

DPG-Series Inclinometer

Instruction Manual

DPG-Series Inclinometer



Version 1.1

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1 History

Ver.	Date	Purpose	Author
1.0	2013-01-28	Creation	M.Zürn
1.1	2015-07-07	Update Chapter 3.1 Point 7 & add. Minor changes Update of Fig. 5.2, Dimensions & Weight	F.Schwieger

2 General Information

The NS-xx/DPG2-RUx is a μC controlled inclinometer for industrial applications. The NS-xx/DPG2 features a measuring range up to $\pm 30^\circ$.

2.1 Features

- two inclination sensor cells based on a conductance measurement principle
- electronic excitation and readout of the cell signal
- digital linearization
- temperature compensation
- outputs RS232 & voltage

2.2 Type and order codes

Required type of product can be ordered by use of one of the following part numbers:

Type	Measurement angle	Output	Supply	Order number
NS-5/DPG2-RUD	+/- 5°	RS232, voltage	+7... 30 VDC	G-NSDPG2-003
NS-10/DPG2-RUG	+/-10°	RS232, voltage	+7... 30 VDC	G-NSDPG2-001
NS-15/DPG2-RUG	+/-15°	RS232, voltage	+7... 30 VDC	G-NSDPG2-002
NS-30/DPG2-RUN	+/-30°	RS232 ,voltage	+7 ... 30VDC	G-NSDPG2-005

3 General Information

Thank you for purchase of a DPG2-Series inclinometer from Measurement Specialties. This manual offers information on the proper installation and operation. For further technical information on the performance of the DPG2-Series inclinometer, please see the Specification, DPG2-Series inclinometer

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3.1 Notice



Please observe all proper safety rules and regulations for electrical devices when installing this inclinometer. In addition, the following recommendations are made.

1. Do not apply power to the inclinometer during installation.
2. Avoid applying any mechanical pressure or stress to the housing.
3. Do not operate an inclinometer beyond the maximum angular sensing range or threshold. Irreparable damage may occur.
4. Do not exceed the maximum fastening torque for the mounting screws, as the base plate may become warped and/or irreparably damaged.
5. Use detergents free of solvents or acid for cleaning of the housing.
6. Avoid direct solar radiation.
7. Recommended tightening torque of cable gland (3 ± 0.5 Nm) should be checked once in a year after purchase to secure IP class of sensor module.
8. Should the inclinometer fail to operate properly, consult this manual for possible solutions. Do not attempt to open the inclinometer, as damage may occur. For other troubleshooting measures, please contact our service team.

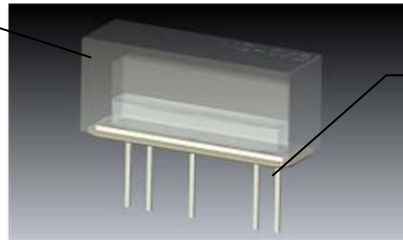
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4 General function of the inclinometer system

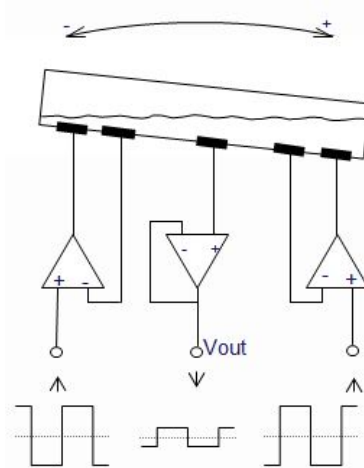
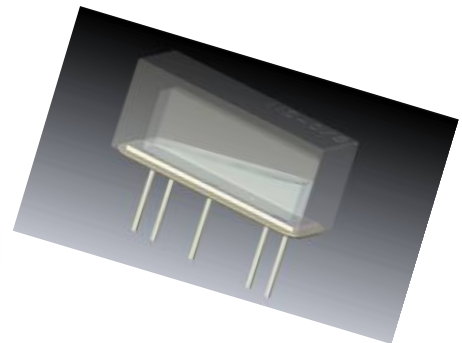
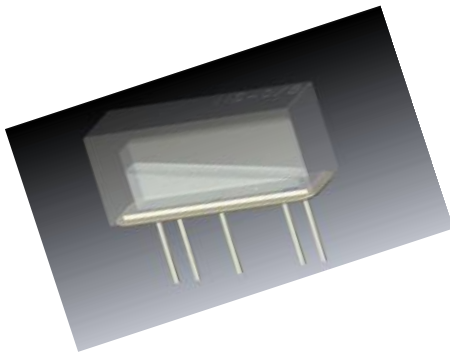
4.1 Description of the liquid/conductive measurement principle

