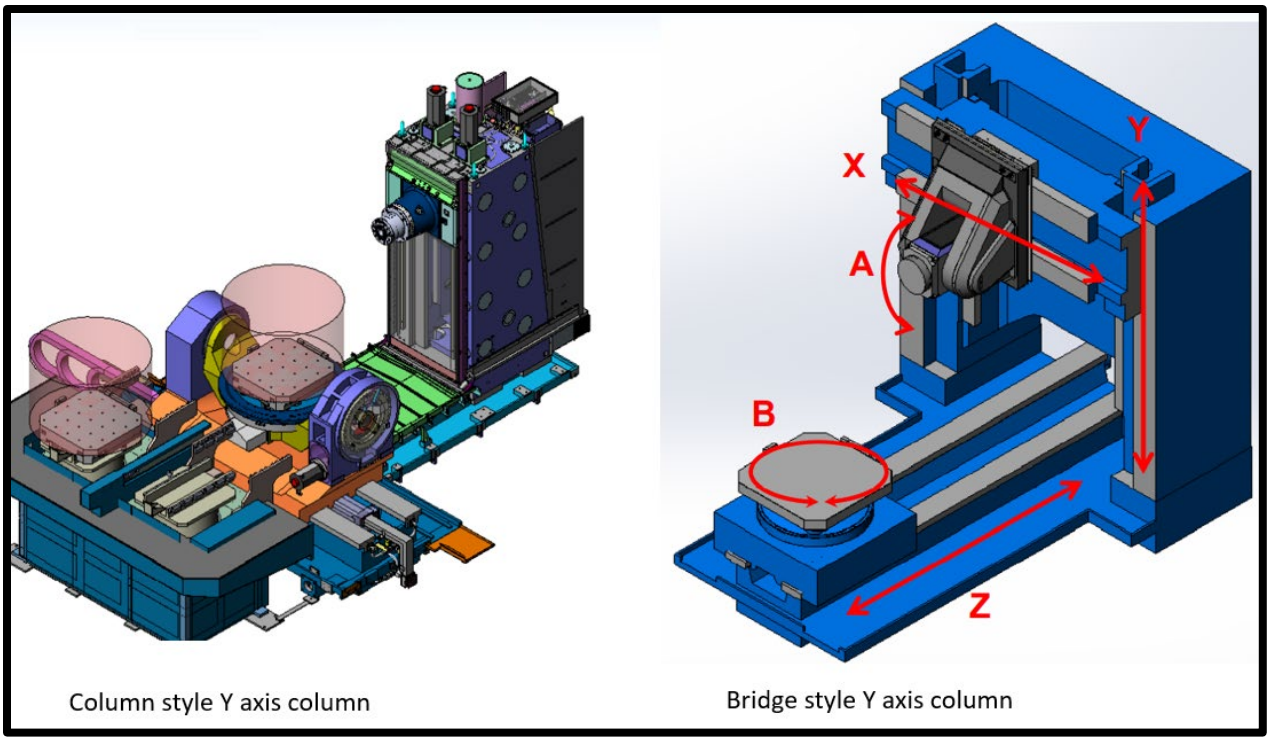
Large 5-axis machine tool requirements -December 2, 2021:

1. The machine tool axis configuration needs to be a rotary B axis stacked on a linear Z axis stacked on the machine tool frame. The spindle must be attached to a rotary A axis which is stacked on a linear X axis stacked on a linear Y axis stacked on the machine tool frame.
2. The Y axis needs to be a “bridge-style” design, also known as a “fixed gantry style”, and not a “column-style” design. Please refer to Figure 1 for a graphical representation of this requirement.
3. The machine tool must be able to operate as a horizontal spindle configuration and a vertical spindle configuration.
4. The machine tool spindle center point must be able to reach 50 mm beyond the 1,000 mm pallet on all four sides of the pallet while in the vertical spindle configuration.
5. The machine tool must have a hybrid guide system for the Y axis. A hybrid guide system is a linear constraining system that incorporates both box way guides and roller guides.
6. The machine tool must be actuated by dual servo motors/ballscrews in the Y axis.
7. The machine tool spindle must have a direct drive spindle with a minimum of 56 kW continuous power. The spindle must also be able to perform a 107 kW milling cut for 2 minutes. The spindle must have 525 N-m of continuous torque with a 2 minute extended duty cycle torque of 1,000 N-m. The spindle must also have a 12,000 rpm maximum rotational speed.
8. The machine tool structure must have an X direction direct frequency response function(FRF) at least as stiff as the one shown in Figure 2. The allowable deviation in dynamic compliance (Magnitude m/N) is +30%. A stiffer structure is acceptable. The X direction direct FRF must be measured with the spindle positioned as high as possible in the Y axis (approximately 1.3 meters above the pallet). The compliance of the most flexible mode of the structure must not be greater than 80 nm/N.
9. The machine tool axis travels must be a minimum of 1,500 mm in the X direction, 1,300 mm in the vertical (Y axis direction), and 2,000 mm in the Z direction. The B axis must be 360 degrees range of motion with infinite travel in either clockwise or counterclockwise direction. The A axis must travel from +45 to -110 degrees.
10. The machine tool must have a feed rate of 25,000 mm/min or faster.
11. The machine tool must have a minimum of 137 tool storage locations that are accessible by the machine tool for automatic tool changes.
12. The machine tool must have through-spindle coolant that has a minimum flow of 95 liters per minute at 6.5 MPa.
13. The machine tool must have a maximum “chip-to-chip” tool change time of 12 seconds for a tool less than 20 kg, and 14 seconds for a tool less than 30 kg and greater than 20 kg.
14. The machine tool must have a maximum pallet change time of 45 seconds for a 3,000 kg load and 55 seconds for a 5,000 kg load.
15. The machine tool must have a Professional 6 Fanuc 31*i*-B controller.
16. The machine tool must have Tool Life Monitoring that measures the amount of time a tool has been used and the distance the cutter has traveled.
17. The machine tool must be delivered, installed, and operational by January 17, 2022.
18. The machine tool must include all the features listed starting on page 3 of this document.



