Mazak

INTEGREX i AM
VARIAXIS j AM

Mazak

INTEGREX i AM
VARIAXIS j AM

[Additive Manufacturing]

YAMAZAKI MAZAK CORPORATION

1-131 Takeda, Oguchi-cho, Niwa-gun, Aichi-pref., Japan
TEL : +(81)587-95-1131

www.mazak.com

E

AM SERIES 19.01.0 G 99J671118E3

The integration of additive manufacturing technology and multi-tasking

Advanced additive manufacturing (AM) technology integrated into multi-tasking machines and simultaneous 5-axis machining centers

- Produce parts in the minimum amount of time – ideal for prototype component production
- Deposit a different kind of material on base material for increased versatility

INTEGREX i-400S AM

MULTI-LASER METAL DEPOSITION

LASER METAL DEPOSITION

Additive manufacturing technology added to multi-tasking machine with second spindle

Shown with optional equipment

VARIAXIS j-600/5X AM

MULTI-LASER METAL DEPOSITION

LASER METAL DEPOSITION

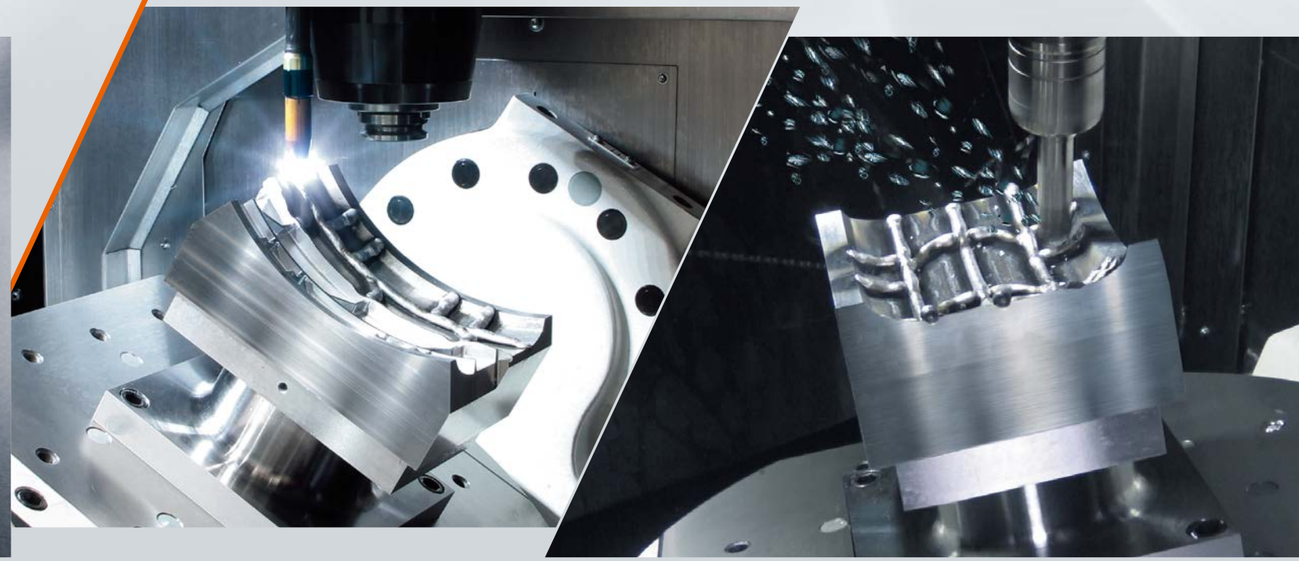
WIRE ARC

Additive manufacturing technology added to simultaneous 5-axis machining center

Shown with optional equipment

Multi-laser metal deposition, laser metal deposition

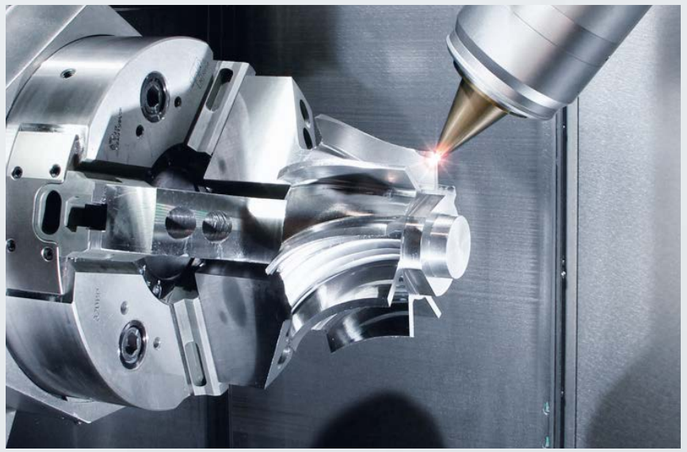
Wire arc AM



3 AM technologies expand the capabilities of machine tools

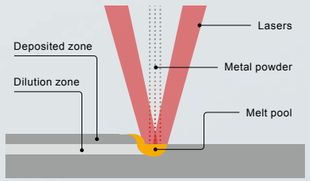
Deposit a different kind of material on base material for increased versatility, machine the workpiece to the required tolerances in the same setup for considerably reduced in process time.

