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Product Manual

NANOSCAN
NPC-D-6110
NPC-D-6220
NPC-D-6330
NANOMECHANISM CONTROLLER
USER MANUAL

Closed loop digital servo controller for positioning of up to three Queensgate NanoMechanisms

EN-014635-UM Rev 2

Safety Precautions

WARNINGS

HAZARDOUS VOLTAGES

The Product generates high voltage and relies on the provision of a protective earth (ground) conductor to prevent user accessible components developing a hazardous potential in the event of an insulation failure. This protective earth is provided by the external power supply and only an approved power supply should be used with the product. Additional protection is provided by special NanoMechanism interface connectors and cable assembles. To maintain the integrity of the operator safety systems only approved NanoMechanisms and cables should be used with the product. The product should not be used if there are any signs of damage or if the equipment is believed to be faulty. It should be returned to the manufacturer for investigation and repair.

DO NOT remove the equipment's protective covers. There are no user serviceable parts within the equipment and removal of the cover will expose the user to potential high voltage hazards and will invalidate the Warranty.

MUST read the manual before using the controller to understand how to correctly and safely operate the product. Incorrect use of the equipment may lead to personal injury or damage to property. Always turn the equipment off and remove the mains plug when not in use. Always use the equipment as specified in this manual.

CAUTIONS

ELECTROSTATIC SENSITIVE DEVICES (ESD)

The unit contains components that are susceptible to damage through electrostatic discharge at the NanoMechanism and interface connectors. Removal of protective connector covers and connection of cables must be performed in a static safe environment using approved static safety handling procedures.

ENVIRONMENT

The unit is designed for use indoors in a dry environmentally controlled manufacturing facility, office or laboratory. The temperature and relative humidity should be kept within those specified in Table 2-1. Significant dust or acoustic/mechanical vibration may cause faulty operation or damage to components so should be avoided. Maintain adequate cooling of the controller by not restricting the air flow to and from the fan cooling vents. For prolonged periods of operation it is advisable to keep the environmental humidity to a minimum.

DIRECTIVE AND STANDARDS APPLIED:

2004/108/EC	EMC Directive BS EN 61326-1:2006 Electrical equipment for measurement, control and laboratory use EMC requirements — Part 1: General requirements FCC part 15, subpart B
2006/95/EC	Low Voltage Directive BS EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements
2003/108/EC	WEEE Directive

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Related documents

Document Ref	Title	Usage
EN-014217-UM	NanoScan NPC-D Series NanoMechanism Controller - Controller Interface Library	Details the usage of controller interface DLL in order to send commands to the controller
EN-014429-UM	NanoScan NPC-D-6xx0 Series NanoMechanism Controller - Command Set And Control System	Lists and explains usage of NPC-D 6xx0 controller commands and structure of control system
PS-00006-UM	Nanobench 6000 User Manual	Details the usage of Nanobench 6000 application to calibrate stages and configure controller

Revision history

Revision	Changes
1.0	First version.
2.0	General: Reformatted for Prior Scientific and NanoScan rebranding. Updated front and back panel artwork.

1 Introduction

1.1 Overview

The NanoScan NPC-D-6000 series digital controller is a multi-axis closed loop piezo actuator controller. It can control up to 3 channels of Queensgate NanoMechanisms.

NPC-D-6110 is a single axis version, NPC-D-6220 is a dual channel version and NPC-D-6330 is a three channel version. In the document, controllers will be referred to as NPC-D-6xx0 where xx represents the number of channels.

Each channel of the controller is part of a closed loop positioning system which utilises piezo actuators in a flexure guided NanoMechanism (also referred to as a “Stage”). The controller incorporates a high voltage power amplifier to drive the piezo electric actuator and a precision capacitive positional sensor measurement circuit for closed loop operation. The controller is designed to work with all Queensgate NanoMechanisms (with appropriate Queensgate recalibration and suitable adaptor cables, if required).

1.2 Features

The NPC-D-6xx0 series of controllers have the following features:-

- Standalone single, dual or triple -axis digital controller for NanoMechanisms.
- Digital signal processing with 24 bit data resolution.
- Closed loop controller with open loop operating mode.
- 4th order linearization algorithm for high positional accuracy.
- Digital PID control loop for ease of setting up.
- Fast 20µs control loop update.
- Supports NanoMechanism EEPROM calibration data storage for automatic setup.
- Low noise floor offers precise imaging & focussing.
- Dynamic high-power output NanoMechanism drive with 20 bit resolution.
- Soft-start / stop technology protects loads and increases piezo life.
- Front panel LEDs to provide instant operational status.
- USB and Ethernet control interfaces.
- Easy to interface with OEM software using supplied DLL (Dynamic Link Library).
- Examples of software in C/C++, Python and LabVIEW® provided.
- Analogue input for external analogue control of NanoMechanism position.
- Analogue output for external analogue reporting of NanoMechanism position, configurable to also report other data if required.
- User programmable function playback feature allows pre-programmed waveform to be replayed with no further PC interaction required.
- Configurable TTL inputs to allow external control of function playback.
- Configurable TTL outputs to trigger external hardware synchronized with function playback.
- TTL In-Position outputs to indicate when NanoMechanism reaches the desired/set position, with configurable position accuracy.
- Configurable TTL quadrature or step-and-direction inputs and outputs to allow external control of NanoMechanism position using stepper motor controller type interfacing.

