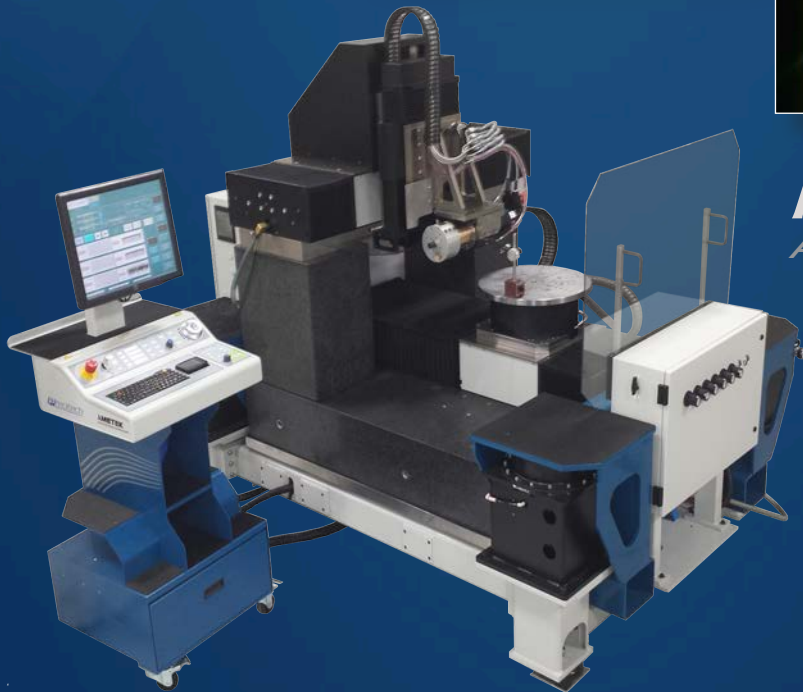


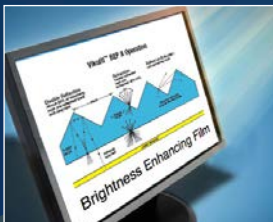


Global Manufacturer of Innovative Ultra Precision Machining Solutions

**Part of our fleet of machines
optimized for light management
applications...**



Freeform® MGG
AND ULTRA PRECISION MILL



**Unparalleled flexibility in
grooving and ultra precision milling**

AMETEK®
ULTRA PRECISION TECHNOLOGIES

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Freeform[®] MGG

AND ULTRA PRECISION MILL



Microgroove generator for machining grooves on flat and freeform surfaces

Key Specifications	
Groove depth variability	< 3 microns over a 450 mm dia.
Maximum grooving spindle speed	15,000 RPM
Machinable area	600 mm dia. (rotating work piece) 600 x 600 mm (translating work piece)
Slide travel	X axis - 600 mm Y axis - 600 mm Z axis - 150 mm

* The Freeform[®] ML is the ideal ultra precision machine for parts under 300 mm diameter.

Key Benefits

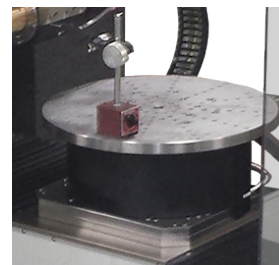
- ▶ **Simple, straight forward tool path programming allows for maximum usability**
- ▶ **Productivity enhancing integrated diagnostic tools**
- ▶ **Unparalleled application flexibility enabled by several unique machine configurations**
- ▶ **Maximize the performance of your end product by maintaining groove depth variability of less than 3 microns**
- ▶ **Reduced sensitivity to vibration enabled by its integral TMC MaxDamp[®] isolation system**
- ▶ **Reduced setup time thermal management of on-machine heat sources**
- ▶ **Easy to use UPx machine control and a functional ergonomic console**

Typical Applications

- ▶ **Retroreflective film molds street signs, highly reflective clothing, automotive reflectors**
- ▶ **LED lighting applications light bending, focusing, enhancing, filtering, color shifting**
- ▶ **Other freeform grooving applications**



Standard Features



Hydoround rotary axis

Precitech's rotary axis is the stiffest in the industry. The Hydoround rotary axis comes standard on the Freeform[®] MGG enabling the machining of intersecting grooves.

Load Capacity	454 Kg (1000 lbs.)
Max. Speed	10 RPM
Radial Error Motion	0.10µm (4µ") @ 1" @ 1" above table
Coning Error	1.0nm/mm (1.0µ"/in.)
Radial Stiffness	525N/µm (3,000,000 lbs./in.)
Axial Stiffness	875N/µm (5,000,000 lbs./in.)
Moment Stiffness	17N-m/µrad.
Moment Stiffness	(150 lbs.-in./µrad.)



