Mazak

# INTEGREX i AM
# VARIAXIS j AM

[ Additive Manufacturing ]

# 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 on a Multi-Tasking machine with a second spindle


## VARIAXIS j-600/5X AM

MULTI-LASER METAL DEPOSITION

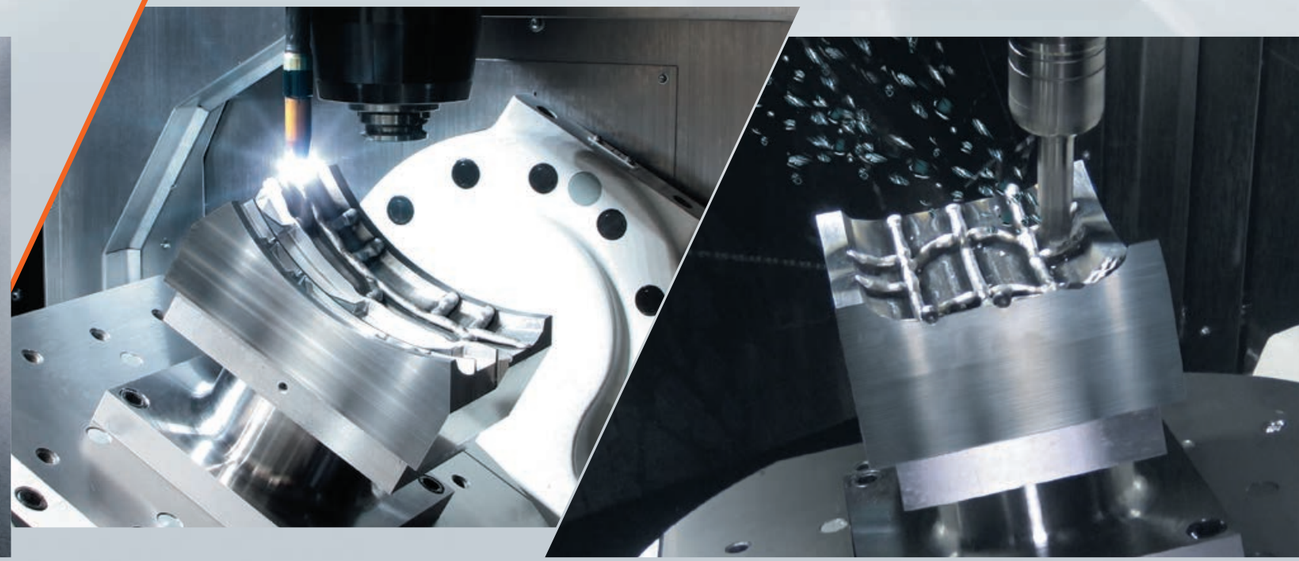
LASER METAL DEPOSITION

WIRE ARC

Additive manufacturing technology on a simultaneous 5-axis machining center


**Multi-laser metal deposition, laser metal deposition**

**Wire arc AM**



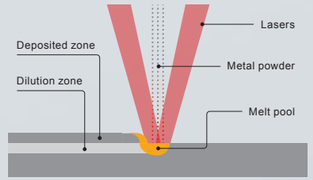
# 3 AM technologies expand the capabilities of machine tools

## Multi-laser metal deposition

Perform Done In One® machining with multi-laser metal deposition processes, ideal for producing strong, durable valves used in the aerospace and chemical industries, as well as the precision machining of molds and turbine blades.

