Linear Piezo Stage LPS-30 system→preliminary data sheet

LPS-30x

- PiezoMotor driven system
- Travel range 15 to 85mm
- Bidirectional repeatability 500pm
- Maximum operation speed 10mm/sec
- Integrated ***zero drift encoder*** with up to 5pm resolution and Zerodur®-like scale. (50pm with our controller)
- Force: 10N / 20N
- Ultra precise and robust design
- High stiffness and high dynamic.
- Material: Stainless steel, Titan or Invar-36 with ceramic bearing
- Vacuum compatible, non-magnetic

The LPS-30x is a low profile linear stage with an integrated customized PiezoMotor and linear encoder systems developed by NANOS Instruments. The stiff and robust design with cross roller bearings in steel or ceramic guarantee a smooth and highly accurate movement in the range of sub nanometers. This stage has a ultra high precision and is available in Stainless steel, Titan or Invar-36, together with a Zerodur®-like scale. The optical sensor only generates 20mW (15mW as option) in the stage and has a special cooling profile. This results in practically zero drift with highest resolution from the first minute. This stage is available in several dimensions, also as versions with an aperture or as a goniometer, and can be combined as building blocks for a multi-axis stage. It has a high force and is ultra precise.

Specifications

LPS_30x with the dimension 30x Lx14mm					
Lenth L (mm)	30	50	60	80	100
Travel range (mm)	15	35	45 (15*)	65 (35*)	85 (55*)
Force (N)	10	10	10 (20)*	10 (20*)	10 (20*)
Open loop stiffness (N/µm)	3	3	3/6	3/6	3/6
Max operation speed (mm/s)	10	10	10	10	10
fast movement** (mm/s)	50	50	50	50	50
Hybrid encoder V2 (nm) with ABZ, 18mA @ 5V ***	61 nm 10nm MC101	61 nm 10nm MC101	61 nm 10nm MC101	61 nm 10nm MC101	61 nm 10nm MC101
Hybrid encoder V3 (nm) with ABZLL, 18mA @ 5V ***	61 nm 10nm MC101.	61 nm 10nm MC101.	61 nm 10nm MC101.	61 nm 10nm MC101.	61 nm 10nm MC101.
Hybrid encoder V4 (nm) with ABZ, 3mA @ 5V*[4]	10 nm 1 nm Tango	10 nm 1 nm Tango	10 nm 1 nm Tango	10 nm 1 nm Tango	10 nm 1 nm Tango
Optical Encoder with ABZ ; 4mA @5V (nm) *[5] glass/robax scale Casting Stainless/ Titan/ Invar	0,5 nm 50pm Tango	0,5 nm 50pm Tango	0,5 nm 50pm Tango	0,5 nm 50pm Tango	0,5 nm 50pm Tango
Bidirectional Repeatability (Encodercounts) *[6]	2	2	2	2	2

* optional two motors or two encoders possible
** Fast movement is possible for a short time with the LEGS-Drive®-Ultra Controller
note the maximum Encoder sending frequence at highest resolution
*** the MC101 and the LEGS-Drive®-Ultra Controller are able to oversample and filter the encoder sensor to increase the resolution. In this case short fast steps take longer. The sensor gets a special firmaware for this.
*[4] refer to the the datarsheet Hybrid encoder V4. 1nm is possible with the tango system.
*[5] 5pm is the maximum resolution but it is noisy. 500pm is stable with +/- 1encoder count. With the tango system in combination with the MC101 we can drive it down to 50pm with +/- 1 counts stability. See diagram 8/9/21
*[6] depend on the system. See a number of diagrams at the end of this document

Order code for this stage:

(please call for support, we will help you to find the right solution)
LPS-30-L-P-S-M-A

L = Length 30/50/60/80/100

P = Piezomotors 1 or 2 motors for 10 or 20 N (two motors up to 60mm length)

S = Sensors	V2_61	61nm resolution(magnetic encoder) ABZ TTL
	V2_O	Oversample function (LEGS-Drive®-Ultra Controller or MC101; magnetic encoder) ABZ TTL
	V3_61;	61nm resolution(magnetic encoder) ABZ, 2 limit, Error TTL
	V3_O	Oversample function (LEGS-Drive®-Ultra Controller or MC101; magnetic encoder) ABZ, 2 limit, Error TTL
	V4_10	10nm resolution (magnetic encoder) ABZErr TTL
	V4_T	Tango Sytem allowed ultra high and precise oversampling with a factor of 500.000. So we get down to 1nm resolution Only the MC101 controller supports this.
	1O-G	0,5nm resolution ABZErr TTL (MC101 can drive it higher) (1 optical encoder with glass scale in stage material)
	1O-G-T	Tango System allowed ultra high and precise oversampling with a faktor of 400.000. So we get down to 50pm resolution. Only the MC101 controller supports this. (1 optical encoder with glass scale in stage material)
	2O-G	0,25nm resolution with double accuracy (2 optical encoder with glass scale in stage material, for LEGS-Drive®-Ultra Controller or MC101)
	1O-R	0,5nm resolution (MC101 can drive it higher) (1 optical encoder with Robax scale in stage material)
	1O-R-T	Tango System allowed ultra high and precise oversampling with a faktor of 400.000. So we get down to 50pm resolution Only the MC101 controller support this. (1 optical encoder with Robax scale in stage material)
	2O-R	0,25nm resolution with double accuracy (2 optical encoder with Robax scale in stage material, for legsdrive ultra Controller or MC101)

M = significant material for stage and encoder case.

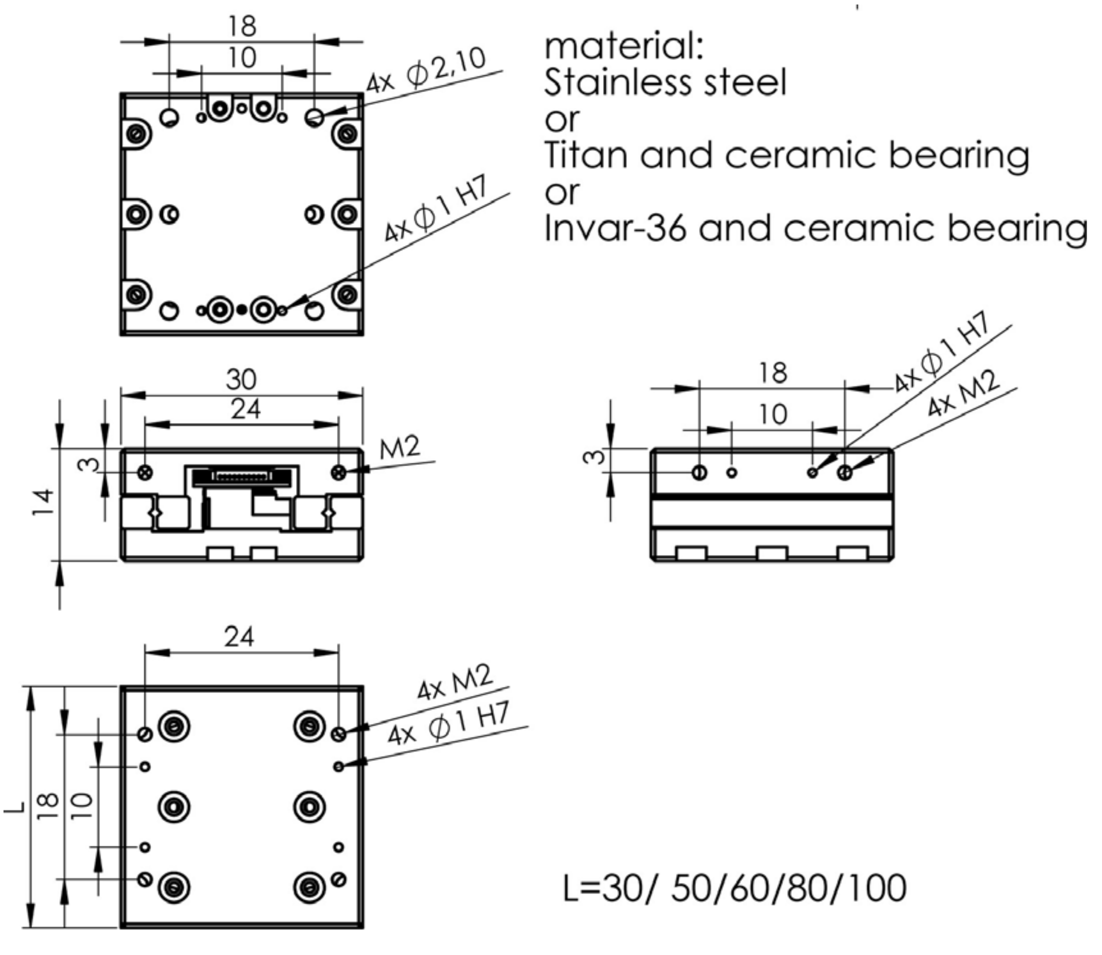
S = Stainless steel for all parts (zero drift at constant temperatur)
T = Titan and ceramic guiding (nonmagnetic)
I = Invar and ceramic guiding (smallest drift over the temperatur range)

