

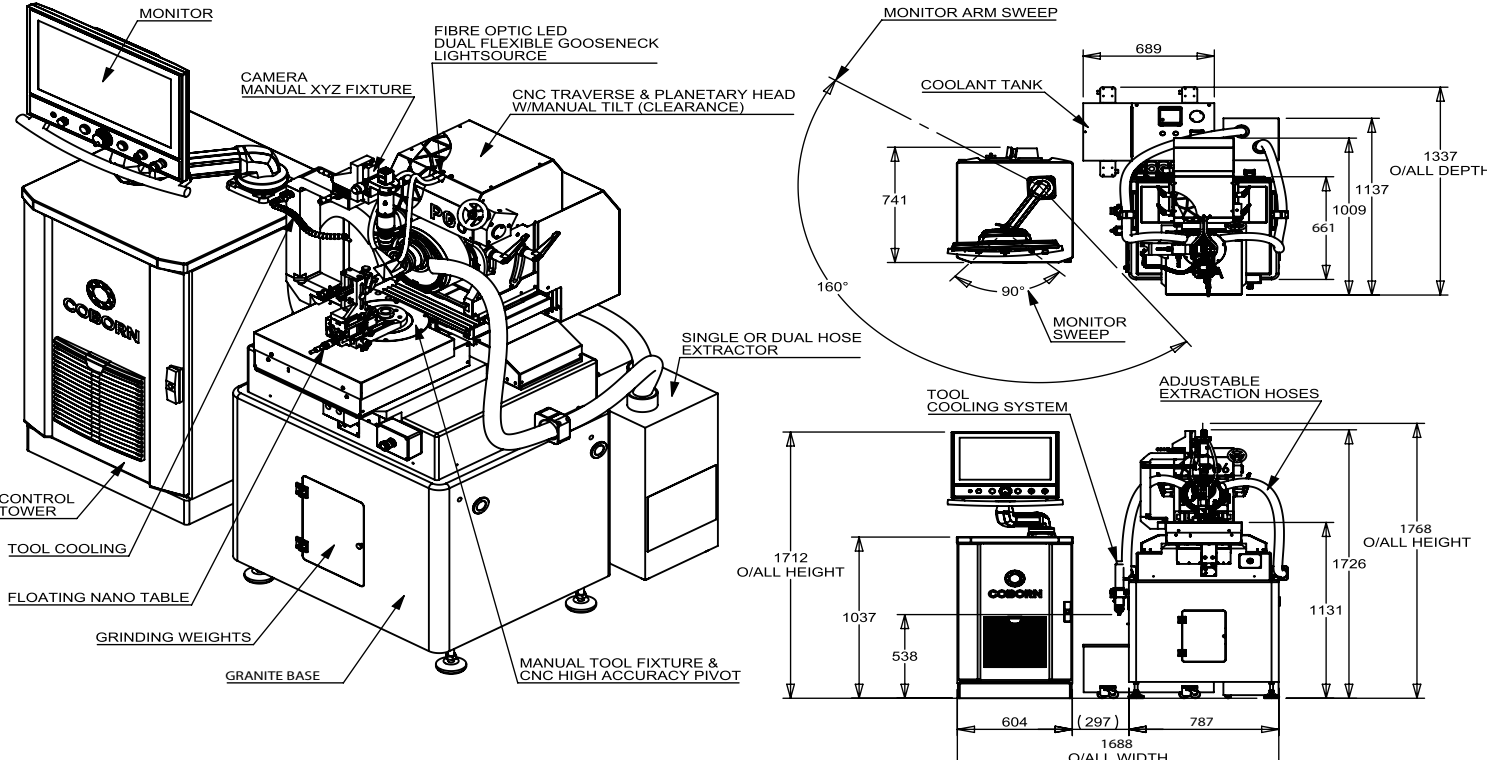
PG6 TECHNICAL SPECIFICATION

Area

Machine dimensions (w x d x h)	790mm x 1310mm x 1900mm
Control tower dimensions (w x d x h)	610mm x 640mm x 1910mm
Machine weight	800kg
Control tower weight	160kg
CNC control system	CNC control with Intel i7 processor running Coborn .net software on a Windows platform
Grinding wheel spindle	2.0kW 0 - 12000 rpm programmable liquid cooled high-precision air spindle
Grinding wheel	Ø 85mm Metal bond wheel or cast iron lap
Pivot spindle	High-precision air spindle with radial error < 0.00005mm
Process inspection	Coborn integrated camera inspection system X60 to X600 magnification
Electrical requirements	380 / 220 3phase 50/60 Hz 16amps
Mechanical options	Rotary axis (RM) programmable, Coning spindles (CS) manual, Work piece clamping systems

