

ROKU-ROKU

SINCE 1903

Android II
ULTRA PRECISION MICRO FINE MACHINING CENTER

Vision
ULTRA PRECISION MICRO FINE MACHINING CENTER

Cega
SUPER PRECISION MICRO MACHINING CENTER
SSS

Mega
SUPER PRECISION MICRO MACHINING CENTER
SSS

HCI
High-Speed High-Precision
Multi-Purpose Machining Center

MC MACHINERY
SYSTEMS, INC.

a subsidiary of  Mitsubishi Corporation

HISTORY

HISTORY OF ROKU-ROKU: A CENTURY OF PRECISION

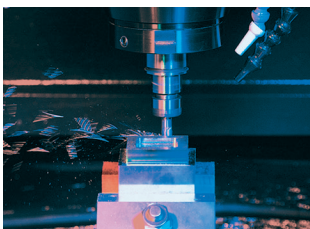
Roku-Roku is one of the oldest manufacturer of machine tools in Japan. Starting in 1903, Roku-Roku has been designing, building and researching new machining fields for more than 100 years. This extensive experience has taught them that the most important factor in achieving superior results is the construction of the machine.



MC MACHINERY SYSTEMS: THE MITSUBISHI EXPERIENCE

As the importer and support network for the Roku-Roku line of high-speed vertical machining centers in North America, we know that providing the best solutions means much more than just providing the right equipment. We call it The Mitsubishi Experience. We have built a reputation as a world-class manufacturer and solution provider to the metalworking industry. We help our customers succeed by leveraging decades of know-how to keep them one step ahead of their competition.

Roku-Roku VMCs from MC Machinery are a perfect match for high-precision EDM shops looking for innovative ways to enhance efficiency, or as stand-alone centers when you need the ultimate in precision. We have extensive experience incorporating Roku-Roku VMCs into automated manufacturing cells to reduce labor costs and boost productivity to unprecedented levels.



High-Speed Hard Milling



Graphite Electrode Production Cell



Hard Milling a Mold

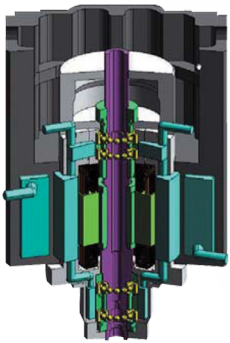
CONTROL / SPINDLE



HIGH-SPEED FANUC CONTROL

- 20% faster processing speeds, 9.1 nanosecond/block
- 1,000-block look ahead for optimized performance
- NANO Smoothing and Interpolation for unmatched precision
- Nanometer Drive Resolution with 16-million count encoders
- Accuracy Compensation Suite includes: backlash, pitch error, inclination and straightness, thermal growth and 3D volumetric
- AI Contour Control II uses bell-shaped acc/dec and servo delays effectively eliminating trajectory errors in corners and small radii
- New 10.4" LCD with QWERTY keyboard
- Super PC X provides 10 finishing modes
- Powerful G-Code Editor allows background editing of programs displayed side-by-side on the screen
- Additional 4th or 5th axis program processing

Coupled with the Fanuc 31i-B5 controller, the Roku-Roku Super PC X optimizes velocity, acceleration and deceleration with a super high-speed processor and AI Contour Control II. High-speed processing, Nano Smoothing and 1,000-block look ahead minimize geometric errors during high-speed processing, providing a finish other machines simply can't match. The Super PC X can be set to one of ten different modes from High-Precision to High-Speed – to meet any shop's machining needs. The Roku-Roku line of equipment also features Fanuc's Digital Intelligent Servo with five-place decimal input and high-resolution glass scale feedback. This combination results in unsurpassed speed and accuracy – even in complex, three-dimensional contours comprising short, consecutive line segments or arcs.



High Speed integrated motor spindles up to 60,000 RPM using ceramic bearing technology, oil mist or grease packed lubrication and liquid cooling to provide dynamic stability, quietness and reliability for continuous operation.

ROKU-ROKU DESIGNED INTEGRAL SPINDLES

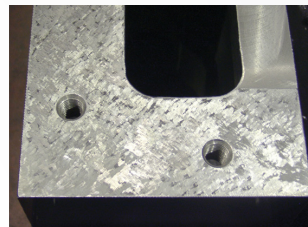
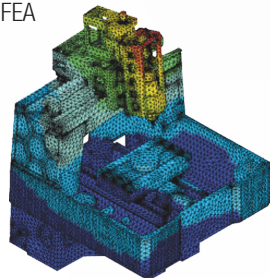
Roku-Roku has become synonymous with success. Using the latest technology available, we give our machines a competitive edge few others can boast.

Roku-Roku does not use off-the-shelf spindles. Our proprietary designs offer ultra high-speed performance and incorporate the latest angular-contact bearing technology. These special long-life spindle designs use two large bearings at the top and two at the bottom of the integral motor. In "dry" models, these ceramic grease-packed bearings completely eliminate contamination of graphite work pieces and the machining area from dripping spindle oil. Our "wet" flood coolant models use an oil-mist lubricated system. Dynamic, real-time Z-axis thermal compensation on all our spindles eliminates thermal growth and ensures Z-depth accuracy.

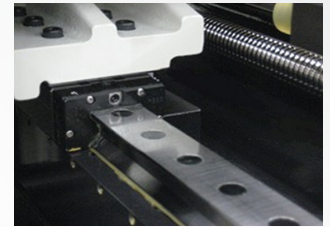
Roku-Roku's vertical machining centers are hand crafted and built solidly to jig-borer standards. The company still hand scrapes mating surfaces to eliminate vibration and by using computer Fine Element Design (FEA), creates its machine bases with a three point leveling system for maximum rigidity. Roku-Roku VMCs combine state-of-the-art spindle technology, smooth-action roller-pack type linear guides and the latest in high speed Fanuc control with linear glass scales. The result? A smoother finish and higher accuracy parts than other VMCs can produce.



FEA



Hand Scraped Surfaces



Roller Pack LM Guides

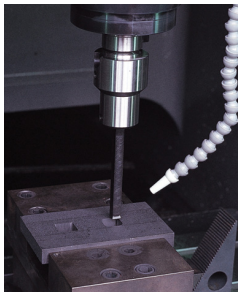
The oil mist cooled spindle machines use a dual-layer jacketed and oil cooled using an ultra-precision chiller system that holds 0.2 deg F operating range.

The grease packed spindle machines use a single jacket oil cooling systems with a ± 1.0 deg F operating range.

HC-SERIES

DUAL-PURPOSE MACHINES

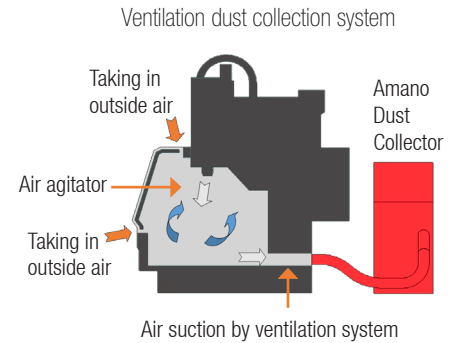
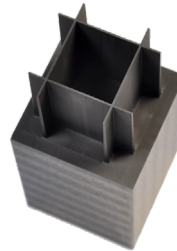
Roku-Roku is a leader in developing technology that meets the needs of the marketplace. Several years ago, it became apparent that many shops did not want, or could not afford, to buy two high-end VMCs - one for graphite and another for hard milling. Roku-Roku created a new category of high-end VMCs by combining technology from their industry-leading graphite and steel-cutting VMCs. The result was the HC-Series - still the industry's leading hybrid machines. These hybrid machining centers combine the ability to machine graphite, using grease packed high-speed spindles and cutting edge dust collection, with the ability to hard mill mold steels using a mist lubrication system, allowing highly versatile, high-precision machining.



Super J-Cut Broaching Tool

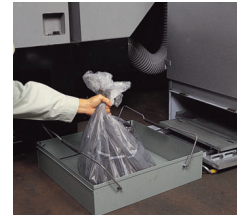
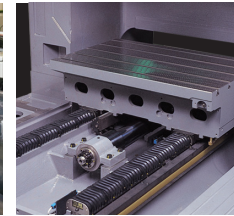
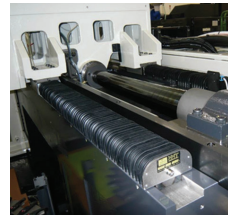
EXPANDING APPLICATIONS

Just when you thought it was impossible to machine sharp, square, inside corners on a milling machine, Roku-Roku develops the Super J-Cut Broaching System. The system provides a square broaching tool keyed into the spindle nose and uses the movement of the Z-axis to broach square corners.



DUST PROTECTION AND COLLECTION

As a graphite machining center, great care was taken in consideration of providing the best in dust collection and prevention. The HC Series provides a full enclosure cover and dust preventive structure for ways, screws, and ATC as standard equipment. The high-performance Amano PiA-15M or PiA-30M Dust Collector is capable of changing the working area air six times per minute. The dust collection and protection during graphite machining both outside and inside of the machine, such as ball screw and LM guide rail for work table, are perfectly complete.



Y-Axis Covers

Dust Removal



HIGHLY RIGID CAST STRUCTURES

Roku-Roku believes that a machine's foundation is the key to high-accuracy fine-finish machining, so great effort is taken to design and build the one-piece column and cross beam which creates a bridge-style mono-block casting, providing extra-rigid support and a wide X-axis guide base. Horizontal placement of the saddle above the cross beam places the gravity point inside the cross beam, which minimizes any excess head movement.

APPLICATION EXAMPLES



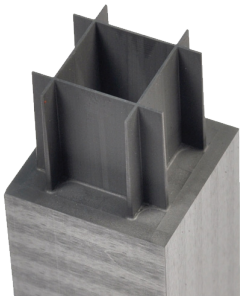
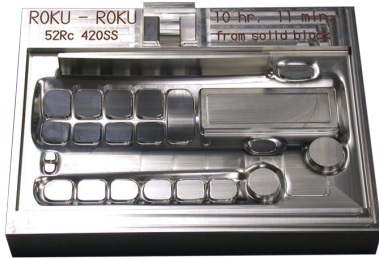
HC-658 II

Graphite Electrode Machining:

Machine:	Roku-Roku HC-658 II			
Material:	Carbon			
TOOL	DESCRIPTION	RPM	IPM	TIME
T1 = (3/32" ball e.m.)	Roughs detail.	13,000	100	
T2 = (1/16" ball e.m.)	Semi-finishes detail.	14,500	100	
T3 = (3/64" ball e.m.)	Finishes detail.	14,500	100	
T4 = (1/2" flat e.m.)	Profiles outside edge.	14,500	100	
Normal Mode	Original test / 100% feed rate over ride			4 hr. 39 min.
High Speed Mode	Original feed rates / Part labeled as part 3 / 160% over ride			2 hr. 44 min.
High Speed Mode	Feed rates @ 250IPM / Part labeled as part 2 / 100% over ride			2 hr. 41 min.