Nanoform[®] X style operator console

All of the most popular ease-of-use features of the Nanoform[®] X style operator console comes standard on the Freeform[®] MGG. The console includes convenient storage for all standard accessories, programmable soft keys, and both jog wheel and directional arrow axis controls.



UPx integrated diagnostic tools

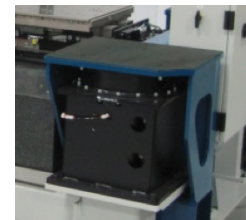
Precitech's innovative UPx control system enables the next level of process optimization. The QNX operating system features true real-time connectivity between the user front end and machine control. This enables many unique diagnostic tools and software functions such as the ability to monitor following errors and vibration sources while the parts are being cut.



Fully contouring vertical axis

The Freeform[®] MGG is a true freeform machine and its potential applications are virtually limitless. Freeform[®] MGG features the same contouring vertical axis as Precitech's industry leading Freeform[®] L diamond turning machine.

Slide travel	150 mm
Drive system	Linear motor
Bearing type	Oil hydrostatic

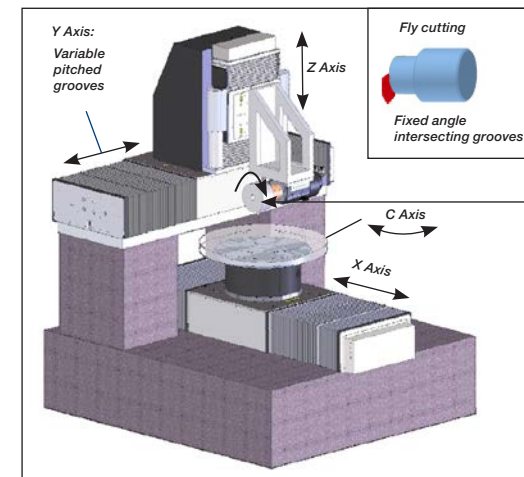


TMC MaxDamp Vibration Isolators

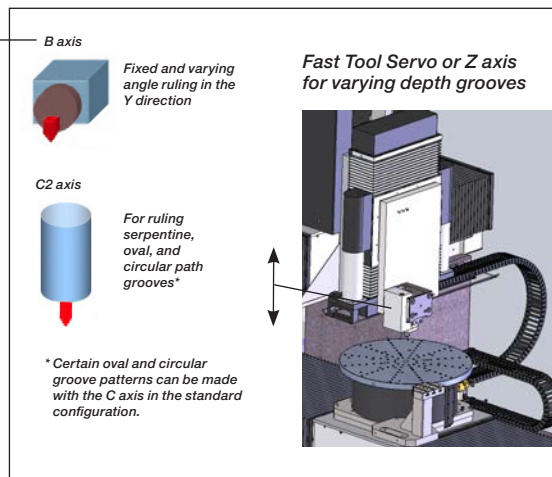
TMC, an Ametek company, and vibration control experts, helped to design the vibration isolation system on the Freeform[®] MGG. The built in MaxDamp[®] high performance vibration isolators optimize the Freeform MGG[®] for ultra precision machining.

Available Options and Custom Configurations

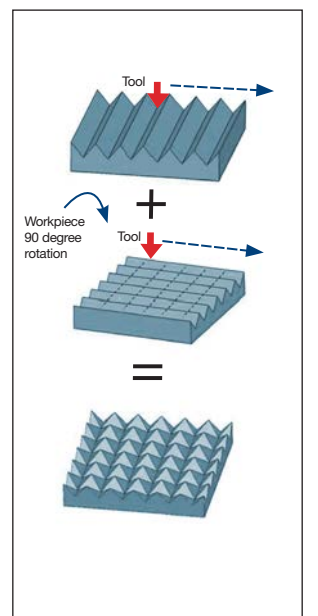
Standard 4 axis configuration



Optional configuration

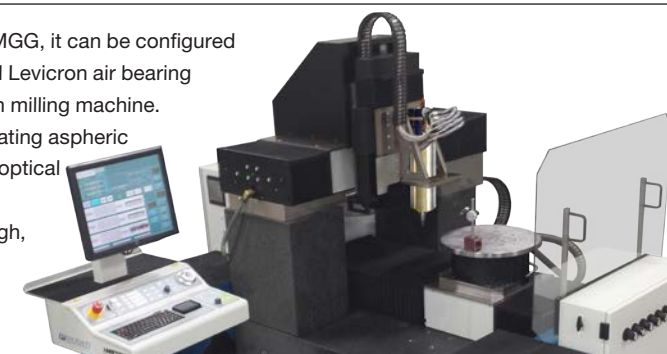


Typical grooving process



Ultra precision milling configuration

Furthering the flexibility of the Freeform[®] MGG, it can be configured with a 60K or 80K RPM vertically mounted Levicron air bearing spindle, thereby creating an ultra precision milling machine. This machine configuration is ideal for creating aspheric lens arrays and other structures requiring optical surfaces. The capacity of this machine is 600 mm wide x 600 mm long x 150 mm high, which is the largest ultra precision milling machine available on the market.



