Publication Date: 2021-04-19

Product Change Notification

Subject	Type of change:	Test process
PI offers various motion technologies. In the past, different metrology approaches came up, due to different requirements in the technologies. For a transparent description of the measurement standard, these different approaches are now unified to one measurement standard. This new measurement standard is based on the ISO 230 standard but has some slight changes to it, to comply to former measurements done by PI. **This document describes the changes between the current measurement evaluation and the evaluation according to the unified measurement standard for motor-driven PI products.** The new measurement standard will apply from the 3rd of May 2021 on for the whole PI Group.		

This is the announcement of a change to one or more products currently offered by Physik Instrumente (PI) GmbH & Co. KG. Find detailed information on this change as well as a list of affected products on the following pages.
This change will be implemented within 6 months of the publication date.
This notification has no influence on the life cycle of products that have already been discontinued.
If products are affected that have already been listed in previous change / discontinuation notifications, this notification has no suspensive effect with regard to the end of the product life cycle or the last possible order dates.
If you have any questions about this notification, please contact your sales representative.

Reasons for the Change

PI wants to give customers insight into our data acquisition procedure as well as the algorithms used for data evaluation.

For historical reasons PI has used two different software suites for data acquisition and data evaluation: One designed mainly for piezo applications, another one designed mainly for DC motors. However, both software solutions acquire the measurement data with a series of static measurements and work very similar.

In the future PI wants to use only one software for the following reasons:

- Technolgy: Over the last years hybrid systems, which contain both technologies, have become more and more important. The separation in two clear technology branches is therefore no longer possible.
- Transparency: The customer needs to be able to reproduce the data acquisition and evaluation. A unified measurement standard for data acquisition and evaluation is required for a transparent communication.
- Uniformity: The design of the test report as well as the measurement data it contains depends on the measurement software applied, because the two software suites use slightly different methods for data

Reasons for the Change
acquisition and evaluation. PI wants to provide reliable measurement values independent of the applied software.

Description of the Change

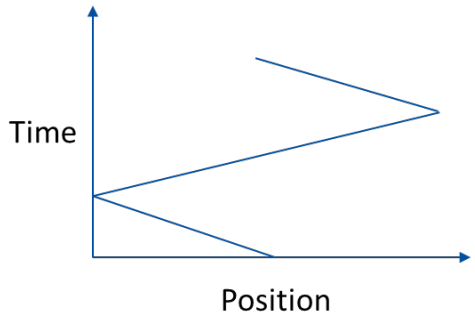
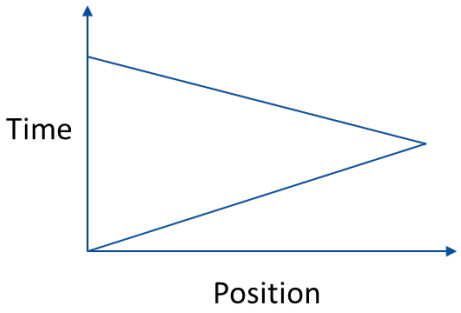
Data acquisition:

The data points are still recorded as a sequence of static measurements (point-to-point motion). However, the order of the measurement points is different.
The current sequence is:

- Move from the central position to the minimum position
- Move from the minimum position to the maximum position
- Move from the maximum position to the central position

The sequence according to the new standard will be:

- Move from the minimum position to the maximum position
- Move from the maximum position back to the minimum position
- The following picture shows the motion over time:

Current motion sequence:	New motion sequence:
Center – Min – Max - Center	Min – Max – Min
	