2 NPC-D-6xx0 Series Specifications

2.1 NPC-D-6xx0 Specifications

Table 2-1: NPC-D-6xx0 Specification

Parameter	Value	Units	Comments
Mechanical			
Size (Width x Depth x Height) Height includes feet Not including protruding components at front and rear of controller	318 x 240 x 90	mm	Additional space required for front and rear connectors and cables.
Weight	3.0	kg	
Cooling	Fan forced air	--------	Vents on rear and base
Electrical			
Power input (to External bench top power supply)	100 to 240 nominal 47 to 63	Vrms Hz	Using external supply. ***Only use Queensgate approved power supply*** -provides protective earth connection
DC Power input	+24 ± 0.75 @ 5A	V	***Only use Queensgate approved power supply***
DC Power input connector	4 pin DIN Plus protective earth connection	--------	Rear panel
Connectivity			
USB	2.0 compliant	--------	USB type B connector. Note: power not taken from USB port.
Ethernet	IEEE 802.3	--------	RJ45 connector. Requires a Cat 5 male to male cable. **MUST use shielded Ethernet cable.**
Analogue input Command	BNC	--------	Per channel – Front panel
Analogue Position Monitor output	BNC	--------	Per channel – Front panel
“TRIG” input, “TRIG” output, “IN-POS” output and stepped I/O Interface	25 pin D-type socket	--------	Rear panel
Controller Synchronising signals	9 pin D-type socket	--------	Rear panel

Environmental – Operational			
Temperature	10 to 40	ºC	
Relative Humidity	5 to 80	%RH	Non-condensing
Environmental - Storage and Shipping			
Temperature	-20 to 70	ºC	
Relative Humidity	0 to 95	%RH	Non-condensing

2.2 NPC-D-6xx0 Series Performance Specifications

Table 2-2: NPC-D-6xx0 Performance Specification

Parameter		Value	Units	Comments
General				
Warm up time		40 (typ)	Min	
"ANA I/P" analogue input position command per channel		-10 to +10	V	Connector BNC – Single ended MAXIMUM input: ±15V
"ANA I/P" analogue input impedance (per channel)		> 50k	Ohms	
"POS MON" analogue output position monitor per channel		-10 to +10	V	Connector BNC - Single ended MAXIMUM output: ±15.5V
"POS MON" analogue output current (per channel)		± 5m	A	Maximum drive/sink current
"IN-POSITION" Output, "TRIG" Output Stepped Output	Logic "0"	< 0.8	V	15 pin D-Type on rear panel. **For OUTPUTS** Load impedance: > 1k ohms. MAXIMUM output: 5.5V **For INPUTS** Input impedance: 50 ohms. MAXIMUM input: 5.5V
	Logic "1"	2.4 to 5	V	
"TRIG" Input Stepped Input	Logic "0"	< 0.8	V	
	Logic "1"	2.4 to 5	V	
NanoMechanism interfacing – controller – per channel				
Connector		17W2 D type	-------	Mixed signal connector
HV output swing		-20 to +120 or -30 to +150	V	Factory set but software selectable
HV drive current		160mA	mA	
HV amplifier bandwidth		TBD	kHz	
HV amplifier intrinsic noise		0.3	mV	

Table 2-3: Example of NPC-D-6xx0 System performance

Parameter	Value	Units	Comments
NPS-X-15 NanoMechanism – System			
Range	> 15	µm	Calibrated Closed loop.
Linearity	0.01	%	Typical.
Bandwidth (small signal)	280	Hz	Typical on Fast PID setting.
Stage noise	0.01	$nmHz^{-½}$	
DPT-D NanoMechanism – System			
Range	See DPT-D specification sheet	µm	Calibrated Closed loop.
Linearity	0.1	%	Typical.
Bandwidth (small signal)	300	Hz	For DPT-D-40. Bandwidth's will vary depending upon DPT-D variant.
Stage noise	0.02	$nmHz^{-½}$	
OSM-Z-100 NanoMechanism – System			
Range	100	µm	Calibrated Closed loop.
Linearity	0.01	%	Typical.
Bandwidth (small signal)	100	Hz	Typical on Fast PID setting.
Stage noise	0.03	$nmHz^{-½}$	

3 Unpacking and Handling

3.1 Unpacking the NPC-D-6xx0

Carefully remove the product's transit packaging. DO NOT remove the connector protective covers until connections are to be made. Retain the transit packaging for possible future use.

Visually inspect the system for transit damage and check for missing items. If any damage or missing items are apparent do not attempt to install the system.

If the system is damaged in any way, report the damage to the manufacturer and return the product using the returns procedure. If there are missing items, report them immediately to the supplier (see contact details at the end of this document and refer to the company website www.queensgate.com).

The contents of the NPC-D-6xx0 package are listed as follows:

Table 3-1: Contents of the NPC-D-6xx0 package

ITEM	QUANTITY
Controller Specific	
NPC-D-6xx0 NanoMechanism Digital Controller (NPC-D6110, NPC-D-6220 or NPC-D-6330 – depending upon order)	1
Power Supply 120W* (Universal input with +24V dc output)	1
Mains IEC Power Supply Lead	1
Software (containing user manual, Controller Interface software and results file)	1
USB cable	1
NanoMechanism Stage extension cable(s)	(optional)
NanoMechanism Stage adaptor cable(s)	(optional)

*The NPC-D-6xx0 should only be used with supplied power supply.

3.2 Using the NPC-D-6xx0

The NPC-D-6xx0 is a robust unit and requires no special handling precautions other than that normally followed with electronic equipment.

- Static discharge to any of the connectors may cause damage, so ensure that all personnel handling the unit are adequately grounded.
- The controller should not be subjected to mishandling or used in hostile environments.
- The controller is a free standing unit and should be located on any stable flat surface (e.g. workstation or a desk) providing protection against accidental damage.
- Do not obstruct the controller's vents and cooling fan air flow as this may cause overheating.

- The cooling fans fitted to the controller will produce a small level of acoustic and vibrational noise. For best system performance it is recommended that the controller is located away from and vibration isolated from the NanoMechanism - for example by placing on a rubber mat.
- It is recommended that the rear panel mounted power switch is used to turn the controller on and off rather than using the power supply wall switch. Ensure that the power supply is connected and powered before turning on the controller. Turn off the controller before powering down or disconnecting the power supply.
- Ensure the controller is switched OFF before connecting and disconnecting the NanoMechanisms.

3.3 Mounting the NanoMechanism (stage)

NanoMechanisms (also referred to as “stages”) are devices with nanometre resolution and stability. They require care in use and should not be subjected to large torques and shocks (see NanoMechanism specification datasheet for more details).

