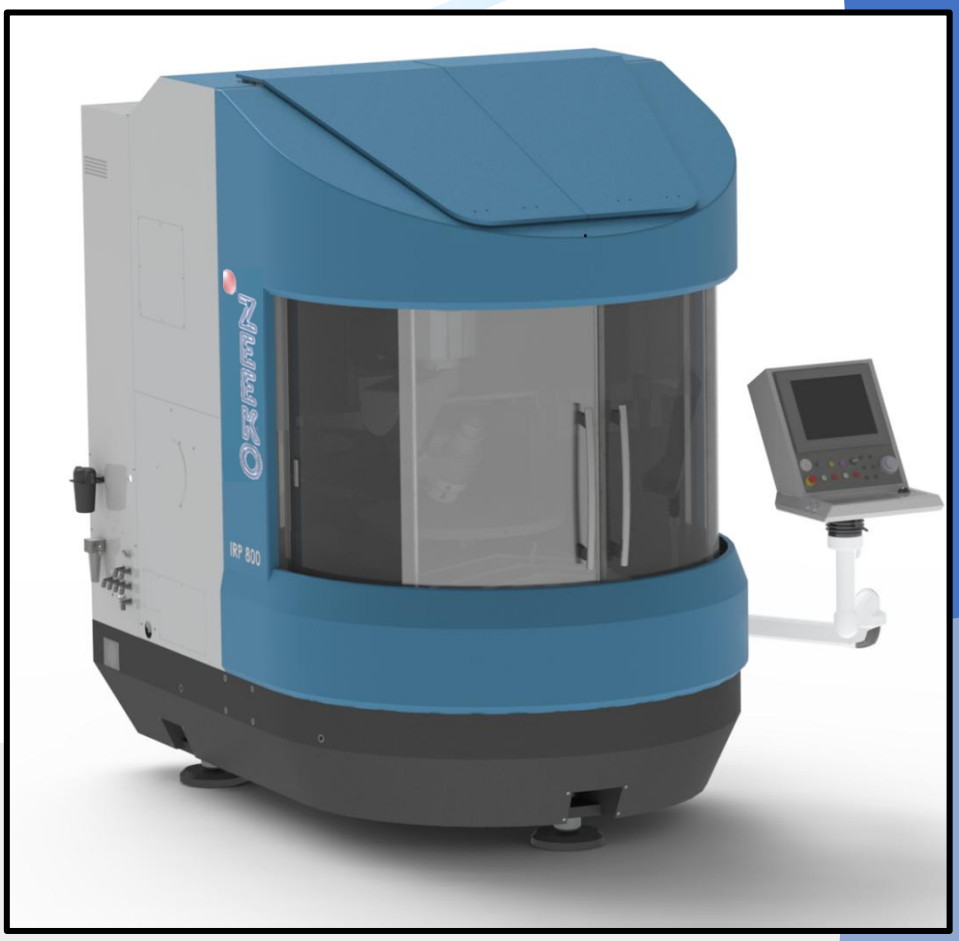
ZEEKO

Specification & Utilities Manual



IRP800 FL 7-axis

Version 2, Rev d

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Contents

Liability Statement

Zeeko (hereinafter referred to as “the Manufacturer”) warrants that the CNC machines are free from defects in materials and workmanship for a period of one year from the date of delivery. The Manufacturer will repair or replace, at its option, any defective CNC machine or part thereof, provided that the CNC machine is returned to the Manufacturer, or an authorized service engineer site visit is arranged, within the warranty period.

This warranty does not cover normal wear and tear, damage caused by improper installation, operation, maintenance, or modification, or any damage resulting from misuse, abuse, negligence, accident, or natural causes.

The Manufacturer’s liability under this warranty is limited to the repair or replacement of the defective CNC machine or part thereof, and does not include any incidental or consequential damages, such as loss of profits, loss of production, loss of data, or injury to persons or property. The Manufacturer disclaims any implied warranties of merchantability or fitness for a particular purpose, and any other warranties not expressly stated herein.

The Manufacturer is not liable for any direct, indirect, incidental, or consequential damages arising from the use or inability to use the CNC machines, whether based on contract, tort, or any other legal theory, even if the Manufacturer has been advised of the possibility of such damages. The Manufacturer’s maximum liability under any circumstances shall not exceed the purchase price of the CNC machine.

Some jurisdictions do not allow the exclusion or limitation of certain warranties or damages, so some of the above exclusions or limitations may not apply to you. This liability statement gives you specific legal rights, and you may also have other rights that vary from jurisdiction to jurisdiction.