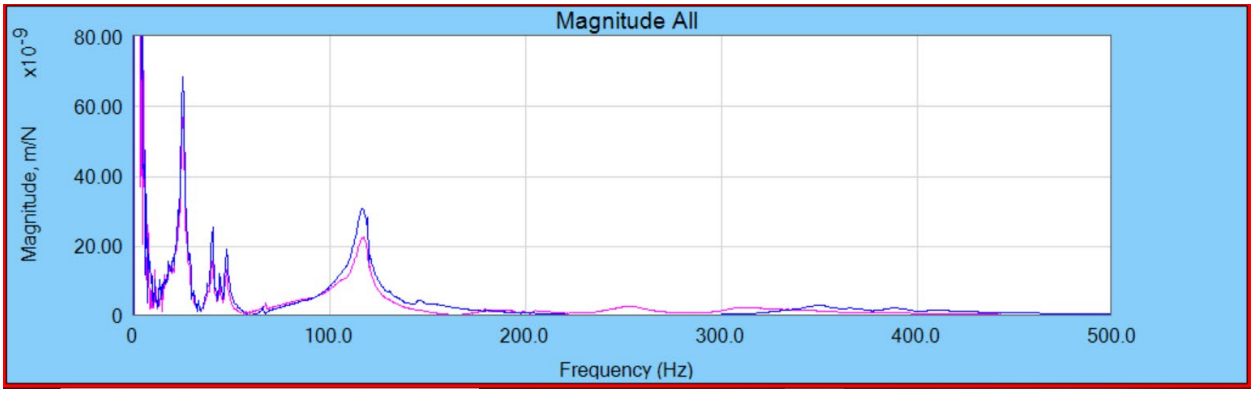


Figure 2 – X direction direct FRF measured with Y positioned as high as possible (Shown in Figure 1).

Part Processing Productivity Advantages

- 20 to 12,000 rpm high performance HSK-A100 spindle with 1,002 Nm of duty rated torque ready for hard metal roughing challenges. The spindle also features 107 kW duty rated and 56 kW of continuous power (134 / 75HP), making it a high performance solution in structural aluminum as well. This balance of power, torque and speed make the spindle an ideal choice for highly productive and flexible aerospace machining challenges.
- Full 5-axis high performance machining of large hard metal or aluminum aerospace components.
- Compact, A-Axis tilting head with 155° total range of motion (+45° ~ -110°).
- B-axis utilizes a unique roller cam design that provides superior torque, speed and reliability while eliminating backlash associated with traditional table designs.
- Large Ø1,500 X 1,500mm (Ø59" X 59") work envelope supports production of large aerospace components.
- Unique deep cavity column and A-axis kinematic structure allows positioning the spindle center line (A-90°) to 550mm beyond the B-axis center. Machine tool supports 5-sided machining of large cylindrical and prismatic work pieces up to 1,000 X 1,000 X 800mm (39.4" X 39.4" X 31.5").
- 984 ipm rapid and feed rate in each linear axis. A and B-axis rapid positioning of 10 RPM.
- Professional 6 Control with 15" color LCD provides enhanced 5-axis programming features and excellent networking capability
- Operator screen display must be in English.
- Large windows and 5-axis machine kinematics provide ideal visibility to the cutting zone.
- Single Touch Functions:
  Including Auto Zero to return all the axes to their reference position automatically; Auto Tool Change to change the tool in the spindle with tool at the tool change position automatically; Specific Tool Change to change the tool in the spindle with a tool specified by the operator such as a probe and setup position return to move the X and Y axes to a designated setup position.

Setup Time Reduction

- Horizontal spindle machining eliminates labor intensive chip removal and cleaning because chips fall out of and away from the part and fixture during machining.
- 137 Tool Magazine reduces job to job setup time by allowing tools to be stored in the magazine rather than away from the machine
- Five – sided machining in a single setup eliminates multiple operations
- Automatic Pallet Changer with two 1,000 x 1,000mm (39.4" x 39.4") tapped hole pallets optimizes spindle utilization. Setup of the next job is transparent to the current machining operation. Machine tool can be incorporated into flexible multi pallet, multi machine cell. This allows one or more machines to be linked to a bank of pallets and work setting stations. Pallets are delivered to the machine and set up areas via a rail guided vehicle.

- **Thermal Stability**

  Thermal Stabilizer system continuously circulates a glycol based fluid through jacketed chambers in the machine column. This ensures consistent machine casting temperature throughout the large work envelope.