Hard Milling 420 Stainless with Oil Mist Lubrication:

Machine:	Roku-Roku HC-658 II			
Material:	420SS (52Rc)			
TOOL	DESCRIPTION	RPM	IPM	TIME
T1 = (10mm bull nose e.m.)	2D roughs top and cavity Leaves .012 stock / .075 Z level	6,500	50	2 hr. 21 min.
T2 = (8 mm ball e.m.)	3D roughs cavity leaves .008 stock / .008 step over	9,000	50	1 hr. 36 min.
T3 = (5mm ball e.m.)	Semi-finishes cavity Leaves .0015 stock / .008 step over	12,000	70	1 hr. 02 min.
T4 = (3mm ball e.m.)	Semi-finishes cavity Leaves .0015 stock / .005 step over	20,000	70	1 hr. 13 min.
T5 = (5mm ball e.m.)	Finishes cavity .005 step over	24,000	70	2 hr. 32 min.
T6 = (3mm ball e.m.)	Picks out stock remaining from 5mm ball / .0025 step over	30,000	60	0 hr. 46 min.
T7 = (2mm ball e.m.)	Picks out stock remaining from 3mm ball / .0015 step over	32,000	50	0 hr. 41 min.
TOTAL MACHINE TIME: 10 hr. 11 min.				



Graphite Electrode Machining with Sharp Inside Corners:

Machine:	HC-658 II									
Material:	Graphite	Hardness	N/A							
Cutter	Type	Description	RPM	IPM	Rad/step	Axial/Step	Stock/Left	Prog/Tol	Mode	Time
6mm Bull/1mmR	Diamond	Rough	12000	125	0.1000	0.0250	0.0030	0.0010	Std	4m 43s
6mm Bull/1mmR	Diamond	Finish walls	12000	125	0.0030	0.0030	0.0030	0.0010	Std	7m
Broaching Tool	carbide	Broach corners	N/A	80	0.0200	x	0.0000	0.0002	Std	2m 8s
TOTAL MACHINE TIME: 13m 58s										

HC-548EX

Hard Milling 420 Stainless with Oil Mist Lubrication:

Machine:	HC-548EX									
Material	420SS	Hardness	52Hrc							
Cutter	Type	Description	RPM	IPM	Rad/step	Axial/Step	Stock/Left	Prog/Tol	Mode	Time
6mm Ball	TiAlN	Rough	6420	45	0.1	0.012	0.01	0.001	Std	22m
3mm Ball	TiAlN	Rest Rough	12800	90	0.015	0.003	0.002	0.001	Std	4 m
3mm Ball	TiAlN	Finish	18000	51	0.002	0.002	0	0.0002	Std	53 m
2 mm ball	TiAlN	Fin Channel	27200	51	0.002	0.002	0	0.0001	Prec	10m
1mm Ball	TiAlN	Fin Top	30000	67	0.002	0.002	0	0.0001	Prec	8m
TOTAL MACHINE TIME: 1 hr 37 m										



MODELS AND SPECIFICATIONS



HC-435 II

Machine Options

- Upgrade to 40 Position Tool Changer
- Upgrade to 60 Position Tool Changer
- Semi-Dry Cutting System (Oil Mist)
- Automatic Centering (Blum Infrared Probe)
- Automatic Centering (Renishaw Infrared Probe)
- Full 20mm (7.874") Column Riser (Max Spindle Height 17.7")
- 3R / EROWA Robot Interface Kits
- Pneumatic Side Door for Automation
- 4th and 5th Axis Unit Including Interface
- Transformer: Sized to your application



HC-548EX

Machine Options

- Upgrade to 30 Position Tool Changer
- Semi-Dry Cutting System (Oil Mist)
- Automatic Centering (Blum Infrared Probe)
- Automatic Centering (Renishaw Infrared Probe)
- Rigid Tapping
- Super-J-Cut (Corner Broaching System)
- 3R / EROWA Robot Interface Kits
- Pneumatic Side Door for Automation
- 4th and 5th Axis Unit Including Interface
- Transformer: Sized to your application



HC-658 II & HC 878 II

Machine Options

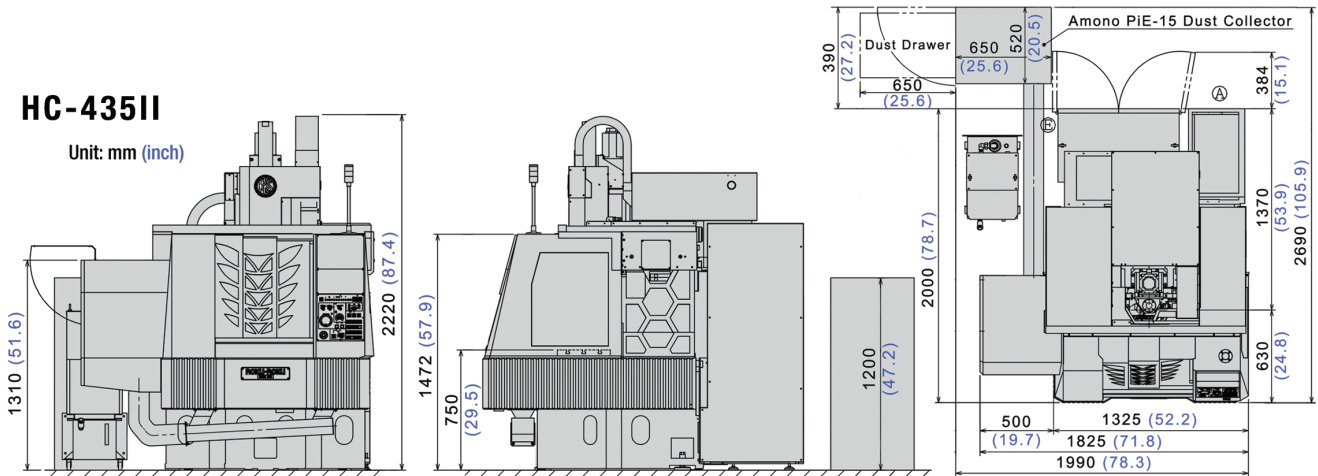
- Upgrade to 40,000 RPM 7.4HP Spindle
- Upgrade to 30,000 RPM 20HP Spindle
- Upgrade to 60 Position Tool Changer
- Flood Coolant System Package (Tank, Nozzle and Coolant Device, Removes Dust Collection System)
- Mist Collection for Flood Coolant System
- Chiller for Flood Coolant System
- Left Hand CNC Control Version
- Semi-Dry Cutting System (Oil Mist)
- Super MAC II Part Probing w/ Renishaw OMP400
- Automatic Centering (Blum Infrared Probe)
- Automatic Centering (Renishaw Infrared Probe)
- Rigid Tapping
- 3R / EROWA Robot Interface Kits
- Pneumatic Side Door for Automation
- 4th and 5th Axis Unit Including Interface
- Transformer: Sized to your application
- HC-878 II Only:
- Chip Conveyor
- Bed Gutter Coolant Rinse

Model	HC-435 II	HC-548EX	HC-658 II	HC-878 II
Spindle Power	5HP	8.4HP	8.4HP	8.4HP
Spindle RPM Range	3,000~36,000	200~32,000	200~32,000	200~32,000
Spindle Tool Holder	HSK E25	HSK E40	HSK E40	HSK E40
Spindle Lubrication Type	Grease Packed	Grease Packed	Grease Packed	Grease Packed
Spindle Cooling	Chilled Oil Jacket	Chilled Oil Jacket	Chilled Oil Jacket	Chilled Oil Jacket
Z-Axis Thermal Compensation	Direct Sensor Type	Direct Sensor Type	Direct Sensor Type	Direct Sensor Type
Linear/Rotary Scales	3-Axis Standard	3-Axis Standard	3-Axis Standard	3-Axis Standard
Table Size	23.6" x 13.0"	23.6" x 14.1"	29.5" x 19.7"	37.4" x 29.5"
Table Height From Floor	29.5"	31.5"	31.5"	33.5"
Max Workpiece Weight	220 lbs.	440 lbs.	440 lbs	440 lbs
X x Y-Axis Travel	16.1" x 13.0"	18.1" x 14.1"	23.6" x 19.7"	33.5" x 29.5"
Z-Axis Travel	7.8"	10.2"	15.7"	16.0"
Table to Spindle Nose Distance	7.0" ~ 14.9"	5.9" ~ 16.1"	7.8" ~ 23.6"	8.8" ~ 24.6"
Max Cutting Feed Rate	394"/min	1,181"/min HS mode	787"/min HS mode	394"/min HS mode
Rapid Feed Rate	590"/min.	1,181"/min.	787"/min.	787"/min.
Positioning Accuracy	+/- 0.000039"	+/- 0.000098"	+/- 0.000060"	+/- 0.000120"
Repeatability	+/- 0.000012"	+/- 0.000039"	+/- 0.000020"	+/- 0.000039"
ATC Tool Number	20	12	30	30
Max Tool Diameter	0.25"	2.36" (3" non-adjacent)	2.36" (3" non-adjacent)	2.36" (3" non-adjacent)
Max Tool Length	3.1"	9.8"	9.8"	9.8"
Max Tool Weight		6.6 lbs.	6.6 lbs.	6.6 lbs.
Machine Weight	5,500 lbs.	8,830 lbs.	12,100 lbs.	15,500 lbs.
Blum Laser	Standard	Standard	Standard	Standard
Corner Broaching	NA	Optional	Standard	Standard
Dust Collector	Amano PIE-15	Amano PIE-30	Amano PIE-30	Amano PIE-30

LAYOUT DRAWINGS

HC-435II

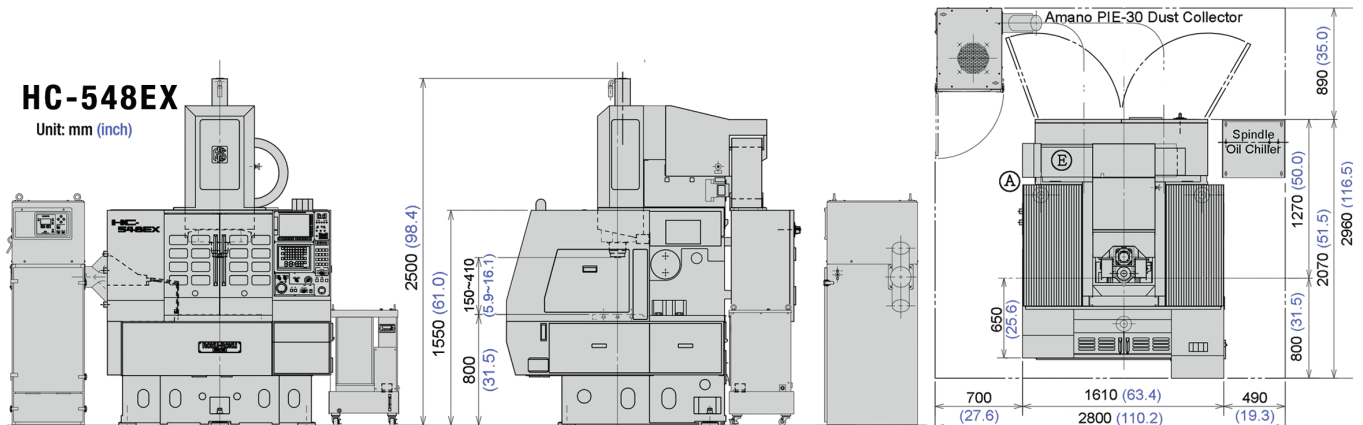
Unit: mm (inch)



Machine Height: 87.4" Installation Footprint: 71.8" x 78.7" (Machine Unit Only) Machine Weight: 5,500lb.
 Power Requirement: 208V ±5%, 60Hz, 12.5kVA (depends on options) Compressed Air Supply: 14.1CFM @ 72psi.