Multi-laser metal deposition



Additive manufacturing method

Multiple laser beams around the nozzle efficiently melt powdered material supplied from the nozzle center.



Heat source : Laser

- Laser resonators : Direct Diode Lasers 600 W (total)
- Spot diameter : Φ1.5 mm (Φ0.06")

Material : Metal powder

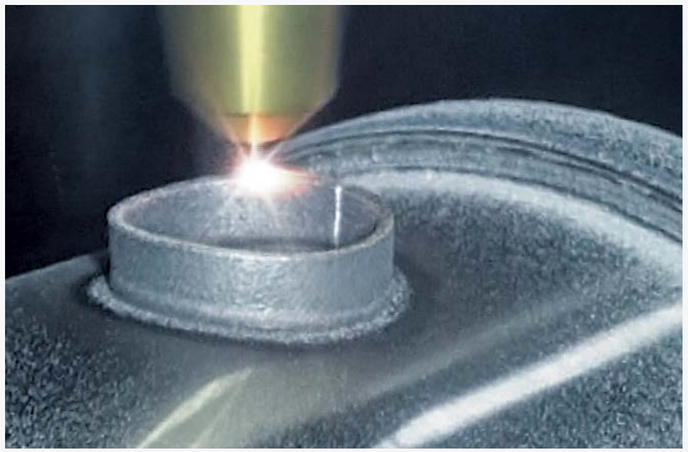
Surface

t = 5.0 mm (0.2")

Precision additive manufacturing

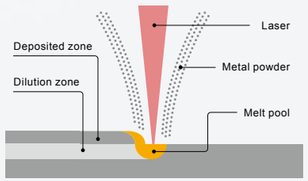
Height : 0.3 mm (0.01")
Width : 1.0 mm (0.04")

Laser metal deposi tion



Additive manufacturing method

Laser from the nozzle center melts the base material and the metal powder supplied from around the nozzle.

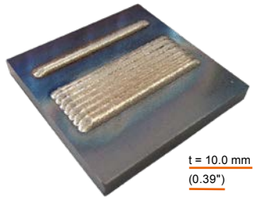


Heat source : Laser

- Laser resonator :
  Fiber laser 1.0 kW / 2.0 kW / 4.0 kW / 6.0 kW
- Spot diameter :
  Φ1.0 mm (Φ0.04"), Φ3.0 mm (Φ0.12"), Φ6.0 mm (Φ0.24")

Material : Metal powder

Surface



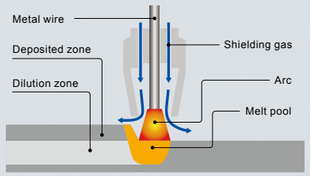
t = 10.0 mm (0.39")

Height : 1.5 mm (0.06")
Width : 3.0 mm (0.12")

Wire arc AM

Additive manufacturing method

Metal wire melted by an electrical arc is deposited on base material. Programmable welding automation is performed.



Heat source : Arc

- Type of arc : MIG
- Max. current : 300 A

Material : Metal wire

Surface

t = 15.0 mm (0.59")

Compared with laser metal deposition, more material can be added in a shorter amount of time.

Height : 4.0 mm (0.16")
Width : 7.0 mm (0.28")

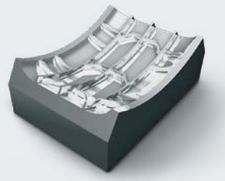
Applications

Near net shape

A near net shape workpiece normally requires a casting to be produced. With additive manufacturing technology, the casting process is not necessary for considerably reduced production time.

Tire mold (die and mold)

Base material : A5052
Added material : A5356



Shaft (general machinery)

Base material : SUS316
Added material : Inconel 718

Screw conveyor (general machinery)

Base material : SUS304
Added material : SUS316L

Cladding with different types of metal

Material cladding can be performed on a different type of base material to increase durability.

Impeller (automotive)

Base material : SUS316
Added material : Stellite #6

Roll die cutter (die and mold)

Base material : S45C
Added material : SKD61

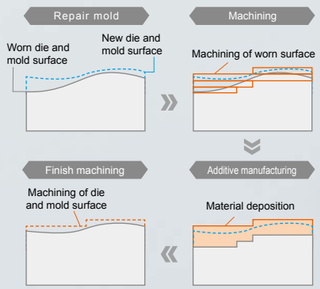
Blade (agricultural equipment)

Base material : SUS304
Added material : Tungsten carbide

Repair

For the machining of a repair part, additive manufacturing and finish machining can be performed in a single workpiece setup.