Platinum electrodes are deposited in pairs on the base of the sensor's cell parallel to the sensitive axis. The chamber is partially filled with an electrolytic liquid. When an alternating voltage is passed between two electrodes, the electric current will create a dispersed field. By tilting the sensor and thereby reducing the level of liquid, it is possible to confine this stray field. Because of the constant, specific conductivity of the electrolytes a variance of resistance is formed in relation to the liquid level. A basic differential principle will yield an angle of inclination from the polarity signs.

Ceramic housing



Ceramic base plate with electrodes



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5 Mechanics and Conditions

5.1 Mounting Instructions

The inclinometer is designed for horizontal mounting, meaning the base plate of the inclinometer with the three mounting holes needs to be placed on the horizontal plane of the object to be measured. The mounting surface must be smooth and free of dust and grease. Fasten inclinometer to the surface to be measured with three M4 screws, and use recommended tightening torque (depends on property class of chosen screws, e.g. 2.9 Nm if M4 8.8 class screws are used with dry threads).

5.2 Installation

Prior to installation, please check for all connection and mounting instructions to be complied with. Please also observe the general rules and regulations on low voltage technical devices.

Avoid shock and vibration during measurement, as these could adulterate the measurement results. Inclinometer sensors that base on a fluidic measurement principle are optimal for static measurements and suitable to only a limited extent of dynamic measurement.

5.3 Measurement

Tilt angle measurements are made in the 'X' and 'Y' axis' (longitudinal and lateral respectively), with the reference being the horizontal plane.

5.4 Mounting

For operation this inclinometer has to be mounted horizontally (see Fig. 5.1), reference is the base plate.

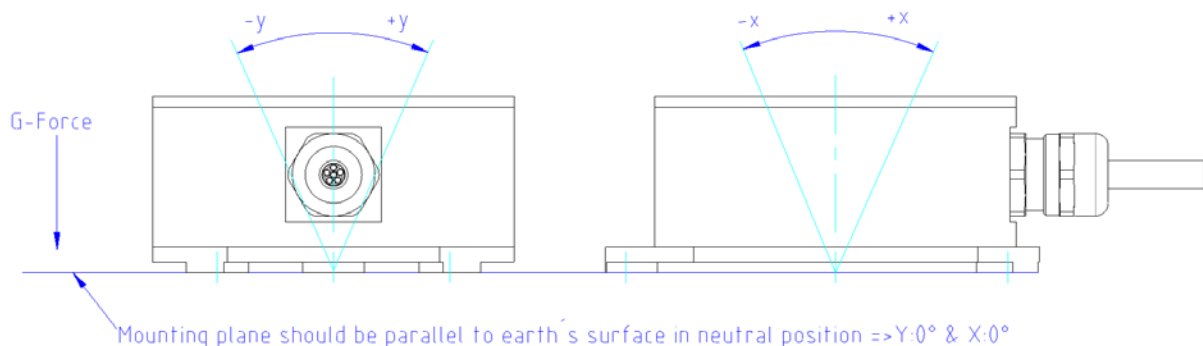


Fig. 5.1 Mounting position of sensor module & inclination axis

5.5 Mechanical data

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Weight				270		g
Dimensions		W x D x H	84 x 70 x 34.2			mm
Protection class			IP 67			