  Jacket cooling of the spindle allows continuous high performance machining while maintaining exception thermal stability and rigidity to achieve the best quality part

  Spindle Temperature Compensation via an Oilmatic unit which utilizes a thermocouple to monitor bed temperature and maintains the spindle lubricant oil within ± 4° F.

  High volume / high pressure coolant system provides 1,000 psi through spindle coolant at a flow rate of 26 gallons / minute. Through spindle coolant and high volume / pressure nozzle coolant (217 psi / 13 gpm) work in conjunction to quickly evacuate hot chips and heat from the work piece and critical machine components.

  Large 1,000 liter secondary coolant tank is supplied by a 20 micron cyclonic filter system then cooled with a Coolant Temperature Controller. System maintains a stable coolant temperature to ensure consistent part quality.

- **Error Proofing**

  Advanced motion control technology assures high performance / high accuracy machining of complex part geometries.

  Pallet Seat Confirmation assures proper and accurate positioning of the work piece/pallet after each pallet change with precise air sensing integrated with pallet locators.

  Tool Clamp Confirmation assures proper and accurate clamping of the tool holder into the spindle after each tool change by precise sensing of drawbar location, eliminating risk of scrape parts.

  Spindle Condition Monitor continuously monitors spindle speed, temperature, load and vibration with integrated sensors throughout the spindle assembly, allowing for the immediate shutdown of the spindle if cutting conditions exceed specified limits, protecting the integrity of the high production spindle.

  Variable Posture Control maps and compensates for linear and rotary positioning errors. This eliminates error stack up and optimizes volumetric accuracy throughout the work envelope.

  Air piping to machine side table for vacuum part holding assist. Stabilizes machining of thin walled aerospace parts

- **Design Considerations**

  High torque, integral drive spindle provides duty rated torque of 739 ft lbs and 143 HP for high material removal rate machining in tough to cut hard metal materials.

  12,000 rpm maximum spindle speed coupled with high speed rotary A/B axis (10/10 rpm) supports high speed semi-finish and finish machining cycles even in complex 5 axis geometries.

  High Pressure and High Volume Through Spindle Coolant (1000 psi @ 26 gpm) evacuates chips and provides optimal cooling to the tool tip. Four nozzles (217 psi @ 13 gpm) positioned around the front face of the spindle enhance the cutting conditions and chip management.

  Highly rigid A-axis integrated with compact high torque spindle work in conjunction with B-axis table to provide ideal accessibility to parts.

  Large meehanite castings and box way construction provide the stiffness necessary for high performance titanium machining.

  Active damper system monitors machining vibrations in each linear axis. Counter forces are dynamically applied to each axis, suppressing the detected vibration. Eliminating vibration increases metal removal rates and tool life.

- **Control Features for Five-axis applications**

  High Speed Smooth Tool Center Point control for 5-axis machining

  Cutter radius compensation for 5-axis machining

  Manual feed for 5-axis machining

  Tilted working plane command

  Workpiece setting function

- **Automatic Monitoring Systems**

  Spindle Load Monitor

  Automatic monitoring of spindle load enhances process reliability and supports reliable unattended machining. Spindle load conditions can be specified and signal an alarm if cutting conditions are outside the desired condition, reducing tool breakage/cost and improving process reliability.

  Tool Life Monitoring

  Measures the amount of time a tool has been used or the distance the cutter has traveled. When the tool life for a given tool expires an alarm will be generated preventing further use of the tool.

  Spare Tool Selection

  This function can be used to call a spare (backup) tool automatically or continue to restart the machining process when the tool requested by the part program has a spindle load, adaptive control or tool life alarm condition associated with it.

Reliability and Maintainability

- Automatic Lubrication on all linear axes
- Air Dryer is provided to protect pneumatic components throughout the machine from effects of moisture
- Automatic spindle taper cleaning occurs during every tool change via air purge from inside the spindle, eliminating manual intervention
- Fully Enclosed Splash and Chip Shield w/ Internal conveyors maintain a clean work space
- Multiple coolant systems (Nozzle, through spindle, spindle carrier & shower coolant) maintain a clean work zone during production, reducing manual labor and machine down time.
- Maintenance Advice System automatically provides reminder to operator of regular maintenance required plus up to (20) custom user defined items can be added
- Powerful visually guided maintenance screens streamline the trouble shooting process to reduce machine down time
- Maintenance placards are placed strategically around the machine to identify location of key components to reduce maintenance and troubleshooting time.

Controller

High Performance Control provides the perfect blend of Microsoft Windows 7 OS graphical user interface (GUI), networking and storage capability with the proven stability of controller hardware. It features a highly integrated, embedded control system capable of fast execution of commands, high reliability, flexibility, integration capability and ease of operation.