HC-548EX

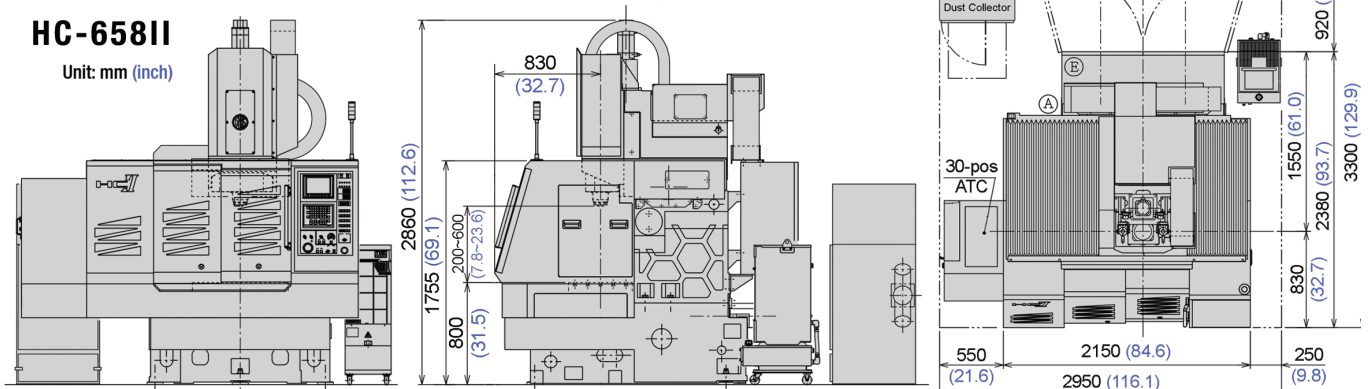
Unit: mm (inch)



Machine Height: 98.4" Installation Footprint: 106.3" x 116.5" Machine Weight: 8,830lb.
 Power Requirement: 208V ±5%, 60 Hz, 22kVA (depends on options) Compressed Air Supply: 21.2CFM @ 72psi.

HC-658II

Unit: mm (inch)



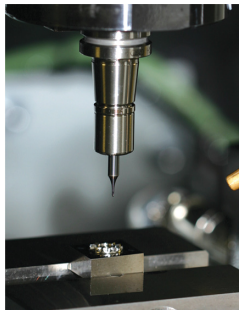
Machine Height: 112.6" Installation Footprint: 116.1" x 129.9" Machine Weight: 12,100lb.
 Power Requirement: 208V ±5%, 60 Hz, 22kVA (depends on options) Compressed Air Supply: 21.2CFM @ 72psi.

MEGA / CEGA

MICRO FINE MACHINING CENTERS

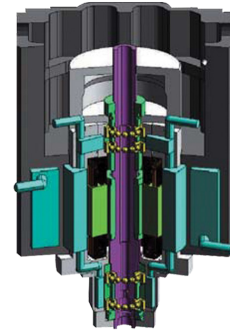
Back in 1996, Roku-Roku was faced with a market challenge: design a machine to meet micro fine machining detail at very high speed. The development concept went to extremes in reaching its specified targets for machining with high precision, high speed, and small cutter diameters. It was in every way an intrepid challenge. After a great deal of market research and examination of current construction methods, Roku-Roku came up with a completely different strategy which resulted in the release of the MEGA prototype. Initially ridiculed as reckless at the time, the MEGA won praise from the market which started its evolutionary process of improving the machine's dynamic balance, axis response and thermal stability bringing us to the 6th generation MEGA SSS design (now available in a 400 and 600 version with spindle speeds of 40,000 and 60,000 RPM respectively.)

When the need arose for a larger more powerful version of the MEGA, the CEGA was born and through the same process of evolution has now become the CEGA SSS-300 model using a higher horse power 30,000 RPM spindle, or the SSS-400 using a 40,000 RPM spindle depending on your application.



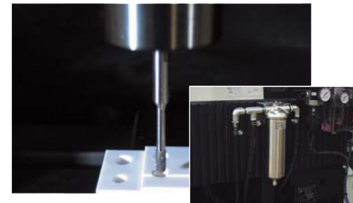
COMMITMENT TO DYNAMIC BALANCE

High accuracy and fine surface finish are products of a dynamically balanced spindle and Tool Holder System. Roku-Roku designs their integral motor spindles with the finest materials available, including special ceramic bearings, to achieve a dynamic run-out at the spindle taper of 0.5 μm . Combined with an ultra-fine $\pm 0.2^\circ \text{F}$ precision double-layered oil circulation jacket and HSK-E25 / HSK-E40 tool holders, this allows continuous operation with maximum speed producing beautiful seamless surface finish with multiple tools.



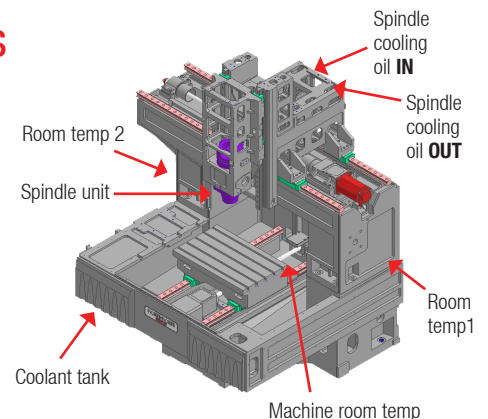
EXPANDING APPLICATIONS

Both the MEGA and CEGA Series have the ability to add the "RG Machining" package which provides a precision grinding function with high-speed chopping function, dual dust preventative covers for the Y-axis screw and ways, and a 100 μm mesh sludge filter. Adding the 150,000 RPM Turbine Spindle device elevates RG Machining capability to true CNC jig grinder status providing optimum cutter surface speed for ultra-small diameter tools. The turbine spindle is attached and removed automatically by the ATC and provides a tool shank diameter of 4mm.



SPECIAL OPTION PACKAGES

Both the MEGA and CEGA Series have the ability to add the "M-Kit" Accuracy & Productivity Monitoring System which combines seven (7) thermal sensors that can be connected to a data logger to monitor and record the behavior of the machine in your environment. The kit includes temperature displays for the room, machining area, spindle, spindle oil cooling, machine casting, coolant, linear motors and linear scales. The goal of this system to achieve actual workpiece machining accuracy to within $\pm 1.5\mu\text{m}$.



APPLICATIONS EXAMPLES

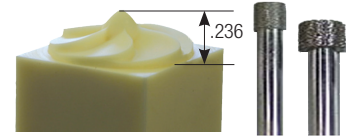


Material: Alumina (Al₂O₃ 99.5%)
Hardness: HV1800
Work Size: .787 x .787 x .787"

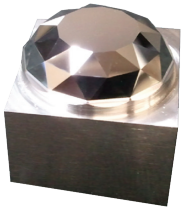
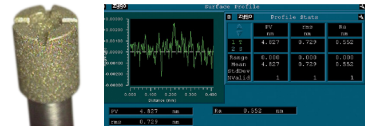
MEGA SSS-400

Machining Alumina by Electro-Plated Diamond Grinding Wheel:

Machining Conditions			
Major process	Tool used	Feed rate mm/min	Sp speed RPM
Roughing	φ3.0 Square diamond plated grinding stone	1,000	35,000
Roughing 2	R1.0 Ball diamond plated grinding stone	1,500	35,000
Finishing	R0.5 Ball diamond plated grinding stone Cycle time : 7 hours 24 minutes	1,500	35,000



Surface Finish:
0.552nm Ra



Material: Micro Grain Carbide AF1
Hardness: 92.5HRA
Work Size: .787 x .787 x .787"

Tungsten Carbide Flat Surface Machining:

Machining Conditions						
Process	Tool used	Rotation	Feed rate mm/min	Sp speed min-1	Slit XY X	rest
Roughing	R2.0 Diamond coated end mill	24,000	240	30,000	0.35 0.15	0.05
Semi-fin	R2.0 Diamond coated end mill	24,000	240	30,000	0.03	0.01
Finishing	8.0 Diamond electric coat grinding stone	4,000	200		0.1 0.001	0

Finishing tool: Special diamond electric coat grinding stone for cemented carbide
Coolant: Water-soluble coolant oil
Cycle time: 50h

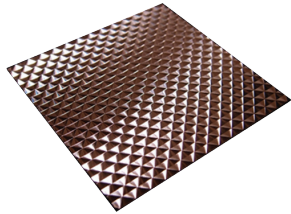
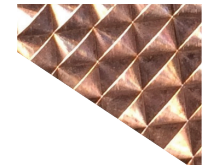
MEGA SSS-600

Copper Mirror Finish Micro-Tool Machining:

Machining Conditions			
Process	Tool used	Feed rate mm/min	Sp speed min-1
Roughing	R1.0 Ball end mill	2,500	30,000
Semi-finishing	R0.3 Ball end mill	500	50,000
Finishing	R0.3 Luminous DCL	200	50,000

Cycle time: 60 hours

Surface Finish:
0.032μm Ra



Material: Copper
Work Size: 2.0 x 2.0 x .787"
Finishing Pass Depth: 0.0002"

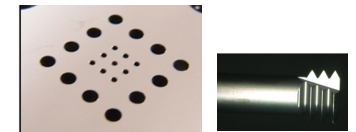
CEGA SSS-300

Top Surface Finishing with Drilling and Tapping in Carbide:

Machining conditions				
Process	Tool used	Depth mm	Feed rate mm/min	Sp speed min-1
Φ1.0 Drill	Diamond coated drill UDCMX 2100-100	-8.0	7.5	20,000
Φ0.4 Drill	Diamond coated drill UDCMX 2040-040	-3.2	5.0	30,000
M4 Tap	Diamond coated thread milling UDCT M4-0.7-8	-7.0	10	20,000

Cycle time : Φ1.0 : 1 minutes 6 seconds / Hole 0.4 : 41 seconds / Hole
M4 Tap : 3 minutes 20 seconds / Hole (Helical threading)