### Additive manufacturing method

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

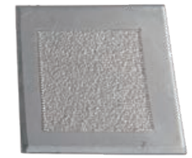



Heat source: Laser

- Laser resonators: DDL 600 W (total)
- Spot diameter: ø1.5 mm (0.06")

Material: Metal powder

Surface



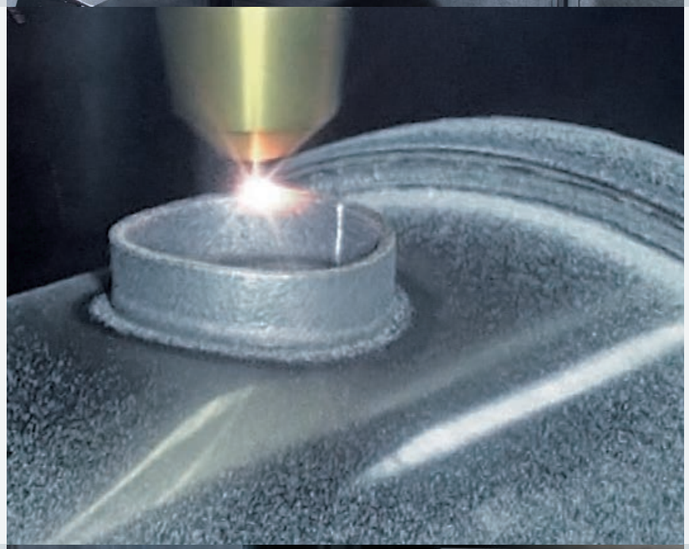
t = 5 mm (0.2")

Precision additive manufacturing

Height: 0.3 mm (0.01")
Width: 1 mm (0.04")

## Laser metal deposition

Expensive materials used in aerosace, energy and medical industries can be formed into near-net shapes  by laser metal deposition to reduce total production time. For increased durability and corrosion resistance, additive manufacturing can be used to apply different types of metal to a wokpiece's surface.



### Additive manufacturing method

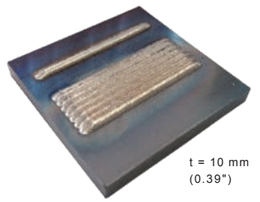
Laser from the nozzle center melts the base material and the metal powder supplied from around the nozzle.


Heat source: Laser

- Laser resonator:
  Fiber 1.0 kW, 2.0 kW, 4.0 kW, 6.0 kW
- Spot diameter:
  ø1.0 mm (ø0.04"), ø3 mm (ø0.12"), ø6 mm (ø0.24")

Material: Metal powder

Surface

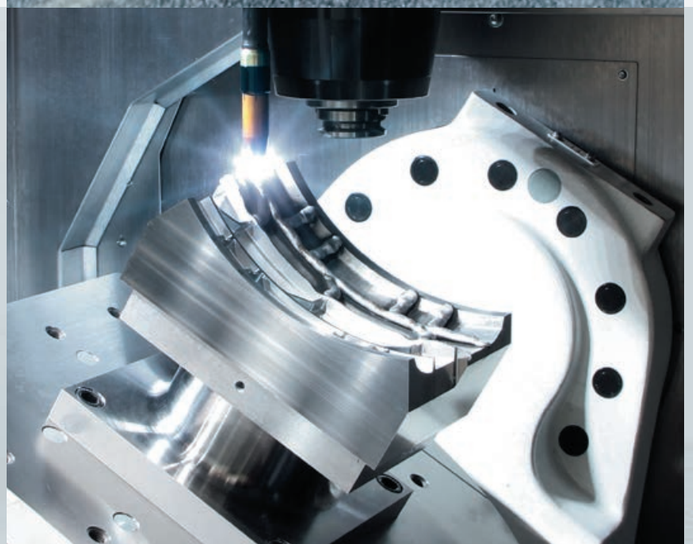


t = 10 mm (0.39")

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

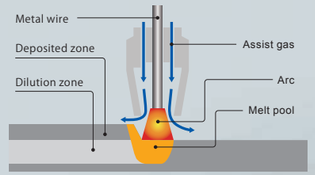
## Wire arc AM

Wire arc AM is suitable for a variety of processes, such as component near-net shape, repair of molds and other AM applications. Compared with laser metal deposition, more material can be added in a shorter amount of time.