Technical Product Specifications **Freeform® MGG**

Machine base and control		Description
Machine base	Completely sealed natural granite	
Control system	UPx™ machine tool control featuring advanced Motion Wire architecture.	
System intranet includes	Windows 7 computer & UPx Data Store (Windows network compatibility, USB and printer support, logging functions)	
Machine Type	4 Axis (optionally up to 6 Axis) CNC Micro Groove Generating Machine	
Vibration isolation	TMC MaxDamp® self leveling pneumatic vibration isolation system	
Programming resolution	0.01 nanometer	
Operating System	QNX-real time OS utilizing non proprietary motion control boards for advanced capability and performance	
Linear oil hydrostatic slideways		Description
Type	Hydrostatic oil bearing box-type slide ways manufactured by Precitech	
Material	Dura bar cast iron	
Thermal control	Liquid cooled horizontal linear axis	
Travel	X 600 mm, Y 600 mm, Z 150 mm (vertical)	
Maximum feedrate	3000 mm/min	
Drive system	Linear motor	
Motor location	Located centrally and mounted vertically eliminating offset drive forces and minimizing thermal distortions	
Position feedback	34 picometers	
X-Axis straightness	Horizontal: 0.50 micron / 460 mm Vertical: 0.50 micron / 460 mm (measured near the B axis table top)	
Y-Axis straightness	Horizontal: 0.50 micron / 460 mm Vertical: 0.75 micron / 460 mm (measured near the B axis table top)	
Z-Axis straightness	Horizontal: 0.75 micron / 150 mm Vertical: 0.75 micron / 150 mm	
X-Axis stiffness	Vertical: 438 N/micron (table center), Horizontal: 438 N/micron (table center)	
Y-Axis stiffness	Vertical: 438 N/micron (table center), Horizontal: 438 N/micron (table center)	
Z-Axis stiffness	Vertical: 263 N/micron (table center), Horizontal: 263 N/micron (table center)	
Rotary oil hydrostatic C axis		Description
Type	Bi-conical, self compensating, patented oil hydrostatic bearing with integral motor, encoder & vacuum feed through	
Load capacity	454 kg	
Tabletop size	457 mm diameter	
Maximum Speed	3600 deg/min	
Feedback resolution	0.014 arc-sec	
Positioning accuracy	+/- 1.0 arc-sec	
Radial error motion	0.10 micron @ 1 inch above table	
Axial error motion	0.10 micron	
Coning error	1.0 nm / mm	
Co-planarity	C to X axis < 1 arc sec, C to Y axis < 1 arc sec	
Radial stiffness	525 N / μm	
Axial stiffness	875 N / μm	
High speed flycutting/milling spindle		SP75FF flycutting spindle manufactured by Precitech
Air supply pressure	690 KPA	Levicron milling spindle 610 KPA
Air consumption	50 lpm	70 lpm
Radial load capacity	32 kg Ultimate Load Capacity	29 Kg ultimate
Axial stiffness	70 N/micron	50 N/micron
Radial stiffness	22 N/micron	35 N/micron
Axial error motion	Under 0.05 micron	< 30 nm asynchronous
Radial error motion	Under 0.05 micron	< 30 nm asynchronous
Maximum speed	15,000 RPM	80,000 RPM (stiffness increases 50% with 60k RPM model)
Options included with the base MGG Ultra system		
Standard fly cut head	Fly cutting tool holder, adjustments: Rake & Roll (recommended top speed 5000 RPM)	
Tool setting	Optical tool setter using a Kinematic mount	
Mechanical indicator	Electronic gage (integrated) with finger style high accuracy LVDT head and magnetic base	
Cutting lubrication	Tool air mist lubrication system	
Optional Equipment		
Thermal enclosure		
Air shower, temperature control:	+/- 0.1 degree C	
A axis		
C2 axis		
Ultra precision milling configuration		
Precitech FTS70 Fast Tool Servo system		
Standard and custom built vacuum fixtures		
Facility Requirements		MGG ultra
Power	208 or 230 VAC - 4.0 KVA 1 phase - 50/60 Hz	
Air supply	Typical: 10 SCFM @100 PSIG, filtered to 50 microns and dry to 10C pressure dew point	
Floor space (does not include controller and auxilliary equipment)	2500 mm x 1800 mm	