By purchasing, installing, operating, or using the CNC machines, you agree to be bound by the terms and conditions of this liability statement. If you do not agree with this liability statement, do not purchase, install, operate, or use the CNC machines.

Machine description

The IRP800 is a 7-axis CNC polishing/form generating machine capable of producing ultra-precision surfaces on a wide range of materials and surface forms.

The machine includes an option for roof doors in order that an optical test tower with a tower-mounted interferometer can provide an uninterrupted clear aperture view of the workpiece on the rotary table.

Machine dimensions: (without accessories)

- Size: 2070 mm wide x 2700 mm deep x 2850 mm high.
- Mass: 8500 kg.

Arrangement of the axes

The arrangement and definition of the 7 CNC axes is as follows:

- X is a linear axis which mounts horizontally to the polymer-granite bridge.
- Y is a linear axis which mounts horizontally to the polymer-granite base and is aligned perpendicular to the X-axis.
- Z is a linear axis which mounts vertically from the X-axis and is aligned perpendicular to both the X and Y-axes.
- C is a rotational axis that holds the workpiece. It is mounted vertically to the Y-axis
- A, B and H are rotational axes configured such that the spherical polishing tool, mounted on the H-axis, rotates about a point in space called the virtual pivot point (VP). This 3-axis assembly mounts to the Z-axis.

Polymer granite machine base and bridge

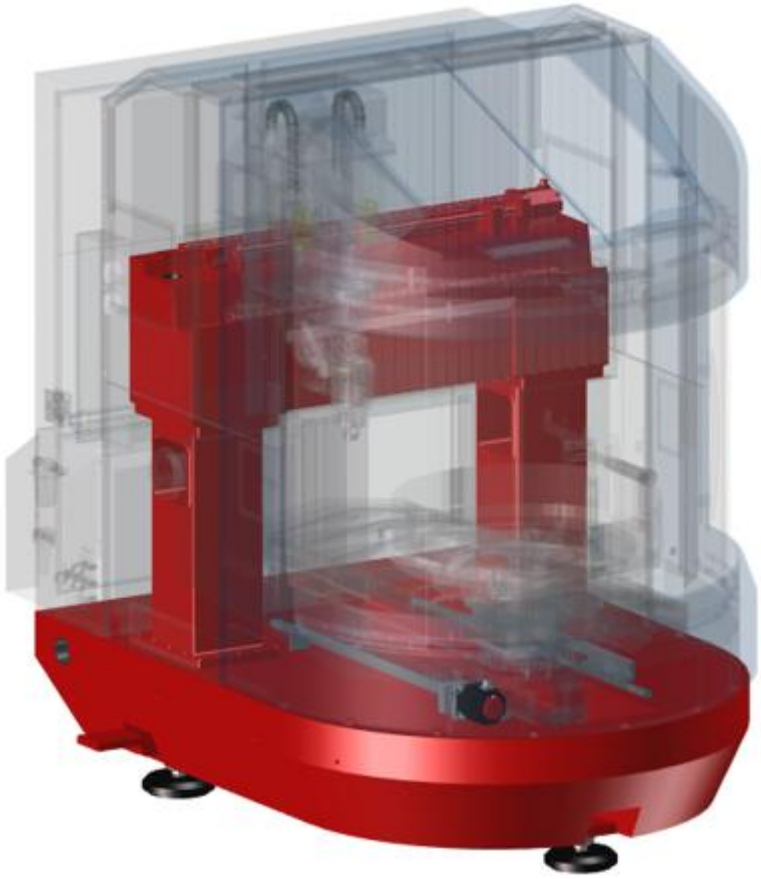


Figure 1

The machine base and bridge are precision cast and machined epoxy-granite composite structures that provide excellent thermal stability and vibration damping characteristics. These two key machine elements incorporate the following features:

- Moulded-in stainless steel inserts for mounting and alignment of the X and Y axes, machine lifting, handling, and transportation.
- Threaded stainless steel inserts for mounting the polishing and electrical enclosures.
- Moulded-in feeds for electrical supply and control cables, compressed air, and slurry supply and return.