Sheet metal mold (die and mold)



Base material : SKD61
Added material : SKD61

Additive manufacturing process　Finish machining

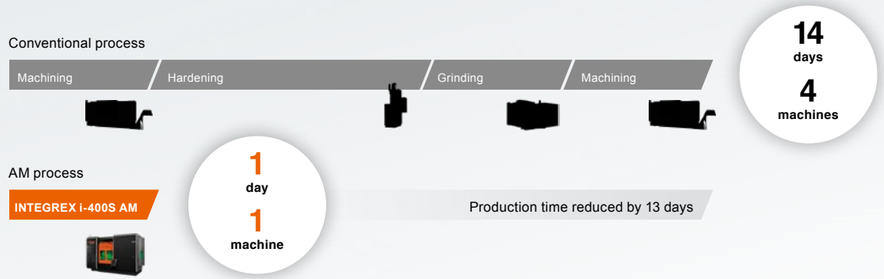
Turbo impeller (automotive)

Base material : Inconel 718
Added material : Inconel 718

Example of process integration

Conventionally, 4 processes (machining, hardening, grinding and machining) are required to produce this workpiece. When performing lot production, multiple workpiece handling, multiple workpiece loading/unloading, and multiple machine setups are required. This results in queues of workpieces waiting for each operation for a lengthy total in-process time.
When produced by the INTEGREX i-400S AM, all operations are performed on a single machine. The machining and additive manufacturing operations eliminate the hardening and grinding processes for a substantial reduction in the total production time.

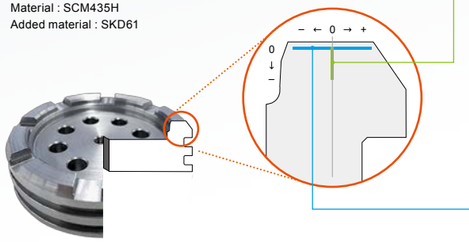
Reduced production time



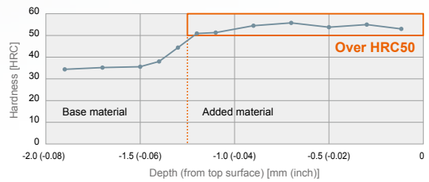
Same level hardness as hardening process is realized

Cap (machinery component)

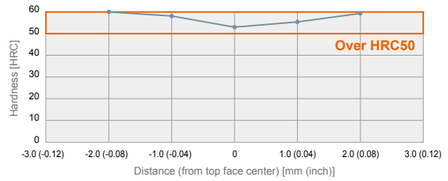
Material : SCM435H
Added material : SKD61



Added material and base material hardness



Added material hardness [0.1 mm (0.004") from top surface]



(example results)

	Workpiece requirement	Additive manufacturing
Hardness (HRC)	50 ~ 55	50.9 ~ 60
Depth [mm (inch)]	1.0 ~ 2.0 (0.04 ~ 0.08)	1.2 (0.05)

INTEGREX i AM SERIES

Integration of DONE IN ONE multi-tasking machines and additive manufacturing technology

- Wide range of specifications and options to meet your production requirements
- Large Y-axis stroke for expanded machining capability
- Gantry type AM head separate from milling spindle for increased versatility
- Laser metal deposition suitable for applying different types of metal
- Multi-laser metal deposition for high precision additive manufacturing of thin material

MULTI-LASER METAL DEPOSITION

- Laser resonators : 600 W Direct Diode Lasers (total)
- Spot diameter : Φ1.5 mm (Φ0.06")

LASER METAL DEPOSITION

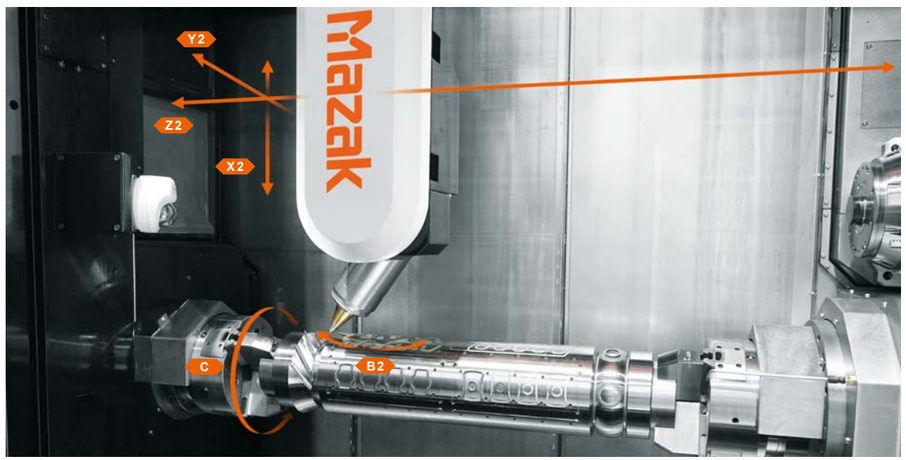
- Laser resonator : Fiber laser 1.0 kW / 2.0 kW / 4.0 kW / 6.0 kW
- Spot diameter : Φ1 mm (Φ0.04") / Φ3 mm (Φ0.12") / Φ6 mm (Φ0.24")