- **Ergonomic operation** - Large 15 inch, color LCD screen is readily configurable to the specific customer needs or preferences. The touch sensitive, on-screen selection provides instant access to information literally at your fingertip. Simply touch the program on the screen and editing can be started. Individual screens can be customized by dragging and dropping. Panel feature allows frequently used selection / functions to be stored for quick access. A full size QWERTY keyboard complements the touch screen for ease of data entry.
- **Streamlined operation** – All screen menus are designed to match typical machining operation flow from setup through production.
- **Operator assistance** – Guidance functions, parameters, M/G codes and machine documentation search functions are available on screen when and where they are needed. Common canned cycles and probe measurement routines include a GUI that prompts the operator for the necessary information and automatically populates properly formatted code into the program.
- **Program data management** – Extensive program & data storage capabilities
    - 2 GB Program Memory (PRO_MEM) – Main memory for storage of user part programs. Available for sub-program calling or macro programs
    - 2 MB controller memory storage (CNC_MEM) – Storage of subroutines and macros used by the machine tool. Ex: measurement macros, ATC / APC subroutines
    - 20 GB M198 / DNC Memory – Used for storage of advanced motion controlled programs and Collision Avoidance Software (CAS) data files. Can also be used for DNC operation via M198 call.

1 GB Data Folder – Typically used for storage of backup machine data and screen captures.

- **Data editing:**
    - Cut, paste, and replace functions
    - Background editing function
    - 2 program simultaneous edit function
    - G code and M code insert function
    - Fixed-form statement insert
    - Final MDI program insert function
    - Coordinate value insert function (i.e.: Playback)
    - Input data comparison and confirmation feature
- **Interface and networking:**
    - Manage multiple data storage locations simultaneously
    - Windows type file tree
    - Full Ethernet network capability
    - Single source management of ALL files on the machine and network
- **Monitoring Functions:**
    - Spindle Load Display
    - Spindle Load Monitoring (Upper/Lower Limit Function)
    - Tool Life Management
    - Direct Spare Tool Selection
    - Parts count function (i.e.: run hour & parts quantity)
    - Machining record function (i.e.: machining time stamp)
- **Enhanced safety**

- Standard Dual Check Safety (DCS) door operation. Select 5-axis machines include Collision Avoidance Software (CAS) system. Level 1 implementation of CAS provides collision avoidance to primitive tool shapes and internal work envelope machine components (spindle, table, trunion, pallet, etc). Level 2 implementation provides enhanced protection capabilities but requires and relies on user data input (tooling, fixture & workpiece models).
- **Advanced Motion Control -** The latest generation of high speed motion control. Machine tool control algorithm accounts for machine dynamic characteristics in conjunction with the desired program cutter path. By analyzing the program geometry, advanced motion control maintains the highest possible feedrates while maintaining precise workpiece geometry. The synergy of highly refined AC digital servos and proprietary software make it possible to feed at rates faster than standard CNC systems while maintaining high accuracy.

Customer Support

- Machine Tool Support Organization including repair parts inventory is headquartered within 300 miles of Knoxville, TN.
- Complete machine tool installation support
- Life-time support for all machine tool brand products
- Multiple regional parts warehouses located throughout North America capable of 24/7 shipment of repair parts.
- 24/7 call center links callers direct to a Technical Phone Support Specialist for fast, free problem resolution
  - Average Machine Tool experience for Technical Phone Support Specialists: 16 years
  - 80% of all problems received into the Call Center result in problem resolution over the phone, without the need to dispatch a Field Service Engineer.
  - If a customer call is not directly connected to a Specialist, utilizing the Machine Tool Service Hot line, customers will experience their first contact with an experienced technician in under 15 minutes over 75% of the time.
- Network of over 200 factory trained and certified Field Service Engineers who are strategically located throughout North America.
- Local “factory based” spindle remanufacturing with full one-year warranty
- Secure, personalized customer portal for machine repair history, manuals, troubleshooting aids and self-help maintenance tools.
- Through the customer portal, the customer can access machine tool’s E-Commerce Parts Store with machine specific BOM access, purchase history, and free ground shipping.
- Machine Life Cycle Services including preventative maintenance programs, alignments, relocations, refurbishments and production support contracts

Technology Transfer

Machine Tool builder will provide valuable training and assistance designed to transfer essential knowledge to achieve full benefits of machine tool’s high productivity machining technology. This process of technology transfer begins after machine order placement.

Pre-Applications Assistance:

Machine tool builder will provide one to two days of manufacturing consultation conducted by machine tools builder's aerospace applications engineer. Key topics include technical review of machine specification, customer purchased option content, 5-axis control functions and next steps required by customer/machine tool builder for startup assistance.

Startup Applications Assistance:

Machine tool builder will provide up to two weeks on site applications assistance. This valuable hands-on manufacturing consultation is targeted toward startup of the machine and cutting of first part. Machine tool builder aerospace applications engineer will provide machine operator training, controller training and assistance debugging first part to be cut on machine. Customer to be ready with first part fixtures, tooling, material and NC programs prior to machine tool builder's applications engineer arrival. A follow up session can be scheduled after gaining experience with the machine.

Documentation/Training

- . Two (2) training credits are included with each machine purchased. Training credits can be exchanged for programming, operator and maintenance classes.
- A complete set of documentation is provided with each machine. Documentation includes Instruction, Periodic Maintenance, Peripheral Device, Parts, Controller Operation manuals and Controller M-Code list. All documentation is provided electronically on a USB key. Optional paper media documentation is available.
- Installation and Maintenance manuals are available free of charge on the machine tool customer portal.

Installation

- Installation supervision is included with the purchase of each machine tool.
- The customer is responsible for having the machine tool unpacked, positioned, cleaned, leveled and connected to air and electrical service.
- After the customer completes the activities listed above. A machine tool builder's service representative will be dispatched to the customer's location for machine start-up. This service preparation will verify proper operation, provide basic operator and preventative maintenance training.