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5.6 Dimensions

The mechanical dimensions of the module are shown in Fig. 5.2

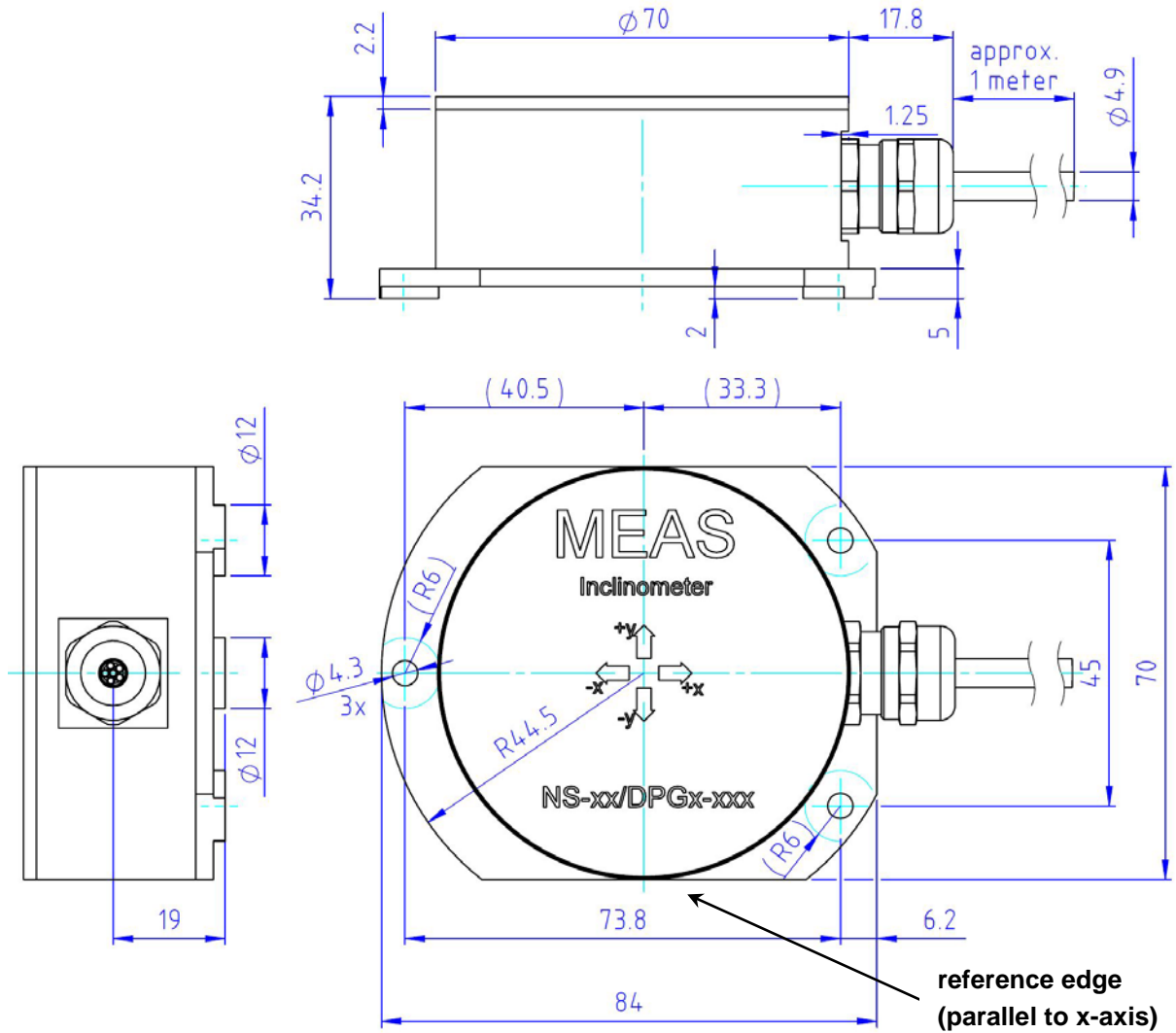
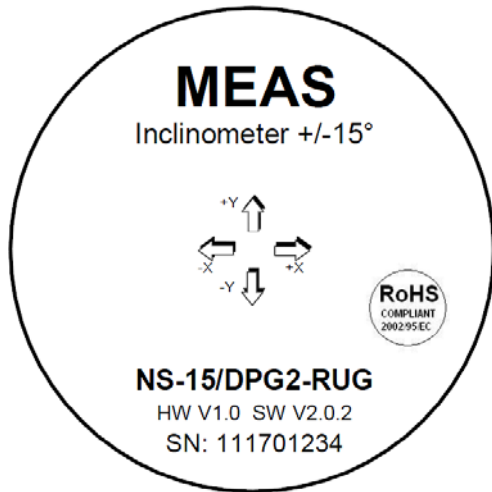


