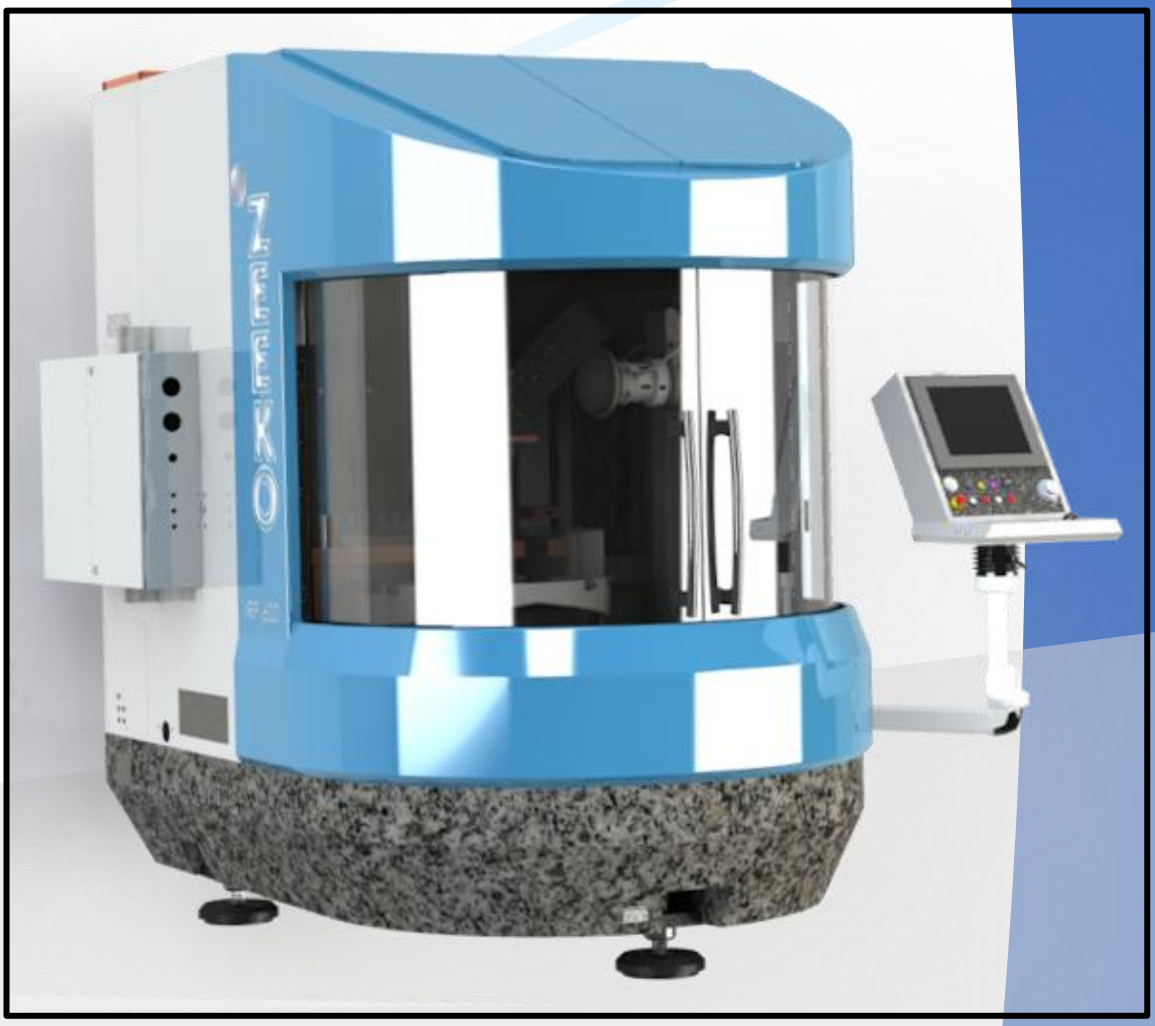
ZEEKO

Specification & Utilities Manual



IRP600 FL 7-axis

Version 2, Rev c

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Contents

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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.