### Additive manufacturing method

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




Heat: Electric Arc

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

Material:
Metal wire ø1.0 mm (ø0.04"), ø1.2 mm (ø0.05")

Surface

t = 15 mm (0.59")

Height: 4 mm (0.16")
Width: 7 mm (0.28")

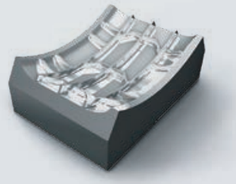
# Applications

## 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, considerably reducing production time.

**Tire mold (automotive)**

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)**

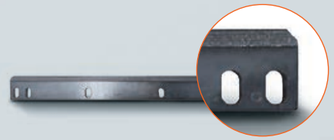
Base material: SUS316
Added material: Stellite #6

**Roll die cutter (die and mold)**

Base material: S45C
Added material: HSS

**Blade (agricultural equipment)**

Base material: SUS304
Added material: Tungsten carbide

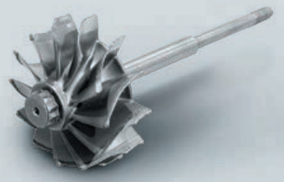


## Repair

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

**Turbo impeller (automotive)**

Base material: Inconel 718
Added material: Inconel 718



**Sheet metal mold (die and mold)**

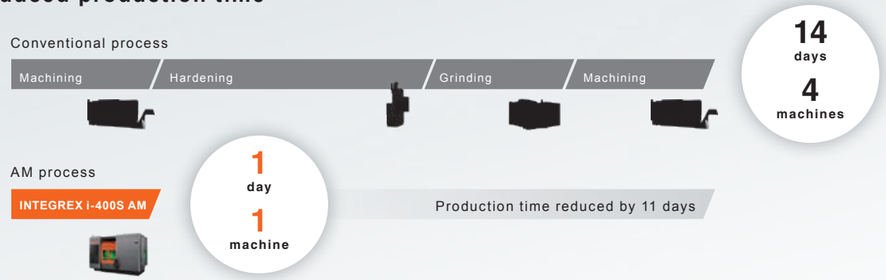
Base material: SKD61
Added material: SKD61

## Production example

Conventionally, four processes (machining, hardening, grinding and machining) are required to produce the component pictured below. When performing lot production, multiple workpiece handling, workpiece loading/unloading, and machine setup processes 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, substantially reducing total production time.

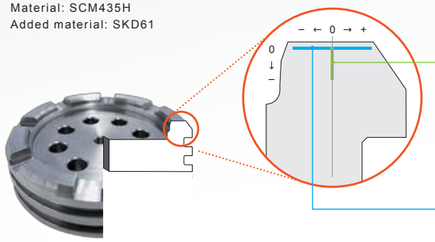
### Reduced production time



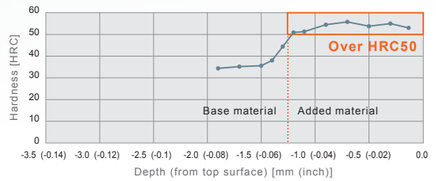

### Achieve the same level of hardness as with conventional hardening processes

Cap (machinery component)

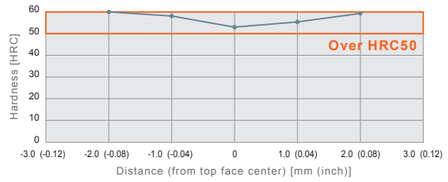
Material: SCM435H
Added material: SKD61




Added material and base material hardness




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




(example results)

| | Workpiece requirement | Additive manufacturing |
|---|---|---|
| Hardness (HRC) | 50 ~ 55 | 50.9 ~ 60 |
| Depth [mm (inch)] | 1 ~ 2 (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 part-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: 600W DDL (total)
- Spot diameter: ø1.5 mm (ø0.06")