Surface Finish:
0.905nm Ra

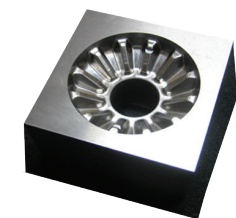
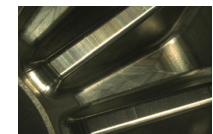


Material: Carbide G3 (VM-400)
Hardness: 90HRA
Work Size: .787 x .787 x .394"

Cold Forging Die Machining is Carbide:

Machining conditions			
Process	Tool used	Feed Rate	Sp Speed
Roughing	φ4 Grinding stone	1,500	30,000
Semi-finishing	φ2 Grinding stone	337	30,000
Simi-finishing	φ2 Grinding stone	350	30,000
Finishing	R1.0	350	under 30,000

Diamond coated Ball end mill
Cycle time: P 12 hours



Material: Carbide VM-50 (87.5HRA)
Gear Size: φ1.575" Depth=0.453"
Finish tool: R0.04" Ball end mill

MODELS AND SPECIFICATIONS



MEGA SSS-400/600

Available Options

- Upgrade to 40 Position Tool Changer
- Upgrade to 60 Position Tool Changer
- Super MAC II-Part Probe (OMP400)
- Super TMS (M&S ONE Touch Laser Tool Calibration)
- Forty (40) Position Automatic Pallet Changer (AHC)
- Semi-Dry Cutting System (Oil Mist + Collector)
- M-Kit (7-Sensor Thermal Data Logger)
- 130mm Column Riser (Max. Spindle Nose Height of 14.96")
- Large Capacity Coolant Tank (40-gal.)
- Large Capacity Coolant Tank Chiller
- 3R / EROWA Robot Interface Kits
- Pneumatic Side Door for Automation
- RG Machining Function (Chopping/Jig Grinding)
- Three (3) Color Patrol Light (Replaces std. 2 Color Light)
- 4th and 5th Axis Unit Includes Interface Kit
- Transformer: Sized to your application



CEGA SSS-300/400

Available Options

- Upgrade to 40 Position Tool Changer
- Upgrade to 60 Position Tool Changer
- Super MAC II-Part Probe (OMP400)
- M-Kit (7-Sensor Thermal Data Logger)
- Sixty (60) Position Automatic Pallet Changer (AHC)
- Schedule Management B
- Chip Wash Cycle with Coolant Bed Flow
- Chip Bucket Sets for Chip Receiver
- Rigid Tapping
- RG Machining Function (Chopping/Jig Grinding)
- Three (3) Color Patrol Light (Replaces std. 2 Color Light)
- Precision Filter Device for Graphite, Carbide & Ceramic Machining
- Spare Filter for Precision Filter Device
- Large Capacity Coolant Tank with Chiller (80 gal.)
- 3R / EROWA Robot Interface Kits
- Pneumatic Side Door for Automation
- X-Axis Guide Cover (Protection for Graphite, Carbide & Ceramic Machining)
- 4th and 5th Axis Unit Includes Interface Kit
- Transformer: Sized to your application



ZEUS (Z-86)

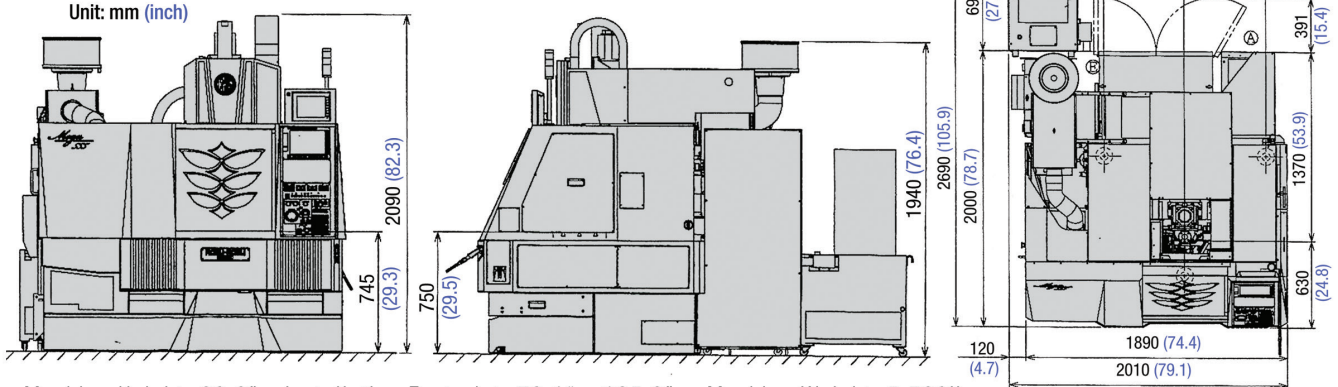
Available Options

- Upgrade to 60 Position Tool Changer
- Automatic Centering (Blum Infrared Probe)
- Super MAC II-Part Probe (OMP400)
- Semi-Dry Cutting System (Oil Mist + Collector)
- Rigid Tapping
- Air Blow
- Automatic Greasing for Axis Guides and Ball Screws
- Large Capacity Coolant Tank with Chiller (100 gal.)
- Mist Collector
- RG Machining Function (Chopping/Jig Grinding)
- 3R / EROWA Robot Interface Kits
- Pneumatic Side Door for Automation
- 4th and 5th Axis Unit Includes Interface Kit
- Transformer: Sized to your application

Model	MEGA SSS-400/600	CEGA SSS-300/400	ZEUS (Z-86)
Spindle Power	4.7HP	20HP/7.4HP	20HP
Spindle RPM Range	3,000~40,000/60,000	200~30,000/3,000-40,000	200~25,000
Spindle Tool Holder	HSK E25	HSK E40	HSK E40
Spindle Lubrication Type	Oil Mist	Oil Mist	Oil Mist
Spindle Cooling	Chilled Oil Jacket	Chilled Oil Jacket	Chilled Oil Jacket
Z-Axis Thermal Compensation	Direct Sensor Type	Direct Sensor Type	Direct Sensor Type
Linear/Rotary Scales	3-Axis Standard	3-Axis Standard	3-Axis Standard
Table Size	23.6" x 13.0"	25.6" x 16.1"	37.4" x 23.6"
Table Height From Floor	29.5"	29.5"	37.4"
Max Workpiece Weight	220 lbs.	440 lbs.	1,763 lbs
X x Y-Axis Travel	16.1" x 13.0"	20.0" x 16.1"	31.5" x 23.6"
Z-Axis Travel	7.8"	12.2"	15.7"
Table to Spindle Nose Distance	1.9" ~ 9.8"	5.9" ~ 18.1"	7.8" ~ 23.6"
Max Cutting Feed Rate	393"/min	394"/min	315"/min 590 HS mode
Rapid Feed Rate	590"/min.	590"/min.	590"/min.
Positioning Accuracy	+/- 0.000039"	+/- 0.000039"	+/- 0.000080"
Repeatability	+/- 0.000012"	+/- 0.000020"	+/- 0.000030"
ATC Tool Number	20	20	30
Max Tool Diameter	0.25"	2.36" (3" non-adjacent)	2.75" (3" non-adjacent)
Max Tool Length	3.1"	9.8"	7.8"
Max Tool Weight		6.6 lbs.	8.8 lbs.
Machine Weight	5,732 lbs.	11,000 lbs.	17,637 lbs.
Blum Laser	Standard	Standard	Standard
Flood Coolant	Standard	Standard	Standard
Fluid Tank Capacity	37 gal.	53 gal.	62.5 gal.

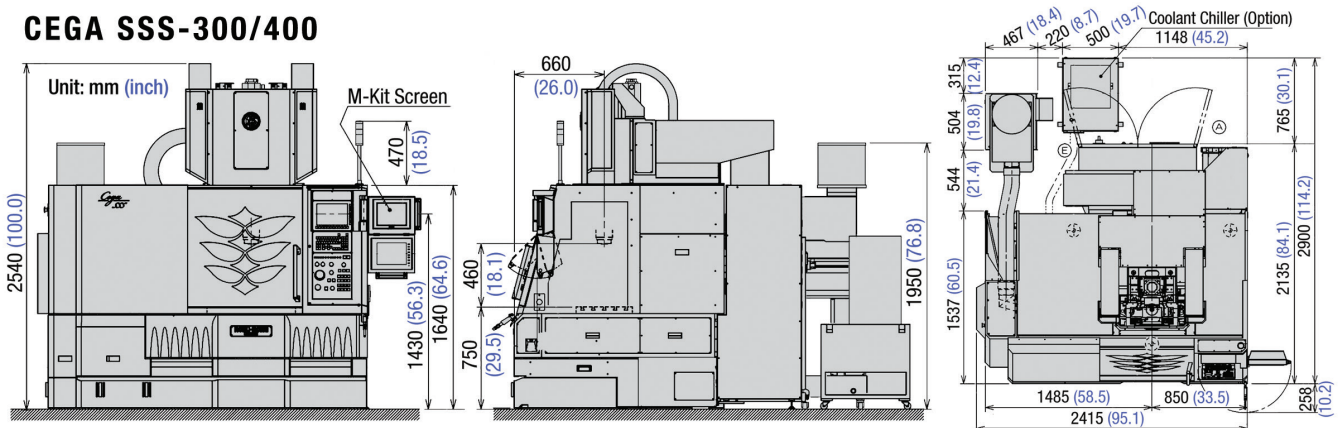
LAYOUT DRAWINGS

MEGA SSS-400/600



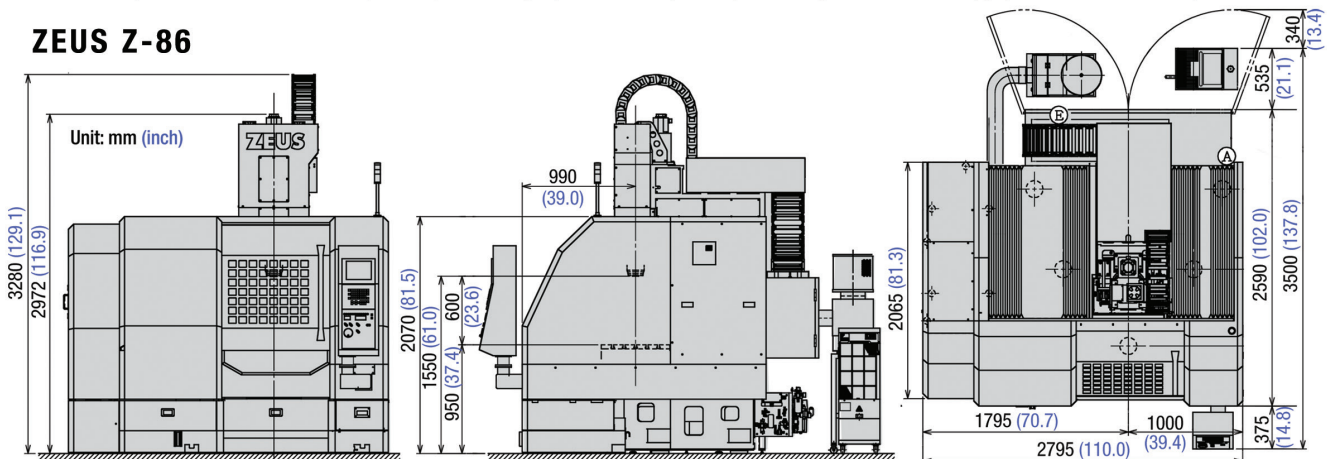
Machine Height: 82.3" Installation Footprint: 79.1" x 105.9" Machine Weight: 5,732lb.
 Power Requirement: 208V ±5%, 60Hz, 14.0kVA (depends on options) Compressed Air Supply: 14.1CFM @ 72psi.