Laser metal deposition machine shown with optional equipment

Laser metal deposition

Gantry type AM head increases versatility

Since the AM head is not integrated in the milling spindle, machining versatility is increased. 5-axis metal deposition can be performed.



Multi-laser metal deposition shown

Automatic change of optimum laser head

When performing metal deposition, 3 types of laser heads can be automatically changed in the AM gantry system. This design allows 5-axis additive manufacturing to be performed as well as providing a large machining area. (The Multi-laser deposition head cannot be changed) Laser heads for automatic change: Fine head, Semi-finish head, High-speed head.

Designed for high speed and high accuracy

High rigidity and high accuracy C-axis disk brake

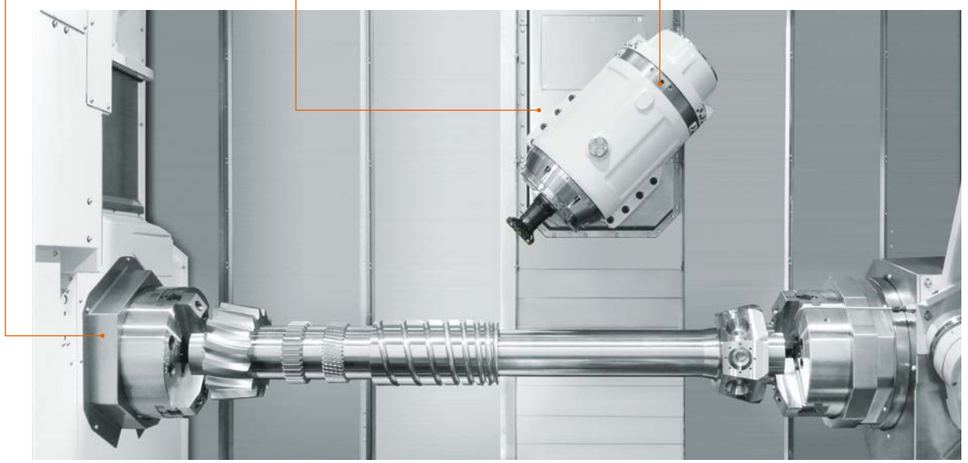
C-axis indexing increment : 0.0001°

High rigidity, high accuracy Y-axis

Large machining area thanks to orthogonal design providing a long Y-axis stroke.

B-axis roller gear cam

Roller gear cam on B-axis eliminates backlash for high accuracy and high efficiency machining.



Integral spindle / motor

Thanks to the integral spindle / motor design, vibration is minimized during high speed operation to ensure exceptional surface finishes and maximum tool life.

Machine	Milling spindle	Turning spindle (main spindle)	Turning spindle (second spindle)
INTEGREX i-200S AM	12000 min^{-1} (rpm), 22 kW (40% ED / 30 min. rating)	5000 min^{-1} (rpm), 22 kW (40% ED / 30 min. rating)	5000 min^{-1} (rpm), 18.5 kW (40% ED / 30 min. rating)
INTEGREX i-300S AM		4000 min^{-1} (rpm), 30 kW (40% ED / 30 min. rating)	4000 min^{-1} (rpm), 26 kW (40% ED / 30 min. rating)
INTEGREX i-400S AM		3300 min^{-1} (rpm), 30 kW (40% ED / 30 min. rating)	4000 min^{-1} (rpm), 26 kW (40% ED / 30 min. rating)

VARIAXIS j-600/5X AM

Integration of high accuracy simultaneous 5-axis machining center and additive manufacturing technology

- High rigidity tilting / rotary table ensures high accuracy machining
- Multi-laser metal deposition, laser metal deposition and wire arc AM are available to meet workpiece requirements
- Excellent accessibility to table and magazine located in front of machine provide exceptional ease of operation

MULTI-LASER METAL DEPOSITION

- Laser resonators : 600 W Direct Diode Lasers (total)
- Spot diameter : Φ1.5 mm (Φ0.06")