Warranty

- A one (1) year machine warranty and two (2) year CNC warranty accompanies each machine excluding perishable items (e.g.: wipers, filters, covers, etc.) This standard warranty from machine tool builder to the original buyer is from date of shipment.

GENERAL SPECIFICATIONS

Machine	Metric	English
Pallet Size (Metric Type)	1,000 mm x 1,000 mm	39.4" x 39.4"
Axis Travel X, Spindle Longitudinal	1,500 mm	59.1"
Axis Travel Y, Spindle Vertical	1,300 mm	51.2"
Axis Travel Z, Spindle Cross	2,000 mm	78.7"
Axis Travel A, Spindle Tilt	+45° ~ -110°	
Axis Travel B, Table Rotation	360° Infinite	
Spindle Nose to Center of Pallet (A = 0°)	-950 ~ 1,050 mm	-37.4" ~ 41.3"
Spindle Center to Pallet Surface (A = 0°)	100 ~ 1,400 mm	3.94” ~ 55.12”
Spindle Drive Motor (Continuous 1,000 – 12,000 rpm)	56 kW AC	75 HP AC
Spindle Speed	20 to 12 ,000 RPM	
Maximum work piece size	1,500 mm dia. x 1,500 mm ht.	59.1" x 59.1”
Floor Space (W x L) w/ APC	6,875 mm x 10,205 mm	22’ 7" x 33’ 6"
Machine Weight	48,000kg	105,820 lb.

Machine Construction

Axis Design

X & Z	Rectangular Box Type Guide Ways	
Y	Hybrid Guide Way (Box with Linear Roller Guide)	

Table (X-Axis)

Rapid Traverse	25 m/min.	984 ipm
Feedrate	25 m/min.	984 ipm
Type of Drive	AC Digital Servo Motor	
Feedback	Closed loop 0.01µm, Morie type scale	
Ball Screw Diameter	#55	
Axis Thrust (cont / max)	14 / 47 kN	3,147 / 10,566 lbs

Spindle Carriage (Y-Axis)

Rapid Traverse	25 m/min.	984 ipm
Feedrate	25 m/min.	984 ipm
Type of Drive	AC Digital Servo Motor	
Feedback	Closed loop 0.01µm, Morie type scale	
Ball Screw Diameter	#63 twin ball screw	
Axis Thrust (cont / max)	75 / 210 kN	16,860 / 47,210 lbs

Traveling Column (Z-Axis)

Rapid Traverse	25 m/min.	984 ipm
Feedrate	25 m/min.	984 ipm
Type of Drive	(2) AC Digital Servo Motor	
Feedback	Closed loop 0.01µm, Morie type scale	
Ball Screw Diameter	#63	
Axis Thrust (cont / max)	28 / 94 kN	6,295 / 21,132 lbs

Tilt Spindle (A-Axis)

Tilt Spindle Positioning Range	+45° ~ -110°	
Pivot distance	400 mm	15.75”
Programming Increment	.0.0001°	
Rapid Traverse	3,600° / min	10 rpm
Cutting Feed Rate	3,600° / min	10 rpm
Indexing Accuracy	± 10.0 arc seconds	
Indexing Repeatability	± 2.0 arc seconds	
Feedback	Closed loop - 0.0001° rotary encoder	
Spindle Tilt Torque (cont / peak)	6,300 / 20,000 Nm	4,646 / 14,750 ft.lb

NC Rotary Table (B-Axis)

