queensgate
a brand of Elektron Technology

Operating manual

NS2000

Queensgate Instruments
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Warranty

Extent

Queensgate Instruments ("Queensgate") warrants that the System 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 System does not conform to such warranty Queensgate Instruments shall at its option:

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

(b) take such steps as Queensgate deems necessary to bring the System 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 System or any part thereof, the period of twelve months shall be substituted by the period left to expire of such manufacturer's guarantee.

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 System and performance of either one of the options under the above warranty shall constitute an entire discharge of Queensgate's liability under the above warranty.

Conditions

The above warranty is conditional upon:

(a) the BUYER providing Queensgate with adequate written notice of the alleged defect within the above warranty period;

(b) the BUYER affording Queensgate reasonable opportunity to inspect the System on site;

(c) the BUYER using and maintaining the System 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, the design in question not having been made, furnished or supplied by the BUYER

NS2000

Operating Manual

Torquay, Devon, United Kingdom
November 2003.

Safety Precautions

WARNINGS

HAZARDOUS VOLTAGES

The NS2000 controller 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. A protective earth (ground) connection MUST be made to the unit.

DO NOT remove the equipment's cover. There is no user serviceable parts within the equipment and removal of the cover will invalidate the Queensgate Warranty.

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 the protective connector covers and connection of cables should be performed in a static safe environment using approved static safety handling procedures (e.g. procedures to BS5783).

Protective covers should be left in place on unused connectors.

ENVIRONMENT

The unit is designed for use in an office or laboratory environment.

Extremes of temperature, humidity, dust or acoustic/mechanical vibration may cause faulty operation or damage to components.

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 carrier. A full report of the damage should be made, including the type and serial number of the instrument, and forwarded to Queensgate Ltd.

Upon receipt of this report, you will be advised of the disposition of the instrument for repair or replacement.

Table of Contents

1 Introduction

The NS2000 is a non-contact capacitive displacement-measuring device. It is a single channel stand-alone module producing an analogue output proportional to the sensor spacing. It works by measuring the change in capacitance of a parallel plate capacitor formed by attaching one plate to the item whose displacement is to be monitored and the other to a reference surface.

The NS2000 needs two sensor electrodes, Target and Probe, which form the plates of the capacitor. The NS2000/sensors combination is factory calibrated for scale factor and linearity and has a nominal 5kHz bandwidth.

The NS2000 can be configured as -S (10pF) for short range or -L (2pF) for long-range measurement. Depending upon the area of the chosen sensor, the capacitance (2pF or 10pF) corresponds to a nominal sensor gap G. For example the NXC NanoSensor, the -S (10pF) nominal gap G is 100µm.

The NS2000 output scale factor can be set either to 0.1G/V, 0.05G/V or 0.01G/V, which for a 100µm nominal gap is equivalent to 10, 5 and 1µm/V.

The output varies linearity with sensor gap and for the 0.1G/V gain setting it is factory set so that the output swings from +5V through 0 to –5V as the sensor gap changes from 150% through 100% to 50% of G, the nominal gap. An offset adjustment facility allows the 0V output to be adjusted between 80% to 120% of the nominal sensor gap.

The measurement bandwidth (5kHz, 500Hz and 50Hz), range (-S, -L) and output scale factor (0.1G/V, 0.05G/V or 0.01G/V) can be adjusted using switches accessible through the side panel.

2 Specifications

Table 1 shows the performance of the NS2000 and table 2 the performance with the NX NanoSensors range. Noise is plotted as a function of nominal gap in Figure 3.