Linear axes

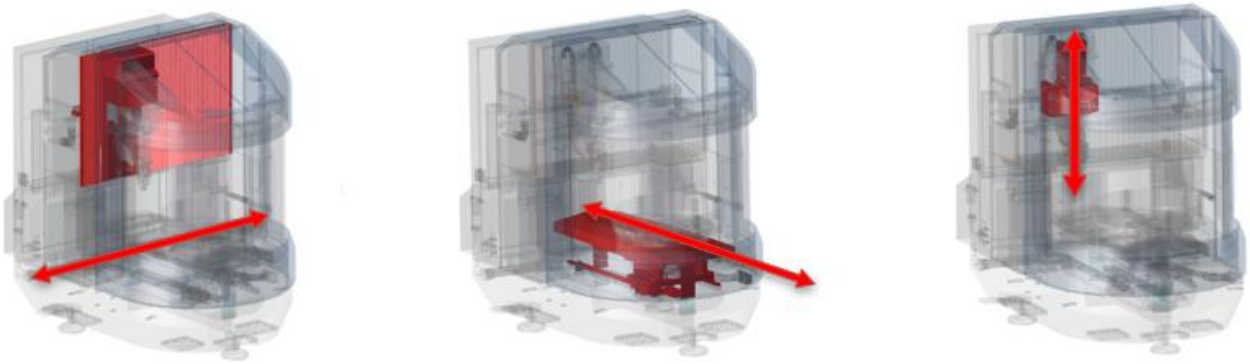


Figure 2

Each linear axis, X, Y & Z, is mounted on a pair of precision linear motion rails with position monitored by precision linear scale encoders.

X and Y axes

The X and Y axes are driven by Fanuc linear motors.

- Slide type: Precision linear motion rails.
- Travel (X-axis): ± 475 mm.
- Travel (Y-axis): ± 475 mm.
- Drive system: Fanuc Linear Motor.
- Positioning feed-back: Precision linear scale encoder.
- Max velocity: 3000 mm/min.

Z-axis

The Z-axis is aligned with the gravitational vector and is driven by a conventional AC servo motor coupled to a precision C5-grade ballscrew.

- Slide type: Precision linear motion rails.
- Travel (Z-axis): - 395 / +5 mm.
- Drive system: AC servo driven precision ballscrew.
- Positioning feed-back: Fanuc motor mounted rotary encoder.
- Positioning Feed-back: Precision linear scale encoder.
- Max velocity: 3000 mm/min.

Rotary axes and spindles

The A, B & H axes provide the primary tool motions and are often referred to as the Virtual Pivot (VP). The VP is mounted directly to the Z-axis carriage.

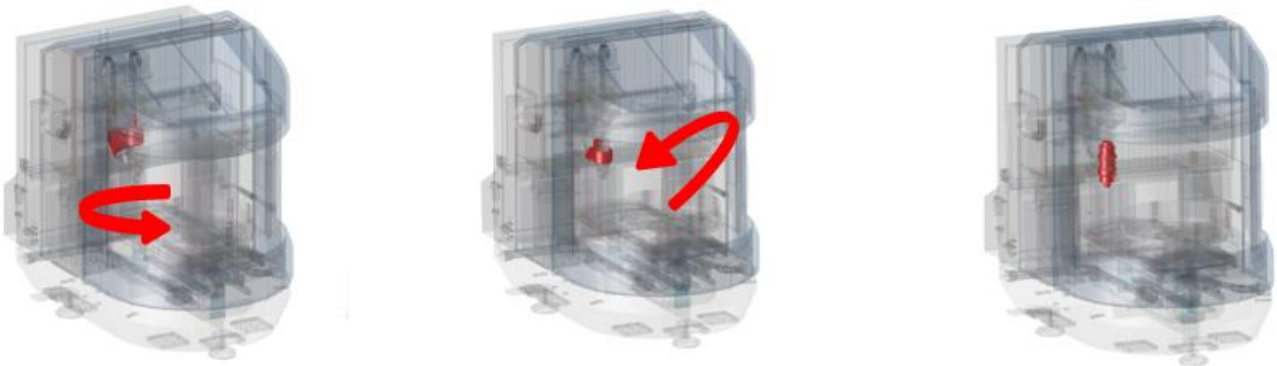


Figure 3

The A-axis is mounted to the Z-axis via an AC servo Harmonic Drive unit with enhanced radial stiffness. Referencing of the position is via a non-contact referencing element. Referencing is only required following power up of the machine.

- Rotational Range: ± 270 °.
- Max Rotational Velocity: 25 rpm.

The B-axis is mounted to the A-axis via AC servo Harmonic Drive unit. Referencing of the position is via a non-contact referencing element. Referencing is only required following power up of the machine.