A = atmosphere
N normal
V vacuum
UHV Ultra high vacuum (please ask for force and life time)

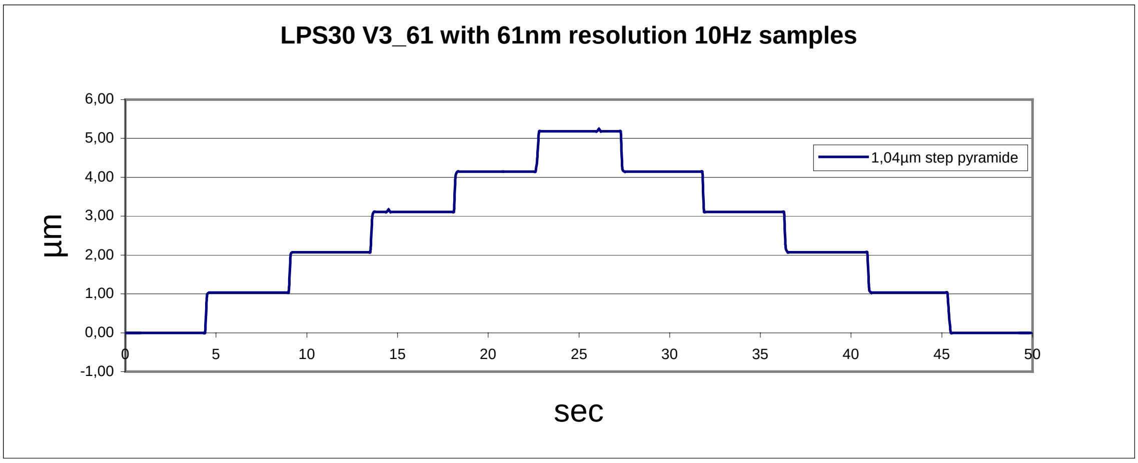
The order code could be for example: **LPS-30-60-2-2OR-I-N**

➔ A stage with 60mm length, 15mm stroke, 2 motors, 20N force, 2 optical encoders with Robax scale, in Invar-36 for normal atmosphere.

Dimensions:



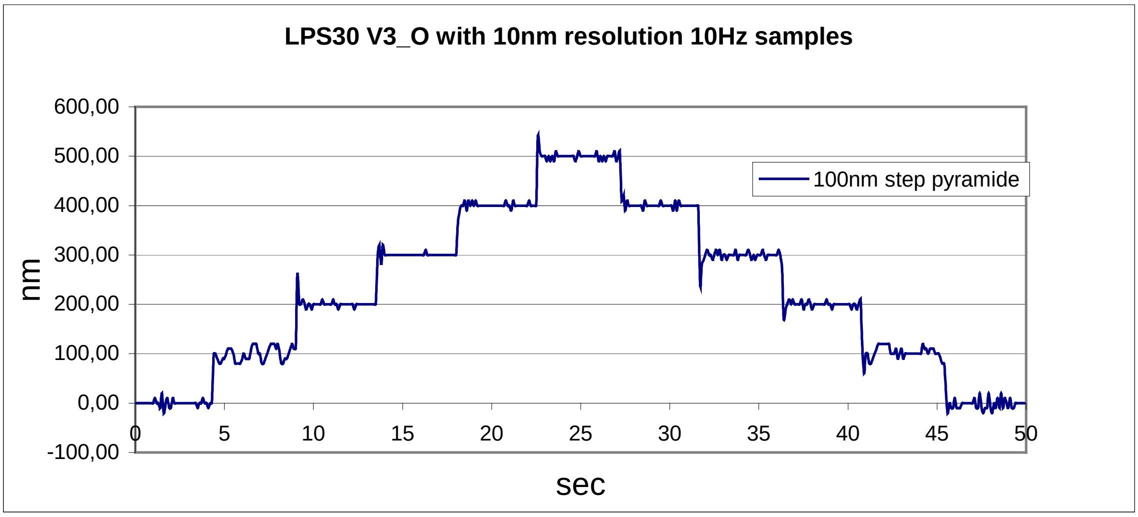
Tests and Measurements:



[1]

In this diagramm [1] is the magnetic encoder V2_61 or V3_61 with index and 2 limit switches. The sensor signal is interpolateted 8192 times and has a linearity of +/- 350nm over all 500µm. The encoder is complete integrated in the system integrated and generates 90mW powerlos. It is a compact version with limit switches.

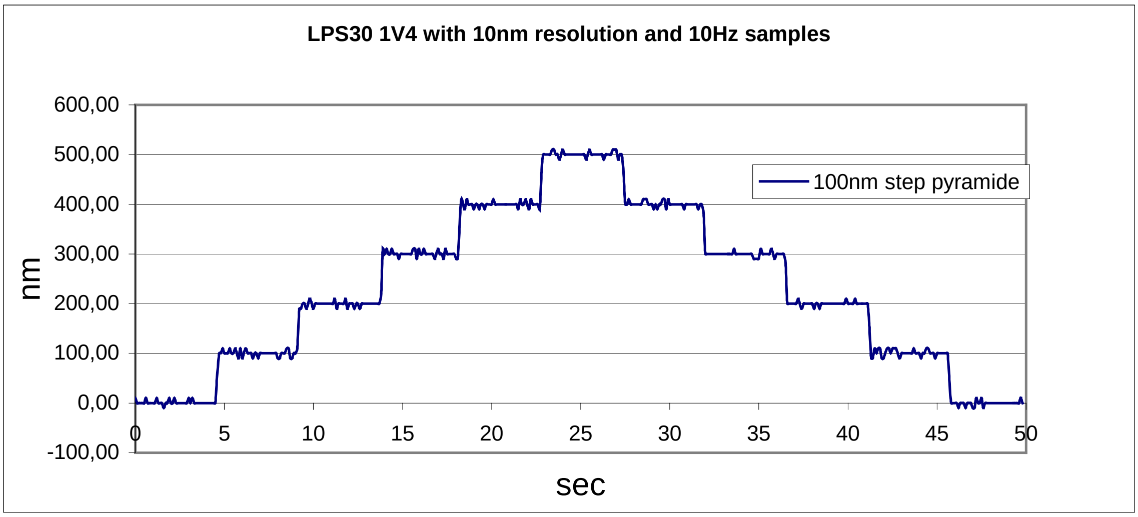
This version generates data in realtime and is for fast movements or for velocity control. Also other controllers support this interface. Ask for the right sending frequency for your system.



