Compact, High-Speed 6-DOF Photonics Alignment Systems

Single-Sided and Double-Sided, Upright and Low-Profile, Fully Automated Array Alignment Routines

F-712.Hxx

- Integrated scan/align routines for SiPh wafers, photonic devices, PICs, and fiber optics
- Powerful array alignment algorithms
- Fast, simultaneous optimization across multiple devices, I/Os, and degrees of freedom (DoF)
- Broad and deep software support for rapid process development, including support for popular languages such as C#, Python, LabVIEW, and MATLAB on Windows and Linux
- Automatic alignment in typically < 0.5 s
- Responsive application and product support from PI worldwide

Problem solved

PI's Fast Multi-Channel Photonics Alignment (FMPA) solutions combine application-optimized, fab-ready, highly dynamic alignment stages with sophisticated controllers that integrate the world's most advanced and effective first-light search, profile, and power optimization alignment algorithms.

Reduction of alignment time by 99 %

This award-winning technology addresses the number one cost driver for photonics test and assembly: the precise alignment required for each element and channel. Legacy alignment technologies date back to the 1980s and can take minutes to complete. PI's fast optical alignment solutions reduce the time required by typically 99 %, routinely completing the task in less than one second. With studies indicating that on the order of 80 % of the cost of a photonic device is consumed in the alignment prior to FMPA, it is easy to see how profound the production economics benefit from reducing that 80 % by 99 %. And with projections of three orders of magnitude escalation in demand for photonic components in the near future, as new applications and devices emerge, FMPA is a true enabler.

Versatile, compact, proven solutions for 6-DoF alignment challenges

These integrated solutions combine PI's premier compact hexapod with a highly dynamic, ultra-resolution NanoCube® fast piezo scanning stage to provide 6-DoF positioning, scanning, and optimization. Since their introduction in 2016, these unique microrobotic solutions have enabled a variety of applications ranging from silicon photonics wafer probing to array alignment and automated photonics device assembly and are the first choice of many elite OEMs and in-house integration teams. The applications are complex, but the reasons for the choice are simple: groundbreaking alignment speed that improves production throughput by two orders of magnitude, an easy-to-master command set complemented by broad and deep software support, and global application expertise and support.

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Synergies for higher performance

The combined hexapod and NanoCube® mechanisms operate synergistically to enable simultaneous optimization across multiple channels, I/Os, and DoF, with parallel optimization across all DoF and I/Os. For example, the NanoCube® offers extreme speed and long life through flexure guides and PICMA piezo drives, while the hexapod offers generous travel that includes pitch-yaw-roll positioning and alignment optimization important for arrayed waveguides, etc. High-resolution analog inputs provide connectivity to power measurement devices, such as PI's F-712.PM1 high-bandwidth optical power meter, for optimization and profiling, enabling efficient and fast automated fiber optical alignment. Soft limits are supported to ensure process safety.

Low profile and upright configurations

PI's 6-DOF fiber alignment systems include the F-712.HA1, F-712.HA2, and F-712.HU1 standard configurations.
The F-712.HA1 and F-712.HA2 single-sided and double-sided angled configurations offer a low profile. This means that the alignment can be performed close to (or even under) the mounting surface thanks to the hexapod's angled mounting. Ideal for silicon photonics wafer probing applications.
The F-712.HU1 single-sided upright configuration is ideal for device characterization and packaging processes. Upright configurations for two or even more sides are available on request.
Starting with these sophisticated platforms, it is easy to configure further alignment solutions of unprecedented speed that support functionalities such as submicron-sensitive wafer proximity automation.