Table 1: NS2000 Module Specifications

Parameter	**NS2000**	**Units**	**Notes**
Size	218mm x 77mm x 34mm		
Power Supply	±15 ±1	V	
Current Requirement	70	mA Typ	
Sensor Output	0 ±5	V	1
Scale Factor	0.1 or 0.05 or 0.01	GV^{-1}	
Noise Level (-S)	<0.05	$ppmHz^{-½}$ rms	2
Noise Level (-L)	<0.15	$ppmHz^{-½}$ rms	2
Thermal Drift	5	$ppmK^{-1}$ Typ	2
Warm-up time	10	minutes	
Warm-up drift	80	ppm	2

Parameter	NS2000	Units	Notes
PS Rejection	10	$ppmV^{-1}$	2
Linearity Error	<0.2	%	3
Bandwidth	50, 500, 5000 ±10%	Hz	

Notes:
1. Greater range is available at reduced performance. See section 4.1.
2. ppm refers to parts per million of the nominal gap
3. Linearity errors as low as 0.02% can be achieved. Please contact Q'gate (section 7) for further details. Linearity error also depends on the accuracy of the sensor installation. Please see Manual on NanoSensors.

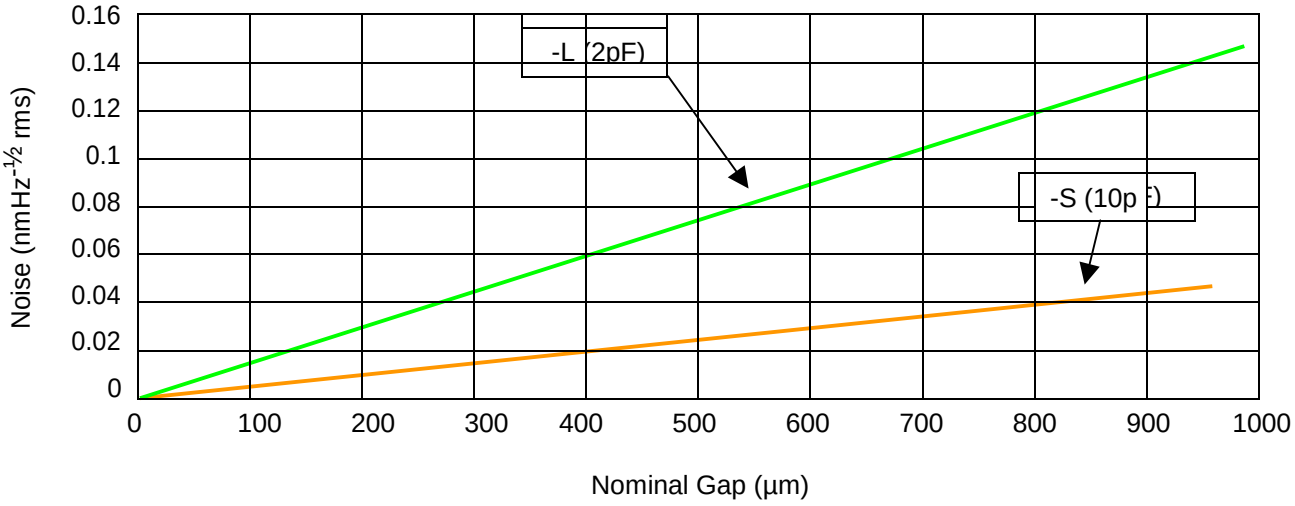
Table 2: Performance with the NX NanoSensors

Sensor	Active Area mm^2	Range	Nominal Gap µm	Scale Factor µm/V (x1 Gain)	Scale Factor µm/V (x10 Gain)	Noise Factor $nmHz^{-½}$
NXA	12	-S	-			
		-L	50	5	0.5	0.008
NXB	22.5	-S	20	2	0.2	0.001
		-L	100	10	1	0.015
NXC	113	-S	100	10	1	0.005
		-L	500	50	5	0.075
NXD	282	-S	250	25	2.5	0.013
		-L	1250	125	12.5	0.188

Notes:
1. For example, the noise of the NXC sensor with –L range and a 5kHz sensor bandwidth is:

$$0.75 \times \sqrt{5000} = 5.3\text{nm rms}$$

Figure 3: Noise as a Function of Nominal Gap, 1m Cable



3 Unpacking and Handling

The NS2000 is a robust unit and requires no special handling precautions other than normally followed with electronic equipment. Static discharge to any of the connectors may cause damage, so insure that all personnel handling the unit are adequately grounded.