- Rotational Range: ± 180 °.
- Max Rotational Velocity: 25 rpm.

The H-axis forms the tool holding spindle and is mounted to the A/B axes and completes the virtual pivot assembly. Drive is provided via a AC frameless motor with position feedback from a rotary encoder. The spindle is cooled by an external chiller system. Tooling mounts via a Ø25 mm hydraulic chuck. The H-axis also integrates a load cell arrangement to facilitate part probing essential for process stability and part/machine referencing.

- Speed Range: 10 to 2000.
- Polishing Head radii: R20, R40, R80, R160.

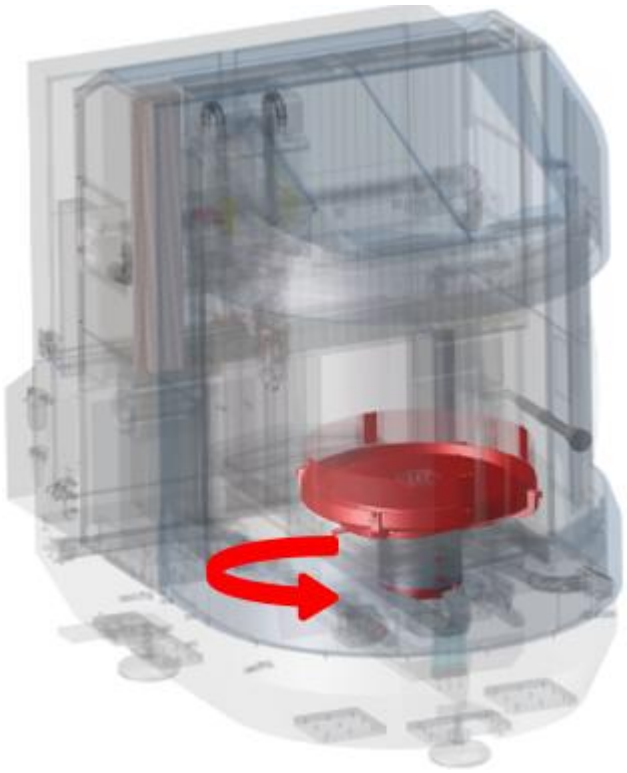


Figure 4

The C-axis forms the work piece mounting spindle and is mounted to the Y-axis. The axis consists of rolling element bearings driven by a brushless AC servo motor, with positional feedback provided by a precision absolute encoder. The spindle is cooled by external chiller system.

The Spindle is supplied with a Ø900 mm turntable and / or Ø40 mm hydroexpansion chuck for work piece mounting.

- Speed Range: 0 to 250 rpm.
- Max Load Capacity: 300 kg.
- Vacuum (Optional): -0.8 bar maximum.

Machine enclosures

The Machine enclosures are provided as follows:

- Stainless steel polishing enclosure (coated internal surfaces for improved runoff)
- Slurry return drains to an outlet on the side of the machine enclosure.
- Slide protection for the X, Y, and Z axes.
- Isolated machine electrical and pneumatic systems.
- Maintenance access to X, Y, and Z axes.

Control system

Figure 5

Zeeko Fanuc (30i-B) System

- Industrial PC:
  - Panel iH Pro – Windows 10 IOT Enterprise LTSC 2016/2019 edition
  - 15” Touch Colour LCD Screen
- 5-axes interpolation (export controlled) with cubic, polynomial, and B-spline (NURBS) capability.
- Designation of control paths: 1 path.
- Least command Increment: 1 µm.
- Data Server option for up to 4 GB NC programs,

Guards, covers and safety features

The equipment specified herein shall conform to requirements of EC and international safety regulations as required by current legislation.

Cover and guards will be provided to protect the operator from:

- Moving machine parts.
- Slurry and spray.

Covers will also protect machine elements from:

- Slurry and fluids.
- Airborne dust and debris.

Electrical interlocks will prevent opening of:

- The polishing enclosure door when the machine is in cycle.
- Electrical cabinet when the machine is energised.

An emergency stop button readily accessible to the machine operator.