**LASER METAL DEPOSITION**

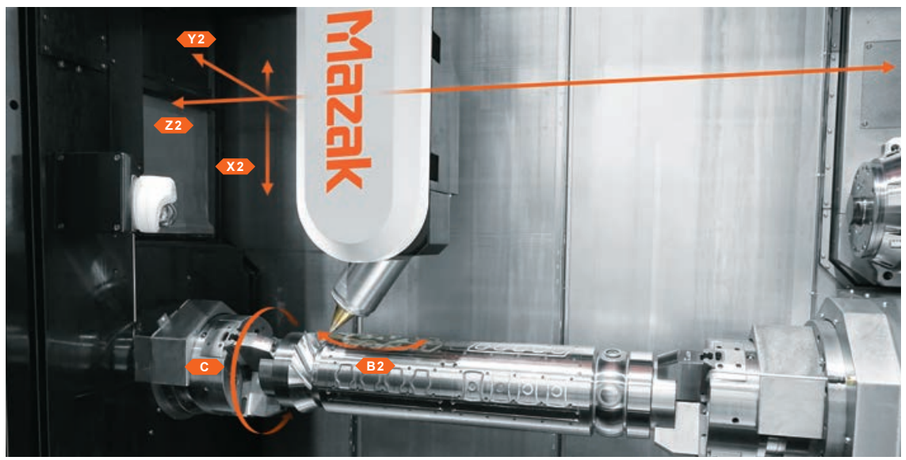
- Laser resonator: 1kW/2kW/3kW/4kW/6kW Fiber
- Spot diameter: ø1 mm (ø0.04")/ø3 mm (0.12")/ ø6 mm (0.24")

Laser metal deposition machine shown with optional equipment

## Laser metal deposition

### Gantry-type AM head increases versatility

Because 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 laser head for optimal machining

When performing metal deposition, 3 types of laser heads can be changed automatically in the AM gantry system. This design allows 5-axis additive manufacturing to be performed and provides a large machining area. (The multi-laser deposition head cannot be changed.) Laser heads available for automatic change include fine head, semi-finish head, and high-speed head.

## Designed for high speed and high accuracy

**High-rigidity, high-accuracy C-axis disk brake**

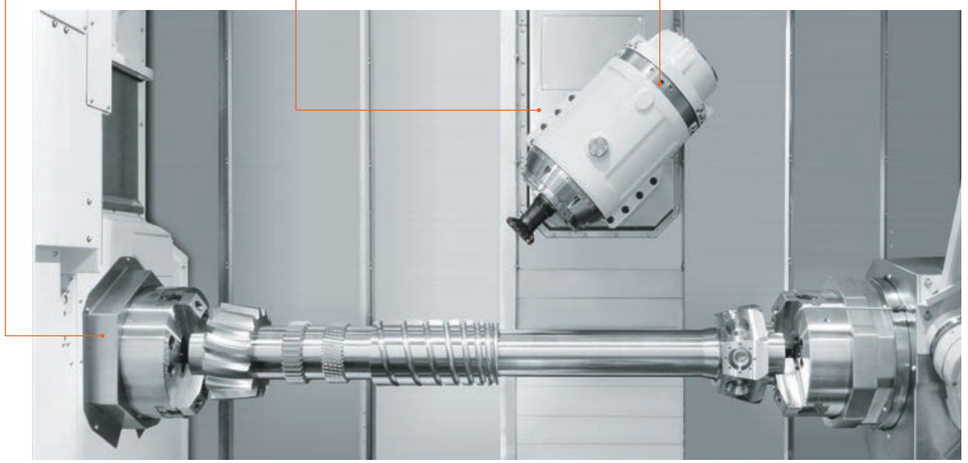
C-axis indexing increment: 0.0001°

**High-rigidity, high-accuracy Y axis**

Large machining area thanks to orthogonal design provided along 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 part-production requirements
- Excellent accessibility to table and magazine located in front of machine provide exceptional ease of operation

**MULTI-LASER METAL DEPOSITION**

- Laser resonators: 600W DDL (total)
- Spot diameter: ø1.5 mm (ø0.06")

**LASER METAL DEPOSITION**

- Laser resonator: 1kW/2kW/3kW/4kW/6kW Fiber
- Spot diameter: ø1 mm (ø0.04")/ø3 mm (0.12")/ø6 mm (0.24")