[2]

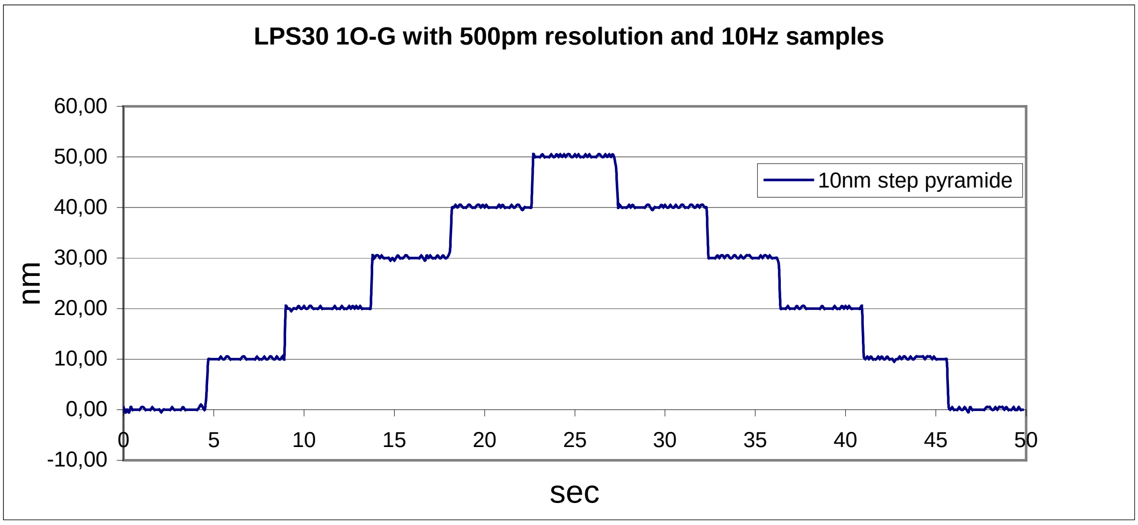
In this diagramm [2] is the magnetic encoder V2_O or V3_O with index and 2 limit switches. It is oversampled with the MC101 down to 10nm resolution. The encoder gets a special Firmware for this function. The sensor signal is interpolateted 50.000 times and has a linearity of +/- 350nm over all 500µm. The encoder is complete integrated in the system integrated and generates 90mW powerlos. It is a compact version with limit switches.

Zero drift systems with realtime encoder data generation and standard quadratur signal



[3]

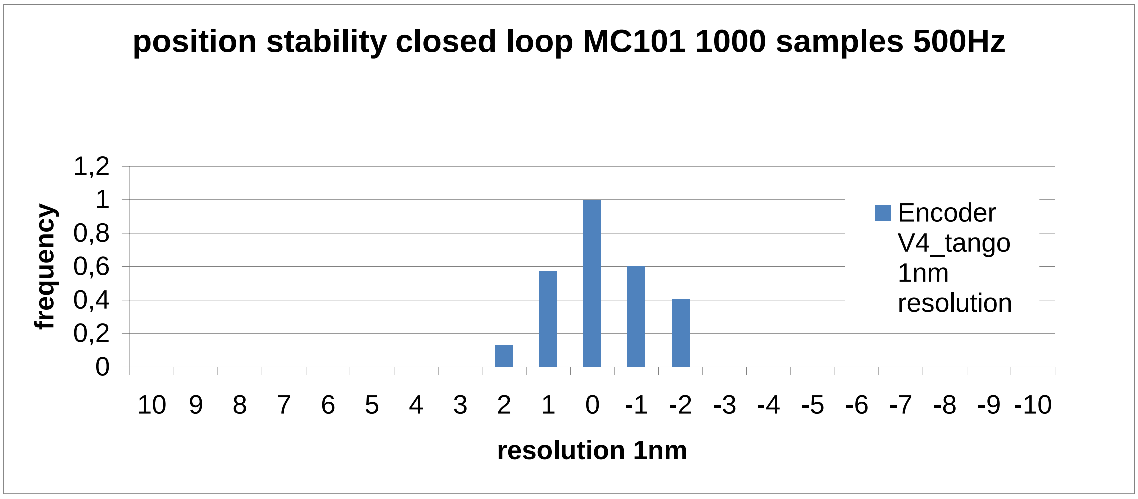
In this diagramm [3] is the magnetic zero drift encoder V4- with 10nm resolution demonstrated. The sensor signal is interpolateted 50.000 times and has a linearity of 200nm over all 500µm.
This version generatse data in realtime and is for fast movements or for velocity control. Also other controllers support this interface. Ask for the right sending frequency for your system.



[4]

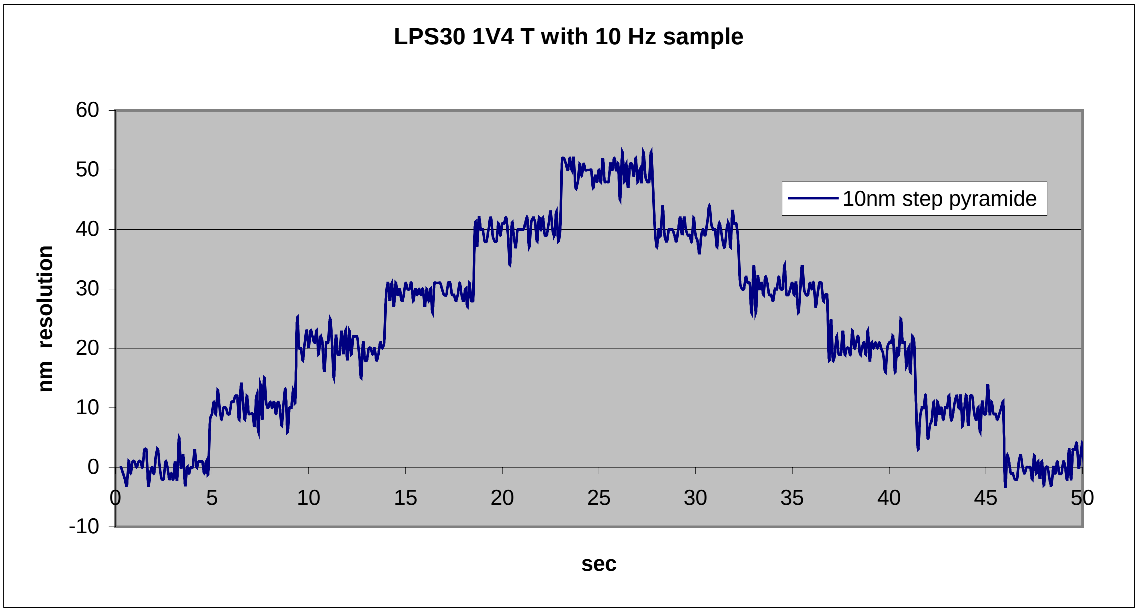
In this diagramm [4] is the optical zero drift encoder 1O_G with 500pm resolution demonstrated. The sensor signal is interpolateted 40.000 times and has a linearity of 10nm over all 20µm.
This version generates data in realtime and is for fast movements or for velocity control. Allso other controllers support this interface. Ask for the right sending frequency for your system. See also the external cross check with the interferometer from SIOS at the nanoscopium Soleil in France in diagram 8

Measurements with the zero drift Tango systems for the MC101 controller only



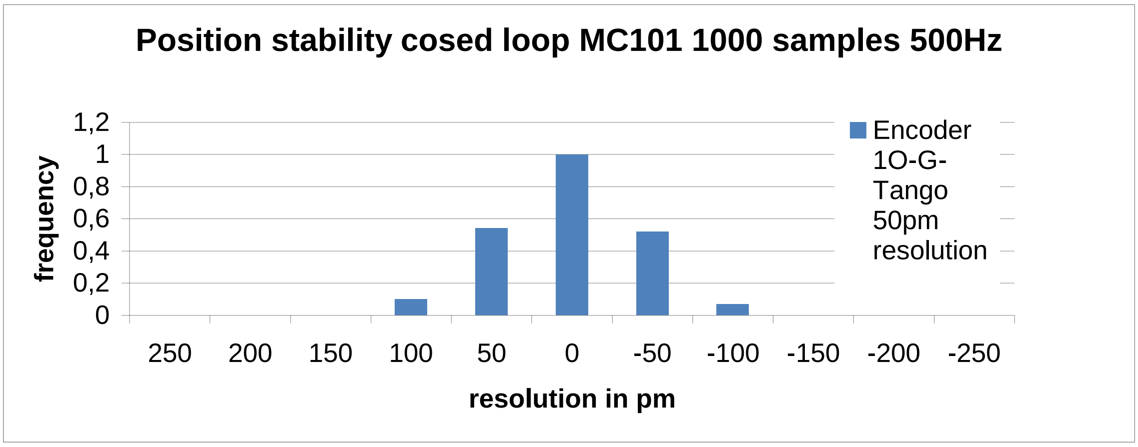
[5]