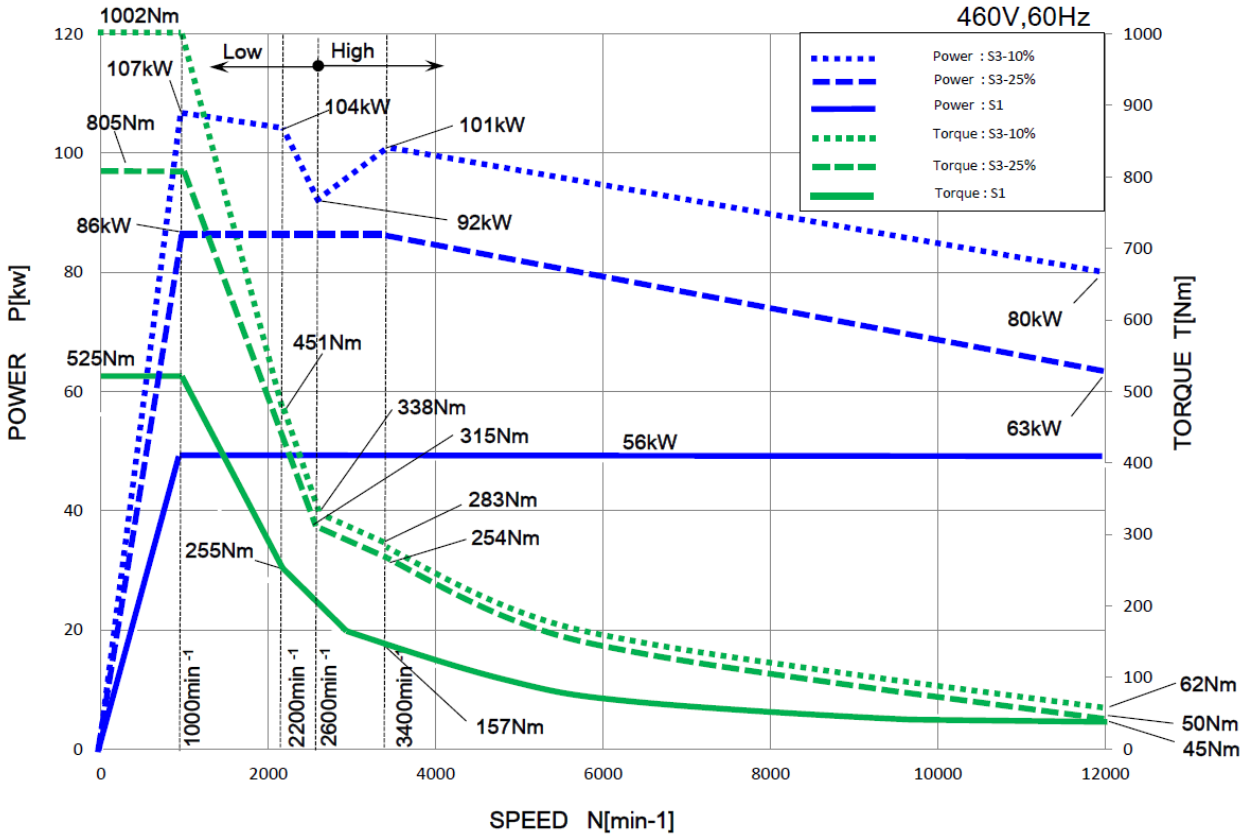
Work piece Positioning on Pallet 1000 x 1000mm pallet	(24) M16 tapped holes & 2 precision edge locators	
Programming Increment	.0.0001°	
Rapid Traverse	3,600° / min	10 rpm
Cutting Feed Rate	3,600° / min	10 rpm
Indexing Time (90° / 180°)	1.7 / 3.2 seconds	
Table Indexing Accuracy	± 10 arc seconds	
Table Indexing Repeatability	± 2 arc seconds	
B-Axis motor cooling function	Standard	
Feedback	Closed loop - 0.0001° rotary encoder	
NCRT Torque (cont/peak)	10,000 / 29,000 Nm	7,375 / 21,387 ft. lb
Locating / Clamp Cone Spacing	500 mm	19.68”
Pallet to Table Clamping Force (sum of 4 cone clamps)	204 kN	45,860 lb.
Vacuum fixture coupling of pallet to table (option)	Requires vacuum pump & condensate separator	

12,000 RPM SPINDLE:

Spindle Nose Taper	HSK-A100	
Tool Shank Types (Standard)	HSK-A100	
Spindle Drive	Integral direct drive	
Tool Clamping Force	45,000 N	10,116 lbs.
Tool Clamping Method	Disc spring clamp	
Spindle Drive Motor – 460V:		
S3 10% ED Rating (@ 1,000 rpm)	107 kW	143 hp
Continuous Rating	56 kW	75 hp
Spindle Torque Characteristics:		
S3 10% ED Rating (20~ 1,000 rpm)	1,002 Nm	739 ft-lbs
Continuous Rating	525 Nm	387 ft-lbs
Spindle Speed Range	20 to 12,000 rpm	
Spindle Speed Increment	1 rpm	
Number of Spindle Speed Ranges	2	
Lubrication	Oil-air bearing lubrication	

Spindle Cooling - Jacket cooling of spindle head & motor. Spindle chiller synchronized to bed temperature.

Spindle Tool Seat Confirmation	Air pressure check at tool / spindle interface
Rigid Tapping	3,000 rpm
HSK-A100 Coolant Duct Tolerance	⌀0.1mm rigid tube seating / ⌀0.3mm flexible tube seating



12,000 min^{-1} standard spindle output and torque characteristics

Accuracies (with proper environment control):

Positioning (Full Travel):

X-Y-Z: with Scales (std)	± 0.005 mm	± 0.00020”
A-axis	±10 sec	
B-axis	±4 sec	

Repeatability:

X-Y-Z: with Scales (std)	± 0.002 mm	± 0.000080"
A-axis	±2 sec	
B-axis	±2 sec	

Quoted accuracies and repeatability are attained through proper application of environmental conditions, and suitable industrial floor for machine stability.

Temperature	10°C ~ 40°C	50°F ~ 104°F
Fluctuation	≤1°C/30 min.	≤1.8°F/30 min.
Humidity	35 ~ 70%	

Automatic Pallet Changer (APC)

Pallet Load Capacity		
Standard	3,000 kg	6,600 lbs
Optional (Not compatible w/ MMC2)	5,000 kg	11,000 lbs
Pallet Change Time		
3,000kg specification	45 seconds	
5,000kg specification (opt)	55 seconds	
Pallet Positioning Repeatability of Pallet Change	± 0.005 mm	± 0.0002"
Pallet Loading Height (distance to floor)	1,350 mm	53.1"
Pallet Seating Confirmation	Air pressure confirmation of pallet locating surface	