**WIRE ARC**

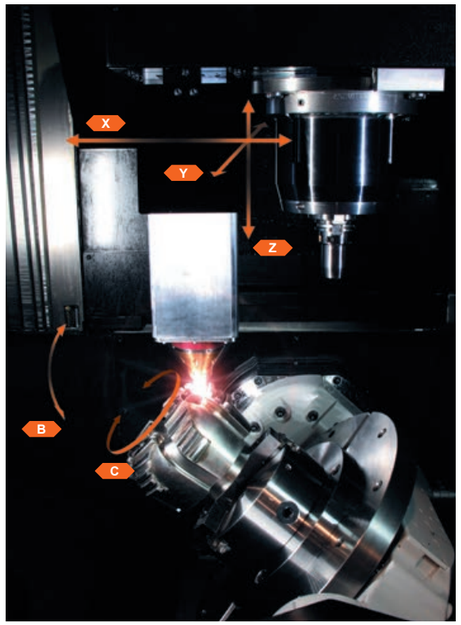
- Type of arc: MIG
- Max. current: 300 A


Wire arc AM machine shown

## Laser metal deposition

### Head for multi-laser metal deposition and laser metal deposition

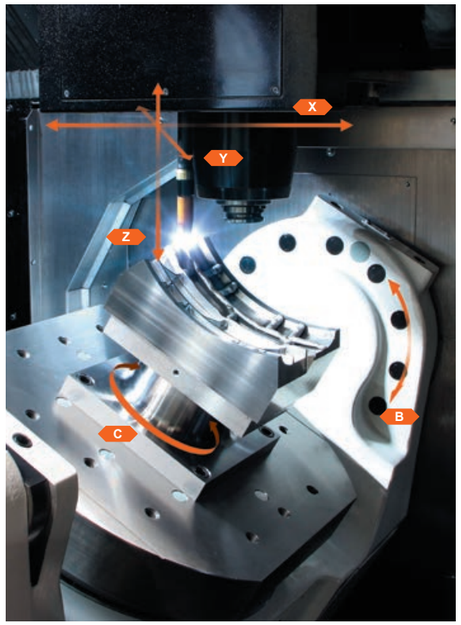
Laser head located near the spindle performs 5-axis metal deposition.




## Wire arc AM

### Head for wire arc AM

Arc torch near the spindle performs 5-axis metal deposition. The compact torch ensures excellent workpiece accessibility.




## Designed for high speed and high accuracy

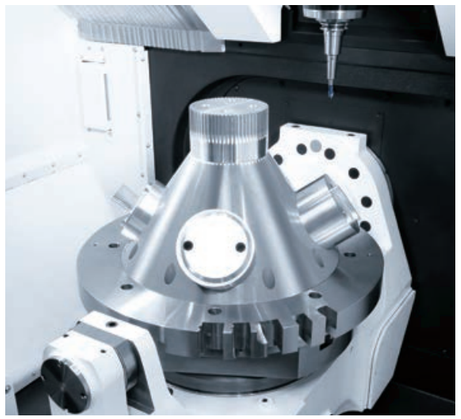
### High-rigidity table

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.