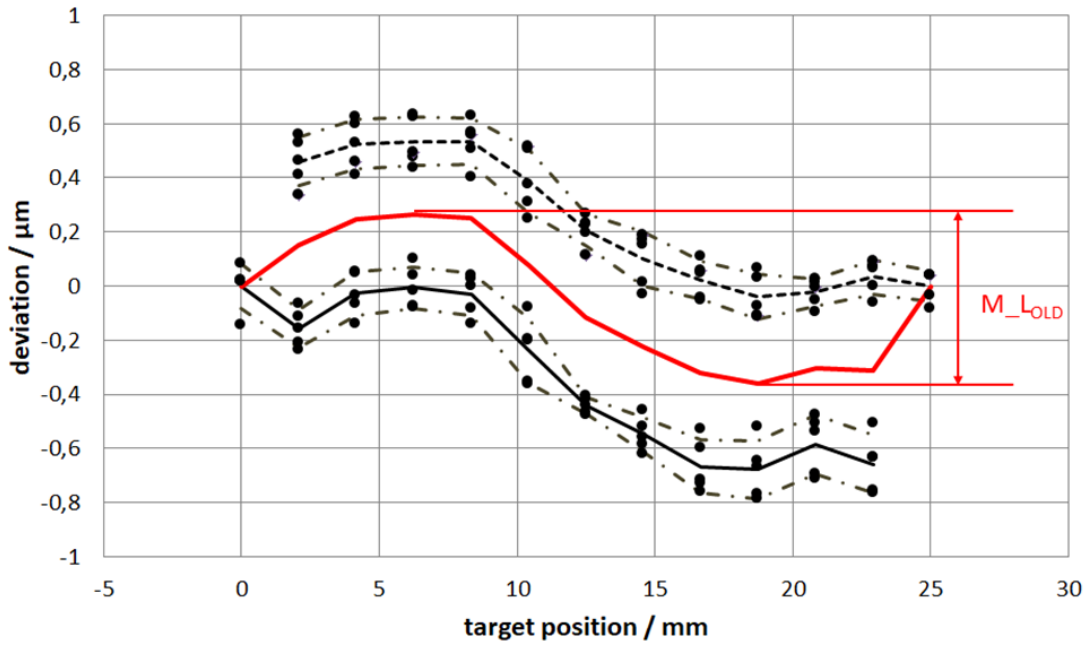
Data evaluation:

For the current measurands, there are either no or only slight changes in the algorithm applied. The following tables give an overview and compare the current and the new algorithms:

- Bidirectional Error:

Description according to current standard	Linearity Error
Description according to new standard	M_L: Bidirectional error (mean, minus regression line)
Changes in evaluation according to new standard compared to old standard	Regression line subtracted instead of endpoint line; calculation only with bidirectionally approached measurement points (without end points) instead of all measurement points
Effects due to new standard	New measurement values are expected to be smaller; spikes at the endpoints are not evaluated any more

Current standard (Linearity Error):



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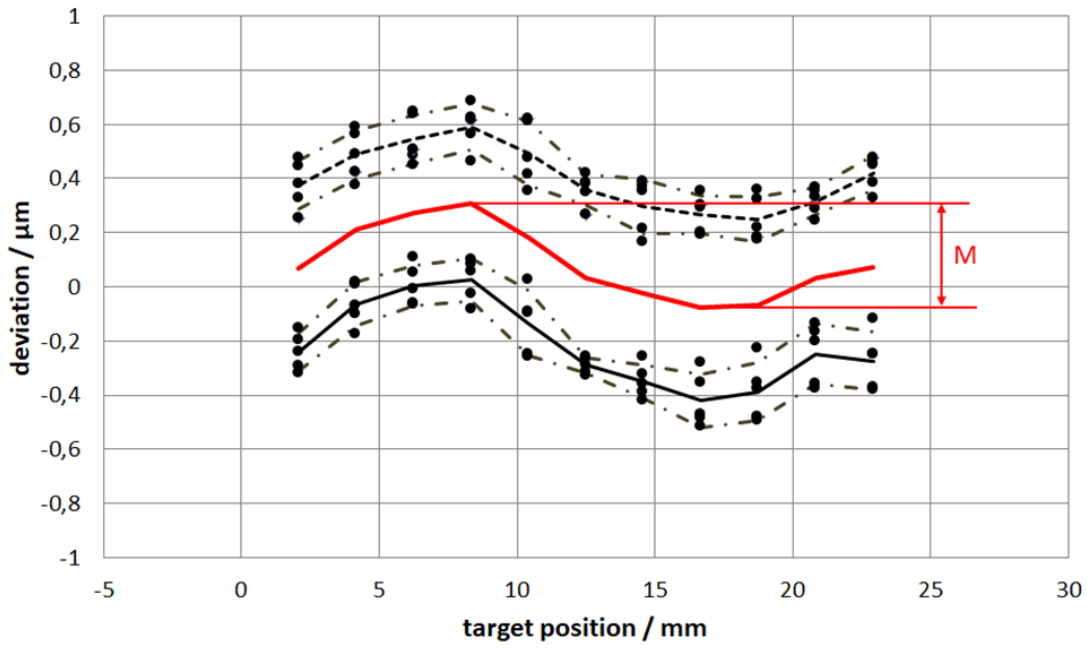
New standard (Bidirectional error (mean, minus regression line):

