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Machine Description

The IRP400 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 = 2600 Kg
- Dimensions = 2100 x 1850 x 2275 (W x D x H mm)

The machine frame is a welded steel structure incorporating the following features:

- 3 point floor mounting
- Integrated electrical and pneumatics enclosures
- 3-point mounting for polymer-granite base
- Peristaltic System attached (optional)
2 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 X 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 Y-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 three axes assembly mounts on the Z-Axis.
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.
Each axis is mounted on a pair of precision THK linear motion rails and driven via an AC servo motor and precision ground ballscrew. Home positions measured via absolute rotary encoders or optional linear encoders.

- **Slide type:** THK linear motion rails
- **Travel (X Axis):** ±275mm
- **Travel (Y Axis):** ±250mm
- **Travel (Z Axis):** 250mm
- **Drive system:** AC servo driven precision ground ballscrew
- **Positioning feed-back:** Home position via absolute rotary encoder
- **Max velocity:** 3000mm/min
5 Rotary Axes & 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 polymer-granite base.

The A-axis is mounted to the Z-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: ±180°
- 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: ±90°
- 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 external SMC chiller system. Tooling mounts via a Ø25mm hydrodehn 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 2500
- Polishing Head radii: Solid or Inflatable R20, R40, Inflatable R80, 120 (Solid R2, R5, R10 optional)

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Footnote:

2 Fixturing may be required to allow the small tools to reach the surface of the component
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 DC servo motor, with positional feedback provided by a precision absolute encoder. Spindle is cooled by external SMC chiller system.

The Spindle is supplied with a Ø450mm turntable and Ø40mm hydrodehn chuck for work piece mounting.

- Speed Range: 0 to 1000rpm
- Max Load Capacity: 50kg
- Vacuum (Optional): -0.8bar maximum
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.
7 Control System

Figure 9: Control Console

Zeeko Fanuc (30i-B) System

- Industrialised 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: 1µm
- Processor: Panel i - Windows embedded Standard 7 OS
- Data Server option for up to 4GB NC programs
8 Guards, Covers & 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
9 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: 75ml/min
  Max flow rate: 280ml/min
- Reservoir capacity: 1 litre
- Tube Type: Ø4.8mm 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: 8ml/min
  Max flow rate: 30ml/min
- Reservoir capacity: 1 litre
- Tube Type: Ø1.6mm Masterflex PharMed BPT
  Long life, high acid/alkali resistance

Agitation method: Magnetic stirrer.
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, 1.5mm
- Nozzle can be mounted axial or at 30° to H-axis.
- Maximum rated pressure is 20bar.
11 Summary Specification

11.1 General

<table>
<thead>
<tr>
<th>General</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Configuration</td>
<td>7 Axis 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.</td>
</tr>
<tr>
<td>Work piece Capacity (1)</td>
<td>Nominal polishing envelope of 550x500x250mm</td>
</tr>
<tr>
<td>Base Structure</td>
<td>Polymer Granite</td>
</tr>
<tr>
<td>Control System</td>
<td>Fanuc</td>
</tr>
<tr>
<td>Dimensions (No Accessories) WxDxH</td>
<td>2100mm x 1850mm x 2275mm</td>
</tr>
<tr>
<td>Suggested Install Dimensions</td>
<td>3100mm x 3850mm x 2400mm</td>
</tr>
<tr>
<td>Weight</td>
<td>2600Kg</td>
</tr>
<tr>
<td>Floor Load Requirements</td>
<td>Minimum loading 100,000Kg/m²; Floor must be even to &lt;3mm/m²</td>
</tr>
<tr>
<td>Environmental Requirements Min/Max Operating Temp.</td>
<td>15°C - 35°C (+2°C/hour Temperature Gradient)</td>
</tr>
<tr>
<td>Max Operating Humidity</td>
<td>75% RH Non Condensing</td>
</tr>
<tr>
<td>Min/Max Storage Temp.</td>
<td>-15°C - 50°C</td>
</tr>
<tr>
<td>Max Storage Humidity</td>
<td>80% RH Non Condensing</td>
</tr>
<tr>
<td>Power Supply Requirements</td>
<td>3Phase+N+E, 200/VAC 50/60Hz 4KW</td>
</tr>
<tr>
<td>Services Requirements</td>
<td>Clean dry air at 185L/min with minimum pressure of 6bar (215L/min with linear encoders)</td>
</tr>
<tr>
<td>Noise Level</td>
<td>&lt;50bB(A) Continuous</td>
</tr>
<tr>
<td>Safety</td>
<td>In accordance with EC Directives 2006/42/EC, 2004/108/EC (EMC) and 2006/95/CE (Low Voltage)</td>
</tr>
</tbody>
</table>