Axis	Description	Feedback Resolution	Program Resolution	Travel
X	Wheel head traverse	0.0001mm	0.01mm	100mm
Y	Wheel head infeed	0.00005mm	0.0001mm	45mm
T	Planetary head tilt	Manual	Manual	0 to 20°
B	Planetary head orientation	0.01°	0.1°	360°/continuous
C	Pivot spindle	0.0001°	0.001°	+/- 100°
V	Infeed table	0.000005mm	0.00001mm	30mm
A	Rotary module (Optional)	0.0002°	0.001°	360°/continuous
TPX	Fixture X	Manual	Manual	12mm
TPY	Fixture Y	0.0005	Manual	12mm
TPZ	Fixture Z	Manual	Manual	75mm
TPA	Fixture tilt	Manual	Manual	-20 to + 20°
Xc	Camera X	0.001mm	Manual	12mm
Yc	Camera Y	0.001mm	Manual	12mm
Zc	Camera Z	Manual	Manual	80mm

DIMENSIONS AND FOOTPRINT



PG6

Coborn Engineering Ltd
Chesham Close, Cedar Road,
Romford, Essex, RM7 7PJ, UK

coborn.com

Tel: +44 (0)1708 744666

Email: sales@coborn.com



PG6
THE BENCHMARK FOR
THE DIAMOND INDUSTRY
COBORN.COM

UNIQUE AUTOMATION FEATURES

Grinding Facets – The ‘Blocking Out’ of a Cutting Tool Radius

Under program control, the machine will generate numerous facets around the radius of a tool.

For each facet, the control will

- Rotate the wheel spindle to the required planetary position for soft direction grinding
- Advance the wheel a controlled amount and allow the tool to grind and 'float' back to the fixed stop
- Move the tool away from the wheel
- Index the pivot and grind the next facet



Grinding the Radius

- The program will then swing the pivot over the required arc to smooth the flank in conjunction with the radius
- Hard spots ('knarts') can be identified and a sub-arc of pivot rotation selected for focussed attention
- Once the tool is completed the wheel will move away from the tool for inspection / unloading

Simultaneous, Synchronous Axis - Grinding Vectors

The planetary, pivot rotation, wheel traverse, wheel in-feed and rotary module (RM) motions are all programmable and in the basic machine run independently of each other. Optional software is available for the PG6 such that the motion of two or more of these programmable axes can be electronically geared to run with synchronous motion. A repeating sequence of grinding directions or vectors can thus be established enabling complex profiles to be generated, such as elliptical, parabolic, hyperbolic and multiple blended radii.



Multi-Axis Configuration

The pivot and grinding wheel axes feature high precision air bearings and in normal production only these two axes would be running for the very final polishing of a low waviness radius tool. The remaining machine axes incorporate high precision linear or rotary bearings. The camera axis alignment is via micrometers.

SINGLE CRYSTAL DIAMOND GRINDING



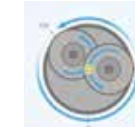
The Structure of Single Crystal Diamond

Like wood, diamond crystals have a 'grain', but unlike wood the 'grain' runs in many possible directions. Diamond can be ground easily as long as the grinding direction is across the 'grain' or put another way - parallel to a 'soft' direction of the crystal. The PG6 works in a very different way to a conventional grinding machine. It is useful to understand why.



The Floating Table with Constant Grinding Load

It is not possible to grind diamond using a positive in-feed mechanism alone because the diamond's hardness varies with crystal direction. Instead a constant force is used to simply apply a steady grinding pressure. The diamond tool is mounted on a linear motion floating table which is held in contact with the wheel by a variable weight until it meets a fixed stop. The floating table also contains the air-bearing pivot motion which enables precise radii to be formed.



Planetary Motion Wheel Spindle

To achieve the correct grinding direction, the PG6 has a wheel spindle which can be positioned in a planetary manner so that the direction of the grinding wheel's motion at the point where it meets the diamond can be aligned with the soft direction of the facet being ground. This enables rapid material removal rates to be achieved.



Edge Perfection and Vibrations

Controlled and low waviness SCD tools can only be produced
vibrations at the wheel/diamond interface are eliminated.

