G800-TR

5-Axis Gantry Vertical

Machining Center

Technical Proposal

The picture is for reference only

Asia Pacific Elite Corp

ADD：No.7, JingKe N. Rd., Nantun Dist.,
Taichung City, Taiwan 40852
Contact us：
TEL：+886-4-23589313
FAX：+886-4-23589853

Contents

A. Main data

1. Specification

Travel		
X-axis	mm	800
Y-axis	mm	820
Z-axis	mm	560
Distance from spindle end to table	mm	170~730

Table		
length × width: load	mm: kg	Ø800: 1,300
Rapid feedrate	m/min	X/Y/Z= 48/ 48/ 48
Acceleration	m/sec^2	X/Y/Z= 6/ 6/ 6

Spindle (Std.)		
Spindle taper	-	HSK100A
Spindle speed	rpm	12,000
Spindle power (S1/S6)	kW	50 / 76
Spindle torque (S1/S6)	Nm	200 / 302

Rotary tilt table		
Swivel/rotation speed	rpm	A= 80, C= 100 /Turning Opt: 1000 RPM
Swivel/rotation torque	Nm	A= 3,740 / 7,480 C= 1,870 / 3,740
Clamping torque	Nm	A= 7,000, C= 2,500
Swivel / rotation angle	deg	A= ±120, C= Cont.

Automatic Tool Changer		
Tool shank	-	HSK100A
Tool magazine capacity	pcs	60
Max. tool length	mm	300
Max. tool diameter- with adjacent tool	mm	125
Max. tool diameter- without adjacent tool	mm	125
Max. tool weight	Kg	15

Accuracy		
Positioning precession	mm	X / 0.008, Y / 0.008, Z / 0.008
Repeatability	mm	X / 0.005, Y / 0.005, Z / 0.005
Ball-Bar Test	mm	XY / 0.015, XZ / 0.015, YZ / 0.015
5-axis TCPM	mm	±0.03