CEGA SSS-300/400



Machine Height: 100.0" Installation Footprint: 95.1" x 114.2" Machine Weight: 11,000lb.
 Power Requirement: 208V ±5%, 60Hz, 32kVA (depends on options) Compressed Air Supply: 14.1CFM @ 72psi.

ZEUS Z-86



Machine Height: 129.1" Installation Footprint: 110.0" x 137.8" Machine Weight: 17,640lb.
 Power Requirement: 208V ±5%, 60Hz, 32.5kVA (depends on options) Compressed Air Supply: 17.5CFM @ 72psi.

ANDROID II / VISION 300/600

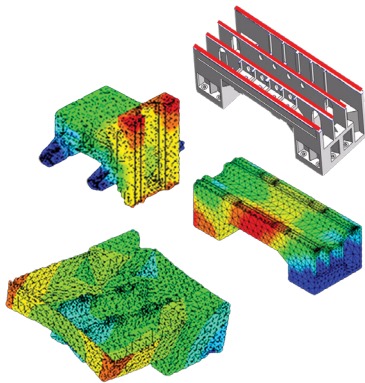
ULTRA PRECISION MICRO FINE MACHINING CENTERS

In order to answer escalating new demands in Ultra-High-Accuracy Micro-Machining, Roku-Roku has thrown off the expectations of the past to create the Android II and Vision 300/600 models, which places the machine and operator in an entirely new relationship. The machine is a pleasure to operate thanks to the elimination of all factors that degrade precision, pushing micromachining hardware as far as it can go while using an operator interface that visualizes data on the behavior of the machine. This allows the operator to perfectly grasp minute-by-minute positional changes in behavior during machining bringing his or her abilities to the maximum.



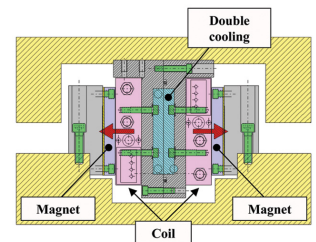
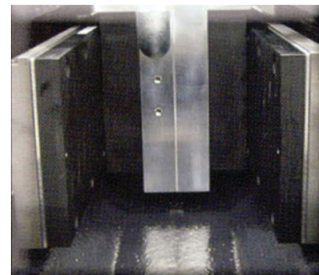
HIGH-RIGIDITY BASIC STRUCTURE

A heat symmetric basic frame structure, designed by Finite Element Analysis (FEA), uses a high-grade cast iron base with Roku-Roku's traditional box-shaped 3-point support system and a 3-layer hollowed cross rail structure with rational rib placement to ensure twist rigidity against spindle head motion while lowering weight. A reduction in thermal displacement is effectively achieved with forced ventilation through the hollow ribbed structures. By creating an ideal rib distribution in the table and saddle, a balance of high-rigidity and reduced weight are obtained for high-motion response. An ideal axis configuration is one of no overhang throughout the machining range, both X and Y-axes. The drive axes are structured separately to thoroughly control mass eccentricity while eliminating factors that could alter orientation.



HORIZONTALLY-OPPOSED LINEAR DRIVE

A system of two horizontally opposed flat linear motors are used in each axis, X, Y, & Z, to cancel out all of the attraction forces completely, suppressing moving objects and eccentric loads on the slide-ways caused by the powerful magnets in the linear motors. To address the heat sources, a double cooling system is used between the heat generating coils and their mounting surfaces. Absolute movement accuracy is maintained with a fully closed loop linear glass scale system with an incredible 0.002 μm (2nm) resolution providing an actual machining precision of $\pm 1 \mu\text{m}$.



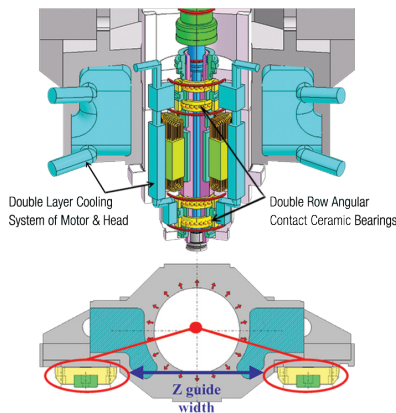
A-H.I.S. CONTROL HIGH-PERFORMANCE SPINDLE

A dual layer cooling system is the heart of the Advanced Heat Isolation System on these machines. The high RPM integral motor spindle uses a direct forced oil cooling system combined with a wide-range jacket separating the spindle head from the casting. Complete heat isolation can be achieved. Perfect control of the coolant temperature is provided by an in-line type oil chiller unit. A system involving centralized exhaust and outside air flow prevents hot air from collecting at the spindle.

An innovative approach to the spindle head design brings the spindle centerline extremely close to the Z-axis guide-ways providing ultimate stability for high-speed Z-axis movement used in micro drilling and chop grinding. This Location combined with the casting cooling jacket, also suppresses displacement in the Y-axis.

SPECIAL OPTION PACKAGES

Both the Android II and Vision Series have the ability to add the "Advanced M-Kit" Ultra-High Accuracy & Productivity Monitoring System which works the same as the MEGA/CEGA version, but combines sixteen (16) thermal sensors that can be connected to a data logger to monitor and record the behavior of the machine in your environment. The goal of this system to achieve actual workpiece machining accuracy to within $\pm 1.0 \mu\text{m}$.



APPLICATIONS EXAMPLES

*Android II
Vision*

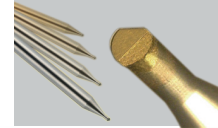


Material: Micro Grain Carbide, AF-1
Work size: .4 x .4 x .787"
Hardness: 92.5HRA
Finish Pass Step Over: 0.00012"

*Single NANO" Finish on Tungstan Carbide Mold Machining: Android II

Machining Conditions			
Process	Tools	Feed Rate in/min	Spindle Speed RPM
Roughing	Diamond coated R2.0 Ball end mill	7.9	24,000
Semi-finishing	PCD R0.02" Ball end mill	11.8	40,000
Finishing	PCD R0.02" Ball end mill	7.9	40,000
Cycle time: 7 hours 10 mintes			

Finishing Cutter: 50Nm particle size single-phase polycrystalline diamond binder-less ball end mill.
Surface Finish: 0.00567µm Ra
Measured by: ZYGO New View 7100



Material: POLMAX
Work size: 1.2x1.2x1.2"
Hardness: 52HRC
Finish Pass Step Over and Depth: X, Y - 0.0002 Z - 0.0002"

Mirror Finishing on a 3D Mold Surface: Vision 300/600 or Android II

Machining Conditions			
Process	Tool Used	Feed Rate in/min	Spindle Speed RPM
Roughing	R0.08" Ball end mill	78.7	16,000
Semi-finishing	R0.08" Ball end mill	39.4	16,000
Finishing	R0.08" Ball end mill	15.7	20,000
Cycle time 3 hours			

Surface Finish: 0.018µm Ra
Measured by: ZYGO New View 7100



Micro Drilling Example: Vision 300/600 or Android II

Machining conditions			
Process	Tool used	Spindle Speed min	Feed rate mm/min
Centering	Φ0.02 x 0.06 Centering drill	12,000	3
Drilling	Φ0.023 x 0.25 Micro drill	12,000	3
Cycle time: 40 seconds / Hole (8 hr 16 min 40 sec for 745 holes)			

This **Micro Drilling Sample** shows off the ability of the Vision 300/600 or Android II to maintain thermal stability over long time periods.

Material: Photoveel II S
Hold diameter: Φ0.0009"
Pitch: 0.002"
Depth: 0.007" (Through hole)

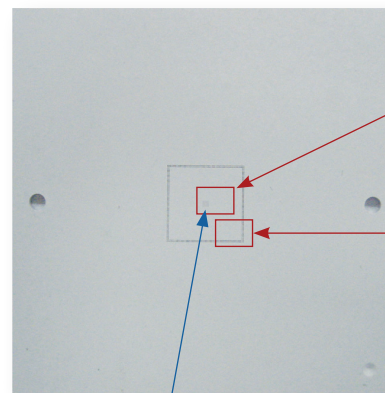


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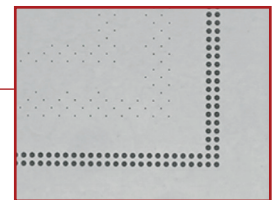
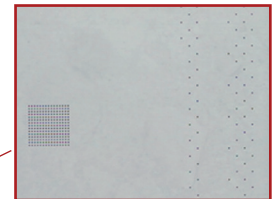


Image zoomed for detail

Circle Test: Vision 300/600 or Android II

Machining Conditions	
Tool Used	End Mill ø6.0mm 4 flutes
Material	Brass
Size	ø60mm t=3mm Outer Circle
Feedrate	200mm/min.
Cutting Depth	0.02mm
Cutting Direction	CW
Room Temp.	73.5° F
Measured by	Talyrond 365 (Taylor Hobson)

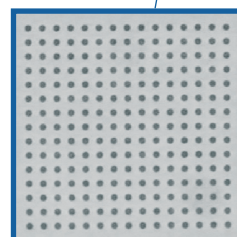
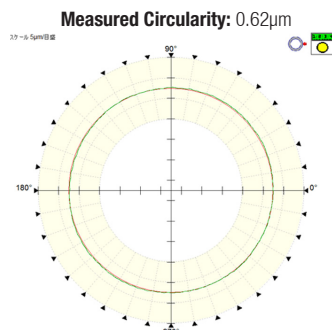
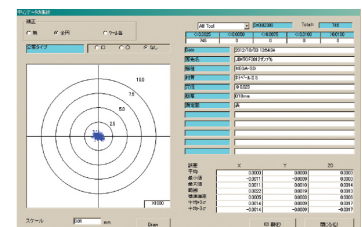