A composite granite base to damp vibrations and the air-bearings in the wheel and pivot spindles are all necessary to ensure that the ultimate perfect edges are achieved. Operators can also introduce vibrations as they press switches or tap the touch screen, to avoid this vibration, all aspects of human interface have been assigned to a separate tower which is connected to the main grinding machine via an umbilical harness. Once the program starts there is no further need for the operator to touch the grinding machine itself.

MULTI-FUNCTIONAL CAPABILITIES

The PG6 is an automatic, ultra-high precision grinding machine that is designed specifically for processing natural or synthetic single crystal diamond (SCD) tools. A world-first engineering solution for the precision manufacture of controlled waviness and complex geometry tools using high quality air bearings for both wheel spindle and the pivot. Programming is extremely simple and minimal training is required.

The PG6 features a new closed loop nano-stop for more accurate finishing of the radius form and the high resolution PoE camera is used in conjunction with an improved optical lens system to enable tool measurements and geometry validation. The updated system provides a quick exchange for optional lenses. The enhanced vision system positioning stages are equipped with 1um resolution micrometre heads for ease of use and more accurate positioning.

The output power of the lap spindle is increased by more than double to enable higher grinding loads and the PG6 is equipped with an LED light source with dual fibre optic goose-neck delivery allowing more precise positioning of the lighting. The optional extraction unit with dual suction points facilitates the removal of any diamond particles to create a cleaner working environment.

PG6 SOFTWARE

Curve Block - Enables the processing of elliptical, hyperbolic, parabolic and cubic forms.

Profile Block - To generate a concave form with multiple blended radii.

Contour Block - To generate a concave form with a single radius.

Helical Block - To generate SCD end mills with primary and secondary cutting clearances.

K-Land Block - To perform a negative cutting edge around the flanks and radius of a tool.

Table Position Tracing – The floating table position is monitored using a five nano-metre resolution scale. This measurement is plotted against pivot angle enabling the operator to identify any points of excessive push-off.

Acoustic Tracing – A touch probe is supplied to enable audio monitoring of the grinding process. The PG6 enhances this well-established technology to plot a graph of amplitude against pivot position giving a visual representation of any variations.

Basic Remote Reporting - Enables vital data extraction and reporting via email over pre-set timed intervals. Such data can be used to analyse the machine output, performance and report any maintenance requirements. Future enhancements will include the ability to have this data analysed automatically and report back to the operator removing the need for human intervention.