LASER METAL DEPOSITION

- Laser resonator : Fiber laser 1.0 kW / 2.0 kW
- Spot diameter : Φ1 mm (Φ0.04") / Φ3 mm (Φ0.12")

WIRE ARC

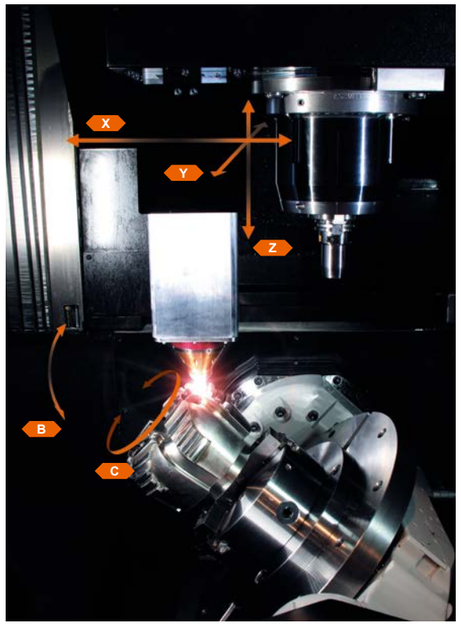
- Type of arc : MIG
- Max. current : 300 A

Wire arc AM machine shown

Laser metal deposition

Head for multi-laser metal deposition and laser metal deposition

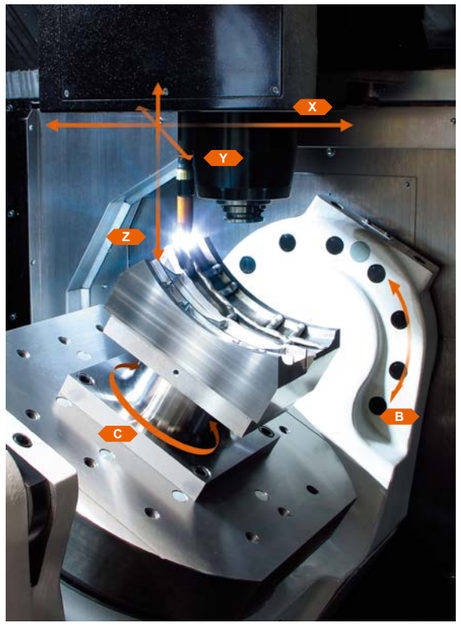
Laser head located near the spindle performs 5-axis metal deposition.



Wire arc AM

Head for Wire arc AM

Torch near the spindle performs 5-axis metal deposition. The compact torch provides excellent accessibility to the workpiece.



Designed for high speed and high accuracy

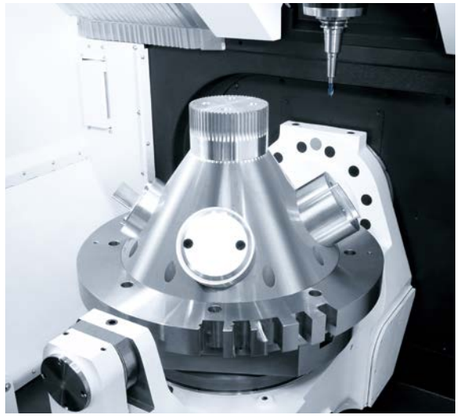
High rigidity table

The B-axis features a trunnion design to provide high rigidity for high accuracy machining.

Minimum indexing increment (B-, C-axis) : 0.0001°
Max. load : 500 kg (1102 lbs)

B-, and C-axis roller gear cam

The roller gear cams on the rotary axes eliminate backlash for high accuracy and high efficiency machining.

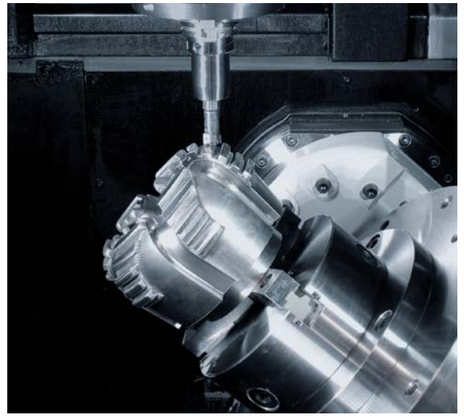


12000 min $^{-1}$ (rpm) CAT No. 40 standard spindle

The high rigidity spindle can perform rough machining and high speed machining of steel and cast iron. The spindle is designed to provide an increased machining area and features a compact spindle cartridge for excellent workpiece accessibility with minimum interference.