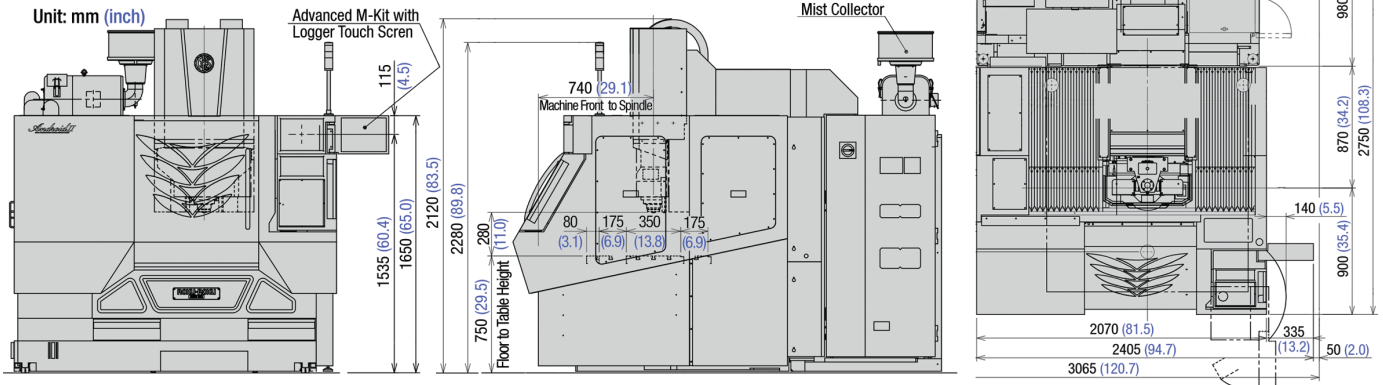
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745 Hole Position Accuracy :
±0.00006" (±1.5 µm)



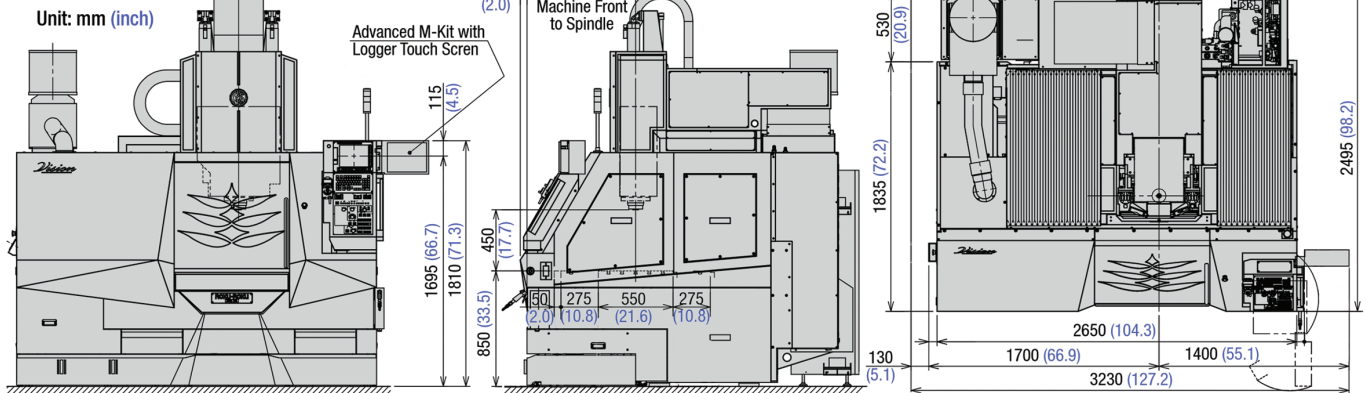
Measured by Mitutoyo
(SQV606-PRO5G)

ANDROID II



Machine Height: 89.8" Installation Footprint: 94.7" x 108.3" Machine Weight: 5,732lb.
 Power Requirement: 208V ±5%, 60Hz, 19.0kVA (depends on options) Compressed Air Supply: 14.1CFM @ 72psi.

VISION



Machine Height: 115.0" Installation Footprint: 127.2" x 107.7" Machine Weight: 19,180lb.
 Power Requirement: 208V ±5%, 60Hz, 36kVA (depends on options) Compressed Air Supply: 14.1CFM @ 72psi.

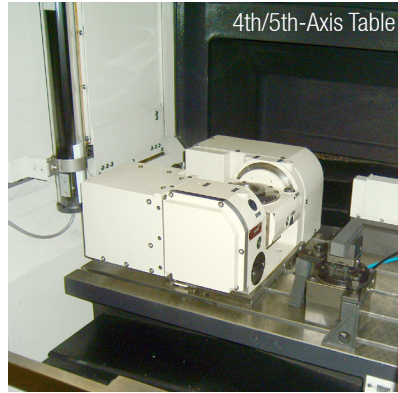
Machine Specifications:

Available Machine Options: Android II & Vision 300/600

- Upgrade to 40 Position Tool Changer
- Upgrade to 60 Position Tool Changer
- Super MAC II Part Probe w/2mm Stylus & Auto Centering Function (OMP400)
- Coolant Nozzle (2-Pieces)
- 150mm Column Riser Package (Max Spindle Height 23.8")
- RG Machining Function (Chopping/Jig Grinding)
- CCD Camera w/ 15" Monitor (60-120X Variable Zoom)
- Advanced M-Kit (Special Software with Operator Information and 16 Thermal Readouts)
- 150,000 RPM Air Turbine Spindle Kit (ATC Changeable)
- One (1) 150,000 RPM Air Turbine Spindle Replacement
- Additional M&H Double TMS Device (Used with Air Turbine Spindle)
- Three (3) Color Patrol Light (Replaces std. 2 Color Light)
- Precision Filter Device for Graphite, Carbide & Ceramic Machining
- Spare Filter for Precision Filter Device
- X-Axis Guide Cover (Protection During Wet Graphite, Carbide & Ceramic Machining)
- Handy-Type Data Logger for the Advanced M-Kit
- Transformer: Sized to your application
- Vision 300/600 Only:
- Air Blow
- Vision Type Non-Contact Tool Measure (DYNALINE)

Model	Android II	VISION 300/600
Spindle Power	5 HP	20 HP
Spindle RPM Range	3,000~60,000	200~30,000/3,000~60,000
Spindle Tool Holder	HSK E25	HSK-E40/HSK-E25
Spindle Lubrication Type	Oil Mist	Oil Mist
Spindle Cooling	Chilled Oil Jacket	Chilled Oil Jacket
Z-Axis Thermal Compensation	Direct Sensor Type	Direct Sensor Type
Linear/Rotary Scales	3-Axis Standard	3-Axis Standard
Table Size	21.6" x 13.8"	29.5" x 21.6"
Table Height From Floor	29.5"	33.5"
Max Workpiece Weight	220 lbs.	660 lbs.
X x Y-Axis Travel	17.7" x 13.8"	25.6" x 21.6"
Z-Axis Travel	7.8"	11.8"
Table to Spindle Nose Distance	3.1" ~ 11.0"	5.9" ~ 17.7"
Max Cutting Feed Rate	590"/min	390"/min
Rapid Feed Rate	590"/min.	590"/min
Positioning Accuracy	+/- 0.000039"	+/- 0.000039"
Repeatability	+/- 0.0000079"	+/- 0.0000079"
ATC Tool Number	20	20
Max Tool Diameter	0.236"	1.77"
Max Tool Length	3.1"	7.87"
Max Tool Weight		3.3 lbs.
Machine Weight	12,787 lbs.	19,180 lbs.
Blum Laser	Standard	Standard
Flood Coolant	Standard	Standard
Fluid Tank Capacity	53 gal.	68 gal.

MULTI-AXIS / AUTOMATION



Roku-Roku's FANUC 31i-B5 control provides the ability to add a 4th or 5th axis unit to any of the machine models vastly expanding their capability to handle multi-axis machining type work. A variety of different unit sizes and manufactures are available to be interfaced to the machines to meet the exact specifications of your application's size and accuracy requirements.

AUTOMATION CHANGES EVERYTHING

Mitsubishi EDM and Roku-Roku high-speed VMCs are in more automated installations than any other manufacturer. From modular cells to fully automated storage and inventory systems, our automation systems will allow you to run back-to-back jobs with virtually no supervision – helping you drive incredible profits and blow the competition away.

Roku-Roku offers their own single machine 24 to 45 position Pallet Handling Systems to support metal or graphite applications. MC Machinery and Roku-Roku have developed special automated solutions to increase EDM throughput as well, for example, an automated cell integrating a Roku-Roku HC-548EX can machine graphite electrodes to be stored and used on a Mitsubishi Sinker EDM – allowing many operations to take place unattended. A special capability Roku offers is the ability to invert the machine control/ATC unit over to the left side for convenient dual-machine automation serving both machines from a single centralized robot.

Several single machine configurations are also available.



Roku Automation



Erowa Automation



System 3R Automation
Roku and Mitsubishi SEDM



System 3R Automation
LH Control Roku provides side by side installation
Available on HC-658II only



Mitsubishi Automation

FULL 5-AXIS CONTROL

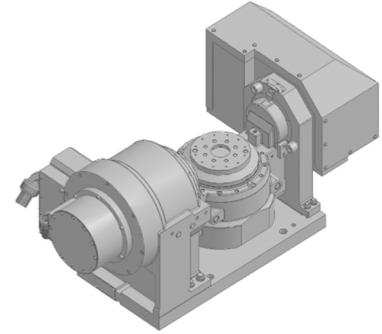


FANUC CONTROL UPGRADE

Roku-Roku has been able to expand the machine controller to work in the world of Simultaneous 5-Axis Machining by adding the NC Package for 5-Axis Machining for the already powerful I FANUC 31 i-B5 CNC Control.

This package includes:

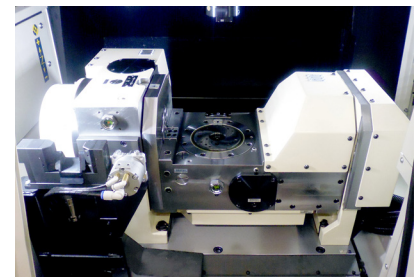
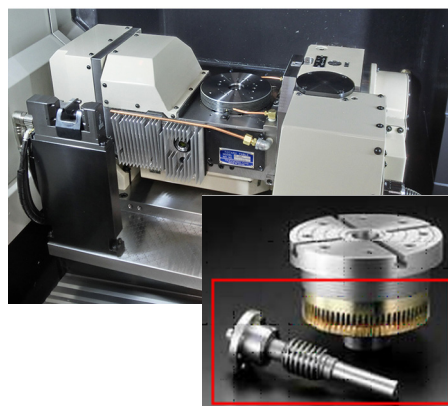
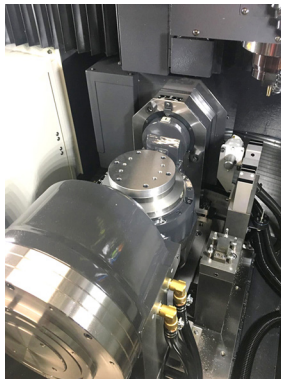
- High-speed smooth TCP
- Tool center point control
- Smooth TCP
- Tool posture control
- Cutting point command
- Expansion of axis move command in tool center point control
- Three-dimensional cutter compensation
- Tilted working plane command
- Multiple command of tilted working plane indexing
- Tool axis direction control
- Expansion of the way to set 5-axis machining function parameters
- Tolerance control



ROKU-ROKU & Tsudakoma

Roku-Roku and Tsudakoma teamed up to design the best two-axis rotary tables to fit the exacting requirements set by the machines themselves. These Ultra-Precision tables are available in both a Direct Drive RTT-216 model specifically designed to complement the Linear Drive System of the Android II-5AXP for high-speed positioning, the RT-261 which is a Worm Drive table used on both the Android II-5AXP and the CEGA SSS-5AXP providing improved thermal stabilization, and the RT-110 also a Worm Drive table specifically designed a bit smaller to fit the MEGA SSS-5AXP platform. High-Value Added Specifications:

- Special table design includes optical rotary scale feedback on both axes.
- A pneumatic clamping system ensures strong support rigidity for both the tilt and rotary axes.
- High efficiency, high precision and best surface finishes can be optimized by utilizing the tilt and rotary axes. Shorter length tools improves tool rigidity and reduces dynamic tool run-out while improving surface quality and extending tool life.
- Tables are designed to accept major manufactures tooling systems such as EROWA and System 3R.