TOOL FORMATS

Low and controlled waviness tools

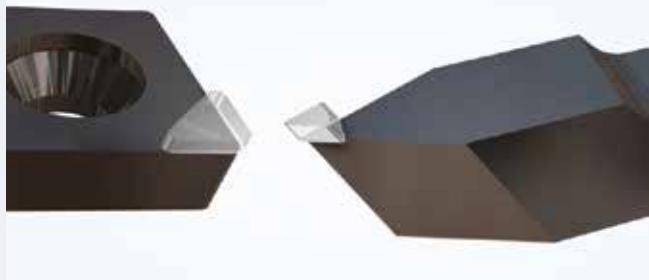
Complex profile tools

Elliptical, parabolic, hyperbolic and blended radii profiles

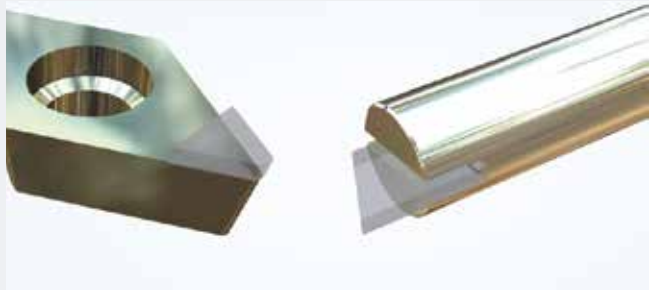
Facetted, coned and radiussed indenters

Concave profile tools

TOOLING



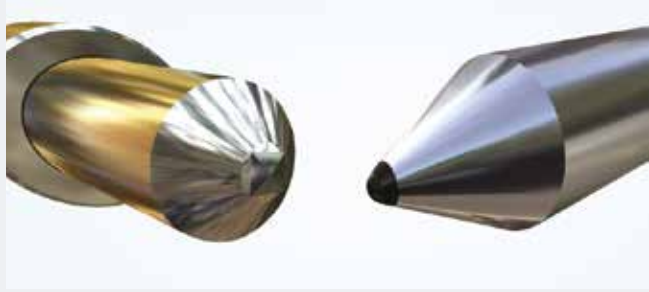
Low and controlled waviness tools



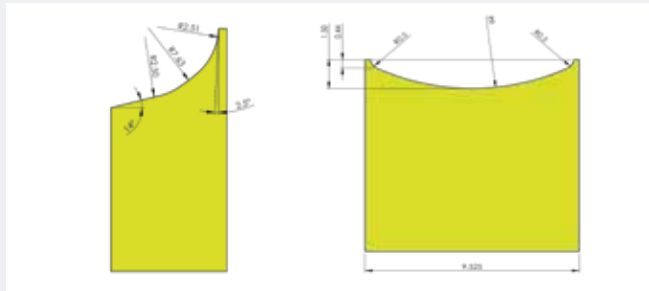
Complex profile tools



Elliptical, parabolic, hyperbolic and blended radii profiles



Facetted, coned and radiussed indenters



Concave profile tools

PG6

Tool Inspection & Graphical User Interface (GUI)

- High resolution touch-screen
- Tool profiles generated from tool program
- Digital zoom and image dragging facility
- Simple programming via menus
- Machine operation training in one day
- Rotary axis training in one additional day

Control System

- Fast Windows-based PC and associated drives
- Connects to grinding machine by umbilical harness to avoid vibration transmission
- All units pluggable
- Remote diagnostics via internet
- 3 phase, multi voltage/multi-frequency supply

Tool Cooling Unit

- Cools tool shank using sub-zero compressed air
- Removes thermal expansion effects
- Programmable 'on/off'

Floating Table

- High precision linear bearings
- Constant load, dead weight systems, 0.5-3.0kg
- 5nm in-feed scale