- Ensure the controller is switched OFF before connecting and disconnecting the NanoMechanisms.
- The mounting surfaces for the stage should be flat (N5 or better).
- The stage must be installed only by the specified mounting points provided – see specific installation drawing. Use spring washers where applicable and do NOT exceed the recommended tightening torques as stated on the installation drawing.
- Stages should not be over constrained. The moving platform should not be restricted in its motion.
- Stages are internally preloaded and can exert a pulling force up to the preload value – see stage specification sheet.

3.4 Cabling

Ensure that the controller is switched off before installing or removing cables, especially the Stage connector. The Stage devices use high voltages and all cables should be inspected before use. Damaged cables should be rejected and replaced. Only use specified cables with the controller and Stages. When routing cables ensure:

- The route does not pose a safety hazard.
- The cable is not twisted or kinked and is not unduly stressed.
- There is no chafing or risk of future mechanical damage.
- The cable is properly strain relieved.
- Use connector locking screws (where fitted) to prevent accidental disconnection. Do not over tighten.

4 Controls and connections

4.1 Front panel

The front panel houses the NanoMechanism (stage) interface connectors, status indicators and analogue interfaces – see Figure 1.

Figure 1: Front panel layout

Table 4-1: Front panel controls and indicators

Description	Range/Operation
“POWER” indicator LED	Indicates the power status and functionality of the product. RED steady = Controller configuring/not ready (can take up to 30 seconds). RED/GREEN flashing = Controller fault condition. GREEN steady = Controller powered and ready for operation.
“COMM” indicator LED	Indicates the state of the controller communications with the connected computer. Not lit = No communications taking place. GREEN lit or flashing = Communications are taking place.

“CLOSED” indicator LED (per channel)	Indicates the status of the stage control Loop OFF = Stage NOT connected ORANGE = Stage settings being loaded on connection RED = Controller operating in OPEN loop mode GREEN = Controller operating in CLOSED loop mode YELLOW = Controller servo output frozen
“IN-POS” indicator LED (per channel)	Indicates the status of the stage position in CLOSED loop mode. ORANGE = Stage settings being loaded on connection OFF = Stage has not reached the desired position GREEN = Stage has reached the desired position (within specified limits) *Note: In OPEN loop mode or with no stage connected, LED is always off.*
Nano Mechanism Connector 	Stage piezo HV supply, power for calibration EEPROM and measuring signals for capacitive sensor operation. NOTE High Voltage present on connector – up to 160Vdc 
“POS MON” connector(s) (per channel)	Analogue position monitor (POS MON) output BNC connector(s) – single ended output(s). Indicates relative position of the stage.
“ANA I/P” connector(s) (per channel)	Analogue command input BNC connector(s) – single ended input(s). Signal used to control the stage position when used in analogue mode.

4.2 Rear panel

The rear panel provides power input, ON/OFF switch, digital I/O and PC connectivity to the controller – see Figure 2.

Figure 2: Rear panel layout

Table 4-2: Rear panel interfaces

Description	Type	Signal type/Range	Maximum input voltage	Function
Power Connector 	4 pin miniDIN with screen	Input +24V dc ±0.75V @ 5A	24.75V	Provides power to the controller electronics and the high voltage generation. ONLY connect an approved power supply. ***NOTE the power supply provides the Safety Earth connection.***
Earth Stud 	M4 threaded stud	0V ground	Do not raise above 0V ground potential	Provides additional product ground to help reduce interference of background electrical noise. Note that under some circumstances this connection may increase electrical noise due to ground loops.
Ethernet Connector	Dual RJ45	10BASE-T 100BASE-T		Ethernet communications. Dual connector master/slave configuration. Used to communicate with an external computer. **MUST use shielded Ethernet cable.**
USB Connector	Type B	USB signals 5V power 2.8V signal	+6V power/data	USB communications. Used to communicate with an external computer. Note power is not taken from the USB connector.
TRIG Input TRIG Output IN_POS Output Stepped Input Stepped Output Interface Connector	25 pin D-type socket	TTL input Low < 0.8V High > 2.4V	5.5V	Provides digital inputs and outputs for interfacing controller to external equipment. **MUST use shielded cable.**
Controller Synchronising signals	9 pin D-type socket	Queensgate use ONLY	Do not apply voltages to connector	DO NOT CONNECT. QUEENSGATE USE ONLY for synchronising 2 or more NPC-D-6xx0 controllers.

Table 4-3: Rear panel 25 pin D-type digital I/O connector pin assignment.

Socket Pin No.	Function	Socket Pin No.	Function
1	TRIG INPUT CH1	14	TRIG OUTPUT CH1
2	STEPPED INPUT A CH1	15	STEPPED OUTPUT A CH1
3	STEPPED INPUT B CH1	16	STEPPED OUTPUT B CH1
4	0V	17	IN-POS OUTPUT CH1
5	0V	18	TRIG OUTPUT CH2
6	TRIG INPUT CH2	19	STEPPED OUTPUT A CH2
7	STEPPED INPUT A CH2	20	STEPPED OUTPUT B CH2
8	STEPPED INPUT B CH2	21	IN-POS OUTPUT CH2
9	0V	22	TRIG OUTPUT CH3
10	0V	23	STEPPED OUTPUT A CH3
11	TRIG INPUT CH3	24	STEPPED OUTPUT B CH3
12	STEPPED INPUT A CH3	25	IN-POS OUTPUT CH3
13	STEPPED INPUT B CH3	--------	

NOTE:
INPUT is defined as input to the controller from external interface.
OUTPUT is defined as output from the controller to the external interface.