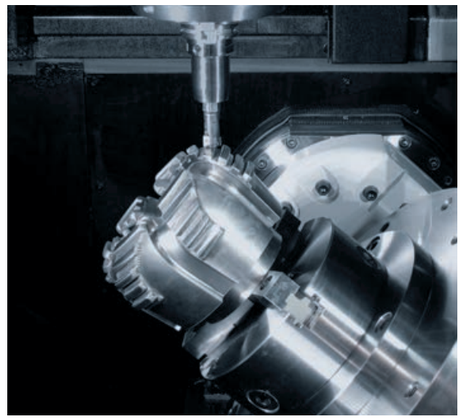


### 12000 min$^{-1}$ (rpm) CAT No. 40 standard spindle

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 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<br>INTEGREX i-300S AM<br>INTEGREX i-400S AM<br>  | MULTI-LASER METAL DEPOSITION | **DDL**<br>• 600 W | **Fixed head**<br>• 1.5 mm (0.06") spot head | **Tank capacity**<br>• 1.1 L (6.7 in³)<br>• 5.0 L (305 in³)<br>**Powder release capacity**<br>• Narrow (2.0 × 0.3)<br>• Medium (3.5 × 0.3)<br>• Wide (5.0 × 0.6)<br>**Heater**<br>• With heater<br>• Without heater |
| | LASER METAL DEPOSITION | **Fiber laser**<br>• 1.0 kW<br>• 2.0 kW<br>• 4.0 kW<br>• 6.0 kW | **Fixed head (AHC)**<br>• 1.0 mm (0.04") spot head<br>• 3.0 mm (0.12") spot head<br>• 6.0 mm (0.24") spot head | |
| VARIAXIS j-600/5X AM<br>  | MULTI-LASER METAL DEPOSITION | **DDL**<br>• 600 W | **Fixed head**<br>• 1.5 mm (0.06") spot head | **Tank capacity**<br>• 1.1 L (6.7 in³)<br>• 5.0 L (305 in³)<br>**Powder release capacity**<br>• Narrow (2.0 × 0.3)<br>• Medium (3.5 × 0.3)<br>• Wide (5.0 × 0.6)<br>**Heater**<br>• With heater<br>• Without heater |
| | LASER METAL DEPOSITION | **Fiber laser**<br>• 1.0 kW<br>• 2.0 kW | **Fixed head**<br>• 1.0 mm (0.04") spot head<br>• 3.0 mm (0.12") spot head | |
| | WIRE ARC | **Electric arc**<br>• 300 A | **Roll type (wire diameter)**<br>• 1.0 mm (0.04") wire<br>• 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 installed on hopper

### Powder feeder

Supplies metal powder to laser head

## Standard Machine Specifications

| | | INTEGREX i-200S AM 1000U | INTEGREX i-200S AM 1500U | INTEGREX i-300S AM 1500U | INTEGREX i-400S AM 1500U |
|---|---|---|---|---|---|
| Capacity | Max swing | ø658 mm (ø25.9") | | | |
| | Max. machining diameter (upper turret) | ø658 mm (ø25.9") | | | |
| | 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) | | | |

*1 Depends on chuck specifications

| | | VARIAXIS j-600/5X AM |
|---|---|---|
| Travel | X-axis travel (spindle head left/right) | 850 mm (33.46") |
| | 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 | ø600 mm × 500 mm (ø23.62" × 19.69") |
| | Max. workpiece size | ø730 mm × 450 mm*1 (ø28.74" × 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 rpm |
| | Spindle taper | CAT No. 40 |
| Automatic tool changer | Tool storage capacity | 18 |

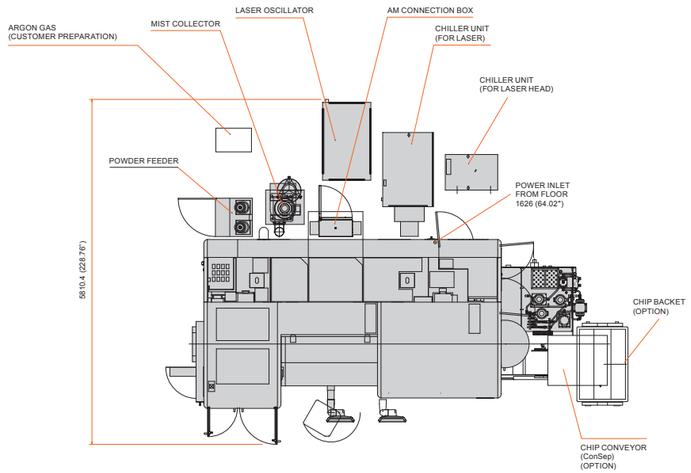
*1 Requires 80 mm (3.15") chamfer on top edge of workpiece