Take care when unpacking the sensor electrodes (Probe and Target). The electrodes are strongly constructed but can be damaged by scratching of the surface or undue force on the leads. Do not allow the electrode surfaces to become contaminated since it could cause short circuits between the electrodes when installed or short circuits between the active central part of the electrode and the guard-ring. If contamination is suspected clean with a lint-free cloth moistened with alcohol, **DO NOT USE ACETONE OR OTHER STRONG SOLVENTS.**

4 Installation

4.1 System Contents

The NS2000 consists of the following items:

Table 4: System Content

Quantity	Description
1	NS2000 Module
1	Power cable (15V) PCNS1 comprising: - 9-way D-type connector, female; - 3-way cable, and - 3 off 4mm banana plugs.
1	Signal output cable OCNS1 comprising: - 1-way size 00 LEMO plug; - coaxial cable, and - 2 off 4mm banana plugs.

Also supplied are the following documents:

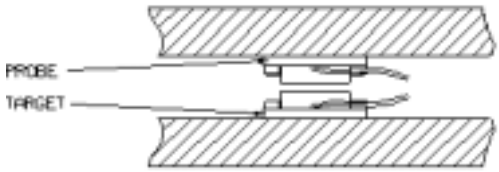
Quantity	Description	Document Number
1	NS2000 Operating Manual (this manual)	NPS1001M

The NX NanoSensors come separately.

4.2 Installing the Sensor Electrodes

The Target and Probe electrodes are installed opposite each other as shown in figure 5. See the NanoSensor Manual for full installation details of the standard range of sensor electrodes.

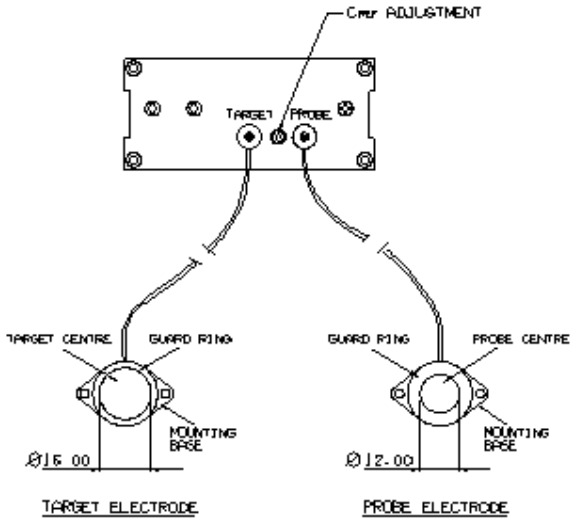
Figure 5: Sensor Installation



4.3 Connecting the Sensor Electrodes

Connect the probe electrode to the socket labelled PROBE and the target electrode to the socket labelled TARGET, see figure 6. Incorrect connection will not cause damage but performance will be reduced.

Figure 6: Sensor Connections

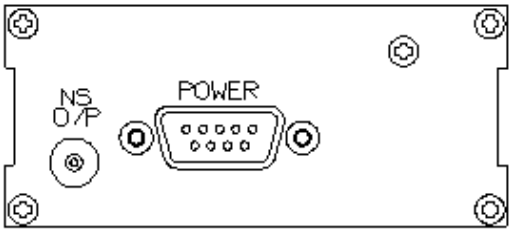


4.4 Connecting the Power

Each NS2000 module requires a -15V, 0, +15V power supply with a minimum capability of 120mA. A stable linear power supply should be used for optimum noise performance. Connect the power

supply to the module 9-way D-Type connector using the 15V power cable PCNS1 Connections are as shown in table 9.