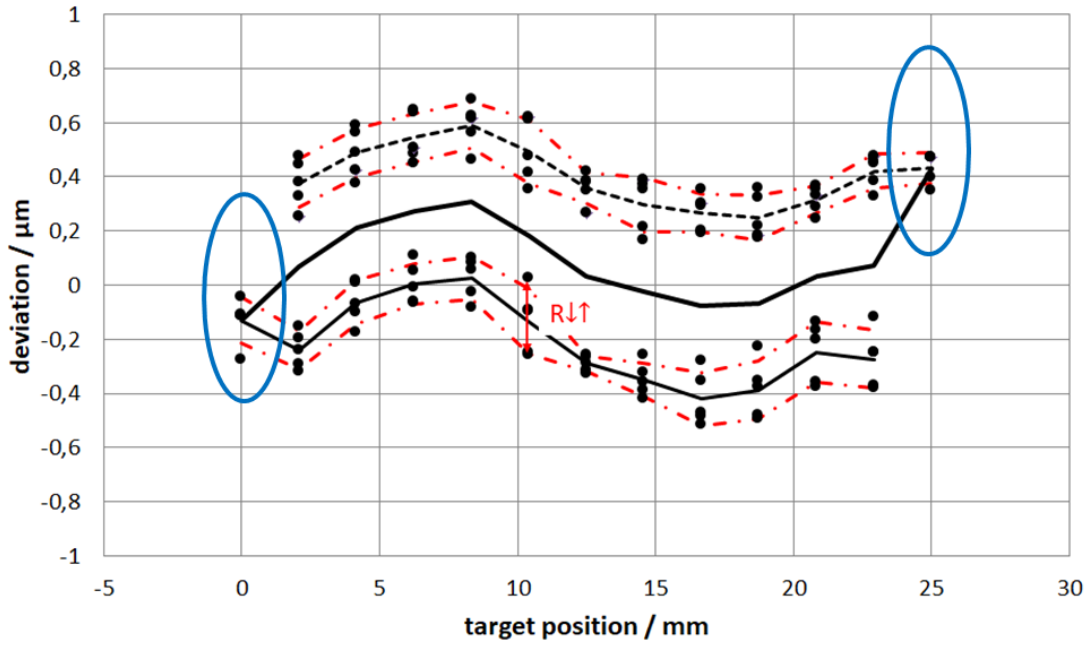


- Repeatability:

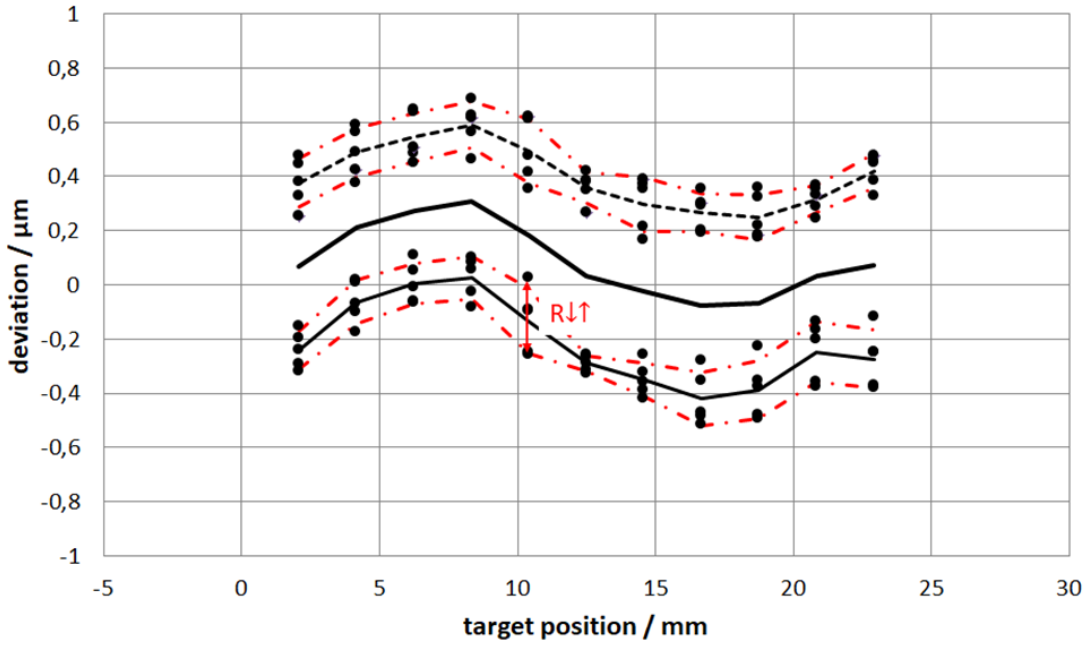
Description according to current standard	Repeatability mean
Description according to new standard	R_fbm: Unidirectional repeatability (mean)
Changes in evaluation according to new standard compared to old standard	Calculation only with bidirectionally approached measurement points (no end points) instead of all measurement points
Effects due to new standard	No changes expected