5 Operating instructions

5.1 Set up

a) Ensure that the controller is switched OFF.

b) Connect NanoMechanism into the NPC-D-6xx0 stage connector (17W2 way D-type) on the front panel.
NOTE: Ensure that the screw locks are tightened.

c) Attach the appropriate control interface cable between the controller and controlling computer – USB, Ethernet, and/or analogue interface.

d) Connect power supply to the NPC-D-6xx0 rear panel.
NOTE: Do not use any other power supply than that specified. The power supply specified provides the electrical Safety Earth connection.

e) If required, connect optional earth cable to the ground stud on the rear of the controller to reduce background electrical noise.
NOTE: This connection may result in additional electrical noise due to ground loop problems – in which case do not use. It is not intended as a Safety Earth connection

f) Connect the mains IEC lead to the power supply and plug into the wall outlet.
Mains IEC lead and wall outlet MUST have EARTH connection.
Turn on the wall socket.

g) On rear panel, toggle Power ON/OFF switch to turn ON the NPC-D-6xx0. The “POWER” LED should be lit RED to indicate that the controller is being configured and then lit green to indicate that the product is ready for use. May take up to 30 seconds to turn green.
If a stage is connected to any of the channels, then the appropriate CLOSED LED will either be RED (open loop) or GREEN (closed loop) depending upon mode of operation selected.
NOTE: If a Stage is not connected, the CLOSED LED will remain OFF.

h) The system is now ready for use.

5.2 Turning on the controller

Always ensure the controller is switched OFF when connecting and disconnecting stage connectors from the controller.

It is best practice to turn on the power supply before turning on the controller. Toggle the rear panel ON/OFF power switch to ON. The POWER LED on front panel will turn RED until the unit has been configured, at which point the LED will turn GREEN when the controller is ready for use.

Note that this configuration process can take up to 30 seconds.

If a stage is attached and is recognised by the controller (reading the stage calibration) then the appropriate CLOSED LED will either be RED (Open loop) or GREEN (Closed loop) depending upon mode of operation selected.

5.3 Moving the stage

There are multiple ways to control the position of the stage:-

- via the analogue input;
- by commands from the controlling PC;
- by commands from the stepped inputs;
- by function playback triggered by the controlling PC or external hardware.

All enabled commands are summed to give an overall position command.

5.3.1 Analogue command input

The ANA-IP is for the application of an analogue position command to the controller. The analogue command is applied via the front BNC connector(s), with an independent input for each channel.

It is used to change the stage position from minimum calibrated position to maximum calibrated position. Note that the analogue command must be enabled in the control software.

The input is single ended, where signal is applied to the connector central core and the connector shell is connected to 0V or signal ground.

Table 5-1: Analogue command table

Analogue input	Stage Position
+10V*	Maximum position (+Range/2)
0V (or disabled via software)	Nominal position
-10V*	Minimum position (-Range/2)
*See results sheet for exact values.	

5.3.2 Digital command input

Digital commands are sent over the chosen communication interface – USB or Ethernet. Digital commands are set in picometres for linear stages or picoradians for angular stages – see stage results sheet for units.

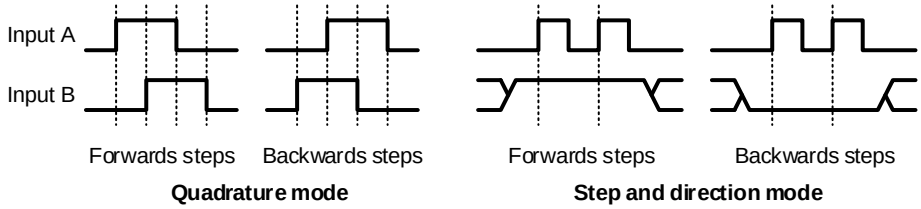
5.3.3 Stepped input command

The stepped inputs may be configured as quadrature or step and direction interfaces. For each forwards or backwards step received, the commanded position moves by a configurable step in the relevant direction.

For quadrature mode, input A leads input B when commanding forwards movement on the stage; and input B leads input A when commanding backwards movement. With the standard Gray Code system as used for stepper motor controllers, each edge on each input indicates a step in the appropriate direction.

For step and direction mode, input B controls whether a step is to be forwards or backwards, and a rising edge on input A triggers a step in the appropriate direction.

Figure 3: Stepped input commands



To ensure the controller can be easily integrated with other systems, this is also configurable to reverse direction, and for step and direction mode to trigger on rising or falling edge.

5.3.4 Function playback

Function playback allows a waveform to be set up by the PC and triggered to play without further intervention from the PC. Digital commands cannot be sent to the controller as fast as the controller's sample rate, so this allows the playback of more accurate movement profiles, as well as ensuring the waveform does not suffer from the inevitable jitter associated with sending periodic digital commands over a communications interface.

Configurable trigger outputs allow external equipment such as a camera to be triggered synchronously with the waveform, for example at intervals during a constant-velocity ramp. Configurable trigger inputs may be used to start, stop or pause playback on any channels, after waveforms have been set up by the controlling PC, allowing integration with control hardware.

5.4 POSMON output

5.4.1 Analogue POSMON

The NPC-D-6xx0 generates an analogue output proportional to the stage position relative to its nominal position for each channel. This is called Position Monitor or POSMON. It is a single ended analogue output with the connector shell connected to ground.

Table 5-2: Position Monitor output table

POSMON Output	Stage position
+10V*	Maximum position (+Range/2)
0V	Nominal position
-10V*	Minimum position (-Range/2)
*See results sheet for exact values.	

Position Monitor or POSMON can be converted to a position in microns by multiplying the POSMON voltage by the scale factor stated in the results sheet that comes with the system.

For a linear system, **stage position (µm) = POSMON (V) * Scale Factor (µm/V)**

For an angular system, **stage position (µrad) = POSMON (V) * Scale Factor (µrad/V)**

POSMON output range can be customised to customer request, check the stage results sheet for actual values.

5.4.2 Digital POSMON

The stage position can be read over the chosen communication interface – USB or Ethernet. See the controller interface command set manual EN-014429-UM for full details.