Variable Weight Loading For Table

- Programmable table force

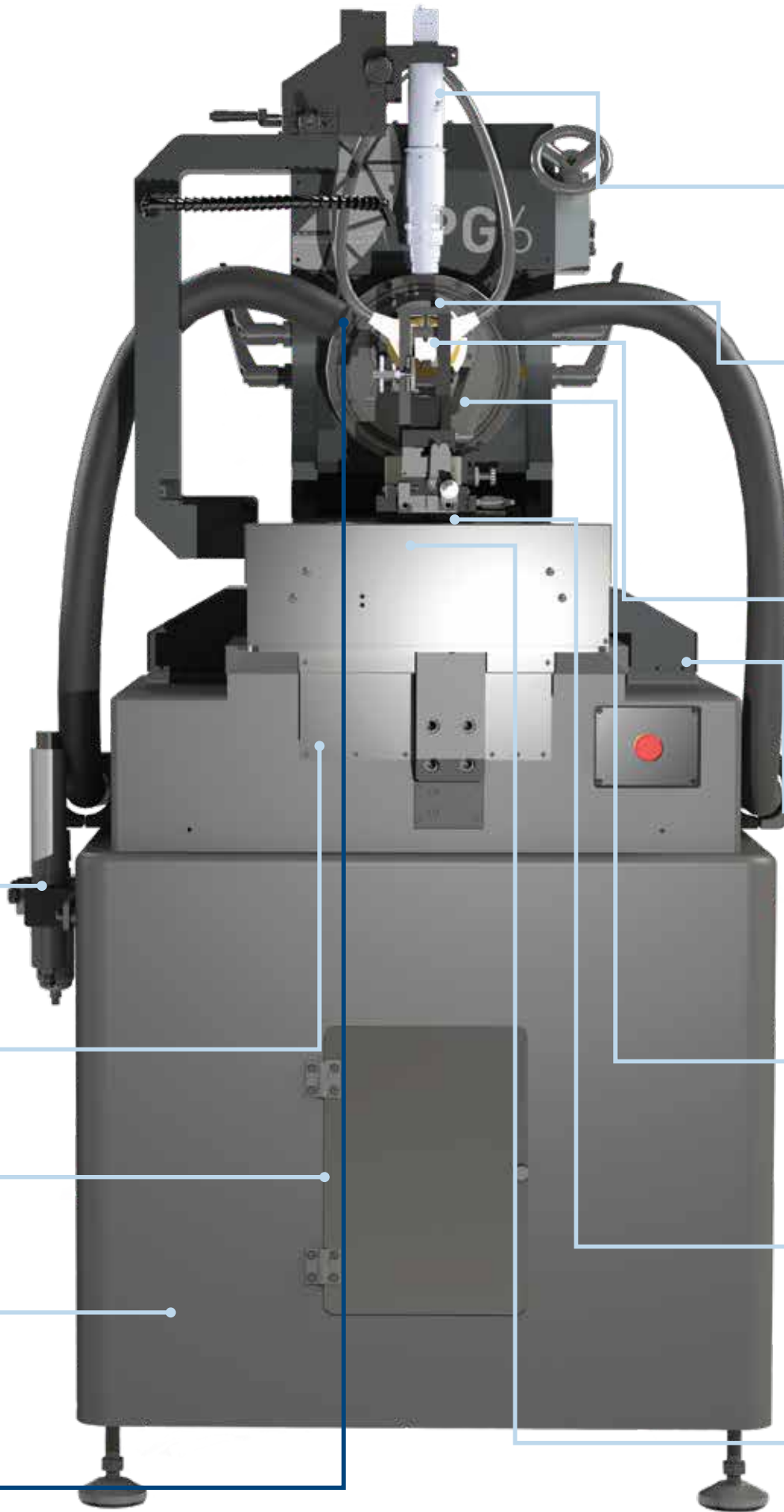
Composite Granite Base

- For optimum vibration damping and thermal stability

OPTIONAL

Extraction Unit

- An extraction unit with dual suction points to extract any diamond particles for a cleaner working environment.



Camera

- GigE camera for fast image capture
- X, Y micrometer adjustment for camera alignment

Zoom Lens

- Extra long focal length for in-process inspection
- x60 - x600 magnification
- x1000 magnification - optional extra (inspection only)

Planetary Motion

- Coborn, high precision planetary with rolling element design
- 0.1° planetary position resolution
- AC servo motor drive via non-influencing motor and belt
- Speed, direction and angular position programmable
- 0 - 20° tilt for conical clearance

Wheel Traverse

- Non-influencing linear drive
- Can be synchronised
- Fully programmable speed, and stroke
- Sinusoidal acceleration / deceleration

Air-Bearing Wheel Spindle

- Ultra-high precision air-bearing
- Water cooled to provide thermal stability
- Speed up to 12,000 rpm programmable
- Rotation direction programmable
- Brushless, vibration free integral drive

Tool Post

- X,Y tool position adjustment via micrometers
- Tool height adjustable
- +/-20° tilt cylindrical clearance
- Nest accepts round and square shank tools

Air-Bearing Pivot

- Ultra high precision air-bearing pivot
- Brushes, vibration free integral drive
- <50nm rotational error
- Maximum arc of rotation 182°
- Position resolution 0.001°
- Position & speed programmable

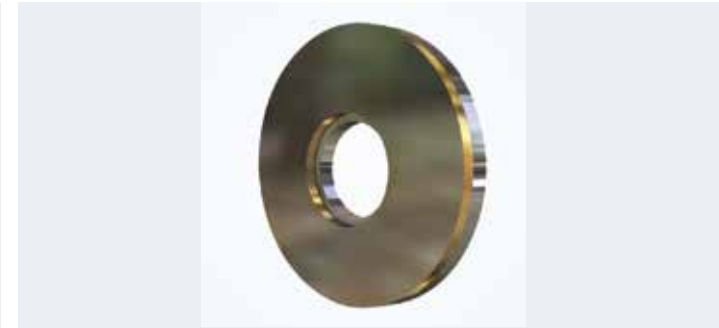
OPTIONAL FIXTURES & EXTRAS

Many optional fixtures are available and the most common are shown below. Coborn can also design and supply custom fixtures and tool holding solutions according to customer requirements.



RM76 – Rotary Axis

- For coning, cylindrical grinding and index positioning
- Programmable rotation to 0.001°
- Collet chuck to suit tools up to Ø16mm
- Other adaptors available



SAM – Metal Bond Wheels

- High quality, porosity free
- Extremely long life, designed for dry grinding
- Dynamically balanced to gyroscopic tolerances



TRC – Tool Radius Check

- Microscope with image analysis software to measure tool radius and radius waviness
- Generates custom designed QC graphical data sheets which can then be supplied with the associated tool



Optional Software Module

- Helical Block
- Curve Block
- Contour Block
- DXF Import Module
- K-Land Block
- Profile Block



PS2B – Planetary Scaife Bench

- For top lapping of SCD tools after radius grinding
- Re-sharpening worn tools and general facet work
- Adjustable planetary motion allows 'set and leave' operation