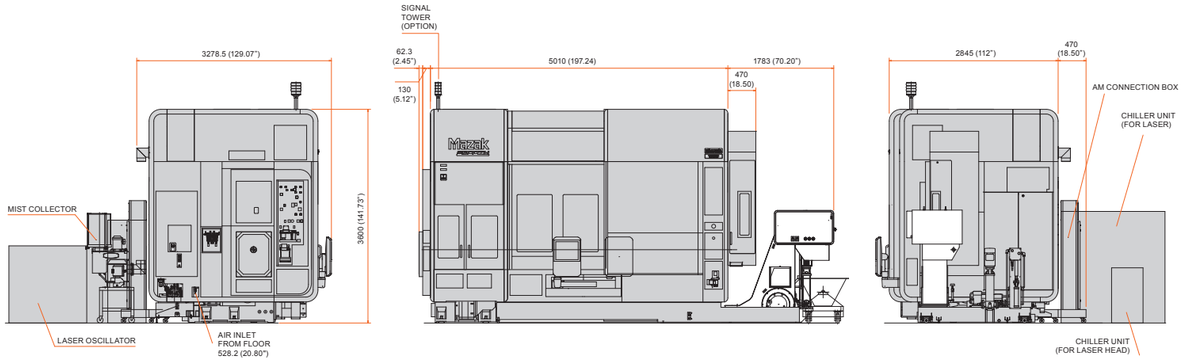
# Machine Dimensions

## INTEGREX i-400S AM

[Laser metal depostion]

Unit: mm (inch)

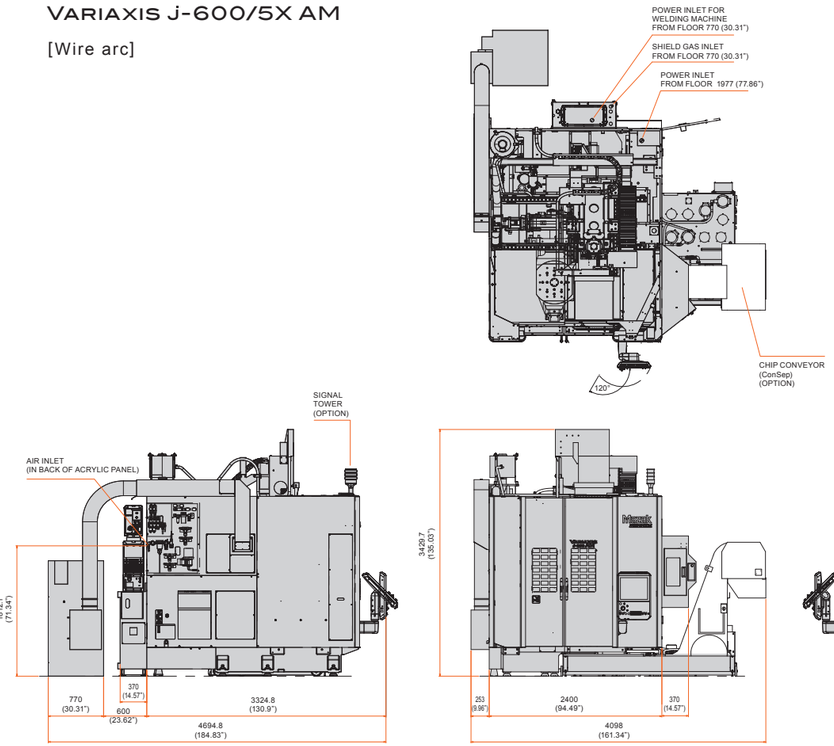



## VARIAXIS j-600/5X AM

[Wire arc]

Unit: mm (inch)




## Additive manufacturing application examples

### Multi-laser metal deposition and laser metal deposition

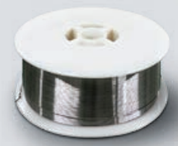
| Material | Metal powder material | Industry |
|---|---|---|
| Ti | Titanium alloy | Aerospace, medical |
| Fe | Chromium molybdenum steel | General machinery, aerospace |
| | Stainless steel | General machinery |
| | High speed steel | Tooling, mold |
| | Mold steel | Die and mold, general machinery |
| 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, semi conductor |
| 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



INTEGREX i AM
VARIAXIS j AM

Mazak

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

www.mazak.com



E

AM Series 18.08.0 X 99J671118E0