APPLICATIONS EXAMPLES

Roku-Roku 5-AXIS

Powered Metal Mold Carbide Punch



Conventional Processing

1. Profile Grinding w Diamond Wheel
2. CNC Sinker EDM (requires electrodes)

Cycle Time: 120 hrs.

ANDROID II-5-AXP Method

Machining by 5-Axis High Speed Mill

Cycle Time: 24 hrs.



Material: Nylon

Work Size: Ø3.0" x 6.0

Blue Globe

Machining Conditions			
Process	Tool used	Feed rate mm/min	Sp speed min-1
Roughing	12mm Ball end mill	3,020	20,000
Semi-finishing	8mm Ball end mill	4,528	30,000
Finishing	6mm Ball end mill	3,000	40,000
Engraving	1mm Ball end mill	740	50,000

Cycle time: 1 hour

Surface Finish: 0.4µm Ra

Finishing Pass Depth: 0.025mm



Material: H13 Hardened

Hardness: Hrc 52

Work Size: 50mm x 50mm x 50mm

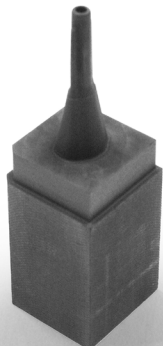
Cap

Machining Conditions			
Process	Tool used	Feed rate mm/min	Sp speed min-1
Roughing	6mm Ball end mill	1,990	13,260
Semi-finishing	5mm Ball end mill	2,055	10,820
Finishing	2mm Ball end mill	2,315	44,560

Cycle time: 1.5 hours

Surface Finish: 0.5µm Ra

Finishing Pass Depth: 0.05mm



Material: POCO 3 Graphite

Work Size: 25mm x 25mm x 100mm

Graphite Part

Machining Conditions			
Process	Tool used	Feed rate mm/min	Sp speed min-1
Roughing	6mm Ball end mill	1,900	16,000
Semi-finishing	3mm Ball end mill	3,000	28,000
Finishing	1mm Luminous DCL	2,500	40,000

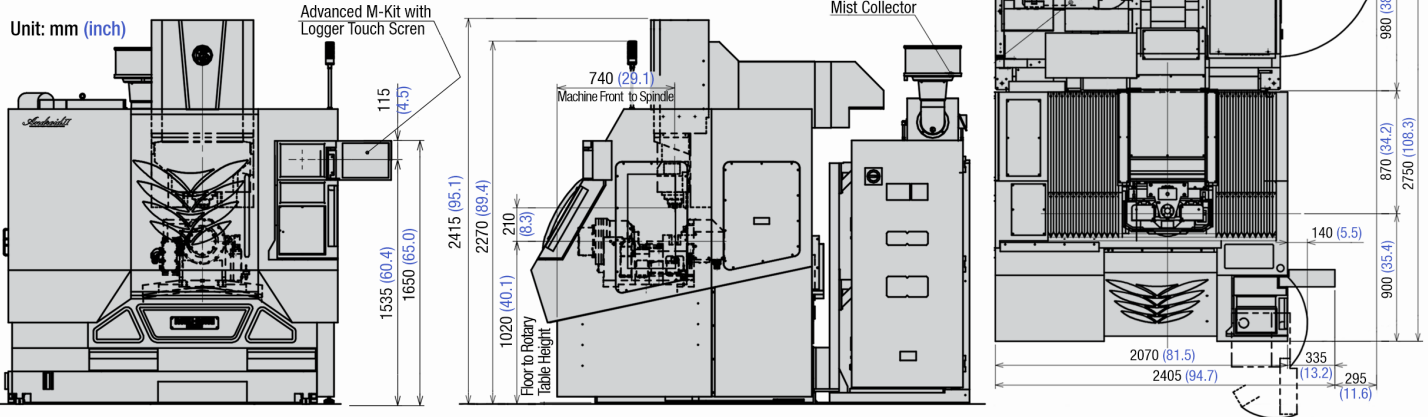
Cycle time: 30 minutes

Surface Finish: 0.3µm Ra

Finishing Pass Depth: 0.05mm

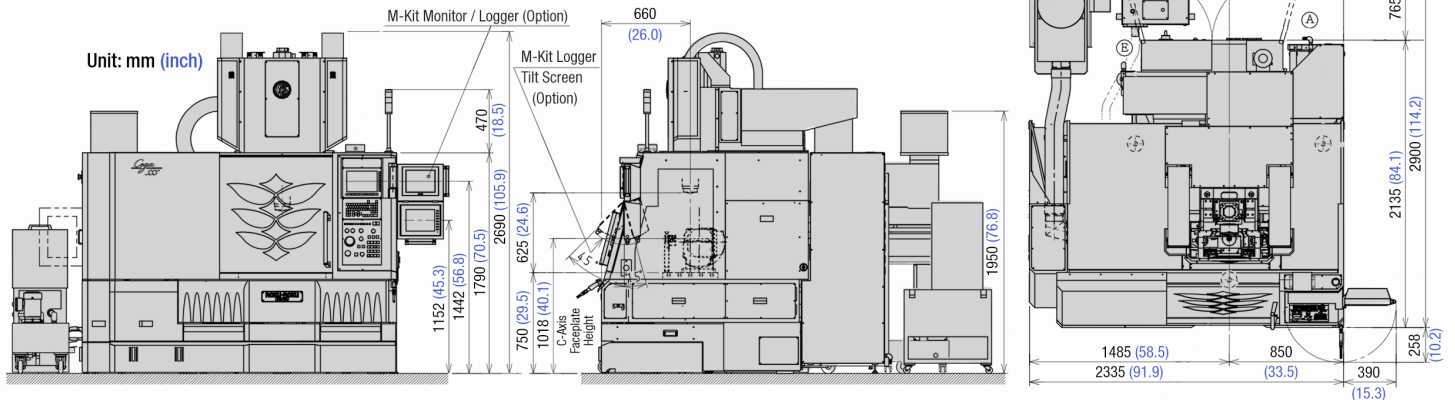
5AXP LAYOUT DRAWINGS

ANDROID II



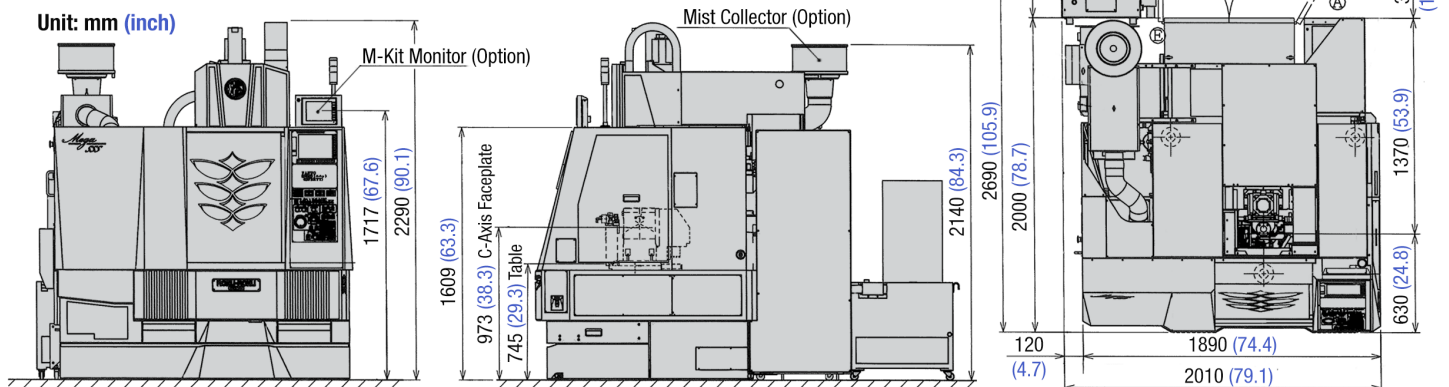
Machine Height: 95.1" Installation Footprint: 94.7" x 108.3" Machine Weight: 14,109lb.
 Power Requirement: 208V ±5%, 60Hz, 27.5kVA (depends on options) Compressed Air Supply: 14.1CFM @ 72psi.

CEGA SSS



Machine Height: 105.9" Installation Footprint: 94.7" x 114.2" Machine Weight: 12,100lb.
 Power Requirement: 208V ±5%, 60Hz, 32kVA (depends on options) Compressed Air Supply: 14.1CFM @ 72psi.

MEGA SSS



Machine Height: 90.1" Installation Footprint: 79.1" x 105.9" Machine Weight: 6,173lb.
 Power Requirement: 208V ±5%, 60Hz, 14.1kVA (depends on options) Compressed Air Supply: 14.1CFM @ 72psi.