Fig. 5.2 Top and lateral views with dimensions of the inclinometer with metric cable screw

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5.7 Label information



The label placed on top of the module contains the following information:

Type Code : see table in chapter 2.2
 HW/SW Code : internal Hardware/Software-Versions
 Serial No.: YYWWNNNNN

Serial Number consists of nine digits. YY shows the year of production (2011=11), WW the week of the production and NNNNN the unique number for identification and traceability.

5.8 Cable and configuration

The inclinometer is delivered with a cable of approximately 1 m length.

Type of cable: LiYCY 6x0.14mm²
 Conductor resistance: 131 Ohm/km
 Capacity: 90pF/m at 1kHz

Following configuration/cable color scheme is in use:

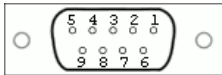
Cable color	Name	Description	Type
White	Vcc	Positive power supply	Supply, Input
Yellow	GND	Ground	Supply, Input
Brown	Out X	Voltage output X	Output
Green	Out Y	Voltage output Y	Output
Grey	RxD	RS 232 input	Input
Pink	TxD	RS 232 output	Output

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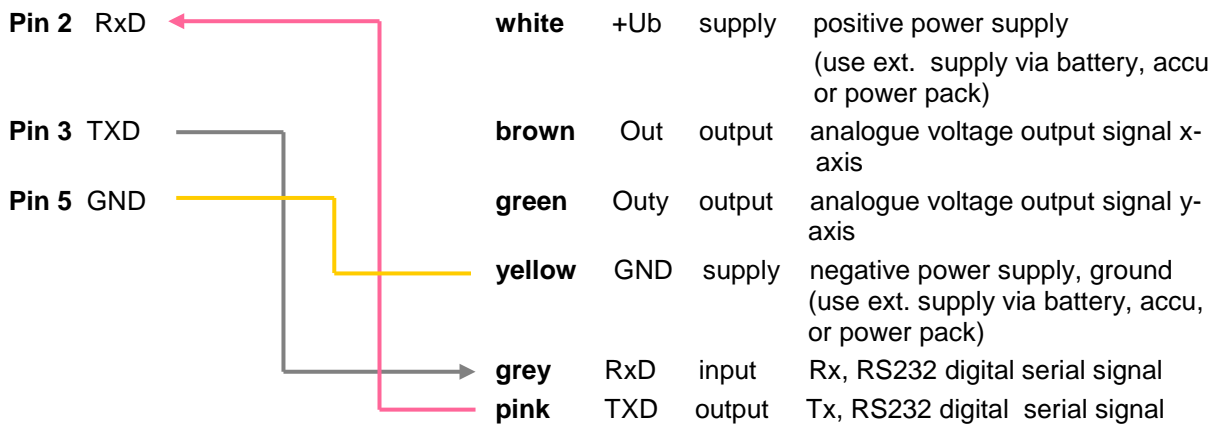
5.9 Connecting to a PC using an RS 232 interface

PC side

Sub D-connector 9 pins



Cable/wire of NS-xx/DPG2-x



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6 Interface

6.1 Digital Output RS232

For digital communication, the standardized RS 232-Interface (V24) is used in duplex mode. After startup the sensor transmits the angle values in degrees (°) continuously.