Electrical specification

Power supply

The machine is designed for operation on 3-phase, 4 wire systems (i.e. 3 phases + Earth). The machine can accept the following mains voltage:

- 3 Phase + E, 400 V 50/60 *Hz +/- 5%
- 13 kVA (customer must supply a transformer or power supply to meet this specification)

WARNING: *The machinery must only be plugged into a socket which has a protective earthed conductor. The primary side must match the incoming customer supply voltage. If a supply transformer is required, the secondary voltage supply to the machine must match the machine voltage specification.*

Compressed air

The IRP machine operates with compressed air to fulfil the following functions:

- Air purges to axes and joints exposed to polishing slurries
- Precision linear scale encoder air purges
- Bonnet (polishing tool) air pressure
- Vacuum systems for vacuum work holding where fitted (chucks)
- Pneumatic systems for the control of fluid systems

Description	Pressure
Minimum input pressure	6 bar
Maximum input pressure	8 bar
Volumetric requirement	350 l / min (air purges to max.).

NOTE: *Mist separators are fitted internally to all machines.*

Environmental specification

The IRP 800 must be installed inside a room with the following characteristics:

Temperature and humidity

Temperature and humidity	
Mandatory operating temperature	20 °C +/- 1.0 °C
Maximum operating humidity	75 % RH, non-condensing
Storage temperature	-15 to +50 °C
Maximum storage humidity	80 % non-condensing
Maximum temperature gradient	<2 °C / hour

Cleanliness

The IRP machines do not require siting in an ISO class cleanroom. However, we recommend that the machine is sited in a separate room to:

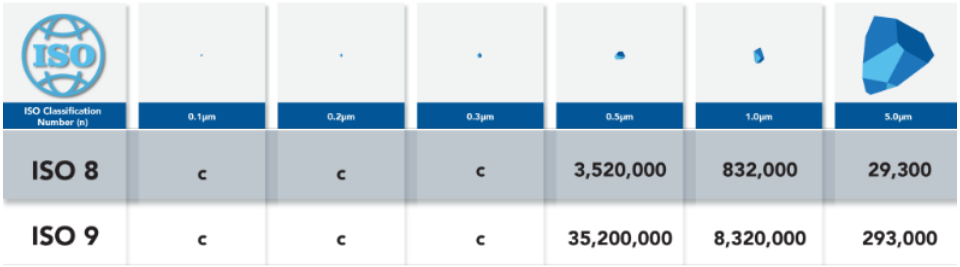
- Rooms containing conventional milling and grinding machines
- Rooms containing diamond turning machines
- Rooms subject to metal swarf or grinding dust
- Rooms subject to any other processes that generate airborne particulate matter

The room should be clean, but not necessarily a clean-room as classified by ISO. IRP machines typically use Cerium Oxide slurry as the polishing medium and when this dries on surfaces, it can produce a dust which would be classed as a contaminant in ISO-class cleanrooms. It is for this reason we recommend that if you require the rooms to be clean, you adhere to practices for cleanrooms of ISO class 8 or 9, but without the rigorous filtering required. The resulting air changes and also cleanliness protocols will ensure a room that is clean to a very high standard.

NOTE: *A cleanroom classification basically tells you how clean a cleanroom is. While we typically consider cleanrooms to use HEPA filters and multiple layers of protection, cleanrooms can really be any room where precautions are taken to ensure that the product stays clean from contaminants.*

There are 9 ISO classifications of cleanrooms:

- ISO 1
- ISO 2
- ISO 3 (FS 209 E class 1 equivalent)
- ISO 4 (FS 209 E class 10 equivalent)
- ISO 5 (FS 209 E class 100 equivalent)
- ISO 6 (FS 209 E class 1,000 equivalent)
- ISO 7 (FS 209 E class 10,000 equivalent)
- ISO 8 (FS 209 E class 100,000 equivalent)
- ISO 9 (room air)



ISO Classification Number (n)	0.1µm	0.2µm	0.3µm	0.5µm	1.0µm	5.0µm
ISO 8	c	c	c	3,520,000	832,000	29,300
ISO 9	c	c	c	35,200,000	8,320,000	293,000

Room vibration requirements

Each IRP machine is equipped with passive vibration isolation feet. The IRP800 is no different in this respect. To ensure best results, we recommend a vibration environment corresponding to:

- Residential day (ISO) 200 75 barely feelable vibration.

ZeekoJet polishing (Option)

H-axis is a ‘combo head’ capable of Classic polishing and additionally, optional fluid Jet Polishing (FJP) or Ultra-sonic Fluid Jet Polishing (UFJP). (U)FJP specification is as follows:

- Bonnet and hydraulic chuck are removed and optional FJP adaptor is assembled. Adaptor has removable probe for probing routines (UFJP is mounted to the side of the B-axis arm and does not pass through the H-Axis)
- Nozzle bore range available: 0.25, 0.5, 1.0 mm.
- Maximum rated pressure is 20 bar.