Application fields

PIC production, alignment of fiber arrays, collimators, optical components or lenses, silicon photonics wafer probing, testing, assembly, and packaging of photonics and fiber optics

Specifications

Motion and positioning	F-712.HA1	F-712.HA2	F-712.HU1	Unit
Number of active axes	9	18	9	
Rough positioning				
Active axes	X, Y, Z, θ_X, θ_Y, θ_Z			
Travel range in X, Y, Z	±6,5, ±16, ±8,5		±17, ±16, ±6,5	mm
Travel range in θ_X, θ_Y, θ_Z	±14,5, ±10, ±10		±10, ±10, ±21	°
Minimum incremental motion in X, Y	0.1			µm
Minimum incremental motion in Z	0.1		0.05	
Max. velocity	10			mm/s
Sensor type	Incremental rotary encoder			
Drive type	Brushless DC motor			
Fine positioning				
Active axes	X, Y, Z			
Travel range in X, Y, Z, closed loop	100			µm
Min. incremental motion, open-loop	0.3			nm
Min. incremental motion, closed-loop	2.5			nm
Linearity error, for the entire travel range*	2			%
Repeatability (bidirectional) 10% travel range	2			nm
Sensor type	Incremental linear encoder			
Drive type	PICMA®			

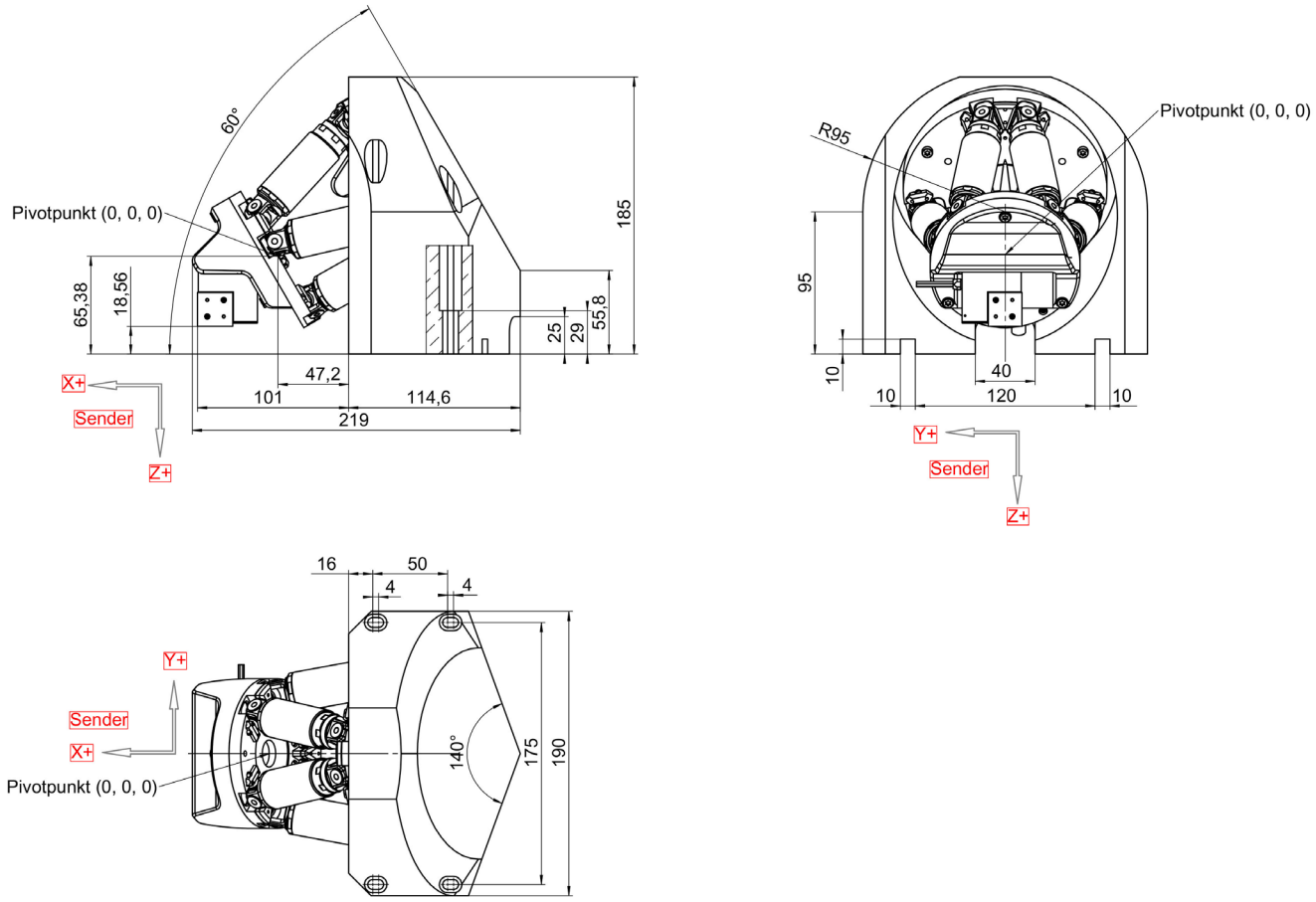
Motion and positioning	F-712.HA1	F-712.HA2	F-712.HU1	Unit
Alignment				
Scanning time of spiraled area scan 500 µm Ø**	< 2	< 5	< 2	s
Scanning time of spiraled area scan 100 µm Ø**	< 0.3	< 1	< 0.3	s
Scanning time of spiraled area scan 10 µm Ø**	< 0.2	< 0.5	< 0.2	s
Signal optimization with gradient search, randomized with ±5 µm (repeatability < 0.01 dB)***	< 0.3			s