6.1.1 Electrical Levels

RS232:

PARAMETER	TEST CONDITIONS	MAX	TYP (†)	MIN	UNIT
V _{OH} High-level output voltage	D _{OUT} at R _L = 3 kΩ to GND, D _{IN} = GND		9	5	V
V _{OL} Low-level output voltage	D _{OUT} at R _L = 3 kΩ to GND, D _{IN} = VCC	-5	-9		V
I _{IH} High-level input current	V _I = VCC	200	15		μA
I _{IL} Low-level input current	V _I at 0 V		-1 5	-20 0	μA
I _{OS} ^(‡) Short-circuit output current	V _{CC} = 5.5 V, V _O = 0 V	60	±10	-60	mA
Ω _O Output resistance	V _{CC} , V ₊ , and V ₋ = 0 V, V _O = ±2 V	300			Ω

(†) TA = 25°C.

(‡) Short-circuit durations should be controlled to prevent exceeding the device absolute power-dissipation ratings, and no more than one output

6.1.2 Interface parameter for all NS-xx/DPG2-RUx (except NS-30/DPG2-RUN)

Baud rate: 9600 Baud
 Format: ASCII, 8 data bits, 1 stop bit, no parity
 String length: 22 byte
 Layout: < D0 ... D21>
 D0 ... D10 = "X=±xx.xxx", <CR>, <LF>
 with D2 = sign (+ or -)
 with D5 = point
 D11 ... D21 = "Y=±xx.xxx", <CR>, <LF>
 with D13 = sign (+ or -)
 with D16 = point

Example:

```
...
X=+00.430
Y=-00.084
...
```

6.1.3 Interface parameter for NS-30/DPG2-RUN

Baud rate: 9600 Baud
 Format: ASCII, 8 data bits, 1 stop bit, no parity
 String length: 20 byte
 Layout: < D0 ... D19>
 D0 ... D9 = "X=±xx.xx", <CR>, <LF>
 with D2 = sign (+ or -)
 with D5 = point
 D10 ... D19 = "Y=±xx.xx", <CR>, <LF>
 with D12 = sign (+ or -)
 with D15 = point

Example:

```
...
X=+00.43
Y=-00.08
...
```

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6.2 Programming commands

6.2.1 Command Reference user level

Default after power on or software reset.

Commands in user level	Input	Output	Comment
Stop continuous output of inclination values	"s"	"s"	Stops the continuous output of angle results or raw values, required for input of commands, terminated by "S" or Reset or Power On, mode temporary
Start continuous output of values	"S"	"X=+01.234", CR, LF, "Y=-00.007", CR, LF, "X=....."	Starts the continuous output of angle results or raw values, mode temporary
Version and serial number	"V"	"DPL2 V1.8.0", CR, LF, "SN:123456789", CR, LF,	Output of SW-Version and serial number, use in stopped mode only
Read one value	"R"	"X=+01.234", CR, LF, "Y=-00.007", CR, LF,	Output of 1 complete string, 1 x-value and 1 y-value, only in stopped mode
Activate setup level	"f" "i" "m" "a"	"f" "i" "m" "a"	Activate the setup level, chapter 6.2.2. Setup level can be deactivated by sending "K" or resetting with "q". The controller automatically exits this level after about 10 minutes of user inactivity with a reset.
	any other	no reaction	No reaction for commands from setup level

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6.2.2 Command Reference SETUP level

Setup level will be used for permanent settings, stored.