Description according to current standard	Repeatability max.
Description according to new standard	R_fb: Unidirectional repeatability (max.)
Changes in evaluation according to new standard compared to old standard	Calculation only with bidirectionally approached measurement points (no end points) instead of all measurement points
Effects due to new standard	No changes expected

Current standard (Repeatability mean & Repeatability max.):



New standard (Unidirectional repeatability (mean) & Unidirectional repeatability (max.)):



Description of the Change

- Backlash:

Description according to current standard	Backlash mean
Description according to new standard	B_m: Backlash (mean)
Changes in evaluation according to new standard compared to old standard	Sum of the real values (with sign) of the backlash at each point instead of sum of the absolute values of the backlash at each point
Effects due to new standard	The new measurement value is more representative for the backlash. It is not as sensitive on position fluctuations during the measurement. The new value is between zero and the current value.

Current standard (Backlash mean):

$$\bar{B} = \frac{1}{m}\sum_{j=1}^{m}|(\bar{x}_i \uparrow - \bar{x}_i \downarrow)|$$

New standard (Backlash (mean)):

$$\bar{B} = \left|\frac{1}{m}\sum_{j=1}^{m}(\bar{x}_i \uparrow - \bar{x}_i \downarrow)\right|$$

Description according to current standard	Backlash max.
Description according to new standard	B: Backlash (max.)
Changes in evaluation according to new standard compared to old standard	Same evaluation as before
Effects due to new standard	No changes expected

Description of the Change

- There are new measurands:
  - A: Bidirectional accuracy:
    The bidirectional positioning accuracy is a measurand that combines all occurring errors (bidirectional error (mean), backlash, repeatability, gain factor) and thus represents the maximum error that can occur during positioning.
  - R: Bidirectional repeatability (max.):
    The bidirectional repeatability (max.) indicates how reliably each individual target position will be hit from both the positive and negative directions. Bidirectional repeatability (max.) combines the backlash and the unidirectional repeatability. It is the maximum measured value.

Test report:

- The report's name changes from “FM 7.5-62 A1” to “FM 7.5-79_A1”.
- The new test report consists of one cover sheet with a summary of the metadata of the measurement setup. Each measurement domain with the measurement parameters and the measurement values is described on the following pages.
- Some categories in the report will be sorted in a different manner:
  - “System Setup” is now “System” and does not include the velocity or acceleration as measurement parameters.
  - “Measurement Setup” divides into “Data Acquisition” and “Measurement Domain”. The “Measurement Domain” section shows more detailed parameters on the following pages.
  - The measurement values in the section “Measurement Results” are now shown in the section “Positioning in X”, “Straightness” or “Angular Error Motion”. The value of the backlash has been removed from the section, instead the value of the bidirectional repeatability has been added.
- For linear stages the bidirectional positioning accuracy without subtraction of a regression line is shown.
- The value "Linearity Error" is now listed as "Bidirectional error (mean, minus regression line)".
- The "Repeatability (RMS)" values are now listed as "Unidirectional repeatability (mean and max.)".
- The value of the bidirectional repeatability (max.) is listed.
- The values of the backlash (mean and max.) are no longer listed.

Find an example for the current / new test reports as an attachment at the end of this document.

Filenames:

The nomenclature of the measurement geometry has changed for all products. This nomenclature is part of the filenames of the test report and the measurement data file. In the current standard a measurement was described as:

Description of the Change
for linear measurements: <moving direction>t<measuring direction> for angular measurements: <moving direction>r<axis for the rotational direction> In the new standard it is described as: E_<measuring direction><moving direction> The angular directions are described as A, B, C which corresponds to rotX, rotY, rotZ. For example, the new description of measurements is now E_ZX instead of xtz or E_BX instead of xry.