12000 min $^{-1}$ (rpm) CAT No.40 standard spindle

Speed	12000 min $^{-1}$ (rpm)
Output	11 kW (15 HP) (40% ED / 30 min. rating)
Torque	65 N·m (48 ft·lbs) (40% ED / 30 min. rating)



Additive manufacturing series

Machine(s)	Hybrid technology	Heat	Head / torch	Material hopper
INTEGREX i-200S AM INTEGREX i-300S AM INTEGREX i-400S AM	MULTI-LASER METAL DEPOSITION	**Direct Diode Laser** • 600 W	**Fixed head** • 1.5 mm (0.06") spot head	**Tank capacity** • 1.1 L (6.7 in³) • 5.0 L (305 in³) **Powder release capacity** • Narrow [2.0 mm × 0.3 mm (0.08" × 0.01")] • Medium [3.5 mm × 0.3 mm (0.14" × 0.01")] • Wide [5.0 mm × 0.6 mm (0.20" × 0.02")] **Heater** • With heater • Without heater
	LASER METAL DEPOSITION	**Fiber laser** • 1.0 kW • 2.0 kW • 4.0 kW • 6.0 kW	**Interchangeable head (AHC)** • 1.0 mm (0.04") spot head • 3.0 mm (0.12") spot head • 6.0 mm (0.24") spot head	
VARIAXIS j-600/5X AM	MULTI-LASER METAL DEPOSITION	**Direct Diode Laser** • 600 W	**Fixed head** • 1.5 mm (0.06") spot head	**Tank capacity** • 1.1 L (6.7 in³) • 5.0 L (305 in³) **Powder release capacity** • Narrow [2.0 mm × 0.3 mm (0.08" × 0.01")] • Medium [3.5 mm × 0.3 mm (0.14" × 0.01")] • Wide [5.0 mm × 0.6 mm (0.20" × 0.02")] **Heater** • With heater • Without heater
	LASER METAL DEPOSITION	**Fiber laser** • 1.0 kW • 2.0 kW	**Fixed head** • 1.0 mm (0.04") spot head • 3.0 mm (0.12") spot head	
	WIRE ARC	**Electric arc** • 300 A	**Roll type (wire diameter)** • 1.0 mm (0.04") wire • 1.2 mm (0.05") wire	—

Powder feeder, material hopper

1.1 L (6.7 in³) 5.0 L (305 in³)

Material hopper

Stores metal powder and used with powder feeder. Different capacities are available.

Heater

Used with hopper to eliminate humidity in metal powder to ensure metal deposition performance.

1.1 L (6.7 in³) 5.0 L (305 in³)
Heater shown is equipped on hopper

Powder feeder

Supplies metal powder to laser head.

Standard Machine Specifications

		Multi-laser metal deposition			
		INTEGREX i-200S AM		INTEGREX i-300S AM	INTEGREX i-400S AM
		1000U	1500U	1500U	1500U
Capacity	Max swing	Φ658 mm (Φ25.9")			
	Max. machining diameter (upper turret)	Φ658 mm (Φ25.9")			
	Max. machining length*1	1011 mm (39.8")	1519 mm (59.8")		
Travel	X1-axis travel	615 mm (24.21")			
	Z1-axis travel	1077 mm (42.4")	1585 mm (62.4")		
	Y1-axis travel	260 mm (10.24")			
	B1-axis indexing range	-30° ~ 210°			
	X2-axis travel	730 mm (28.74")			
	Z2-axis travel	914 mm (35.98")	1423 mm (56.02")		
	Y2-axis travel	260 mm (10.24")			
	B2-axis indexing range	0° ~ 180°			
Main spindle	Main spindle speed*1	5000 min⁻¹ (rpm)		4000 min⁻¹ (rpm)	3300 min⁻¹ (rpm)
	Min. indexing increment	0.0001°			
Second spindle	Second spindle speed*1	5000 min⁻¹ (rpm)		4000 min⁻¹ (rpm)	
	Second spindle travel (W-axis)	1066 mm (41.97")	1574 mm (61.97")		
	Min. indexing increment	0.0001°			
Milling spindle	Milling spindle type	Spindle turret with ATC			
	Milling spindle speed	12000 min⁻¹ (rpm)			
	Min. indexing increment	0.0001°			
Automatic tool changer	Tool storage capacity	36			
Motors	Spindle motor (30 min. rating · 40% ED / cont. rating)	22 kW (30 HP) / 15 kW (20 HP)		30 kW (40 HP) / 22 kW (30 HP)	
	Second spindle motor (30 min. rating · 40% ED / cont. rating)	18.5 kW (25 HP) / 15 kW (20 HP)		26 kW (35 HP) / 22 kW (30 HP)	
	Milling spindle motor (30 min. rating · 40% ED / cont. rating)	22 kW (30 HP) / 15 kW (20 HP)			
Machine size	Machine height	3800 mm (149.61")			
	Floor space requirement	3990 mm × 4200 mm (157.09" × 165.35")	5010 mm × 4200 mm (197.24" × 165.35")		5310 mm × 4200 mm (209.06" × 165.35")
	Weight	16900 kg (37257 lbs)	17450 kg (38470 lbs)	19810 kg (43673 lbs)	20110 kg (44334 lbs)
Sound	Equivalent continuous sound pressure level at operator position (depends on equipment options)	less than 80 db (A)			

