micromachines

Supplementary Materials

A Novel Analog Interpolation Method for Heterodyne Laser Interferometer

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Table S1. Specifications of Renishaw RLE series.

	Differential System	**Plane Mirror System**	**Retroreflector System**
Analogue output signal period	158 nm		316 nm
Digital quadrature nominal output resolutions	10, 20, 39.5, 79, 158 and 316 nm		20, 39.5, 79, 158, 316 and 633 nm
Resolution achievable with REE interpolator	0.39 nm		0.79 nm
Resolution achievable with RPI20 parallel interface	38.6 pm		77.2 pm
Maximum velocity	<1 m/s		<2 m/s

Reference: Renishaw, Data sheet L-9904-2391-04-A.

Table S2. Specifications of Renishaw REE series with the Plane mirror system.

Model	**Interpolation factor**	**Resolution (nm)**	**Max. Velocity (mm/sec)**
REE100	100	3.164	35.4
REE200	200	1.582	17.7
REE400	400	0.791	8.8

Reference: Renishaw, Data sheet L-9517-9319-01-B.

Table S3. Specifications of the commercial linear encoder.

Suppliers	Incremental Linear Encoder System	Accuracy Grade	Max. Interpolation Error	Linearity	Signal Period	Model
HEIDENHAIN	**Incremental linear measurement with very high repeatability** • Steel scale • Small signal period	± 5 μm ± 3 μm ± 3 μm ± 2 μm	± 0.04 μm		4 μm	LF 485 LF 185
	Incremental linear measurement • Glass scale	± 5 μm ± 3 μm	± 0.2 μm		20 μm	LS 487 LS 477 LS 187 LS 177
	Incremental linear measurement for large measuring lengths • Steel scale tape	± 5 μm	± 0.8 μm		40 μm	LB 382
RENISHAW	**Incremental linear encoder system : QUANTiC™**	± 5 μm ± 15 μm		± 2.5 μm ± 3 μm ± 5 μm	40 μm	RKLC40H-S RTLC40H RTLC40H-S RKLC40-S RTLC40 RTLC40-S
	Incremental linear encoder system : TONiC™	± 5 μm		± 2.5 μm	20 μm	RTLC20 RTLC20-S RKLC20-S

Reference: Heidenhain, Date sheet ID571470.
Renishaw, Website https://www.renishaw.com/en/optical-encoders-installation-guides--31030.

Table S4. Specifications of the commercial interpolators.

Supplier	AMAC ASICs		iCHaus	
Model	IPE 40	IPE 201	iC-TW28	iC-TW8
Interpolation factor	4–40	20–256	1–256	0.25–16384
Bandwidth	1.2 MHz–600 kHz	Up to 440 kHz	Up to 700 kHz	Up to 125 kHz

Reference: AMAC, Data sheet PR-46201-1-4-HB-E-IPE201 & PR-46900-HB-1-3-E-IPE40.
iCHaus, Data sheet TW8_datasheet_C3en & TW28_datasheet_D5en.

Table S5. Specifications of the commercial precision positioning machine.

Technical Data	
Measuring and positioning range	25 mm × 25 mm × 5 mm
Resolution	0.1 nm
Probe system	external analog interface for customized probe sensor system is provided
Length of the cable between measuring table and electronics unit	approx. 4 m
Dimensions (H × W × D)	
• NMM-1	340 × 420 × 420 mm (without probe sensor)
• Electronics unit	700 × 553 × 600 mm
Mass	
• NMM-1	95 kg
• Electronics unit	75 kg
Laser safety class according to EN 60825-1	2 M
ANSI Z136.1 (CDRH)	II

Reference: SIOS, Data sheet NMM-1_e_2014_Druck.indd.