Summary specification

General

General	Description
System Configuration	7-xis CNC Optical Polishing Machine constructed on Polymer Granite Machine Base and Bridge, capable of producing ultra-precise surfaces on a variety of optical materials and surface forms.
Workpiece Capacity (1)	Nominal polishing envelope of 800 mm x 800 mm x 350 mm
Base Structure	Polymer Quartzite
Control System	Fanuc
Dimensions (No Accessories) W x D x H	2070 mm x 2700 mm x 2850 mm
Suggested Install Dimensions	4450 mm x 4350 mm x 3850 mm
Weight	8500 Kg
Floor Load Requirements	Minimum point loading 85,000 Kg/m^2 Floor must be even to < 3 mm/m^2
Environmental Requirements **Min/Max Operating Temp.** **Max Operating Humidity** **Min/Max Storage Temp.** **Max Storage Humidity**	 20 °C +/– 1 °C (< 2 °C/hour Temperature Gradient) 75 % RH Non Condensing -15 °C – 50 °C 80 % RH Non Condensing
Power Supply Requirements	3 Phase + E, 400 V +/- 5 % 50/60Hz. 13 kVA (customer must supply a transformer or power supply to meet this specification)
Services Requirements	Clean dry air at 350 L/min with minimum pressure of 6 bar
Noise Level	< 50 dB(A) Continuous
Safety	In accordance with EC Directives 2006/42/EC, 2004/108/EC (EMC) and 2006/95/CE (Low Voltage), Machinery Directives 2006/42/EC

Linear axes

Description	X	Y	Z
Slide Type	Precision Linear Rails	Precision Linear Rails	Precision Linear Rails
Drive type	Fanuc AC linear servo motor	Fanuc AC linear servo motor	AC Servo driven precision grade-C5 ballscrew
Feedback Type	Precision linear scale encoder	Precision linear scale encoder	Motor-mounted position encoder and Precision linear scale encoder
Travel	± 475 mm	± 475 mm	- 395 mm / + 5 mm Max VP to Turntable Throat= 457 ±5 mm Min VP to Turntable Throat= 51 ±5 mm
Max Velocity	3000 mm/min	3000 mm/min	3000 mm/min
Max Acceleration	250 mm/sec^2	250 mm/sec^2	250 mm/sec^2
Positioning Accuracy	< 50 µm over full travel	< 50 µm over full travel	< 50 µm over full travel
Bi-direction Repeatability	< 5 µm	< 5 µm	< 5 µm
Straightness: **Horizontal:** **Vertical:**	 < 30 µm over full travel < 5 µm over 100 mm	 < 30 µm over full travel < 5 µm over 100 mm	 < 30 µm over full travel < 5 µm over 100 mm
Squareness	< 50 µ/m	< 50 µ/m	< 50 µ/m
Circularity	< 50 µm	< 50 µm	< 50 µm

Rotary axes

Rotary Axes	A	B	H (Tool)	C (Workpiece)
Mounting	Z-axis carriage	A Axis Arm	Virtual Pivot Assembly	Base
Spindle/Axis	Axis	Axis	Spindle	Spindle & Axis
Cooled	Not required	Not required	Yes	Yes
Integral Services	N/A	N/A	Air (STD) / (U)FJP (Optional)	Vacuum (Optional)
Drive	Harmonic Drive Direct Drive	Harmonic Drive Direct Drive	AC Frameless Direct Drive	AC Frameless Direct Drive
Feedback Type	Motor Encoder	Motor Encoder	Rotary Encoder, 5000 lines/min	Absolute Encoder
Speed Range	0-25 rpm	0-25 rpm	10-2000 rpm	250 rpm
Load Capacity **Maximum Inertial Load[1]**	N/A	N/A	N/A	300 Kg 2.0Kg*m^2@20rad/s^2
Positional Repeatability @ Motor	± 1 arcmin	± 1 arcmin	-	± 1 arcmin
Working Range	+/- 270 °	+/- 180 °	Continuous-bi-directional	Continuous-bi-directional
Radial Run-Out	Rotation of VP Setting ball mounted in H axis Chuck and rotated about the Virtual Pivot < 50 µm		< 5 µm	< 20 µm
Axial Run-out			< 10 µm	< 20 µm

[1] Maximum Inertial load in standard configuration. Variations may be possible with servo retuning – contact Zeeko for advice.

Contact

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