Diagram [5]

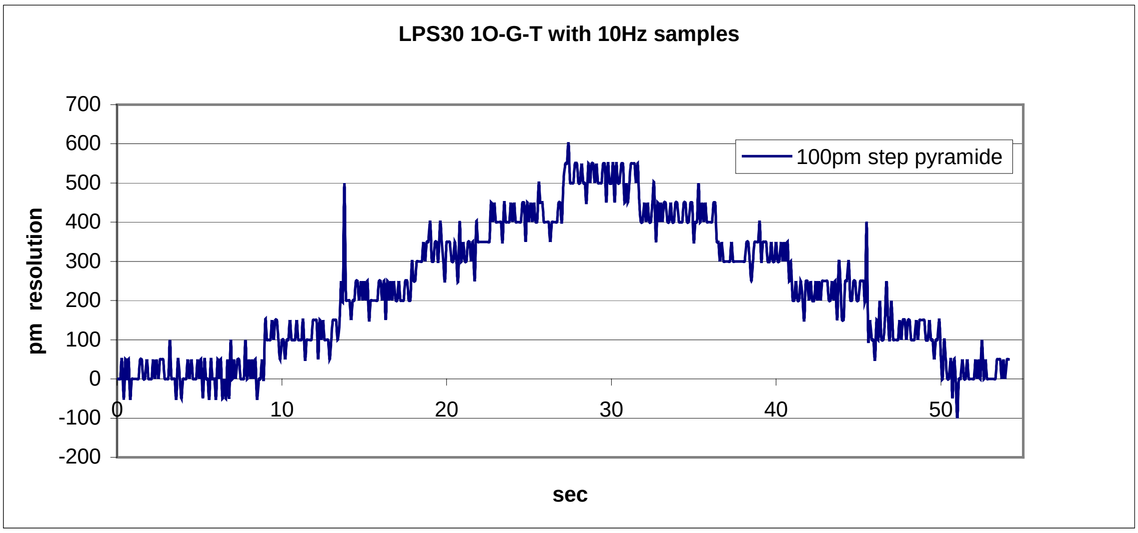


[6]

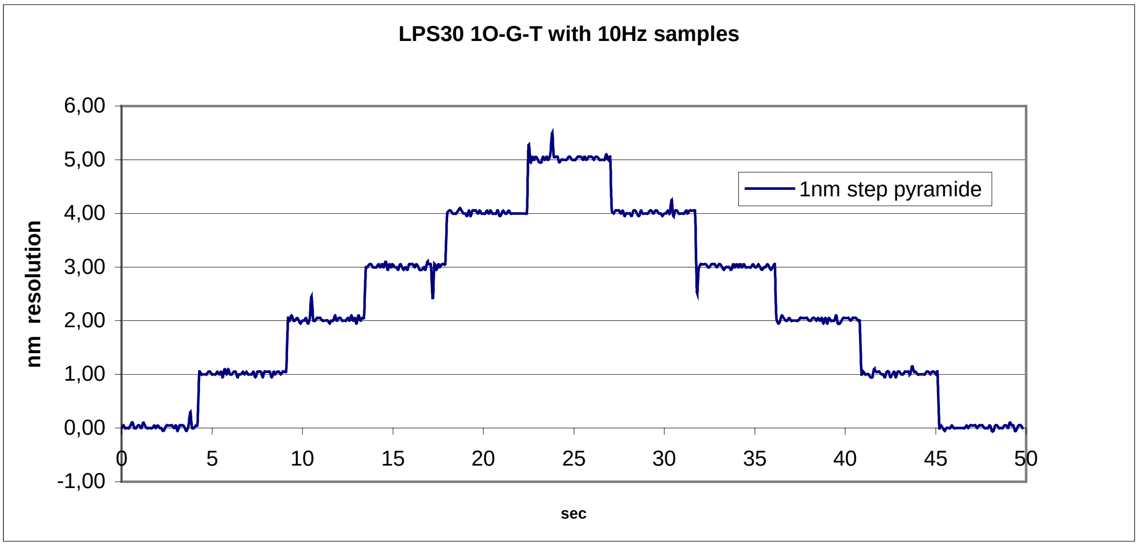
In this diagram [6] is the magnetic zero drift encoder V4-Tango with 1nm resolution demonstrated. The sensor signal is interpolateted 500.000 times and has a linearity of 200nm over all 500µm.



[7]



[8]



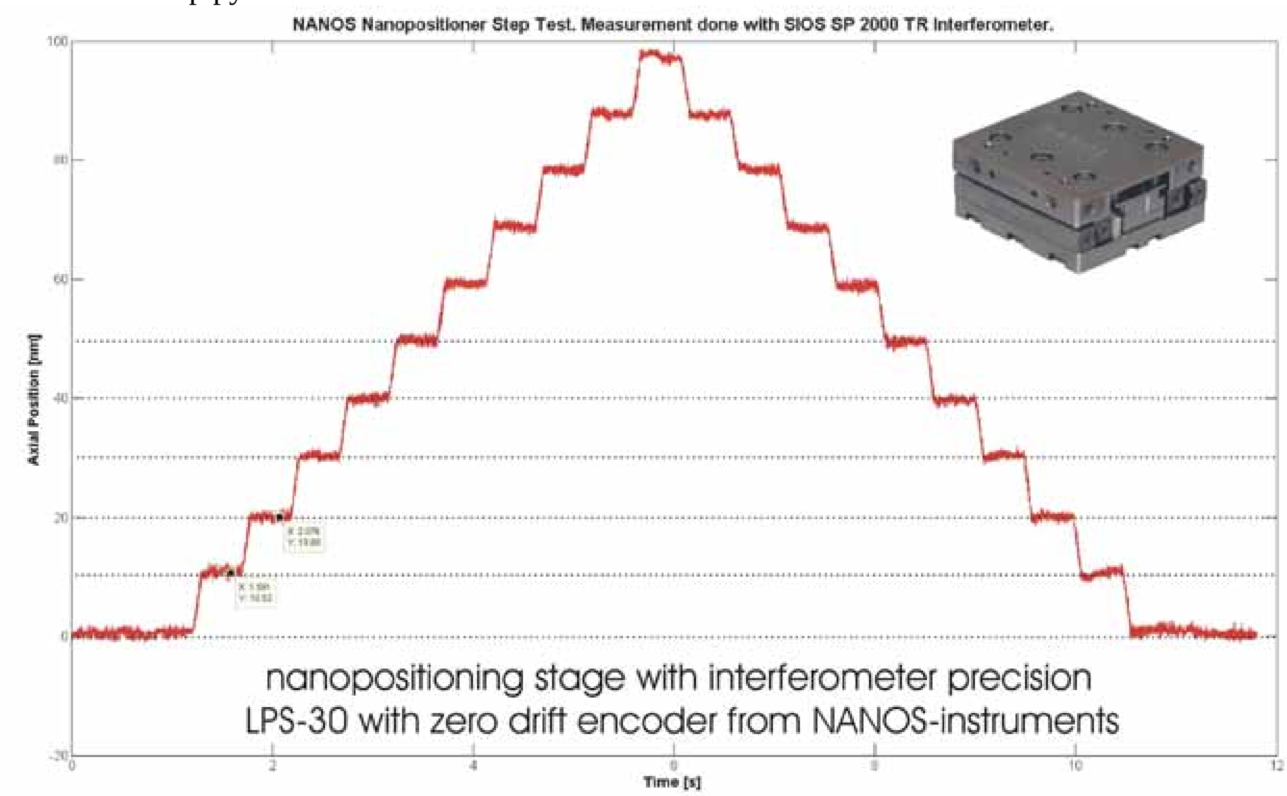
[9]