Position is reported in picometres for linear stages or picoradians for angular stages – see stage results sheet for units

5.4.3 Stepped outputs

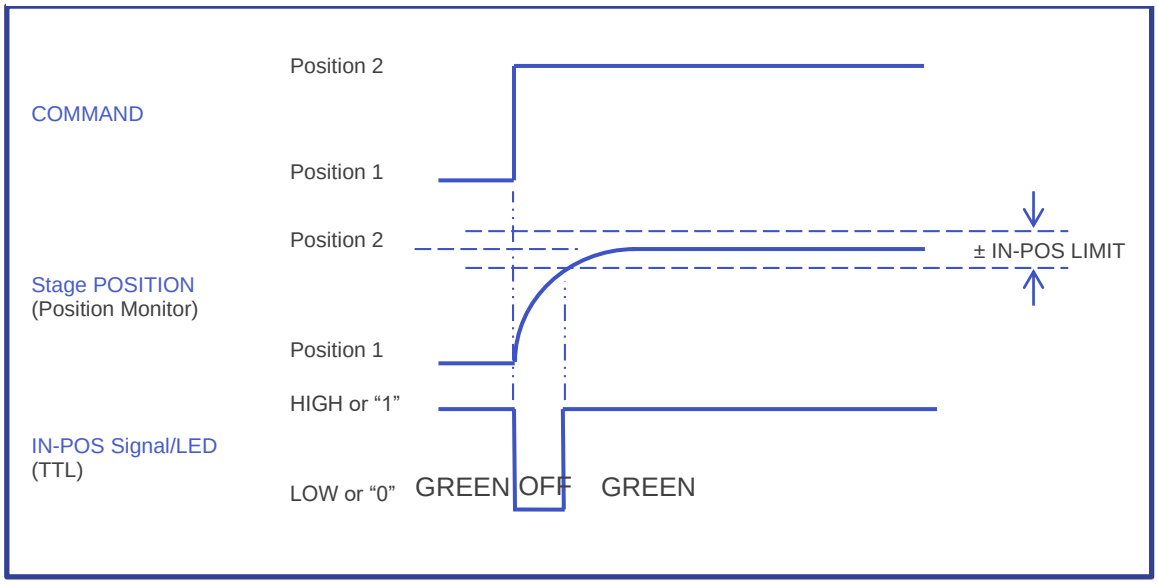
As with stepped inputs, the stepped outputs may be configured as quadrature or step and direction interfaces. Stepped outputs can be configured to report commanded position, echoing back the stepped inputs commands received, or can be configured to report POSMON where movement by a configurable step distance forwards or backwards will produce the appropriate step output. Stepped output pulse timings can be configured as required for receiving hardware.

5.5 IN-POS (In Position or READY) signal output

The IN-POS LED indicates when a commanded position is reached by the stage within the IN-POS limits. IN-POS limits may be configured by the customer. The status is also available as a corresponding TTL signal on the rear panel connector for interfacing to external equipment.

Note that the signal may “oscillate” between the high and low levels if the stage itself is oscillating in and out of the IN-POS configuration settings, e.g. during overshoots and undershoots after a step input. This will be dependent on the system and on the IN-POS configuration.

Figure 4: IN-POS signal output for a typical command step



5.6 TRIG-IP (Trigger Input) signal

The TRIG I/P is a TTL input which allows external equipment to trigger function playback on a chosen channel, as described in 5.3.4. See the controller interface command set manual EN-014429-UM for full details.

5.7 TRIG-OP (Trigger Output) signal

The TRIG O/P is a TTL output which provides a trigger signal to external equipment during function playback at particular stage positions or events, as described in 5.3.4. See the controller interface command set manual EN-014429-UM for full details.

6 Controller interface software

6.1 Control from OEM software

Control of the NPC-D-6xx0 from OEM software on a host PC is provided by the controller interface DLL. This is intended to simplify interfacing to the controller by removing any requirement to handle low-level communications. Commands are passed to the DLL as text, and responses are returned as text. The DLL handles the translation to binary communication over the desired communications link. It also handles link detection and retries, so that messages are transmitted reliably.

As a standard DLL, this may be interfaced to any application/platform which supports DLL usage (e.g. Matlab or Labview), or controlled from an application written in any programming language. Examples of interfacing to the DLL are provided in C++ and Python.

See the controller interface library manual EN-014217-UM for full details of how to use the DLL.

The DLL is supplied on the memory stick provided with the controller. The DLL may currently be used on the following operating systems:

- Windows XP, 7, 8, 10
- Ubuntu 14.04
- Scientific Linux 5.4
- CentOS/RHEL 6.8

The DLL is supplied as prebuilt binaries only. Contact Queensgate if support is required for other Linux distributions.

6.2 Controller interface commands

The command set allows the stage calibrations and configurations to be set as required for the customer application. Commands are sent to the DLL as text, and text responses are received. The same command set is used for the CLI.

The controller interface command set manual EN-014429-UM provides full details of the command set. This includes diagrams of the control loop and descriptions of controller operation for features which may be configured by the customer.