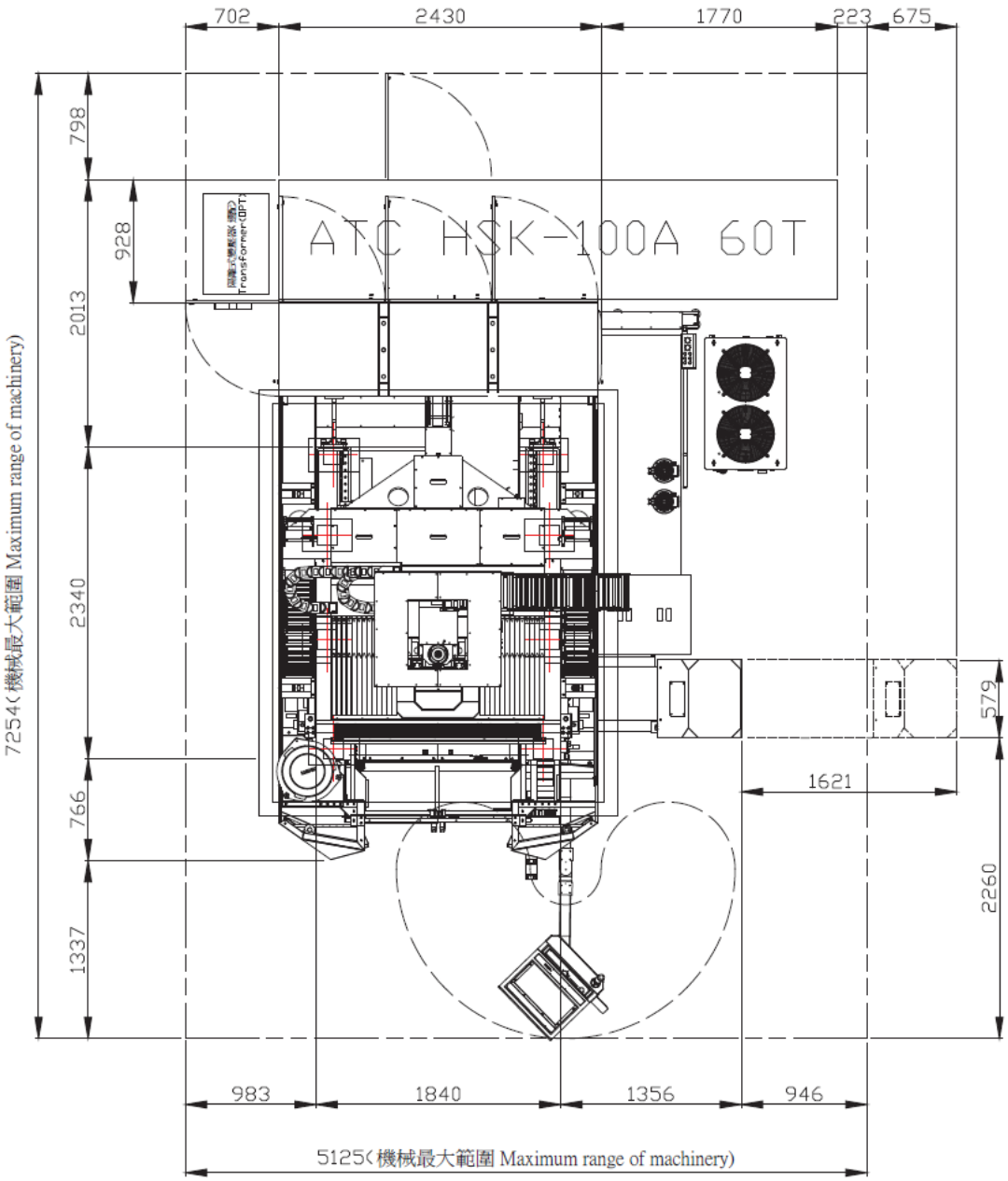
2. Standard accessories

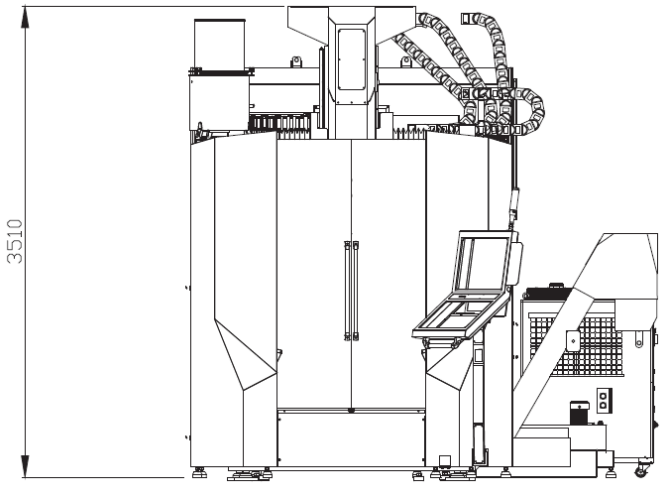
- Heidenhain TNC640 CNC controller with HR510 MPG
- AGA, HSK100A, 12,000rpm, 50 / 76 kW (S1/S6), 200 / 302 Nm (S1/S6), built-in spindle ×1
- AGA rotary tilt table with Ø800
- HSK100A ATC with 60T
- X/Y/Z-axis with high rigidity linear guide way
- X/Y/Z -axis with Heidenhain optical linear/circular scale
- Oil-air lubrication device for spindle
- Spindle chiller
- A/C-axis coolant system with torque motor
- Air conditioner for electrical cabinet
- Coolant around spindle
- Standard coolant tank
- Chain type conveyer system
- Outer side coolant system
- Manual opening / closing top roof sliding cover
- 3 axis grease lubrication system
- Z axis brake system
- Security door interlocks
- Water-proof LED working lamp

3. Option accessories

- BLUM laser tool measurement system × 1
- BLUM workpiece touch probe × 1
- Coolant trough spindle 70 bar
- Air dryer
- Isolating transformer
- Automatic doors by pneumatic and M code
- Table hydraulic clamping

4. Machine layout





Once all the details are confirmed, the official drawing will be provided.