For these three diagramms are used the internal encodersignals in closed loop with the optical tango system. It demonstrate the stability and subnanometer precision. The tango system (1O-G-T) is ten times more precise than the singel system (1OG). But we must reduce the max. speed down to 1mm/s. Note that 100pm is the typical distance of atoms, we have centimeters of travel and a linearity better than 10nm/ 20µm. The sensorsignal is interpolated 400.000 times.

external test of our LPS-30x30

- 0,5nm bidirectional repeatability
- optical zero drift encoder with 0,5 nm resolution is integrated
- power consumption 20mW only
- travel range 10mm
- maximum operation speed 6mm/sec
- force: 10N
- material Stainless Steel.
- size: 30*30*14; mass 75g
- test in air, without temperature regulation but at constant temperature
- without load
- reference mirror ca. 30mm above the table

10nm step pyramide cross check with an interferometer:



[10] Source: Nanoscopium /Synchrotron SOLEIL, France, march 2015. Sensorsystem 1OG with 500pm resolution in the prototyp stage and with the prototype electronic. It demonstrates the complete stage with alle errors from sensor, controller, Software and mechanics. The mirror was mounted 30mm above the table. Ask for the special article about this.

Note that the new tango system could do a pyramide with 10 steps in the noise that you see in this diagram. And also the V2_61 single step is as big as the complete diagramm. The range is from 61nm to 50pm that we can offer. It is a factor over 1000 in these different systems. There are many combinations possible. It depends on the customers need and existing price range. So talk to us to find out the right one.

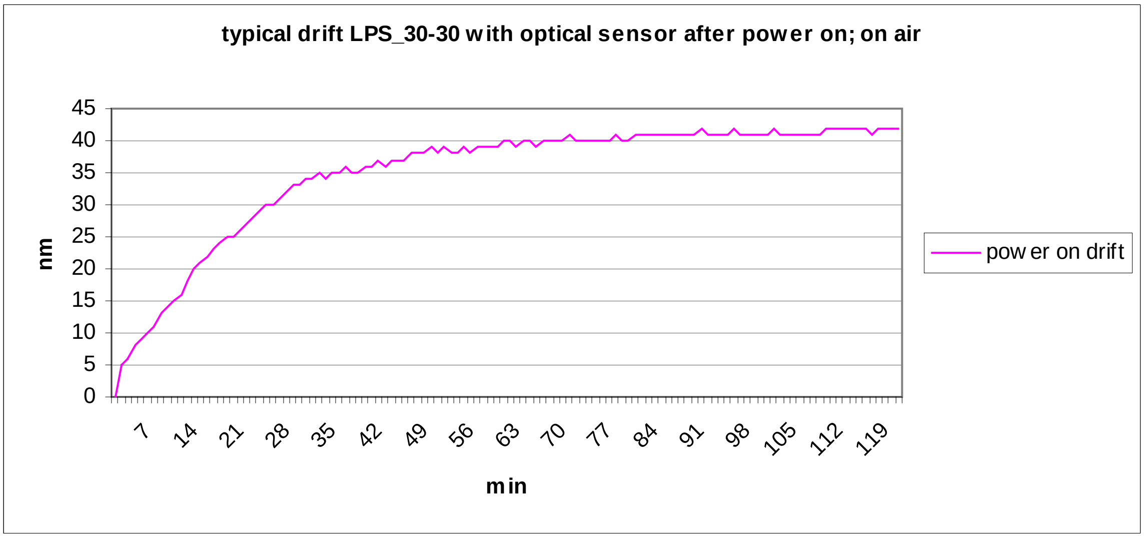


Diagram [11] Start up drift of the LPS 30 in air with the 20mW optical sensor (1OGT)
There is no position changing at the stage when it gets air draft with the same temperatur.
This is only the case with the zero drift sensors.

Speed test in combination with the MC101 controller.

Test with optimized parameters special for this step size. This test are done horizontal without load on a standard lab table without any stabilisation or protections. There are parmeter examples for the done test avalible. This is in that moment necessary when you drive the system at the speed limit. If the setting time could take 30ms the standart parameters are working fine. Note that the µcontroller is doing the calculation and also sending out all 2ms the encoderposition over the uart (500Hz). A situation that is not done normaly.

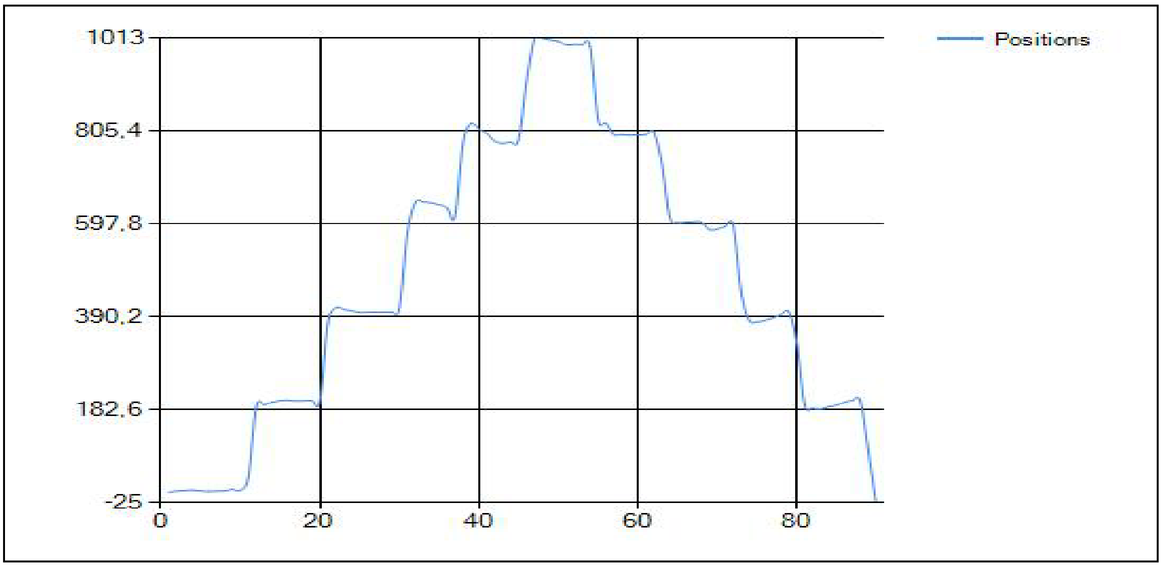


Diagram [12] LPS30-1OG-T with 50pm resolution. 200 count move (10nm) all 10ms (100Hz). For short distance the set time take longer because the calculated moving speed is slow and the filter level is high. So it take some times a bit longer to reach the taget position. Depending from the targed window the setting time goes up. Setting time within 3nm it is typical 3ms. If it have to be more precise the setting time is in the moment longer see diagramm [21]. We optimize this point in the near future.