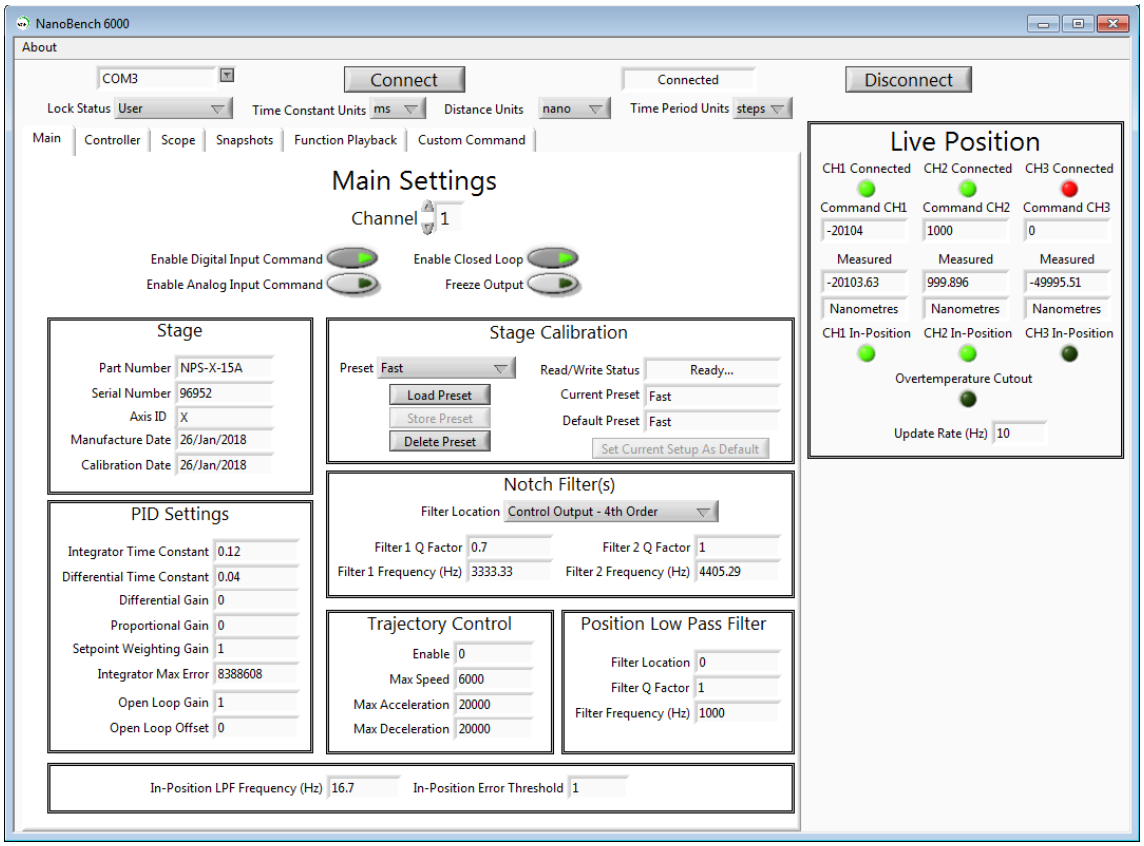
A command line interface (CLI) application is supplied on the memory stick provided with the controller. This allows the controller to be configured by users immediately, using the controller interface command set directly. The CLI application source code is also supplied on the memory stick, as an example of interfacing to the DLL.

6.3 Nanobench 6000 application

When a customer needs to carry out testing and calibration on the system before integrating with OEM software, the Nanobench 6000 application allows user-configurable settings to be changed and the system state to be monitored. The Nanobench 6000 application installer is

supplied on the memory stick provided with the controller. The application requires installation of the Labview 2017 32-bit Run-Time Engine, which is also supplied on the memory stick.

Figure 5: Nanobench 6000



Manual PS-00006-UM describes the Nanobench 6000 application. The command set manual EN-014429-UM is also relevant, because the Nanobench 6000 application simply provides a user-friendly front end to the controller interface commands. For most users, this is easier to use than the command-line interface.

Note that Nanobench 6000 is not intended to replace the need for OEM software to integrate the NanoMechanism and controller into the customer's system. It is only intended for use in calibration, development and testing, and not for wider use in a finished product.

7 Troubleshooting

Problem	Possible reason	Suggested solution
POWER LED is not lit	Power supply not connected.	Connect power supply.
	Power supply is switched OFF at the mains.	Switch on power supply at the mains.
	Power switch on the rear panel is switched OFF.	Toggle power ON/OFF switch to ON position to turn on unit.
	NPC-D-6xx0 is defective	Report fault to Queensgate
POWER LED is red (steady or flashing)	Unit still being configured (LED steady RED)	Wait until the unit has configured itself (up to 30 seconds)
	Fault detected, including software crash (LED flashing RED)	Turn off, wait 10 seconds and then turn on again.
	NPC-D-6xx0 is defective (LED steady or flashing RED)	Report fault to Queensgate
Channel OPEN/CLOSED LED is not lit	Stage not connected	Connect stage
	Stage not detected	Stage faulty – return to Queensgate for inspection.
IN-POS LED is not lit for most of the time	Stage is not settling to the specified levels before receipt of the next position command.	If you are commanding the Stage with a continually changing input (e.g. a ramp) there will be a time lag between the commanded and the measured position. This can be reduced by reducing the command rate change to allow more time for the Stage to settle.
READY LED is not lit all of the time	Stage is not being detected or cannot reach the target position	Check the Stage connection to the controller, that the step parameters are within the range of the Stage and that the Stage is mechanically free to move.
Stage does not move as expected	Stage not connected	Check connector mounting. Check that the Stage is mechanically free to move.
	Controller parameters not correctly set	Adjust PID parameters and check Mode settings.
Stage oscillates	Stage mounting and load.	The stability of a Stage is affected by its mounting method and the load placed on it, particularly if the load is heavy (>100 g) or has its own resonant structure. Consult Queensgate if assistance is required.
	Closed loop parameters are unstable	Adjust the PID parameter settings. Consult Queensgate if assistance is required.
	Controller is running in open loop mode	Switch to closed loop mode

System too noisy	Stage mounting and/or environment.	The installation and environment of the Stage is vital in achieving the required performance levels. Vibration, acoustic noise, drafts and ambient temperature changes can all increase noise levels. Consult Queensgate if assistance is required.
	Noisy analogue command	Ensure the analogue command signal has low noise.
	Excessive background electrical noise	Connect the optional grounding lead to the rear earth stud.

8 Maintenance

8.1 Introduction

The maintenance and repair of the controller and Stage(s) should only be performed by service personal from the manufacturer or authorised personnel. Unauthorised maintenance and repair work may lead to damage of the device, make the controller unsafe and render the warranty invalid. This Chapter provides user maintenance information. The user may only carry out work explicitly listed in this section. **The Controller contains NO user serviceable parts**.

8.2 Routine Maintenance

WARNING

Touching live wires or cables can lead to serious injury or death. The power supply must be switched off and the power cable removed from the socket for at least 5 minutes before any repair or maintenance is carried out.

CAUTION

Damage to electrical and electronic components may occur if liquids leak into the devices. During all care and maintenance work, ensure that no fluids enter into the controller or the Stage.