Commands in setup level	Input	Output	Comment
			This level will be terminated (reset) automatically after about 10 minutes of user inactivity.
Stop continuous output of inclination values	"c"	"c"	Stops the continuous output of angle results or raw values, required for input of commands, terminated by "C", mode permanent, query with "R", see chapter 6.2.1.
Start continuous output of values	"C"		Start the continuous output of angle results or raw values, mode permanent, valid after reset.
Set zero	"N"	"N"	Define 0° position. Offset is stored and used even after reset.
Setback zero	"n"	"n"	Resets the offset displacement
Set lowpass filter	"M", f	"M", f	Input filter settings with count f = "0"..."7", other characters were answered with "E", see item 1) below.
Set output rate	"O", o	"O", o	Set output rate with count o = "1"..."6", other characters were answered with "E", see item 2) below.
Show internal settings	"*"	"O123 M123", CR, LF "OffX=+00.000 OffY=+00.000", CR, LF "Erase Cycl SegF: +00255", CR, LF	"O123": internal setting of output rate in 10ms, "M123": internal filter setting; both values 255 => default settings "Off..": stored Offset values "Erase Cycl Seg...": active Segment and number of erasure procedures for this segment
Show currently temperature [°C]	"T"	"T= 00.00", CR,LF	Readout the currently temperature in °C. Usable at > software version 2.0.2. Without sign ` ` , positive temperature. With sign ` - ` , negative temperature.
Software reset	"q"	"q"	Reset the sensor
Erase both Info segments, (switch to default settings)	"E"	"Seg A deleted" , CR, LF "Seg B deleted" , CR, LF	Erases the info segments of flash storage banks, InfoA and InfoB. This set all changed user values to default settings
Forbidden command	"#"	"#"	Reserved for factory communication

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1) Set low pass filter exponential, with count f =

- "0": Out value = current value
- "1": Out value = (current value + old out value) / 2
- "2": Out value = (current value + 3 * old out value) / 4
- "3": Out value = (current value + 7 * old out value) / 8
- "4": Out value = (current value + 15 * old out value) / 16
- "5": Out value = (current value + 31 * old out value) / 32, default**
- "6": Out value = (current value + 63 * old out value) / 64
- "7": Out value = (current value + 127 * old out value) / 128
- "8"..9: reserved, undefined.

Above calculation was made every 10ms.

For example of time response see chapter 7.2.3: "Step response NS-15/DPG2-RUG"