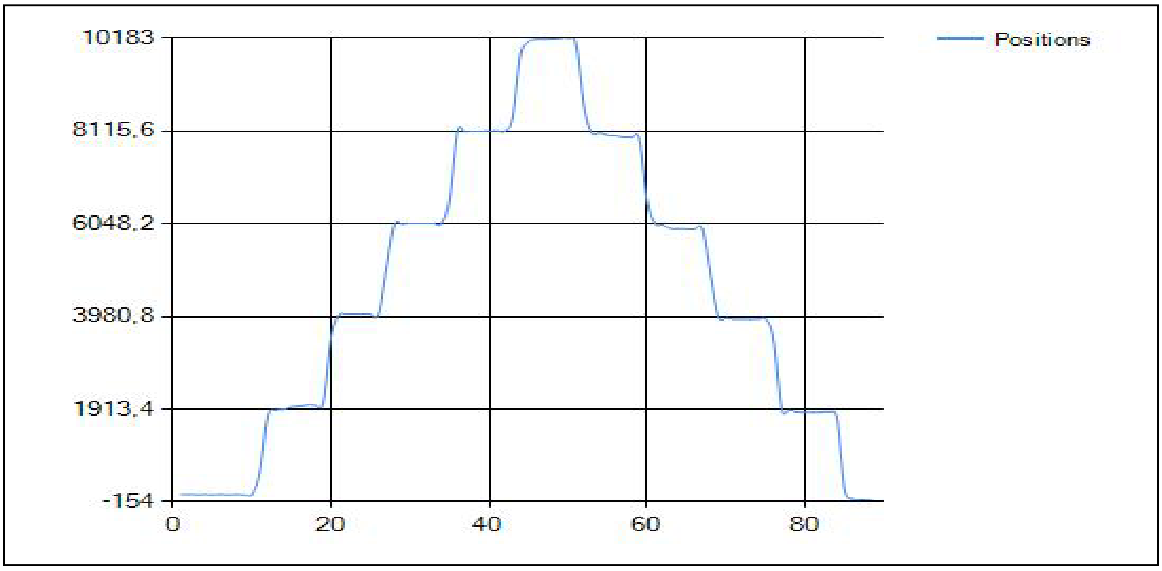


Diagram [13] LPS30-1OGT with 50pm resolution. 2.000 count move (100nm) all 10ms (100Hz). Setting time within 3nm it is typical 5ms.

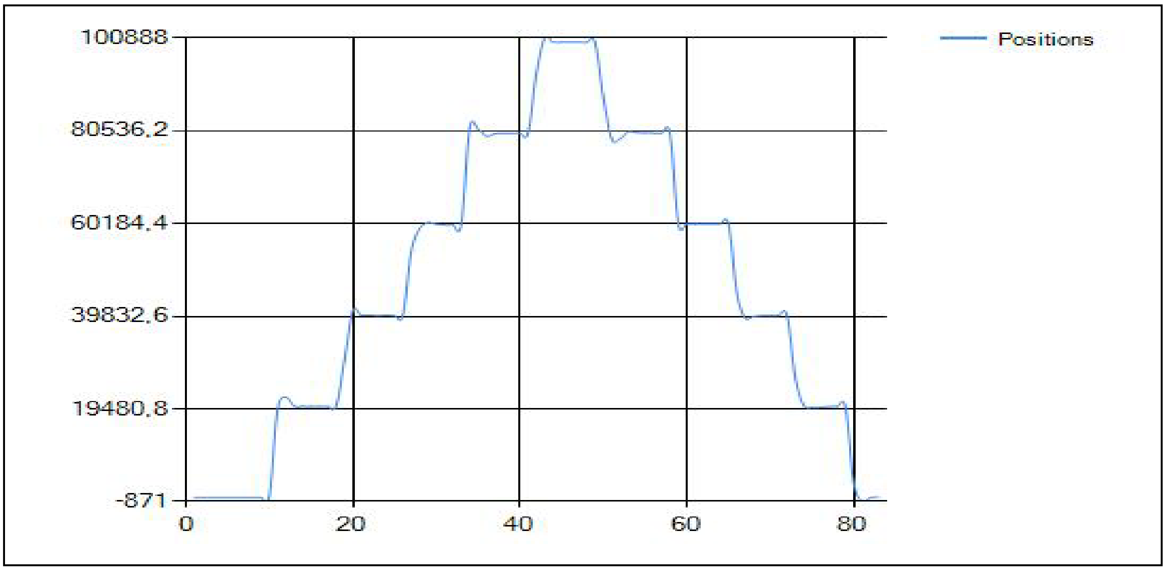


Diagram [14] LPS30-1OGT with 50pm resolution. 20.000 count move (1µm) all 10ms (100Hz). Setting time within 5nm it is typical 5ms.

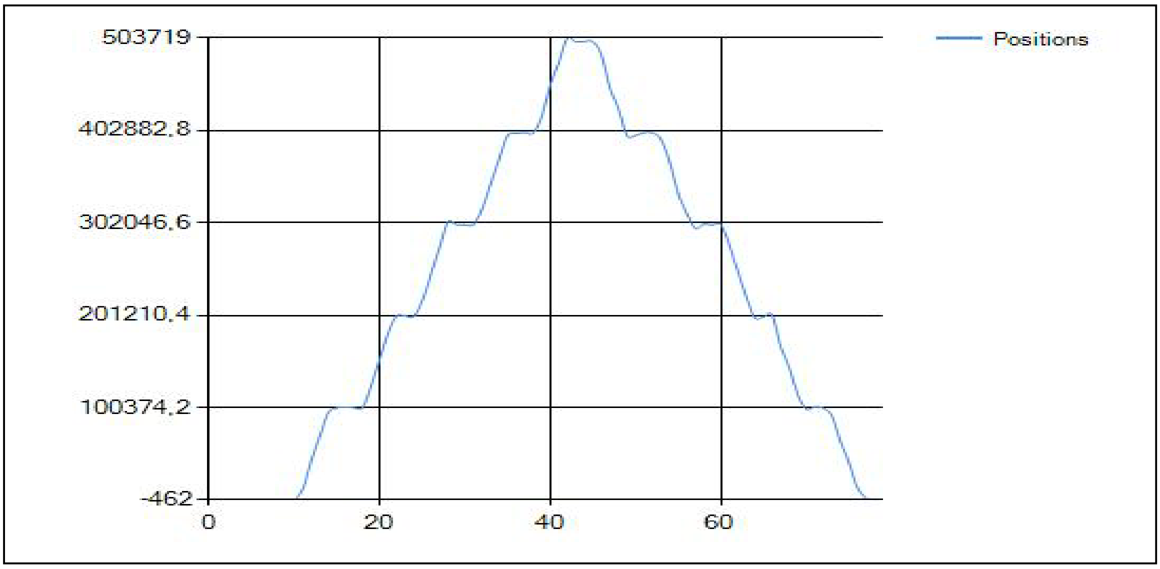


Diagram [15] LPS30-1OGT with 50pm resolution. 100.000 count move (5µm) all 10ms (100Hz). Here is the limit of the calculation frequence from the encoder reached. The encoder counts are puffered sometimes and give it out again. Larger fast steps are only possible with lower encoder resolution or slower setting time. 100.000 within 5ms are 20Mhz. The variation of the speed is sometimes higher an than the counts are bufferd.
In this diagram the motor did one or two full step cycles each 5µm.