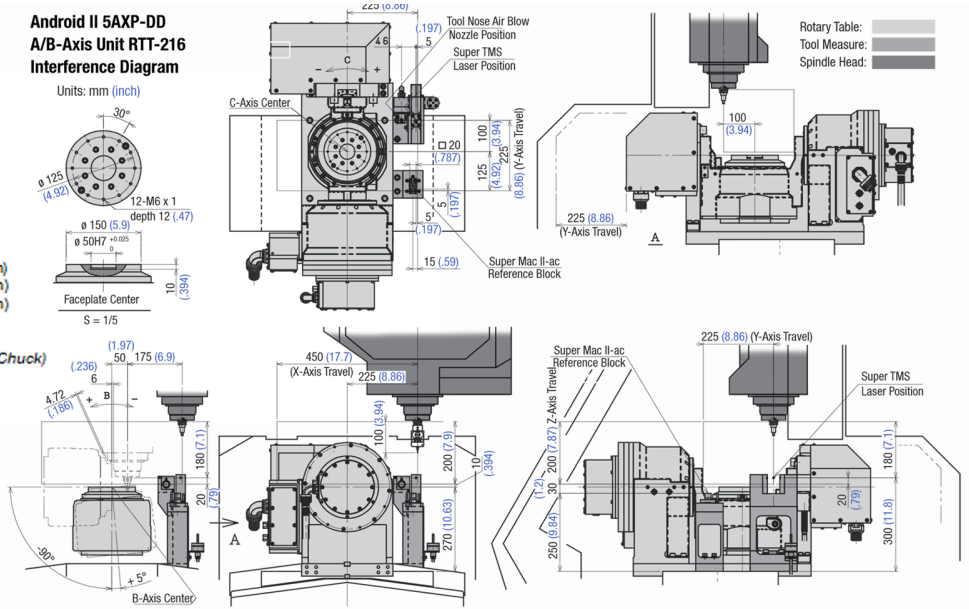
5AXP ROTARY Interference Drawings

RTT-216 Table Specifications Android II-5AXP

Rotary Table Faceplate Size	5.9" (150mm)
Max. Load Capacity	66 lb. (30kg)
Table Height from Floor	40.1" (1020mm)
Tilting Angle Range	-90° ~ +5°
Max. Rotation Speed Rotary Axis	150 RPM
Max. Rotation Speed Tilt Axis	100 RPM
Reduction Ratio Rotary Axis	1/1
Reduction Ratio Tilt Axis	1/1
Servo Torque Rotary Axis	25.8 ft. lb. (35N.m)
Servo Torque Tilt Axis	142.1 ft. lb. (170N.m)
Clamping Torque (brake) Rotary Axis	125.4 ft. lb. (150N.m)
Clamping Torque (brake) Tilt Axis	368.8 ft. lb. (500N.m)
Indexing Accuracy Rotary Axis	± 4 arcsec
Indexing Accuracy Tilt Axis	± 4 arcsec
Open Height from 5X Table to Max. Z Travel	99.6" (253mm) (No Chuck)
Max Part Diameter on Faceplate	7.87" (200mm)
Distance from Table Top to Face of 5X table	11.0" (254mm)
Distance from Rotary Faceplate to Spindle Nose	7.9" (200mm)

Android II 5AXP-DD A/B-Axis Unit RTT-216 Interference Diagram

Units: mm (inch)



Rotary Table:
Tool Measure:
Spindle Head:

Android II 5AXP-WG CEGA SSS 5AXP-WG A/B-Axis Unit RT-261 Interference Diagram

Units: mm (inch)

Rotary Table:
Tool Measure:
Spindle Head:

RT-261 Table Specs Android II & CEGA SSS-5AXP

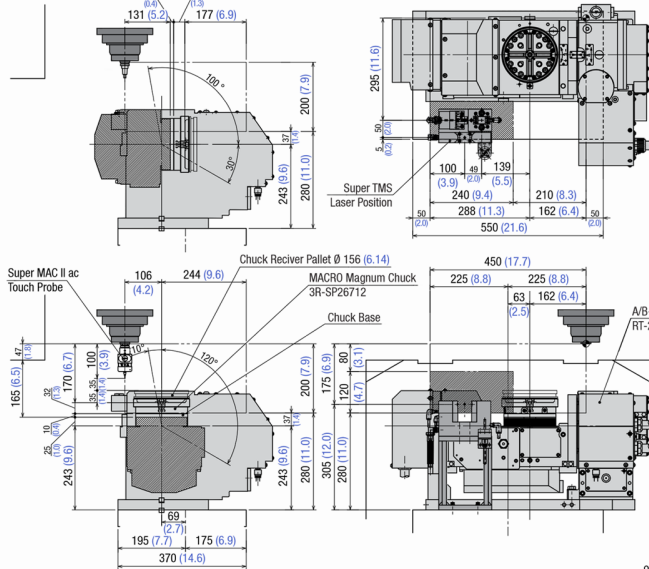
Rotary Table Faceplate Size	5.9" (150mm)
Max. Load Capacity	44 lb. (20kg)
Table Height from Floor	40.1" (1018mm)
Tilting Angle Range	-120° ~ +10°
Max. Rotation Speed Rotary Axis	22.2 RPM
Max. Rotation Speed Tilt Axis	12.5 RPM
Reduction Ratio Rotary Axis	1/180
Reduction Ratio Tilt Axis	1/240
Servo Torque Rotary Axis	1.47 ft. lb. (2N.m)
Servo Torque Tilt Axis	1.47 ft. lb. (2N.m)
Clamping Torque (brake) Rotary Axis	103.3 ft. lb. (140N.m)
Clamping Torque (brake) Tilt Axis	199 ft. lb. (270N.m)
Indexing Accuracy Rotary Axis	± 4 arcsec
Indexing Accuracy Tilt Axis	± 4 arcsec
Open Height from 5X Table to Max. Z Travel	99.6" (253mm) (No Chuck)
Max Part Diameter on Faceplate	7.87" (200mm)

Android II-5AXP

Distance from Table Top to Face of 5X table	10.6" (270mm)
Distance from Rotary Faceplate to Spindle Nose	8.27" (210mm)

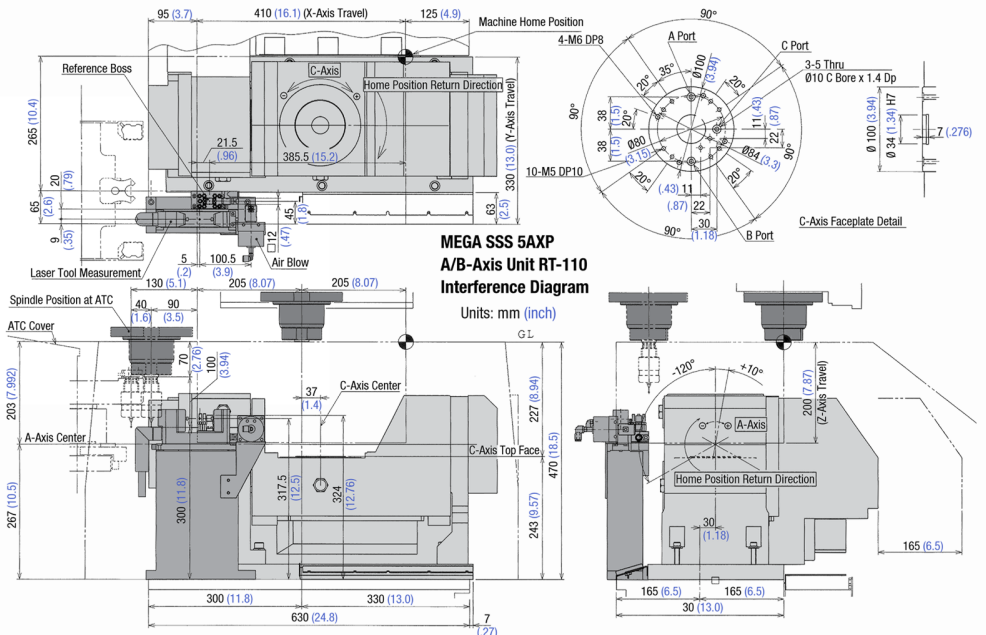
CEGA SSS-5AXP

Distance from Table Top to Face of 5X table	10.55" (268mm)
Distance from Rotary Faceplate to Spindle Nose	14.05" (357mm)



RT-110 Table Specifications MEGA SSS-5AXP

Rotary Table Faceplate Size	3.9" (100mm)
Max. Load Capacity	44 lb. (20kg)
Table Height from Floor	38.3" (973mm)
Tilting Angle Range	-120° ~ +10°
Max. Rotation Speed Rotary Axis	22 RPM
Max. Rotation Speed Tilt Axis	12.5 RPM
Reduction Ratio Rotary Axis	1/48
Reduction Ratio Tilt Axis	1/60
Servo Torque Rotary Axis	1.47 ft. lb. (2N.m)
Servo Torque Tilt Axis	3.34 ft. lb. (4N.m)
Clamping Torque (brake) Rotary Axis	103.3 ft. lb. (140N.m)
Clamping Torque (brake) Tilt Axis	199 ft. lb. (270N.m)
Indexing Accuracy Rotary Axis	± 4 arcsec
Indexing Accuracy Tilt Axis	± 4 arcsec
Open Height from 5X Table to Max. Z Travel	99.6" (253mm) (No Chuck)
Max Part Diameter on Faceplate (0.67" above)	6.14" (7.87" / 156 - (200mm))
Distance from Table Top to Face of 5X table	9.57" (243mm)
Distance from Rotary Faceplate to Spindle Nose	8.94" (227mm)



MEGA SSS 5AXP A/B-Axis Unit RT-110 Interference Diagram

Units: mm (inch)

PREMIER TRAINING, SERVICE AND SUPPORT

Regionalized Service Network

With our industry-leading regionalized service network, we have the most experienced, knowledgeable and responsive employees in the industry. We're here for you with phone support, operation training, on-site service, parts inventory and a robust, interactive website.

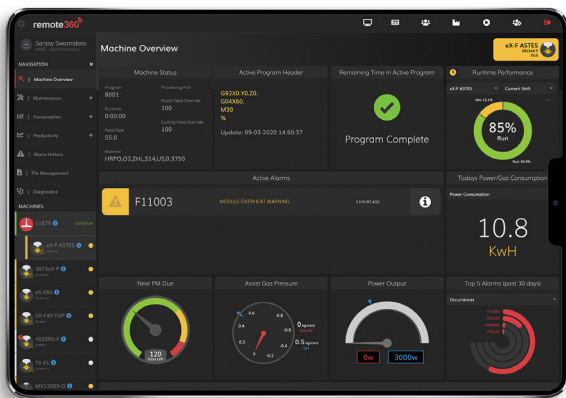
- With regionalized locations throughout North America, we can respond promptly to your service needs.
- We have the largest fleet of service vehicles in the field—three times more than any other company in the industry.
- From installation and on-site training to support and service throughout the life of your system, our national service network is just a phone call away.
- You'll have access to 24/7 support, a detailed interactive parts catalog, printable machine manuals and software.

Application Support

The value of our support stretches well beyond service, parts and training. Our experienced and creative team members put their knowledge and problem-solving skills to work for you—offering application and engineering support that includes creating specialized shop-floor setups that work harder and get better results. Whether developing integrated manufacturing cells from the ground up or adding specific solutions to complement existing operations, our pre-sales, sales, installation and application support staff can help you eliminate bottlenecks, improve accuracy and drive throughput.



remote360



remote360™ Machine Monitoring

remote360 is a robust production monitoring and support solution offering real-time data to help increase productivity, improve efficiency and reduce downtime. It provides:

- Email and mobile notifications of stoppages, completions and maintenance warnings
- Dashboard display of runtime performance by shift, day, week and month
- Proactive support with real-time monitoring and remotely connected service technicians

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