Miscellaneous	F-712.HA1	F-712.HA2	F-712.HU1	Unit
Operating temperature range, mechanics	0 to 50			°C
Operating temperature range, controller	5 to 40			°C
Cable length	2			m

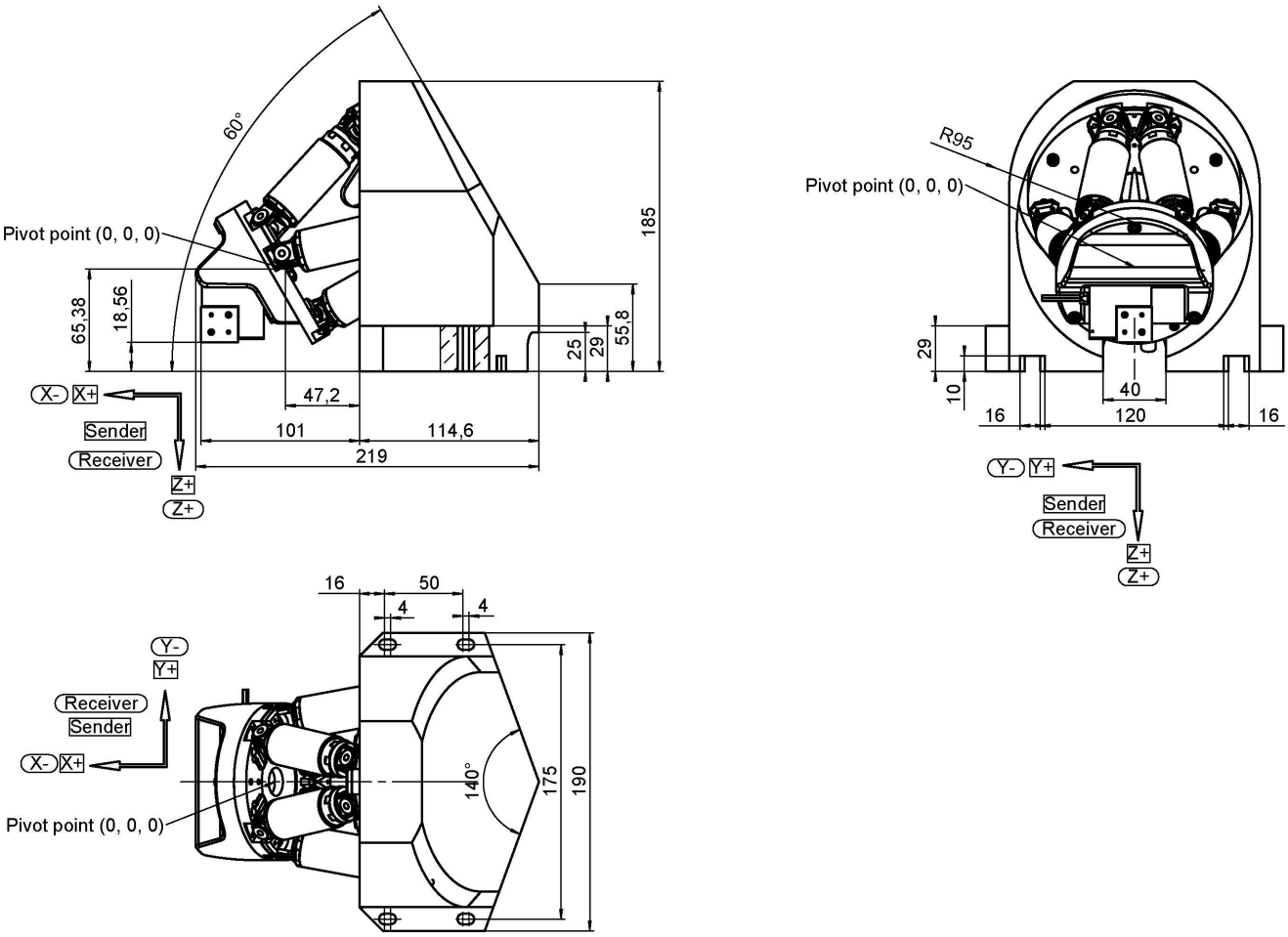
Requirements for the optical power meter		Unit
Output signal	Analog output, ideally converted from linear to logarithmic	
Output voltage range, max.	-5 to 5	V
Bandwidth, min.	1	kHz
Noise level, max.	-60	dBm