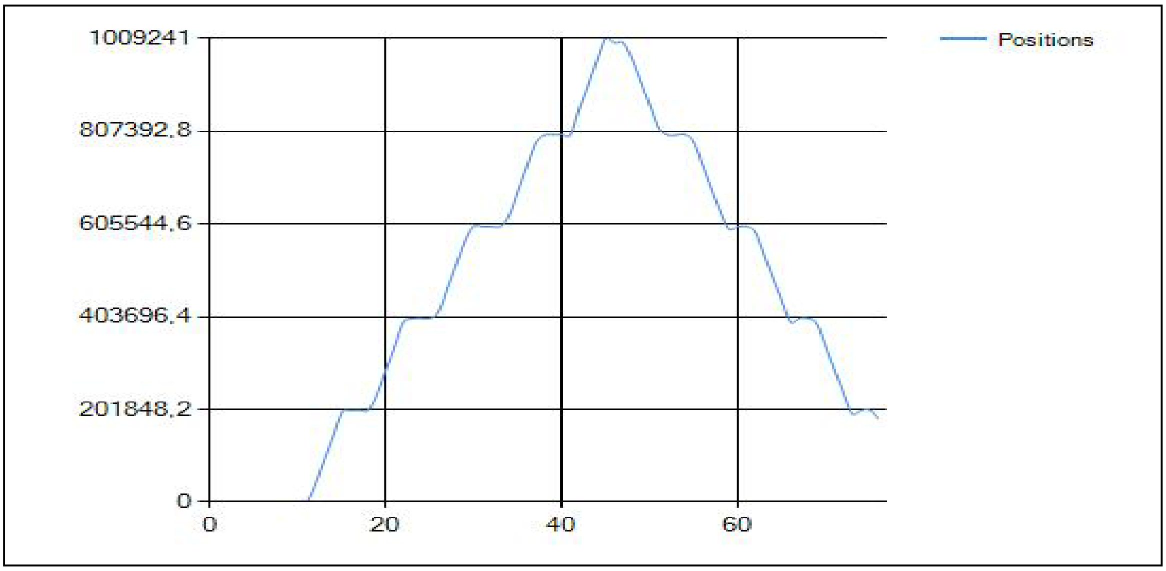


Diagram [16] LPS30-1OGT with 50pm resolution. 200.000 count move (10µm) all 10ms (100Hz). Here is the limit of the calculation frequence from the encoder passed factor two. The encoder counts are puffered sometimes and give it out again. Larger fast steps are only possible with lower encoder resolution or slower stetime. The ABZ out counts of the MC101 are delayed. Internaly it is working faster via SPI. 200.000 counts within 5ms are 40Mhz. This is too fast and not save. Counts could be lost.
In this diagram the motor did three or four full step cycles each 10µm.

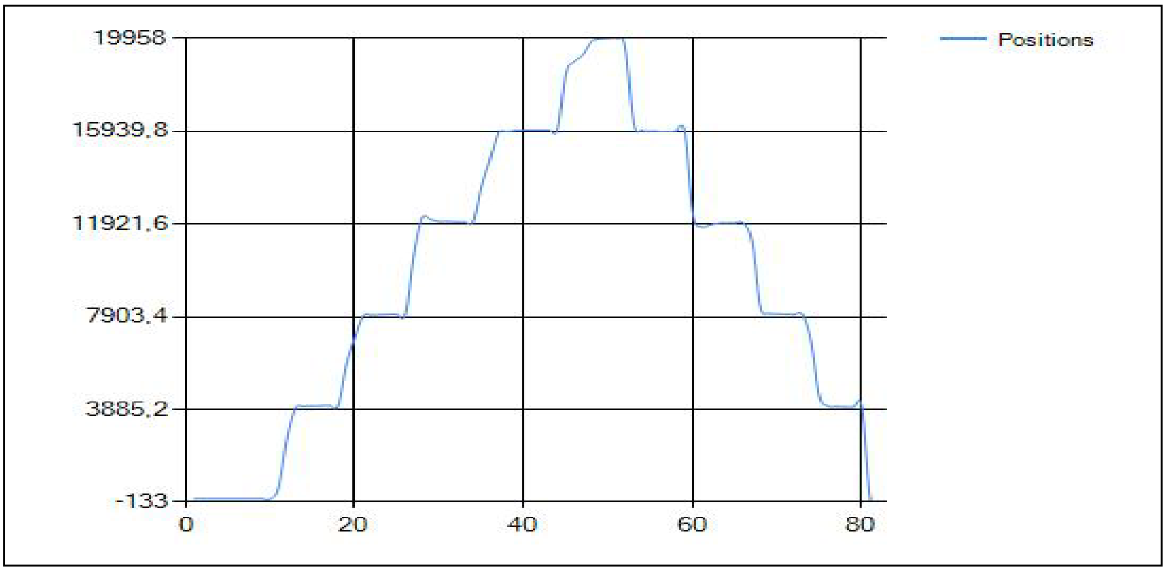


Diagram [17] LPS30-1OGT with 250pm resolution. 4.000 count move (1µm) all 10ms (100Hz). Setting time within 5nm it is typical 5ms.

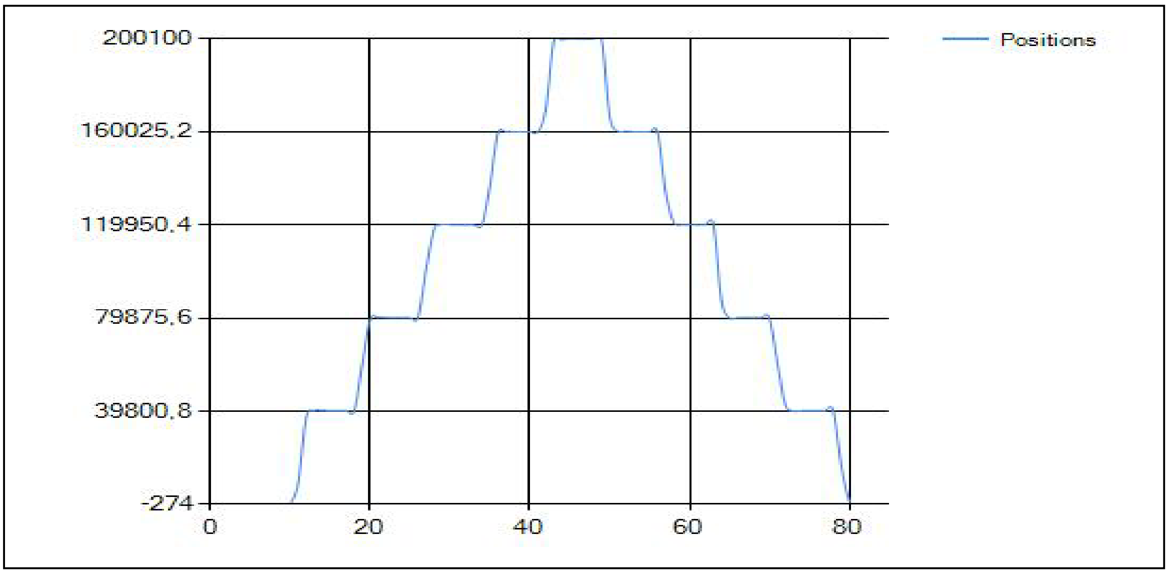


Diagram [18] LPS30-1OGT with 250pm resolution. 40.000 count move (10µm) all 10ms (100Hz). Setting time within 5nm it is typical 5ms.

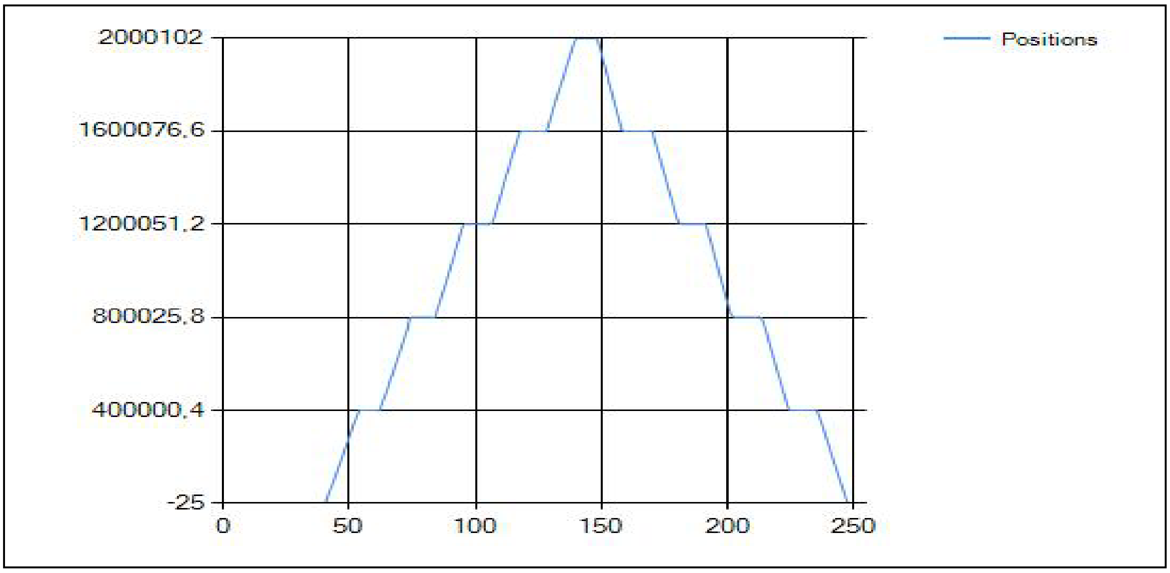


Diagram [19] LPS30-1OGT with 250pm resolution. 400.000 count move (100µm) all 40ms (25Hz). Setting time it is typical 15ms. Here is the driving speed of 10mm/s the limit. If you need it faster we could change the motor step resolution to speed it up and also reduce the encoder resolution.