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Machine Description

The IRP600 is a 7-axis CNC optical polishing/form generating machine capable of producing ultra-precise surfaces on a wide range of materials and surface forms. The machine axes can be used for traditional spiral, raster, and free-form polishing.

- Mass = 9000 Kg.
- Dimensions = 2100 x 2700 x 2800 (W x D x H mm).

The machine frame, composed of epoxy-granite and welded steel structure, incorporates the following features:

- 3-point floor mounting.
- Integrated electrical and pneumatics enclosures.
- 3-point mounting for polymer-granite base.

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. The X-axis carriage is a precision machined stainless steel structure.
- Y is a linear axis, precision machined stainless steel structure, mounted on the polymer-granite base and aligned perpendicular to the X-axis.
- Z is a linear axis, precision machined stainless steel structure, mounted vertically on the Y axis and is aligned perpendicular to both the X and Y axes.
- C is a rotational axis that holds the work piece. It is mounted on the Z-axis.
- A, B and H are rotational axes configured such that the polishing head (H-axis) rotates through a point in space call the Virtual Pivot (VP). This 3-axis assembly mounts on the X-axis.

Polymer granite machine base and bridge

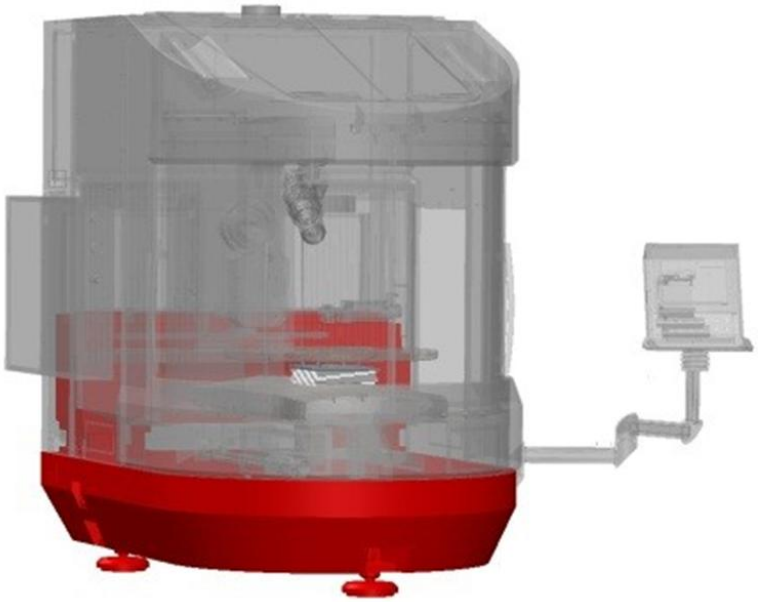

Figure 1

The machine base and bridge are precision cast and machined polymer-granite composite structures that provide excellent thermal stability and vibration damping characteristics. This key machine element incorporates the following features:

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

Linear axes

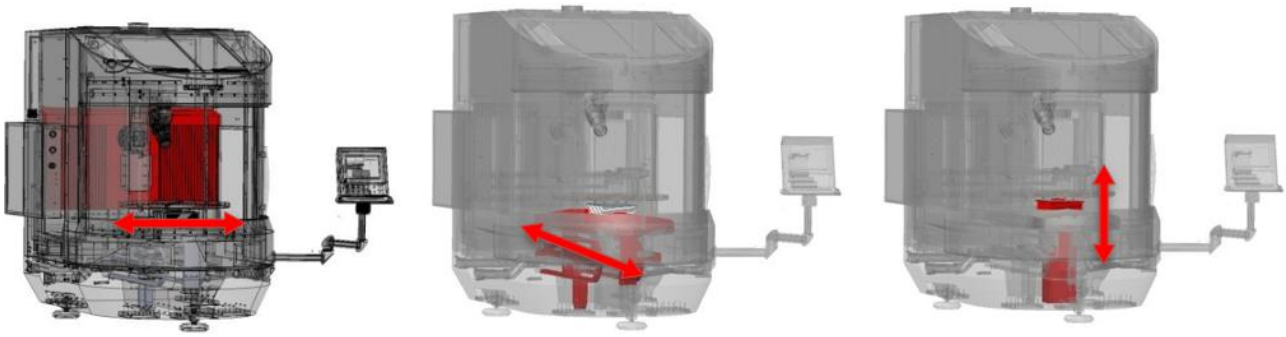

Figure 2

Each linear axis, X, Y & Z, is mounted on a pair of precision linear motion rails with position monitored by glass scale absolute 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): > ± 350 mm.
- Travel (Y-axis) > ± 340 mm.
- Drive system: Fanuc Linear Motor.
- Positioning feed-back: Precision linear glass 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) 500 mm.
- Drive system: AC servo driven precision ballscrew.
- Positioning feed-back: Fanuc motor mounted rotary encoder AND precision linear glass scale encoder.
- Max velocity: 3000 mm/min.

Rotary axis 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 to the X-Axis carriage.

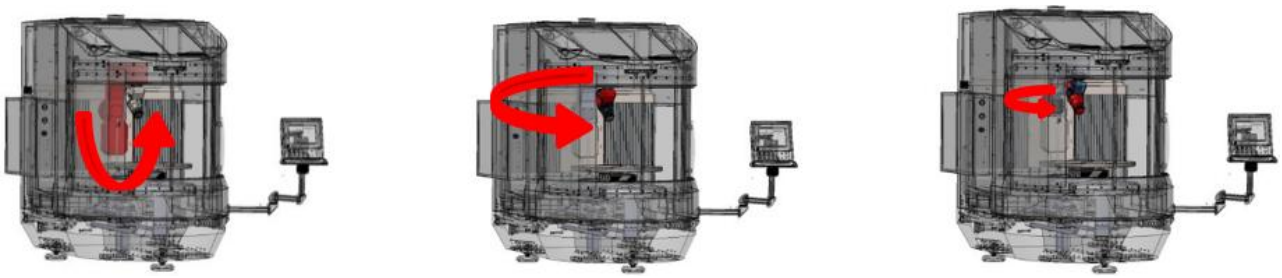

Figure 3

The A-axis is mounted to the X-axis via an AC servo drive 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: -90 ° to + 45 °.
- Max Rotational Velocity: 25 rpm.

The B-axis is mounted to the A-axis via AC servo driven 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 DC frameless motor with position feedback from a rotary encoder. 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.

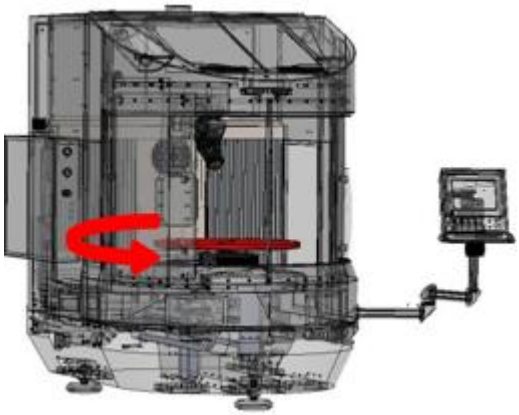

Figure 4

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

The spindle is supplied with a Ø700 mm turntable and Ø40 mm hydrodehn chuck for work piece mounting.

- Speed Range: 0 to 250 rpm with turntable.
- Max Load Capacity: 200 kg.
- Vacuum (Optional): -0.8 bar maximum.

Machine enclosures

The Machine enclosures are provided as follows:

- Uncoated stainless steel polishing enclosure (internal surfaces).
- Slurry return drain passing through the granite base.
- 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 with 15” Touch Colour LCD Screen with Softkeys.
- 5-axes interpolation (export controlled) with cubic, polynomial, and B-spline (NURBS) capability.
- Designation of control paths: 1 path.
- Least command Increment: 1 µm.
- Processor: Panel *i* - Windows embedded Standard 7 OS (Zeeko reserves the right to ship Win XP, 7 or 10).
- 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.

Peristaltic pump system (Option)

The Zeeko mounted peristaltic slurry delivery system can be used to supply polishing slurry in either a closed loop or open loop, total loss system.