B. Technical description

1. Spindle

AGA built-in spindle-e

Long term reliability

Features: Linear motor cooling by independent cooler, equipped with temperature sensor to monitor motor temperature to maintain machine service life and reliability.

High speed & High Efficiency：

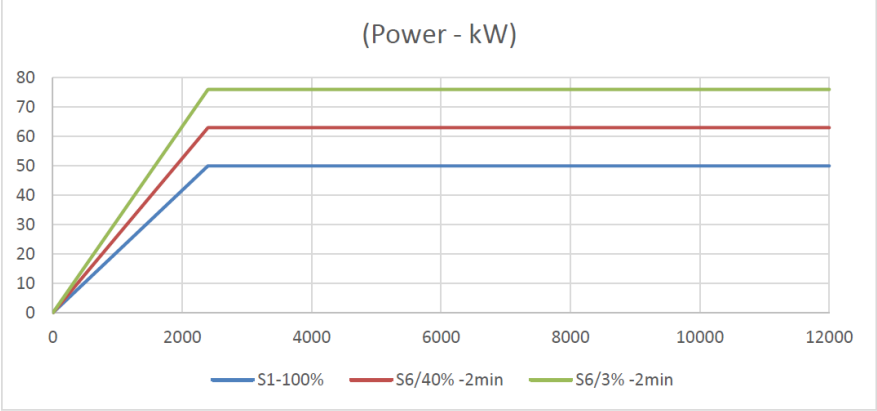
Features: The max. spindle speed 12,000 rpm, 50 / 76 kW(S1/S6) high power and 200 / 302 Nm(S1/S6) high torque, especially suit difficult cut material machining (ex: titanium alloys and nickel-based alloys, etc.) such as aerospace components of engine casing.