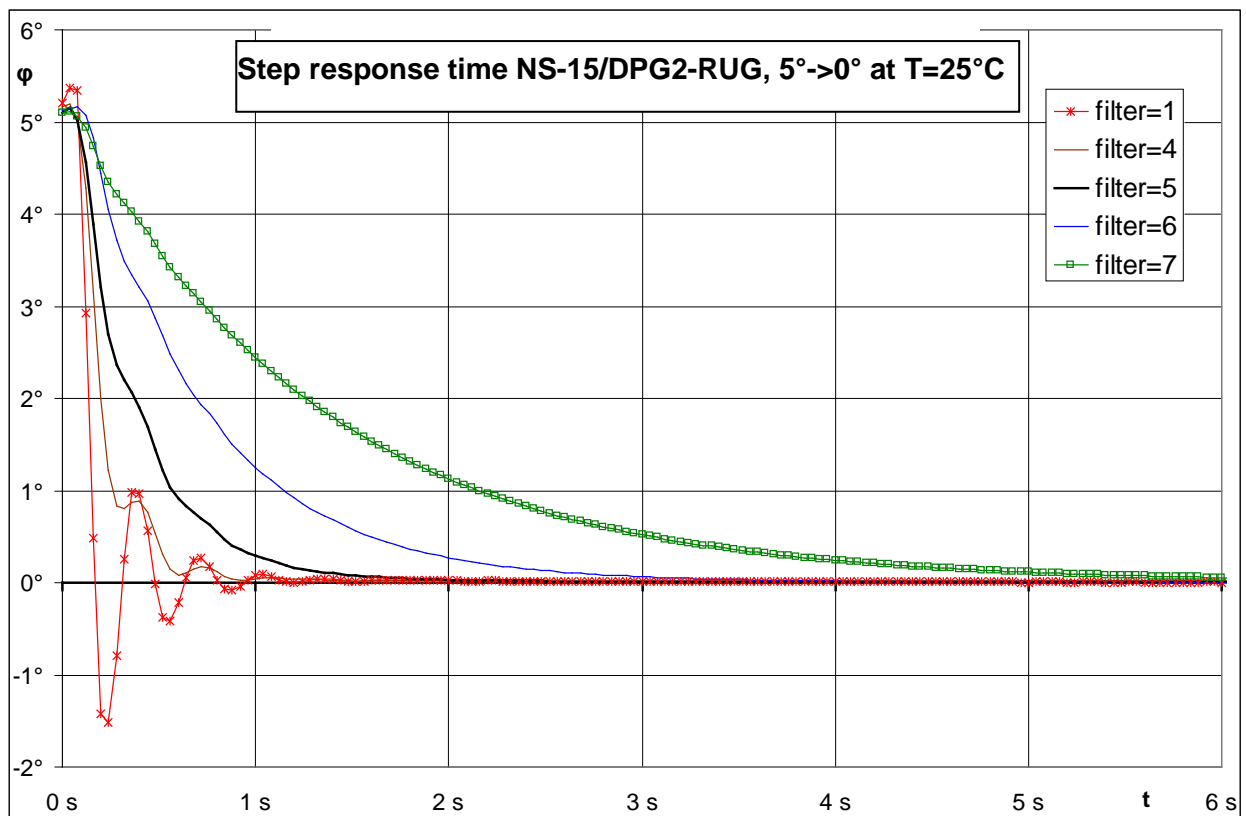
2) Set output rate (strings per second, 1 string contains x and y-value) with count o =

- "1": 40ms (==25Hz)
- "2": 100ms (==10Hz), default
- "3": 250ms (==4Hz),
- "4": 500ms (==2Hz)
- "5": 1000ms (==1Hz) "6": 2000ms (==0,5Hz)
- "0", "7", "8", "9": not defined

6.2.3 Step response/filtering NS-15/DPG2-RUG

Step response NS-15/DPG-RUG, fast change from angle 5° to angle 0°, at Ta=25°C

Measured at output rate 25Hz.



For filter settings see command "M" f in chapter 6.2.2

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7 Qualification Testing

7.1 Standards

The sensor NS-xx/DPG2-xxx complies with:

- IEC/EN 60068-2-2 **High Temperature Storage**
Ta= 85°C, medium : air, 1000h
- IEC/EN 60068-2-78 **High Humidity**
Ta= 85°C , RH= 85%, 1000h
- IEC/EN 60068-2-27 **Mechanical shock test**
A=30g, t=11ms, halfsine, 50 cycles per axis
- IEC/EN 60068-2-6 **Vibration loading**
10 to 150 Hz, 2.5mm amplitude, 5g const. acceleration,
1 octave/minute, 20 cycles per axis
- IEC/EN 60068-2-14 **Thermo shock**
T_{High}=85°C , T_{Low}=-40°C, medium:air-air, T_{dwell}: 15min,
T_{change}: 30sec, 100 cycles
- IEC/EN 61000-6-2 **Interference resistance industry**
- IEC/EN 61000-6-4 **Emitted interference industry**

7.2 Periodical Testing

The periodical testing is done every 3 years in terms of a product audit.

7.3 Material Testing

All materials used in the process will be released by checking the corresponding supplier certificates when available. A regular material analysis from an independent laboratory will not be scheduled.

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8 Additional Information

8.1 Ordering Information

NORTH AMERICA	EUROPE	ASIA
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