High flow rate Pump specification (recirculating or total loss):

- Flow rate:
  - Min flow rate: 75 ml/min.
  - Max flow rate: 280 ml/min.
- Reservoir capacity: 1 litre.
- Tube Type: Ø4.8 mm Masterflex PharMed BPT Long life, high acid/alkali resistance.
- Agitation method: Magnetic stirrer.

Low flow rate pump specification (recirculating or total loss):

- Flow rate:
  - Min flow rate: 8 ml/min.
  - Max flow rate: 30 ml/min
  - Reservoir capacity: 1 litre
- Tube Type: Ø1.6 mm Masterflex PharMed BPT Long life, high acid/alkali resistance.
- Agitation method: Magnetic stirrer.

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 +/- 5 % 50/60Hz.
- Recommend 400 VAC, 50/60Hz 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.*

WARNING: *If the mains voltage supply is not the same as that specified on the machine rating plate, the transformer tappings (if applicable) must be interchanged to correspond with the existing mains voltage.* ***This MUST only be performed by qualified personnel.***

Compressed air

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

- Air purges to axes and joints exposed to polishing slurries
- Glass-scale linear encoder air purges
- Bonnet (polishing tool) air pressure
- Vacuum systems for vacuum workholding 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	300 l / min (air purges to max.).

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

Environmental specification

The IRP 600 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 IRP600 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 Fluid Jet Polishing (FJP). FJP specification is as follows:

- Bonnet and hydraulic chuck are removed and optional FJP adaptor is assembled. Adaptor has removable probe for probing routines.
- Nozzle bore range available: 0.25, 0.5, 1.0, 1.5 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.
Work piece Capacity (1)	Nominal polishing envelope of 600 x 600 x 250 mm
Base Structure	Polymer Granite
Control System	Fanuc
Dimensions (No Accessories) W x D x H	2100 mm x 2700 mm x 2800 mm
Suggested Install Dimensions	4100 mm x 4700 mm x 4300 mm
Weight	9000Kg
Floor Load Requirements	Minimum point loading 165,000 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. Recommend 400 VAC, 50/60Hz 13 kVA (customer must supply a transformer or power supply to meet this specification)
Services Requirements	Clean dry air at 250 L/min with minimum pressure of 6 bar (300 L/min with linear encoders)
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)

Linear axes

Description	X	Y	Z
Slide Type	Precision Linear Motion Rails	Precision Linear Motion Rails	Precision Linear Motion Rails
Drive type	Fanuc AC linear servo motor	Fanuc AC linear servo motor	AC Servo driven precision grade-C5 ballscrew
Feedback Type	Glass scale absolute linear encoder	Glass scale absolute linear encoder	Motor-mounted position encoder and glass scale absolute linear encoder
Travel	> ± 350 mm	> ± 340 mm	+ 5 mm , -495 mm Max VP – Turntable Distance = (590) mm Min VP – Turntable Distance = (90) 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	X Axis Carriage	A Axis Arm	Virtual Pivot Assembly	Z Axis Carriage
Spindle/Axis	Axis	Axis	Spindle	Spindle & Axis
Cooled	Not required	Not required	Yes	Yes
Integral Services	N/A	N/A	Air (STD) / FJP (Optional)	Vacuum (Optional)
Probing	N/A	N/A	125 N Load Cell	N/A
Drive	Harmonic Drive Direct Drive	Harmonic Drive Direct Drive	DC Frameless Direct Drive	DC Frameless Direct Drive
Feedback Type	Motor Encoder	Motor Encoder	Rotary Encoder, 5000lines/min	Absolute Encoder
Speed Range	0-25 rpm	0-25 rpm	10-2000 rpm	1000 rpm (chuck) 250 rpm (table)
Load Capacity **Maximum Inertial Load[1]**	N/A	N/A	N/A	150 Kg 2.0Kg*m^2@20rad/s^2
Positional Repeatability @ Motor	1 arcmin	± 1 arcmin	-	1 arcmin
Working Range	+ 45 °, - 90 °	± 180 °	Continuous-bidirectional	Continuous-bidirectional
Radial Run-Out	Rotation of VP Setting ball mounted in H axis Chuck and rotated about the Virtual Pivot < 40 µm			< 5 µm
Axial Run-out				< 20 µm

Contact

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