*1 Depends on chuck specifications

		Multi-laser metal deposition
		VARIAXIS j-600/5X AM
Travel	X-axis travel (spindle head left / right)	800 mm (31.50")
	Y-axis travel (spindle head back / forth)	550 mm (21.65")
	Z-axis travel (spindle head up / down)	510 mm (20.08")
	B-axis travel (table tilt)	-120° ~ 90°
	C-axis travel (table rotation)	360°
Table	Table size	Φ600 mm × 500 mm (Φ23.62" × 19.69")
	Max. workpiece size	Φ730 mm × 450 mm*1 (Φ28.74" × 17.72")
	Table load capacity (evenly distributed)	500 kg (1102 lbs)
	Table surface configuration	M16 × P2 (5/8-11 UNC) tap 24
Spindle	Speed	12000 min⁻¹ (rpm)
	Spindle taper	CAT No.40
Automatic tool changer	Tool storage capacity	18
Machine size	Machine height	3555 mm (139.96")
	Floor space requirement	2527 mm × 4500 mm (99.49" × 177.17")
	Weight	12000 kg (26455 lbs)
Sound	Equivalent continuous sound pressure level at operator position (depends on equipment options)	less than 80 db (A)

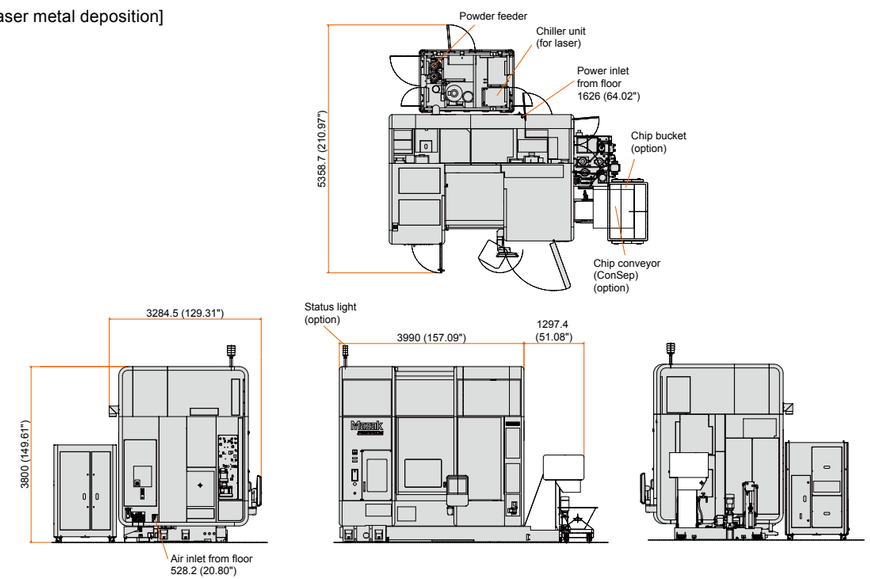
*1 Requires 80 mm (3.15") chamfer on top edge of workpiece

Machine Dimensions

INTEGREX i-200S AM (1000U)

[Multi-laser metal deposition]

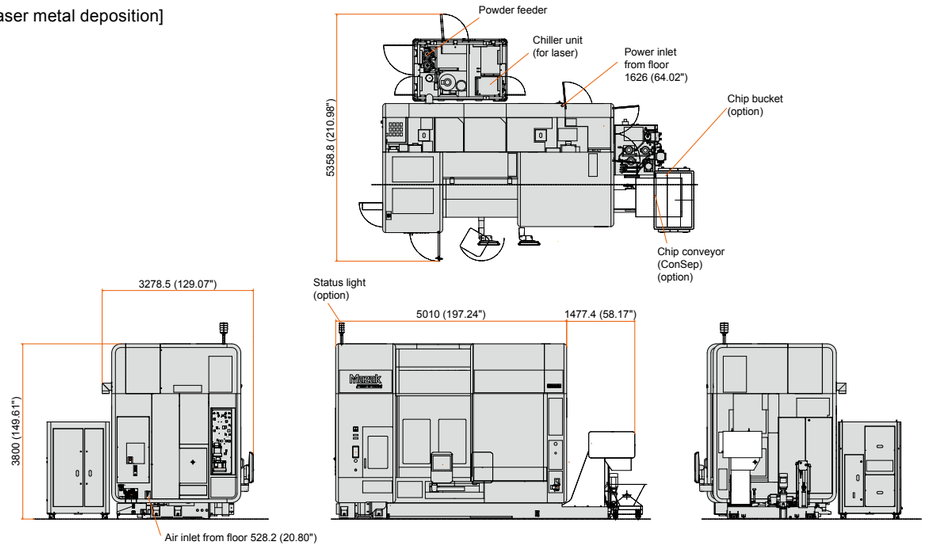
Unit : mm (inch)