Automatic Tool Changer

Capacity: Standard (option)	137 (60, 97) Tools	
Maximum Tool Size Diameter:	300 mm	11.8"
Without limitation	100 mm	3.94”
Maximum Tool Length	600 mm	23.6"
Maximum Tool Weight (ATC 97 or 137)	30 kg	66.1 lbs.
Maximum Tool Moment (ATC 97 or 137)	30 Nm	22.1 ft-lbs
Tool Selection Method	Random Selection (fixed address method)	
Tool Change Time:		
Tool-to-Tool (~20kg / 20 – 30kg)	4 / 6 seconds – *does not include shutter time*	
Chip-to-Chip (~20kg / 20 – 30kg)	12 / 14 seconds	
Tool Preparation Time ATC97 / 137(shortest / longest)	8 / 29 seconds	

Chip and Coolant System

Chip Conveyor (LUCC)	Rear-Left Discharge Double Type (hinge/scaper)	
Chip Conveyor (Internal)	Hinge conveyors on each side of the table	
Lift-up Conveyor Discharge Height	1,250 mm	49.2”
Secondary Filtration	Self-cleaning filtration unit (30µm filtration)	

High Volume Coolant Package:

Coolant Tank Capacity :	1,800L	475.5 gal
Secondary Clean Coolant Tank Capacity	1,000L	264.2 gal
Through Spindle Coolant:		
Pressure	7 MPa	1,015 psi
Volume	100 *l*/min	26.4 gal/min
Spindle Face Nozzle Coolant (4 Nozzles)		
Pressure	1.5 MPa	217 psi
Volume	50 *l*/min	13.2 gal/min
Spindle Top Nozzle Coolant (4 Nozzles)		
Pressure	0.5 MPa	72 psi
Volume	50 *l*/min	13.2 gal/min
Overhead Shower Coolant		
Pressure	0.5 MPa	72 psi
Volume	100 *l*/min	26.4 gal/min
Terrace Washing Coolant		
Pressure	0.5 MPa	72 psi
Volume	50 *l*/min	13.2 gal/min
High volume coolant package includes:		
- Cyclonic filtration for secondary coolant tank	20µm filtration	

- Coolant Temperature Controller for high volume coolant
- Flow switch for high volume through-spindle coolant and spindle face nozzle coolant
- Low limit detection for secondary coolant tank

Utility Requirements

Air:

Air Pressure	0.55 ~ 0.9 MPa	79 ~ 128 psi
Volume	1,000 *l*/min.	35.3 cfm

Supply air line must be ¾" ID or greater with no reducers or nozzles.

Compressed Air Quality	Grade 2.5.2 as specified by ISO Standard 8573-1
Max number of particles per $1m^3$	100 pcs or less $0.001 < x \leq 0.005$ mm
Max number of particles per $1m^3$	6,000 pcs or less in $0.0005< x \leq 0.001$ mm
Max number of particles per $1m^3$	400,000 pcs or less in $0.0001 < x \leq 0.0005$mm
Air Dryer	Standard

Electrical Specification:

Volts	460 (0 ~ +10%)
Phase	3
Cycle	60 Hz
kVA, Sum of all necessities	250 kVA
Breaker required	300 A

Tank Capacities

Hydraulic Tanks (main / APC)	100 / 37 Liters	29.1 / 9.8 gal.
Spindle Temperature Controller (Machine tool builder Spindle Oil)	50 Liters	13.2 gal.
Spindle Air / Oil Lubrication	3 Liters	0.8 gal.
Slideway & Ball Screw Lubrication Units		
Table	4 Liters	1.1 gal.
Slideway & ball screw	12 Liters	3.2 gal.
A-Axis Gear Lubricant	26 Liters	6.9 gal.
Thermal stabilizer	3,800 Liters	1,004 gal.
ATC gear boxes (Arm / 137 ATC)	6.5 / 0.4 Liters	1.7 / .1 gal.

Oils

Hydraulic	ISO 3448 VG32 (Shell Tellus S2 M 32 default)
Spindle Cooling	machine tool builder's Spindle Oil
Spindle Lubricant	Shell SSL8721
Slideway, ball screw & table	Shell Tonna S3 M 68
A-axis gear lubricant	Shell SSL8721
ATC arm gear box	Shell Omala oil 150
97 / 137 ATC gear box	ISO 3448 VG220 (NOK Kluber SYNTHESO HT220 default)

Home Positions

X-Axis	Center of Stroke	
Y & Z-Axis	Stroke (+) End	
A-Axis	Horizontal position	
B-Axis	Long Edge Locator Parallel to X	

Installation

Machine Width (excluding door motion / maintenance area)	6,875 mm	22’ 7"
Machine Depth (excluding door motion / maintenance area)	10,205 mm	33’ 6"
Machine Height	4,525 mm	14’ 10”
Weight (Pallet changer specification)	48,000 kg	105,820 lbs.
Foundation	See recommended foundation drawing	
Environmental Limitations		
Temperature	10 - 40°C	50 - 104°F
Humidity	35 ~ 70%	
Dust	Under 0.3 mg/m^3	

CONTROL SPECIFICATIONS - PROFESSIONAL 6 (Fanuc 31i-B Series)

Controlled Axes

Simultaneous controlled 5-axis positioning - standard;

Programming Method

Inch/metric selection (G20, G21);
Minimum programming increment: 0.0001 mm, 0.0001 deg;
Maximum programmable dimension: ±9 digits (±99999.9999);
Absolute/Incremental programming (G90/G91);
Decimal point programming/Calculator type decimal point input;
Automatic recognition of EIA/ISO code;