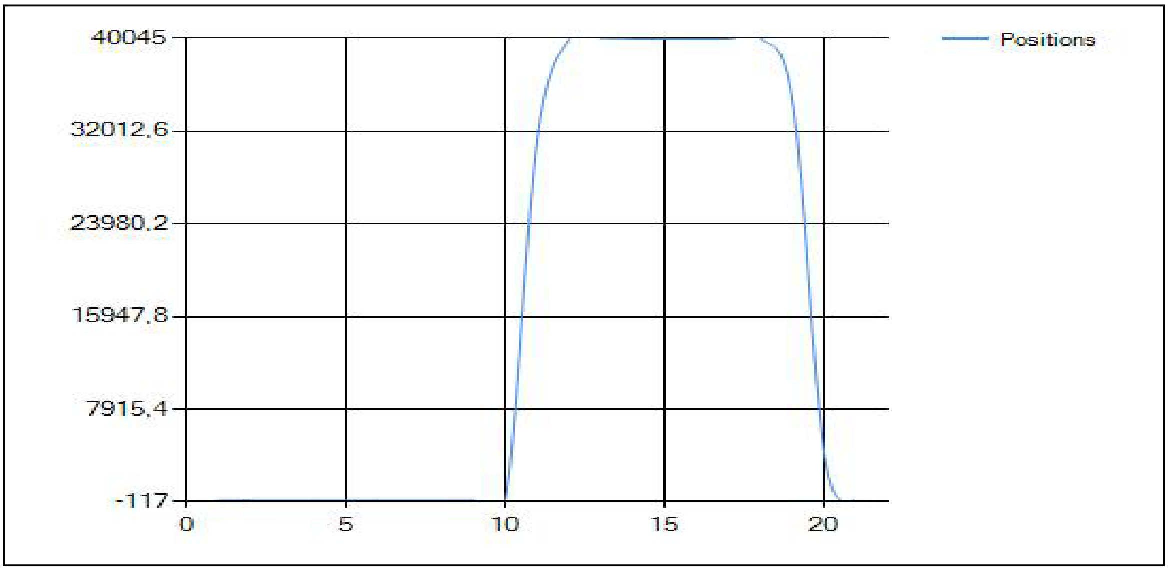


Diagram [20] LPS30-1OGT with 250pm resolution. 40.000 count move (10µm) all 10ms (100Hz). Setting time it is typical 5ms. Here is the driving speed of 10mm/s the limit. If you need it faster we could change the motor step resolution to speed it up.

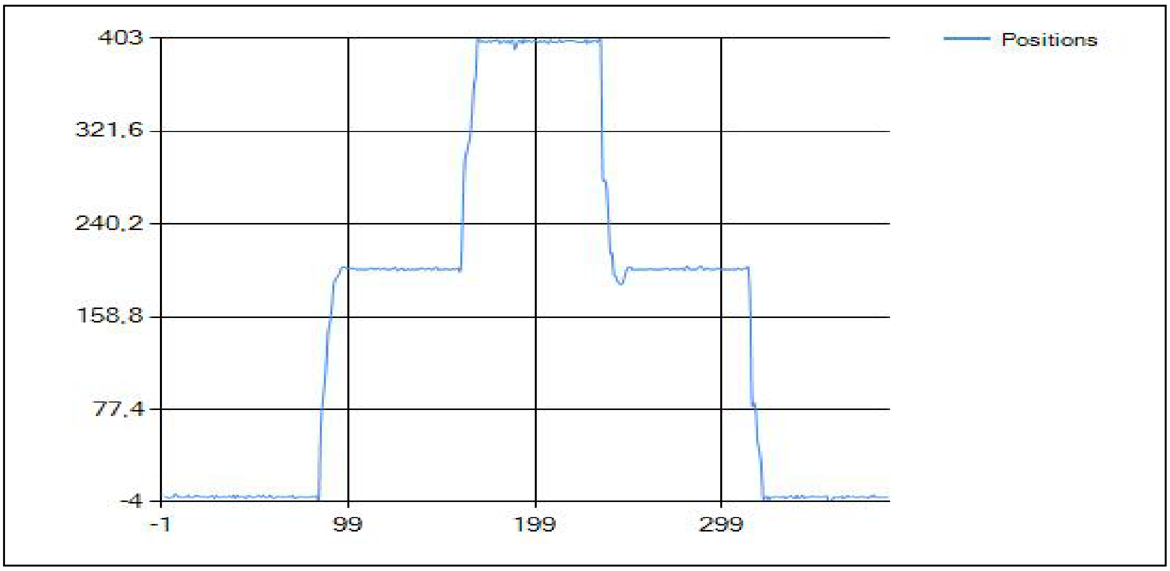
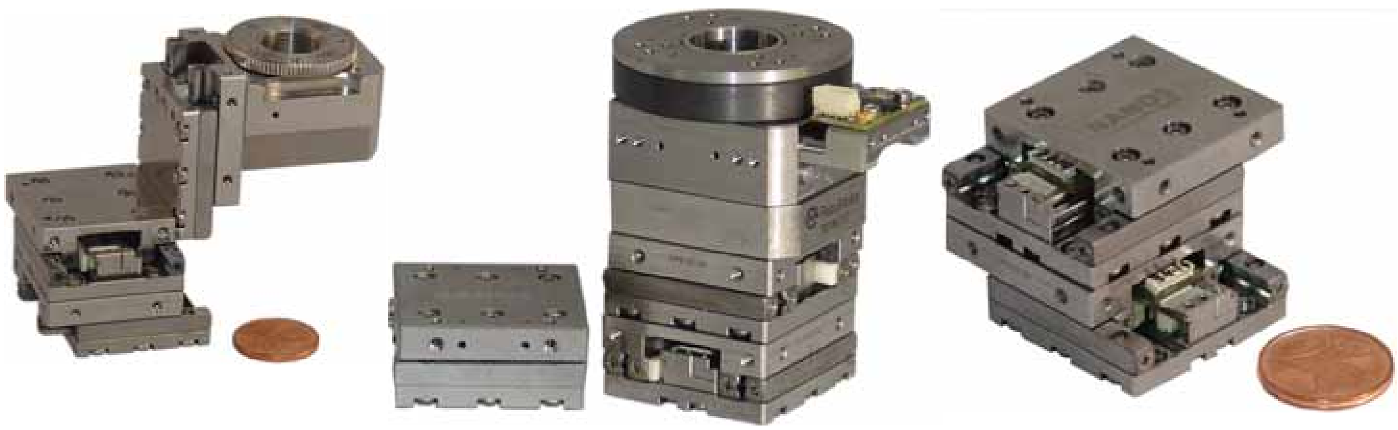


Diagram [21] LPS30-1OGT with 50pm resolution. 200 count move (10nm) all 100ms (10Hz). Setting time it is typical 30ms with a precision of +/-50pm. We work to make the process faster.

Applications



Note: Zerodur® is a Trademark from Schott   Zero drift means very small drift but not zero (endless small)