INTEGREX i-200S AM (1500U)
INTEGREX i-300S AM (1500U)

[Multi-laser metal deposition]

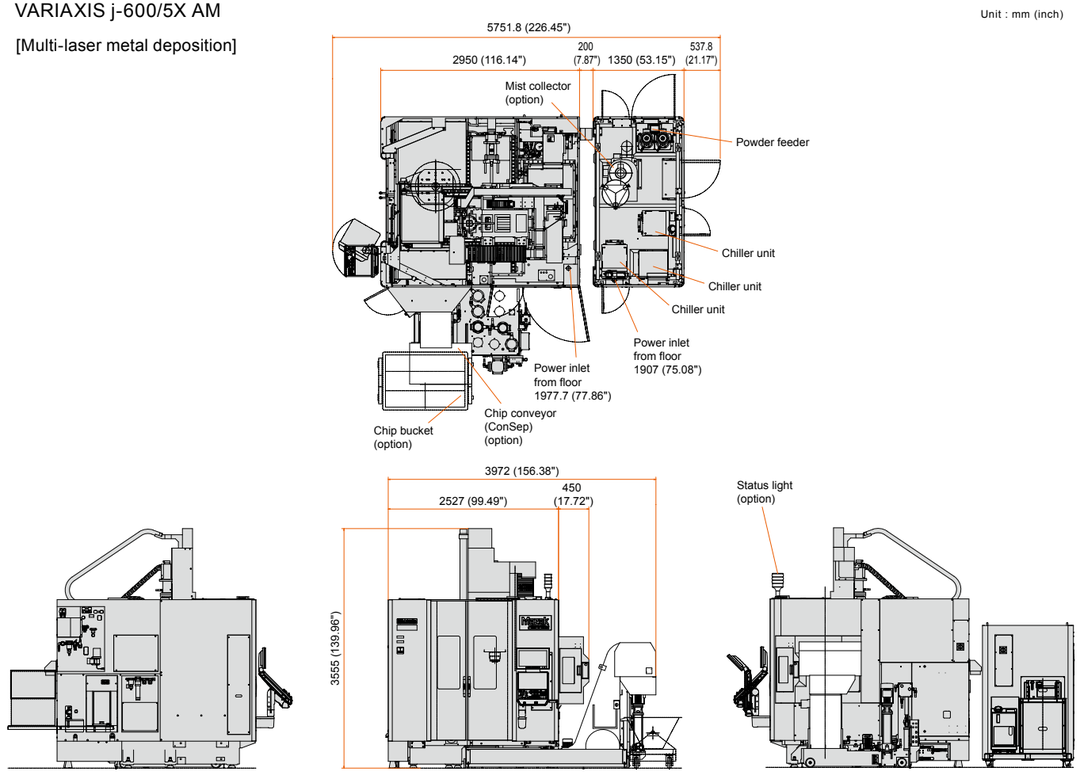
Unit : mm (inch)



VARIAXIS j-600/5X AM

[Multi-laser metal deposition]

Unit : mm (inch)



Additive manufacturing application examples

Multi-laser metal deposition and laser metal deposition

Material	Metal powder material	Industry
Ti	Titanium alloy	Aerospace, medical
Fe	Chromium molybdenum steel	General machinery, aerospace
	Stainless steel	General machinery
	High speed steel	Tooling, mold
	Mold steel	Die and mold, general machinery
Ni	Inconel	Industrial valves, oil, aerospace
	Hastelloy	Aerospace
Co	Stellite	Industrial valves, oil
Others	Copper	Electrical components
	Tungsten carbide	Tooling

Powder for
additive manufacturing

Wire arc

Material	Wire material	Industry
Al	Aluminum alloy	General machinery, semiconductor
Ti	Titanium alloy	Aerospace
Fe	Mild steel	General machinery
	Stainless steel	General machinery
	Mold steel	Die and mold, general machinery
Ni	Inconel	Industrial valves, oil
Co	Stellite	Industrial valves, oil

MIG welding wire