Possible Impact on Fit, Form, Function, Quality and Reliability
Fit, Form, Function: The new measurement standard does not change the procedure of the data acquisition. The evaluation based on the new standard is almost the same as the evaluation based on the current standard. No changes are expected. Quality: The new measurands are explained in detail in a whitepaper available on our website for a better understanding and transparency. This is an improvement to the current reports, which show considerably less explicit measurement values.

Changes to Product Identification as a Result of this Notification
No changes planned.

Products Affected by this Notification (PI Item No.)

6239500051	626292310-0001	H-840.D11	H-860.S2H	L-511.44AD00
623991214	6635V21100	H-840.D12	L-509.10AD10	L-511.4ASD00
623991314	68509121	H-840.D2	L-509.10DG10	L-511.60AD10
623992204	68509131	H-840.D2A	L-509.10SD00	L-511.60DG10
623992314-0000	68509141	H-840.D2I	L-509.14AD00	L-511.60SD00
623992314-0001	F-712.HA1	H-840.D31	L-509.1ASD00	L-511.64AD00
623992414-LS010	F-712.HA2	H-840.G1	L-509.20AD10	L-511.6ASD00
623992414-LS011	F-712.HU1	H-840.G11	L-509.20DG10	L-611.991261V6
623992504	F-712.MA1	H-840.G12	L-509.20SD00	L-731.093111
623992514-LS011	F-712.MA2	H-840.G2A	L-509.24AD00	L-731.093112

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Products Affected by this Notification (PI Item No.)				
6240500057-0001	H-206.F2	H-840.G2I	L-509.2ASD00	L-731.093132
62409110	H-810.I2	H-840.G2IHP	L-509.40AD10	L-731.40SD
62409111	H-811.F2	H-845.D11	L-509.40DG10	L-731.44SD
62409120	H-811.I2	H-845.D21	L-509.40SD00	L-731.4ASD
62409150	H-811.S2	H-845.D31	L-509.44AD00	N-565.160
62409210-0000	H-820.D2	H-845.D41	L-509.4ASD00	N-565.260
62409211-0001	H-824.D2	H-845.D51	L-511.20AD10	N-565.360
62409230-0000	H-824.D2V	H-845.D61	L-511.20DG10	N-725.2A
62409231-0001	H-824.G2	H-850.G2	L-511.20SD00	ND72Z2LAQ
62409250	H-824.G2V	H-850.G2A	L-511.24AD00	V-412.136211E1
6240V23100	H-825.D2A	H-850.H2	L-511.2ASD00	V-417.136211E1
626291410	H-825.G2A	H-850.H2A	L-511.40AD10	V-417.176211E1
626292110-0001	H-840.B2	H-850.H2I	L-511.40DG10	V-417.216211E1
626292210-0001	H-840.D1	H-850.H2V	L-511.40SD00	V-731.096111

In addition:

- All related customized products delivered with a test report

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Attachments: Current / New Test Report

Current test report:

Page 1/2:

Test Protocol for Linear Stage H-811K999_AXIS_Z

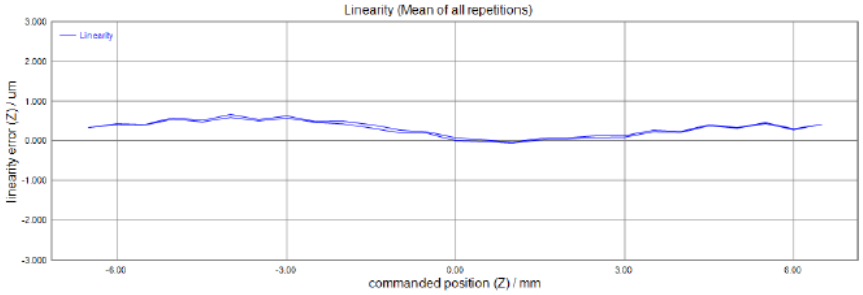
File: H-811K999_AXIS_Z_123456789_ztz_0_1.pdf
Protocol no.: FM 7.5-62 A1
Date and time: 2021-01-21, 10:42:54, Script version: 1.21.3.0, Signed on 2020-11-16 18:35:12 for Framework 1.21.3.0