* without polynomial linearization
** typical time span for scanning the entire area and moving to the highest intensity
*** reaching the global maximum after first light has been found
When measuring position specifications, typical velocity is used. The data is included in the delivery of the product in the form of a measurement report and is stored at PI.
The maximum travel ranges of the individual coordinates (X, Y, Z, θX, θY, θZ) are interdependent. The data for each axis shows its maximum travel range when all other axes are in the zero position of the nominal travel range and the default coordinate system is in use, or rather when the pivot point is set to 0,0,0.
See the dimensional drawings for the default coordinate system and pivot point coordinates of the hexapod. Changing the pivot point will reduce the travel range in θ_X, θ_Y, θ_Z. Changing the orientation of the coordinate system (e.g., when the optical axis is to be the Z axis), will change the travel range in X, Y, and Z.
At PI, technical data is specified at 22 ±3 °C. Unless otherwise stated, the values are for unloaded conditions. Some properties are interdependent. The designation "typ." indicates a statistical average for a property; it does not indicate a guaranteed value for every product supplied. During the final inspection of a product, only selected properties are analyzed, not all. Please note that some product characteristics may deteriorate with increasing operating time.
Ask about customized versions.

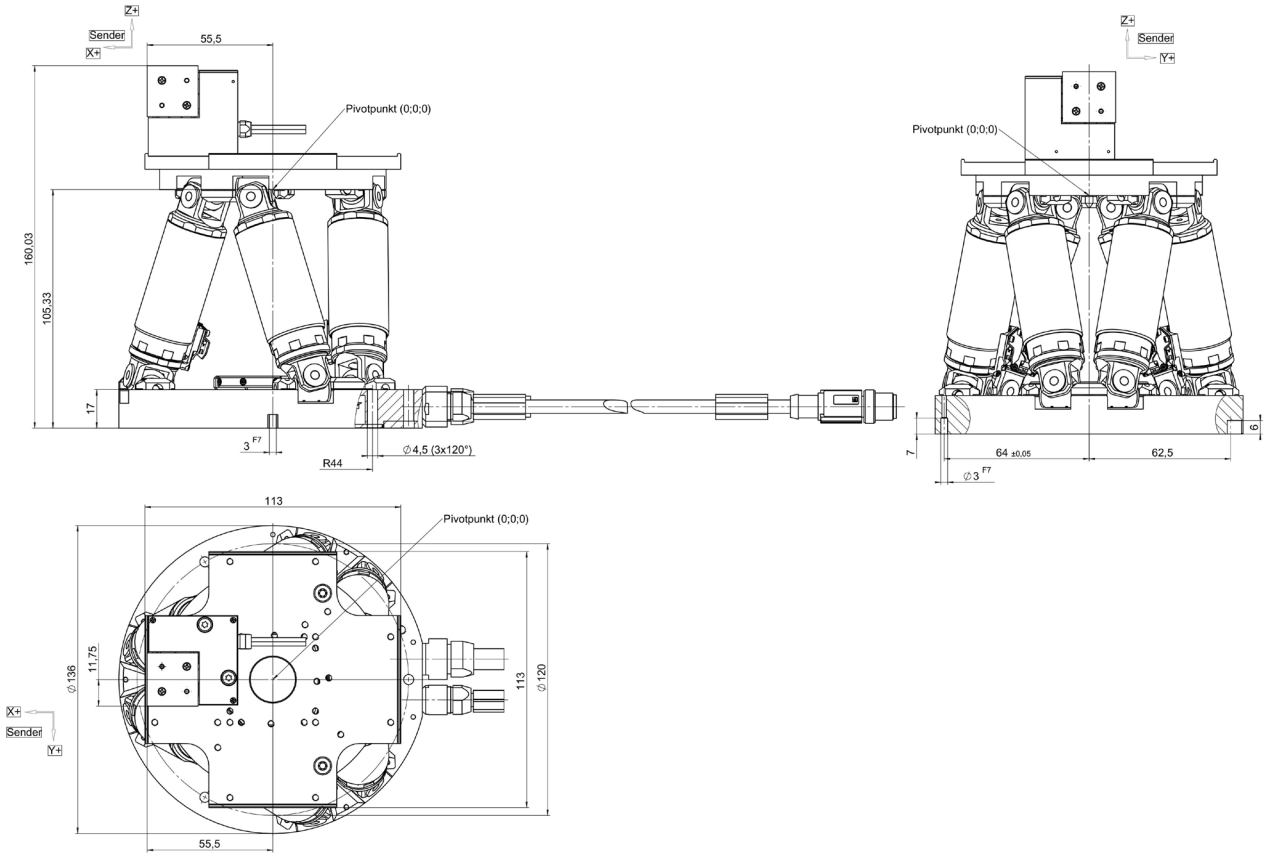
Drawings / Images



F-712.HA1, dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

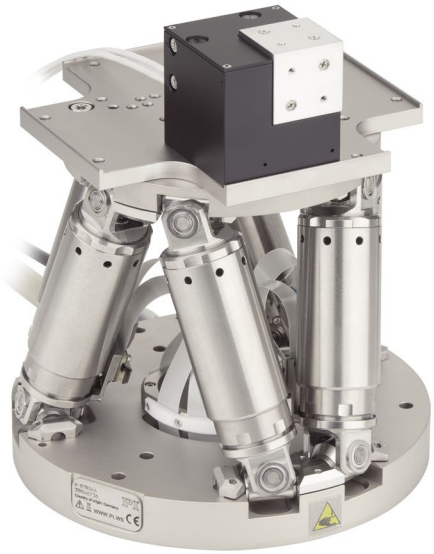


F-712.HA2, dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.



F-712.HU1, dimensions in mm. Note that a comma is used in the drawings instead of a decimal point.

F-712.HA1



F-712.HU1

Ordering Information

F-712.HA1
Single-sided photonics alignment system with H-811 hexapod and NanoCube® Nanopositioner, E-712 digital controller with 4 analog inputs, C-887 Hexapod Motion Controller with 2 analog inputs, firmware routines for extremely fast alignment functions, software package

F-712.HA2
Double-sided photonics alignment system with two H-811 hexapods and two NanoCube® Nanopositioners, E-712 digital controller with 4 analog inputs, two C-887 hexapod motion controllers with 2 analog inputs each, firmware routines for extremely fast alignment functions, software package

F-712.HU1
Single-sided photonics alignment system with H-811 hexapod and NanoCube® Nanopositioner, upright configuration, E-712 digital controller with 4 analog inputs, C-887 hexapod motion controller with 2 analog inputs, firmware routines for extremely fast alignment functions, software package