Figure 8: Rear Panel



If an alternative user-supplied cable is to be used, the D-type pin numbers are shown in table 9.

Table 9: Power Connections

Power Connection	Pin Number	Wire Colour
+15V	1	Red
0V	3	Black
-15V	5	Blue

4.5 Connecting the Output

The output voltage corresponding to the displacement is available at the socket marked NS O/P on the rear panel see figure 8. A lead with mating size 00 LEMO connectors is provided for connection to this: OCNS1.

Measurement of the output voltage is best performed with a Digital Voltmeter having the following performance specifications or better:

Full range	10Vdc
Resolution	$\leq$ 0.01mVdc
Input impedance	>10MΩ

Warning:
Incorrect connection may damage the unit. Check all connections before applying power.

5 Measuring a Displacement

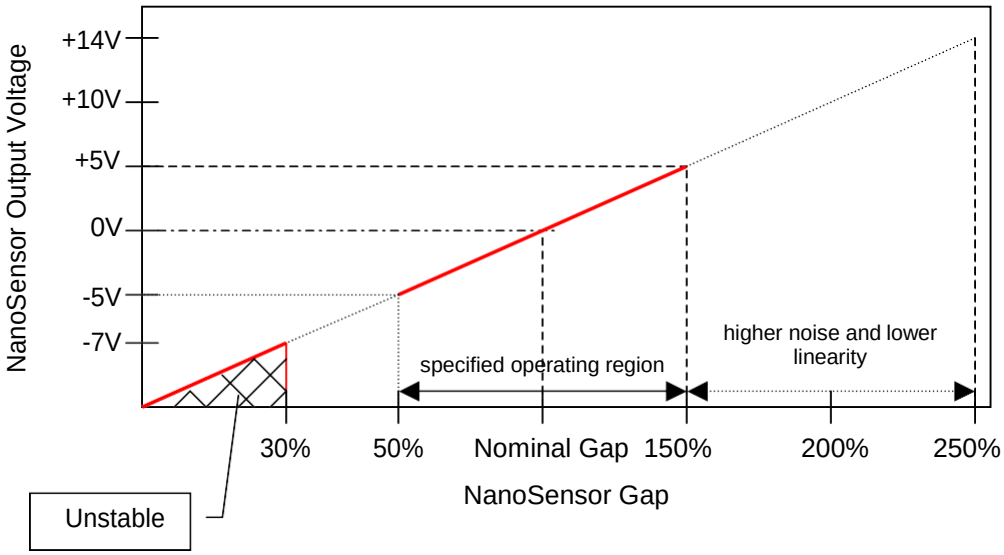
5.1 Choosing the Nominal Gap

The sensors should be installed with gap set as close as possible to the nominal gap. Table 2 shows the nominal gaps available with the standard NX range of sensors. For example with the NXB NanoSensors, the sensor gap should be either 20µm (-S) or 100µm (-L).

Once the gap G is chosen then the scale factor is automatically 1V for 0.1G with the x1 gain setting.

Operation outside the specified ± 50% of the nominal gap is possible with reduced performance as illustrated in figure 10.

Figure 10: Output Voltage Range (0.1G/V)



5.2 Switching on

Once the unit has been installed as described in section 4, operation is straightforward.

1. Verify correct installation in accordance with section 4;
2. Switch on the power supply;
3. The output voltage will now read between -5V and +5V for sensor spacing between 50% and 150% of the nominal sensor gap on the 0.1G/V gain setting.

If the output voltage is outside the range ±5V then the gap between the sensor plates is either too large or too small. The NanoSensor will not be damaged if the plates touch.

5.3 Bandwidth and Range Adjustment

The bandwidth of the NS2000 is factory set to 5kHz. The bandwidth and range setting can be adjusted using the 4-way dual in line switch marked 'bandwidth', see figure 11 as shows in table 12.