11.2 Linear Axes

<table>
<thead>
<tr>
<th>Description</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slide Type</td>
<td>THK SVS 25 Linear Motion Rails</td>
<td>THK SVS 25 Linear Motion Rails</td>
<td>THK SVS 25 Linear Motion Rails</td>
</tr>
<tr>
<td>Drive Type</td>
<td>AC Servo driven Ø35-6 precision ground ballscrew</td>
<td>AC Servo driven Ø35-6 precision ground ballscrew</td>
<td>AC Servo driven Ø35-6 precision ground ballscrew</td>
</tr>
<tr>
<td>Feedback Type</td>
<td>Absolute Rotary Encoder</td>
<td>Absolute Rotary Encoder</td>
<td>Absolute Rotary Encoder</td>
</tr>
<tr>
<td>Travel</td>
<td>±275mm</td>
<td>±250mm</td>
<td>±250mm</td>
</tr>
<tr>
<td>Max Velocity</td>
<td>3000mm/min</td>
<td>3000mm/min</td>
<td>3000mm/min</td>
</tr>
<tr>
<td>Max Acceleration</td>
<td>250mm/sec²</td>
<td>250mm/sec²</td>
<td>250mm/sec²</td>
</tr>
<tr>
<td>Positioning Accuracy</td>
<td>&lt;10µm over full travel</td>
<td>&lt;10µm over full travel</td>
<td>&lt;10µm over full travel</td>
</tr>
<tr>
<td>Bi-direction Repeatability</td>
<td>&lt;5µm</td>
<td>&lt;5µm</td>
<td>&lt;5µm</td>
</tr>
<tr>
<td>Straightness: Horizontal: Vertical:</td>
<td>&lt;10µm over full travel &lt;5µm over 100mm</td>
<td>&lt;10µm over full travel &lt;5µm over 100mm</td>
<td>&lt;10µm over full travel &lt;5µm over 100mm</td>
</tr>
<tr>
<td>Squareness</td>
<td>&lt;50µm</td>
<td>&lt;50µm</td>
<td>&lt;50µm</td>
</tr>
<tr>
<td>Circularity</td>
<td>&lt;50µm</td>
<td>&lt;50µm</td>
<td>&lt;50µm</td>
</tr>
</tbody>
</table>
IRP400 7Axis Ballscrew - Fanuc
Product Specification

11.3 Rotary Axes

<table>
<thead>
<tr>
<th>Rotary Axes</th>
<th>A</th>
<th>B</th>
<th>H (Tool)</th>
<th>C (Workpiece)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting</td>
<td>Epoxy-Granite Base</td>
<td>A Axis Arm</td>
<td>Virtual Pivot Assembly</td>
<td>Z Axis Carriage</td>
</tr>
<tr>
<td>Spindle/Axis</td>
<td>Axis</td>
<td>Axis</td>
<td>Spindle</td>
<td>Spindle &amp; Axis</td>
</tr>
<tr>
<td>Cooled</td>
<td>Not Req'd</td>
<td>Not Req'd</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Integral Services</td>
<td>N/A</td>
<td>N/A</td>
<td>Air (STD)/FJP (Optional)</td>
<td>Vacuum (Optional)</td>
</tr>
<tr>
<td>Probing</td>
<td>N/A</td>
<td>N/A</td>
<td>125N Load Cell</td>
<td>N/A</td>
</tr>
<tr>
<td>Drive</td>
<td>Harmonic Drive</td>
<td>Harmonic Drive</td>
<td>Emoteq DC Frameless Direct Drive</td>
<td>Emoteq DC Frameless Direct Drive</td>
</tr>
<tr>
<td>Feedback Type</td>
<td>Motor Encoder</td>
<td>Motor Encoder</td>
<td>Rotary Encoder, 5000lines/min</td>
<td>Absolute Encoder</td>
</tr>
<tr>
<td>Speed Range</td>
<td>0-25rpm</td>
<td>0-25rpm</td>
<td>0-2000rpm</td>
<td>0-1000rpm</td>
</tr>
<tr>
<td>Load Capacity</td>
<td>Maximum Inertial Load</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Radial Run-Out</td>
<td>±1arcmin</td>
<td>±1arcmin</td>
<td>±1arcmin</td>
<td>±1arcmin</td>
</tr>
<tr>
<td>Axial Run-out</td>
<td>Rotation of VP Setting ball mounted in H Axis Chuck and rotated about the Virtual Pivot &lt; 40µm</td>
<td></td>
<td></td>
<td>±4µm</td>
</tr>
</tbody>
</table>

11.4 Contact

For more information, please visit our website (www.zeeko.co.uk) or contact us via the following:

Zeeko Ltd. | 4 Vulcan Court | Vulcan Way
Coalville | Leicestershire | LE67 3FW | UK
+44 1530 815 832
info@zeeko.co.uk
sales@zeeko.co.uk

2 Maximum Inertial load in standard configuration. Variations may be possible with servo retuning - contact Zeeko for advice.