Measurement Setup	
Meas. Device Type 1	Interferometer
Meas. Device Type 2	
Measurement Type	Start-Up
Measurement Date	2020-10-06, 07:42
Measurement Program	MMP 2.6.0.0 Beta
Data Analysis Program	FlightRecorderMMP
Tester	ABC
Min. Ctrl Input / mm	-6.500
Max. Ctrl Input / mm	6.500
Step Size / mm	0.500
Waiting time / ms	500.000
Number of repetitions	5

System Setup	
Stage	H-811K999_AXIS_Z
Ser. No.	123456789
Controller	C-887
Controller Ser. No.	not available
Controller FW Version	not available
PID	50.000/200.000/300.000
Velocity / mm/s	10.000
Acceleration / mm/s^2	0.000

Measurement Results

	mean in um	max in um
Linearity Error	0.676	
Repeatability (RMS)	0.044	0.069
Backlash	0.038	0.086



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Physik Instrumente (PI) GmbH & Co. KG, Auf der Roemerstr. 1, 76228 Karlsruhe, Deutschland
Tel. +49 721 4846-0, Fax +49 721 4846-1019, E-Mail info@pi.de, www.pi.de

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Current test report:

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Test Protocol for Linear Stage H-811K999_AXIS_Z

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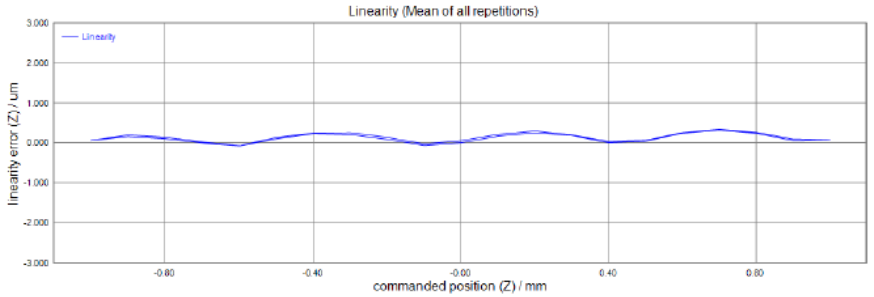
Protocol no.: FM 7.5-62 A1
Date and time: 2021-01-21, 10:42:54, Script version: 1.21.3.0, Signed on 2020-11-16 18:35:12 for Framework 1.21.3.0

Measurement Setup	
Meas. Device Type 1	Interferometer
Meas. Device Type 2	
Measurement Type	Start-Up
Measurement Date	2020-10-06, 07:42
Measurement Program	MMP 2.6.0.0 Beta
Data Analysis Program	FlightRecorderMMP
Tester	ABC
Min. Ctrl Input / mm	-1.000
Max. Ctrl Input / mm	1.000
Step Size / mm	0.100
Waiting time / ms	500.000
Number of repetitions	5

System Setup	
Stage	H-811K999_AXIS_Z
Ser. No.	123456789
Controller	C-887
Controller Ser. No.	not available
Controller FW Version	not available
PID	50.000/200.000/300.000
Velocity / mm/s	10.000
Acceleration / mm/s^2	0.000

Measurement Results

	mean in um	max in um
Linearity Error	0.403	
Repeatability (RMS)	0.058	0.091
Backlash	0.030	0.053



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Physik Instrumente (PI) GmbH & Co. KG, Auf der Roemerstr. 1, 76228 Karlsruhe, Deutschland
Tel. +49 721 4846-0, Fax +49 721 4846-1019, E-Mail info@pi.de, www.pi.de

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Publication Date: 2021-04-19

New test report:

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Test Report for Linear Stage H-811K999_AXIS_Z

File: H-811K097_AXIS_Z_123456789_EZZ.pdf
Protocol no.: FM 7.5-79_A2
2021-03-22 15:22:35, Script version: 1.22.2.0, Signed on 2021-03-18 11:56:15 for Framework 1.22.2.0

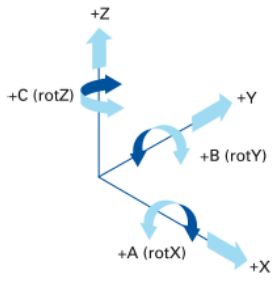
System	
Stage type	H-811K999_AXIS_Z
Stage serial number	123456789
Controller type	C-887
Controller serial number	987654321
Controller firmware version	2.7.2.0
PIStages3.db version	V3.0.43.131

Data Acquisition	
Date, time	2020-10-06, 09:41
Examiner	ABC
Measurement program	HummingBird 1.21.2.903
Data analysis program	HummingBird 1.22.2.0
Measurement devices	Interferometer
Moving direction	Z
Measuring direction	Z

