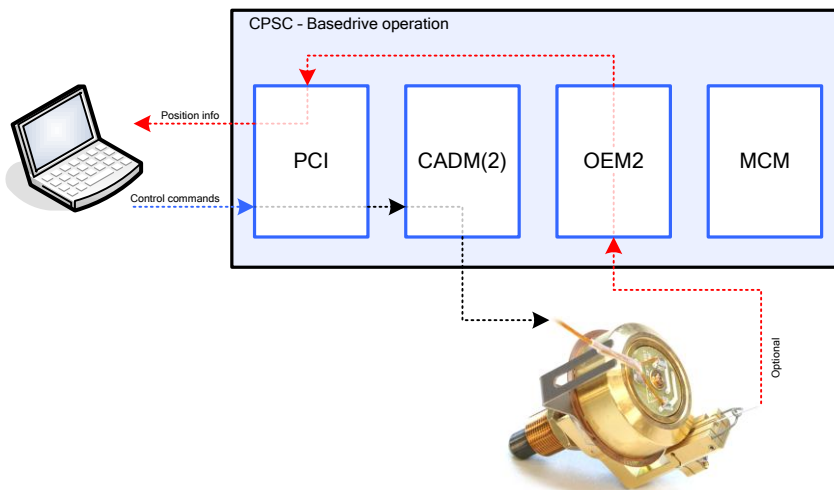
**Mdrive**

Without the need to connect the CPSC to a PC or do any programming, this is a true plug and play way to operate CLA's. Step size and frequency can be set on the MCM and a toggle-switch is used to manually control the selected CLA. Up to 3 CADM2 modules can be addressed, so a total of 3 axes can be driven (9 axes in case of 3x CADM). Parallel operation of CLA's is not possible, only sequential. As it only works in open-loop there is no position information.



**Basedrive**

Basedrive operation is possible when the CPSC is connected to a PC and by using the GUI or CLI. The user can program CLA motion control, both open loop and closed loop. The latter requires the use of Cryo Optical Encoders in combination with an OEM2. Communication overhead sets a boundary at approx. 5 command lines per second, giving a servo update rate of approx. 1Hz in practice. Basedrive is especially suitable for low frequent and set-and-forget applications. Parallel operation of CLA's is not possible, only sequential. Nanometer steps can be made, but detectable resolution is limited by the COE to approx. 300 nm.

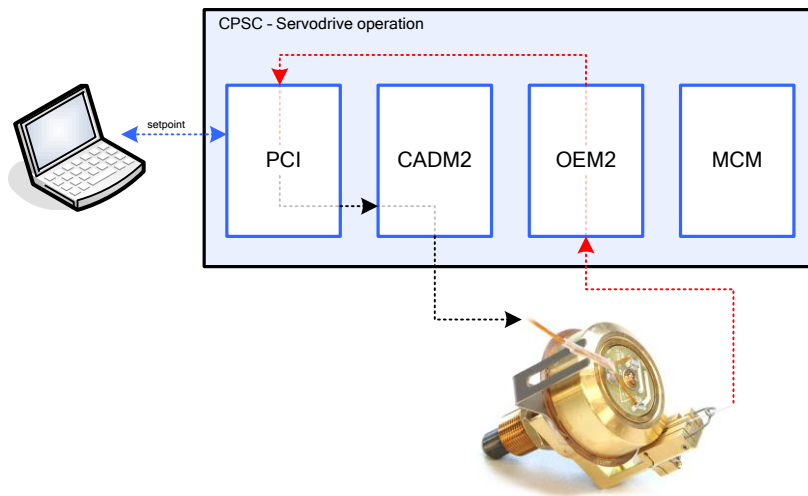


**Servodrive**

The CPSC can be set to operate in an *internal closed loop position control* mode. The operator can simply send setpoints (as number of encoder steps). This Servodrive mode is implemented in the PCI and requires a connection to the PC<sup>[1]</sup> and the use of the *Command Line Interface* (CLI). The closed loop functionality needs both CADM2 and OEM2 modules and CLA's with a Cryo Optical Encoder.

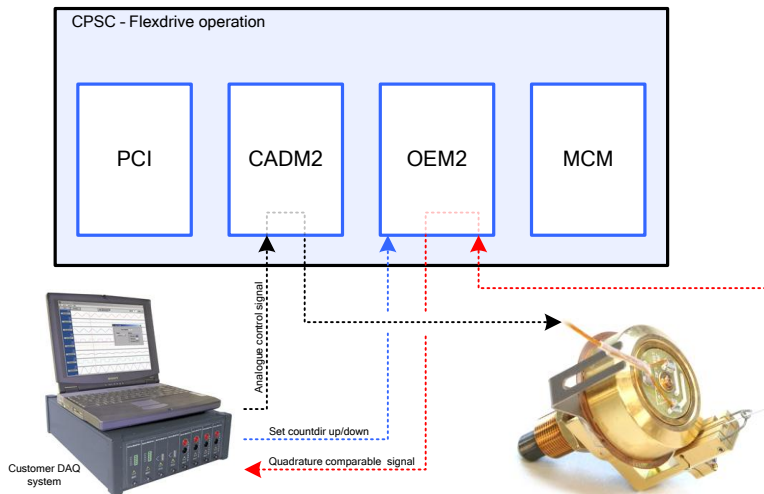
Using Servodrive with multiple CADM2 modules makes it is possible to operate multiple actuators simultaneously by sending only one combined setpoint command. The effective controller bandwidth of 40Hz and up to 5 setpoint commands per second makes this mode of operation suitable for running over points in a grid with a stage. Nanometer steps can be made, but detectable resolution is limited by the COE to approx. 300 nm.

[1]: Connection via USB on Windows OS.



**Flexdrive**

If fastest position control is required, it is possible to connect the CPSC to an external data acquisition (DAQ) system. Each CADM2 module can be controlled via a standard *analogue input signal*, and the OEM2 module is able to output a *quadrature comparable signal* which can be read by industry standard quadrature counter cards. This allows users to create their own position controller using a DAQ system and the default CPSC. For instance integration of experiment feedback or safety signals into the controller is possible.



[1] : Connection via USB on Windows OS.