8.2.1 Tasks

Routine maintenance of the NPC-D-6xx0 and associated Stages consists of:

- Periodic visual inspection of the system for cable and connector security/integrity, mechanical damage and foreign body/liquid contamination.
- Ensure the cooling vents are free from obstruction, dust and debris.
- Regularly use a lint-free dry cloth to carefully clean the surfaces of the device.
- The controller can be cleaned occasionally with a cloth lightly wetted with IPA (Isopropyl Alcohol) to remove any marks. Frequent use may cause cosmetic damage to the controller so should be avoided.

NEVER USE CLEANING POWDER, ABRASIVE CLEANERS, PAINT THINNERS OR SOLVENTS SUCH AS PETROL, ACETONE OR OTHER STRONG SOLVENTS AS THESE MAY DEGRADE THE SURFACES OF THE CONTROLLER.

8.2.2 Periodicity

The manufacturer does not specify maintenance intervals. Maintenance periodicity should be set in accordance with local experience and practice.

9 Factory Configuration

The controller can be factory configured or modified to meet customer specific requirements. These configurations should only be performed by authorised service personal. Removing the protective covers may make the controller unsafe and render the warranty invalid. Consult Queensgate if customisation is required.

The Controller contains NO user configurable internal parts.

10 WARRANTY

10.1 Extent

Queensgate warrants that the Product shall for a period of twelve months from the date of delivery be free from defects in design, workmanship and materials (other than defects attributable to ordinary wear and tear) and, where applicable, shall meet the specifications referred to in the Special Conditions. If the product does not conform to such warranty Queensgate shall at its option:

(a) replace the Product or any part of it found by Queensgate in its sole judgment not to conform to the warranty (all parts replaced by Queensgate becoming the property of Queensgate; or

(b) take such steps as Queensgate deems necessary to bring the Product into a state where it is free from such defects or meets such specifications, PROVIDED THAT if there is a manufacturer's guarantee in force in respect of the product or any part thereof, the period of twelve months shall be substituted by the period left to expire of such manufacturer's guarantee.

10.2 Limitation

Subject as herein provided the aggregate liability of Queensgate in contract, for negligence or otherwise shall in no event exceed the price payable or paid by the BUYER for the Products and performance of either one of the options under the above warranty shall constitute an entire discharge of Queensgate liability under the above warranty.

10.3 Conditions

The above warranty is conditional upon:

(a) the BUYER providing Queensgate with adequate written notice of the alleged defect within the warranty period;
(b) the BUYER affording Queensgate reasonable opportunity to inspect the Product on site;
(c) the BUYER using and maintaining the Product in accordance with any instructions or recommendations of Queensgate and in particular not subjecting the System to misuse, abuse, neglect, accident, improper alteration or modification or negligence in use, storage, transportation or handling;
(d) as regards defects in design.

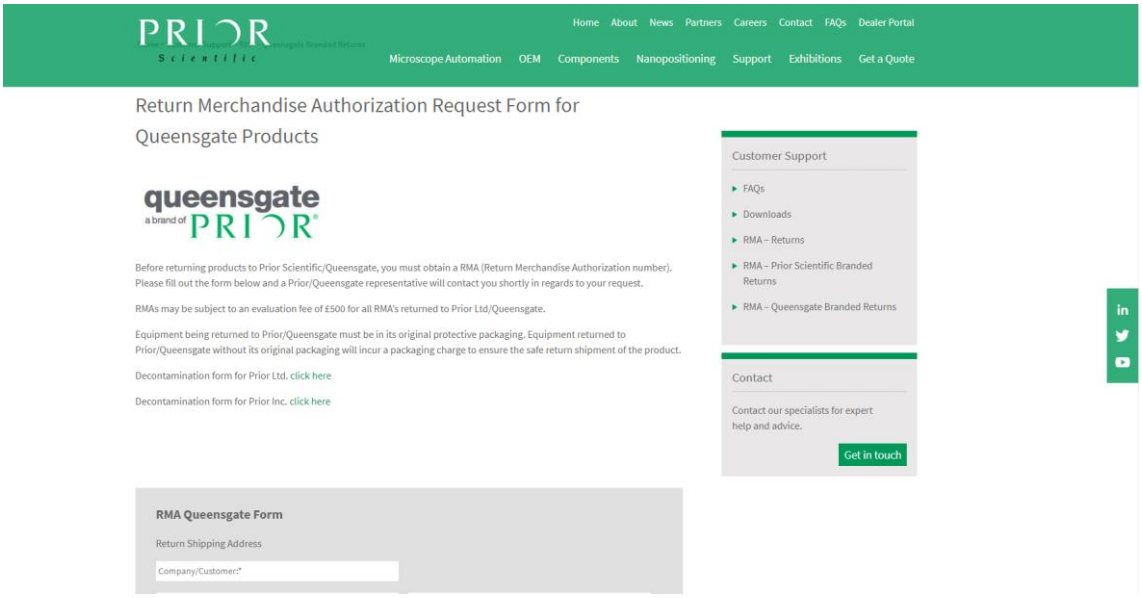
10.4 Damage in Transit

The contents of the package should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the packing list. The manufacturer will not be responsible for shortages against this list unless notified immediately.
If the instrument is damaged in any way, a claim should be made against the courier. A full report of the damage should be made, including the type and serial number of the instrument and forwarded to Queensgate.
Upon receipt of this report, you will be advised of the disposition of the instrument for repair or replacement.

10.5 Warranty and repair Claims

To log a warranty claim or repair it is necessary to log the incident on the Prior Scientific website at: https://www.prior.com/customer-support/rmaqueensgate.

If this is the first time you have registered a warranty claim or repair it is necessary to register on the website. Please make sure this is down using the Queensgate RMA, not the Prior RMA.



Registration can take 24hours to be accepted, if you have not received an email after 24hours please email, inquiries@prior.com.

When returning the unit, ensure that an RMA/RA number is obtained from Prior Scientific and that the decontamination form is completed and returned so that necessary information is supplied to the service department.