Figure 11: NS2000 Side View

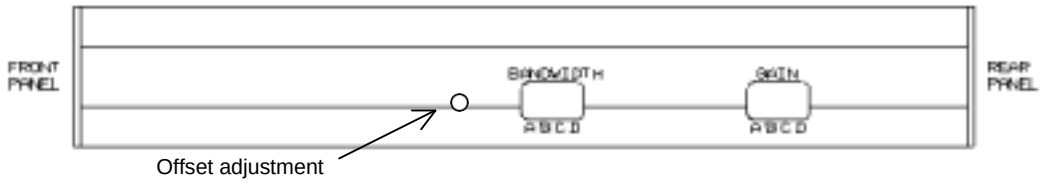


Table 12: Bandwidth and Range Setting

Bandwidth and Range Switch Setting				Bandwidth & Range	Comments	Notes
A	B	C	D			1
on	off	off	-	5kHz	Factory Set	
off	on	off	-	500Hz		1
off	off	on	-	50Hz		
-	-	-	on	-L		
-	-	-	off	-S		

5.4 Gain Adjustment

The gain of the NS2000 is factory set to 0.1G/V where G is the nominal gap. This can be adjusted by the dual in line switch marked gain, see figure 11.

Table 13: Gain Adjustment

Gain Switch Setting				Gain	Comments	Notes
A	B	C	D			1
on	off	off	off	0.1G/V	Factory Set	
off	on	off	off	0.01G/V		
off	off	on	off	0.05G/V		

Notes:
1. SWD is connected to test points on the PCB across, which a selected resistor can be soldered to change the gain to a different value. Consult Queensgate for details.

5.5 Sensor Zero Output Gap Adjustment

A potentiometer accessible through the side panel can be used to change the sensor gap which gives zero volts at the NS2000 output. It is factory set so that the NS2000 output is zero volts at 100% of the nominal sensor gap. The potentiometer can add an offset equivalent to +/- 20% of the nominal sensor gap. For example for the NXC sensor in the –S range setting the nominal gap can be adjusted between 80 and 120µm. This is equivalent to+/- 2V on NS2000 output with the 0.1G/V gain setting.

6 Fault Finding

Problems with the NS2000 are usually due to incorrect connection of the cables, or to failures in the cables.

6.1 Wrong Cable Connections

It is possible to incorrectly connect the cables, which plug into the NS2000. Please check the connections are shown as in table 14.

Table 14: Cable Connections

Cable	**Connect to**
Power supply cable	
9-way D-type	Rear panel of NS2000
Red banana plug (+15V)	+15V power supply output
Black banana plug (0V)	0V power supply output
Blue banana plug (-15V)	-15V power supply output
Target cable	
Plug	Target socket in the centre of the NS2000 front panel
Probe cable	
Plug	Probe socket on the right hand side of the NS2000 front panel
Analogue output cable	
Plug	Output socket on the left hand side of the NS2000 rear panel

6.2 Cable Faults

To check for cable faults, measure the resistance as indicated in table 15.

Table 15: Cable Faults

Measure from	To	Correct Resistance
Power supply cable		
9-way D-type Pin 1	+15V red banana plug	<2Ω
9-way D-type Pin 3	0V black banana plug	<2Ω
9-way D-type Pin 5	-15V blue banana plug	<2Ω
Probe Sensor Cable		
Centre of probe	Guard ring	>100kΩ
Guard ring	Metal base	>100kΩ
Guard ring	Screen of plug	<2Ω
Centre of probe	Centre of plug	<2Ω
Target Sensor Cable		
Centre of target	Guard ring	>100kΩ
Guard ring	Metal base	>100kΩ
Guard ring	Screen of plug	<2Ω
Centre of target	Centre of plug	<2Ω
Analogue Output Cable		
Centre of plug	Core of wire	<2Ω
Screen of plug	Screen of wire	<2Ω
Centre of Plug	Centre of plug	>100kΩ

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