Measurement Domain 1	
Min. commanded position / mm	-6.5
Max. commanded position / mm	6.5

Measurement Domain 2	
Min. commanded position / mm	-1.0
Max. commanded position / mm	1.0

Comment
Measurements based on ISO 230



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Physik Instrumente (PI) GmbH & Co. KG, Auf der Roemerstr. 1, 76228 Karlsruhe, Deutschland
Tel. +49 721 4846-0, Fax +49 721 4846-1019, E-Mail info@pi.de, www.pi.de

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New test report:

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Test Report for Linear Stage H-811K999_AXIS_Z

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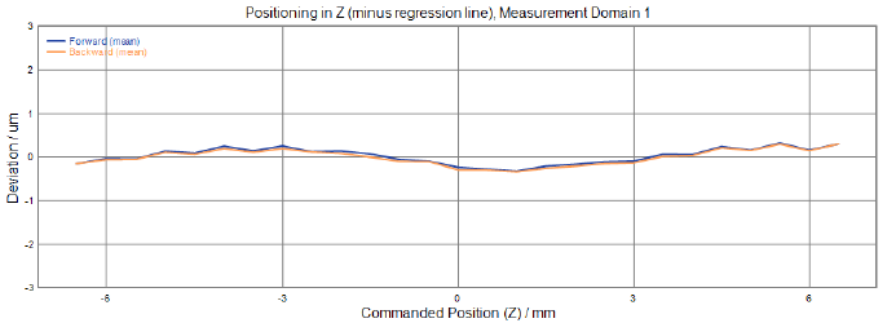
Protocol no.: FM 7.5-79_A2
2021-03-22 15:22:35, Script version: 1.22.2.0, Signed on 2021-03-18 11:56:15 for Framework 1.22.2.0

System	
Stage type	H-811K999_AXIS_Z
Stage serial number	123456789
Velocity / mm/s	10.0
Acceleration / mm/s^2	232.0

Measurement Domain 1	
Moving direction	Z
Measuring direction	Z
Min. commanded position / mm	-6.5
Max. commanded position / mm	6.5
Measuring range / mm	13.0
Bidirectional measuring range / mm	12.0
Step size / mm	0.5
Waiting time / s	0.5
Number of repetitions	4
Data correction	Thermal drift correction is applied to the measurement data

Positioning in Z (minus end-point line), Measurement Domain 1			
M_L	Bidirectional error (mean, minus regression line)	0.6323	µm
R_fbm	Unidirectional repeatability (mean)	+/-0.0360	µm
R_fb	Unidirectional repeatability (max.)	+/-0.0826	µm
R	Bidirectional repeatability (max.)	0.1779	µm



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Physik Instrumente (PI) GmbH & Co. KG, Auf der Roemerstr. 1, 76228 Karlsruhe, Deutschland
Tel. +49 721 4846-0, Fax +49 721 4846-1019, E-Mail info@pi.de, www.pi.de

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2021-03-22 15:22:35, Script version: 1.22.2.0, Signed on 2021-03-18 11:56:15 for Framework 1.22.2.0

System	
Stage type	H-811K999_AXIS_Z
Stage serial number	123456789
Velocity / mm/s	10.0
Acceleration / mm/s^2	232.0

Measurement Domain 2	
Moving direction	Z
Measuring direction	Z
Min. commanded position / mm	-1.0
Max. commanded position / mm	1.0
Measuring range / mm	2.0
Bidirectional measuring range / mm	1.8
Step size / mm	0.1
Waiting time / s	0.5
Number of repetitions	4
Data correction	Thermal drift correction is applied to the measurement data

Positioning in Z (minus end-point line), Measurement Domain 2			
M_L	Bidirectional error (mean, minus regression line)	0.3283	µm
R_fbm	Unidirectional repeatability (mean)	+/-0.0438	µm
R_fb	Unidirectional repeatability (max.)	+/-0.0966	µm
R	Bidirectional repeatability (max.)	0.1931	µm

Positioning in Z (minus regression line), Measurement Domain 2

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Physik Instrumente (PI) GmbH & Co. KG, Auf der Roemerstr. 1, 76228 Karlsruhe, Deutschland
Tel. +49 721 4846-0, Fax +49 721 4846-1019, E-Mail info@pi.de, www.pi.de

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