Contact details

http://www.prior.com

inquiries@prior.com

Queensgate Technology
Units 3/4 Fielding Ind Est,
Wilbraham Road,
Fulbourn,
Cambridge,
Cambridgeshire,
CB21 5ET

10.5.1 RMA Confirmation

RMA requests are processed solely through the internet (https://www.prior.com/customer-support/rmaqueensgate). The RMA confirmation will be issued by e-mail following completion of the online RMA request process. The RMA confirmation will include packaging and shipping instructions and the assigned RMA/RA number. This number must be clearly marked on the packaging when the product is returned and must be clearly displayed upon all associated correspondence to allow immediate recognition and process by our service team.

10.5.2 Return Shipment Packaging

Original packaging must be used, if available, to avoid any potential damage during transportation. If the original packaging is not available then a suitable carton with fully supportive foams/polystyrene chips must be used. Please read carefully the following Packing Instructions carefully.

If instruments are damaged during return shipment, Queensgate will use its discretion to determine whether the item is still repairable. Damaged items will be deemed out-of-warranty and will not be repaired under warranty.

10.5.3 Packing Instructions

- Please use the original packaging where possible.
- The controller and Stage/actuator should be shipped in separate boxes.
- The Stage/actuator must be placed in a sealed padded box. This box should be placed inside a larger one with at least 4 cm clearance on all sides. Fill the voids with foam peanuts or other suitable filler.
- We recommend that you use bubble wrap to wrap controller and Stage. There should be at least 4 cm of bubble wrap around all sides of the controller and Stage. Ensure that the corners are adequately covered.
- Place the bubble wrapped controller inside a suitable sized corrugated cardboard box. Fill any voids that remain with foam peanuts or other suitable filler.
- Packing tape preferred over duct tape, masking tape, cellophane or thick tape to seal the box).
- We recommend the seams are taped for added strength.

10.5.4 Packing list

Returned goods must be accompanied by the following documentation:

- a signed printout of the email receipt you received when requesting the RMA
- a copy of the Purchase Order for the inspection charge (for products out of warranty).

10.5.5 Return Shipment Address

All RMA packages should be shipped to:

Queensgate Technology
RMA Number: *(INSERT YOUR RMA/RA NUMBER)*
Units 3/4 Fielding Ind Est,
Wilbraham Road,
Fulbourn,
Cambridge,
Cambridgeshire,
CB21 5ET

10.5.6 Standard Repair Turnaround Time

For returned instruments that are within the warranty period, the repaired instrument will be targeted for dispatch within 14 working days after receipt of:

- the returned instrument
- a completed RMA request form with an assigned RMA/RA number (which includes the decontamination statement)

For instruments that are returned for servicing and calibration, the work will be targeted for completion within 30 working days after receipt of:

- the returned instrument
- a completed RMA request form with an assigned RMA/RA number (which includes the decontamination statement)
- a purchase order for the service and calibration charge.

For returned instruments that are outside the warranty period, the work will be targeted for completion within 30 working days after receipt of a purchase order number. The repair cost will be sent within 10 working days after receipt of:

- the returned instrument
- a completed RMA request form with an assigned RMA number (which includes the decontamination statement).

Note: Turnaround times do depend on the complexity of the repair and availability of parts.

10.5.7 Disposal Charge

Where a piece of equipment is found to be beyond economical repair and it is not cost effective to return the unit then an option to dispose of the equipment will be offered where possible. The following price covers the inspection and disposal of instruments on behalf of the customer:

- disposal charge – Please contact Queensgate for further information.

Note: These charges will be waived if a replacement product is purchased.

10.5.8 Repair Warranty

Instruments that are shipped to the customer may be new or repaired but will be certified functionally equivalent to the original product and will be warranted for the remainder of the original warranty or 90 days whichever expires later.

10.5.9 Out-of-Warranty

An instrument whose warranty has expired or which has been damaged or misused will be determined to be out-of-warranty. The customer will be notified that the instrument is deemed out-of-warranty and will be sent an estimate for the repair. Should the customer decide not to have the instrument repaired, then a purchase order to cover shipment costs must be supplied. If the customer has decided to take advantage of the 'new for old' policy then the instrument will be returned to the customer or disposed of Free of charge.

10.5.10 Repair Procedures

All instruments that are returned under the RMA process will be repaired or, at the discretion of Queensgate, replaced with either new or refurbished parts.

10.5.11 Device Inspection Service

When a device is returned which has no damage and works within specification, a calibration, inspection and handling charge will be invoiced.

10.5.12 New for Old Policy

When an instrument is returned under the RMA process, which is either very old or has excessive damage resulting in the repair charge likely to exceed 60% of the price of a new item, Queensgate reserve the right to refuse to repair the item and will offer a new replacement at a discount to cover the inspection charge.

10.5.13 RMA Closing Procedure

If Queensgate has not received the RMA requested instrument from the customer within 14 days of the RMA assignment date, the RMA will be closed.

If Queensgate has not received a completed RMA Form & Decontamination Statement within 14 days of receipt of the unit, the unit will be returned unrepaired. The customer will be invoiced for the delivery cost.

If Queensgate do not receive the customer purchase order within 14 days from issuance of the repair quotation, the unit will be returned unrepaired. The customer will be invoiced for the shipment cost.

If the customer has decided to take advantage of the 'new for old' policy then the instrument will be returned to the customer and all repair charges waived.

The repaired instrument will be dispatched to the customer with a suitable repair report and calibration certificate where applicable and the customer will be invoiced for the work completed (if out-of-warranty) and the shipment charge. Queensgate will then close the RMA.

Please note all prices and times quoted may be subject to change at the discretion of Queensgate.

Queensgate is a registered trade mark and a trading name of Prior Scientific Instruments Limited, a company incorporated and registered in England and Wales with company number 00404087 and whose registered office is Units 3/4 Fielding Ind Est, Wilbraham Road, Fulbourn, Cambridge, Cambridgeshire, CB21 5ET. All references throughout this User Manual to Queensgate are references to Prior Scientific Instruments Limited.