Interpolation

Linear interpolation type positioning (G00);
Linear interpolation (G01);
Circular interpolation (G02, G03);
Helical interpolation (Circular + 2 axis linear) (G02, G03);

Feeds

Cutting feedrate, F-digit command;
Feed per minute (G94);
Dwell (G04);
Rapid traverse override (0, 1, 5, 10, 25, 50, 80 100% by rotary switch);
Cutting feedrate override (0-200% in 10% increments by rotary switch);
Feedrate override cancel (M49, M48);

Part Program Storage & Editing

Pro.6 memory storage;

- **2 GB Program Memory (PRO_MEM)** – Main memory for storage of user part programs. Available for sub-program calling or macro programs
- **2 MB Controller memory storage (CNC_MEM)** – Storage of subroutines and macros used by the machine tool. Ex: measurement macros, ATC / APC subroutines
- **20 GB M198 / DNC Memory (Advanced motion control DATA)** – Used for storage of advanced motion controlled programs and Collision Avoidance Software (CAS) data files. Can also be used for DNC operation via M198 call.
- **1 GB Data Folder** – Typically used for storage of backup machine data and screen captures.

Registerable programs (1,000);
Background editing;
Cut, paste, and replace function;
Address, word search;
Program preview;

Operation and Display

Main Operation Panel

15" color LCD;
MDI keyboard – QWERTY layout
Control power ON / OFF switch
Spindle orientation button
Spindle START / STOP button
Emergency stop switch
FEED HOLD switch
Cycle START switch
Tool Unclamp switch
Operator door lock release
Operator mode selection – MEMORY, EDIT, MANUAL & MDI
Jog feed ± buttons
One-touch buttons

- Automatic reference position return for all axis
- Automatic workpiece setting position return
- Automatic tool selection and change for special tool
- Z-axis retraction

Function ON/OFF buttons

- Block skip
- Optional stop
- ECO mode
- Lighting
- Conveyor
- Nozzle coolant
- Single block
- Coolant

Manual display – Controller manuals are accessible on control panel;

I/O Devices

USB interface;
10/100 BASE Ethernet port;

Spindle, Tool & Miscellaneous Functions

Spindle-Speed

S-function direct command (S 5-digit command);
Spindle speed override – Fine increment (50% ~ 120% in 5% increments by rotary switch);
Spindle orientation (M19);
External setting type spindle orientation;

Tool function – T programming 8 digit maximum (T code, FTN or ITN);
M-function – Capable of up to (3) M-codes in a single block;

Tool Compensation

Tool offset memory Type C (D / H code, geometry / wear);
Tool offsets (400 total);
Tool length offset (G43, G44/G49);
Tool radius offset (G41, G42/G40);

Coordinate System

Workpiece coordinate system setting (G92);
Machine coordinate system setting (G53);
Local coordinate system setting (G52);
Workpiece coordinate system – 54 total (G54-G59 & G54.1 P1 ~ G54.1 P48);
Plane selection (G17, G18, G19);
Reference position return (G28);
Reference point return check (G27);
Return from reference point (G29);
2nd reference position return (G30);

Operation Support Functions

Label skip:
Single block;
Optional block skip 9 (/, /2 ~ /9);
Program stop (M00);
Optional stop (M01);
End of program (M02, M30);
Dry run;
Machine lock;
Miscellaneous function lock;
Z-axis feed cancel;
Cycle start;
Feed hold;
Program number search;
Sequence number search;
Program quick restart function;
Retraction for Rigid Tapping;
Manual absolute on/off;

Programming Support Functions

Sub-programming (up to 10 loops nested);
Scaling (G51, G50);
Circular interpolation radius programming;
Custom macro – 600 common variables for customer use (#100 ~ #199, #500 ~ #999, #98200 ~ #98499);
Custom macro – 500 common variables reserved for Machine tool builder (#500 ~ #799, #98000 ~ #98199);
Canned cycles (G73, G74, G76, G80 to G89);
Programmable mirror image (G51.1, G50.1);
Coordinate system rotation (G68, G69);
Tapping mode (G63);
Cutting mode (G64);
Rigid synchronous tapping (G84);
Programmable data input (G10);
Exact stop check (G09);
Exact stop check mode (G61);
Input present coordinate system position;
Program analysis;
High speed program check function (SGI.5)

Machine Error Compensation

Backlash compensation;
Pitch error compensation;

Automation Support Function

Collision Avoidance Software (CAS);
High speed skip function (G31);
Tool Life management (TL);
Spare tool selection;
Spindle Load Monitoring (SL) Upper & Lower Limit;
Spindle load display;
Parts count function;
Machining record function;

Maintenance & Safety

Emergency stop;
Alarm history function;
Self-diagnostics;
Number & position of LS & SOL displayed for alarms;
Automatic display for regular preventative maintenance items;
Help function;

High Speed, High Precision

Advanced Motion Control

5-Axis Function

High-speed smooth TCP;
3-dimensional cutter compensation;
Tilted working plane indexing command;
3-dimensional manual feed;

Energy Savings

ECO mode;

Manuals

(1) Machine tool builder Manual Set;
    a. Safety
    b. Operation
    c. Maintenance
    d. Parts Manual
    e. Controller Operation
(1) Controller Manual Set;