Distance from spindle end to table：170~730 mm

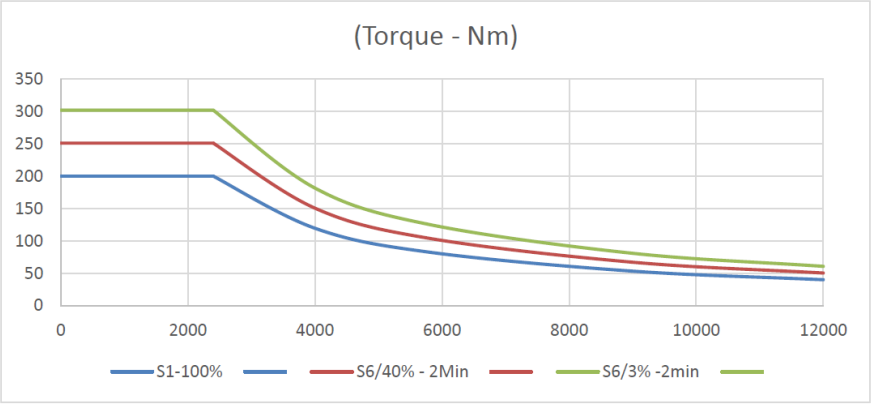
Power supply：100kVA, 380V±5%, 50/60Hz

-12,000 rpm power & torque chart-

Power chart



Torque chart



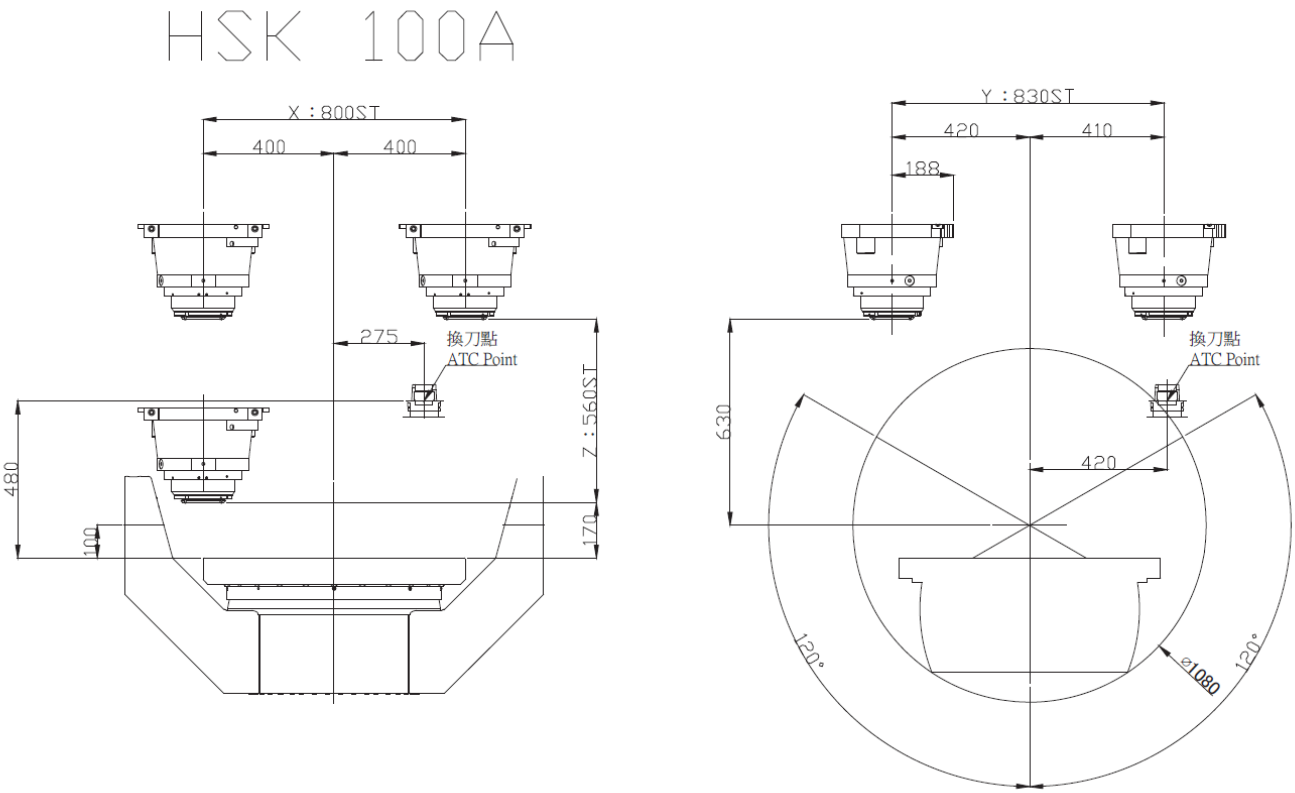
2. Rotary tilt table

Rotary tilt table

- Direct-drive motor is used as the driver of A/C axis tilting and rotating. The advantages of DD motor are space saving, less error, higher resolution, higher torque, and higher speed
- Rotary table is fixed in the double walls for high machining stability
- The max. A-axis speed 80 rpm, 7480, Nm high torque and 7,000 Nm high clamping torque
- An enclosed structure design enhances complete structure.
- Rotating/swinging axis high rotation speed improves production efficiency; Rotary/swinging high precision ensures product quality.

3. Working area

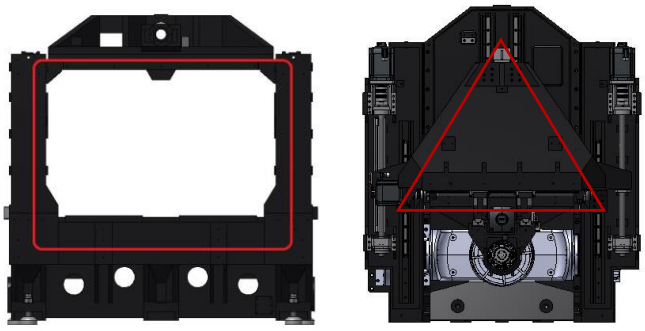
3-1 HSK100A



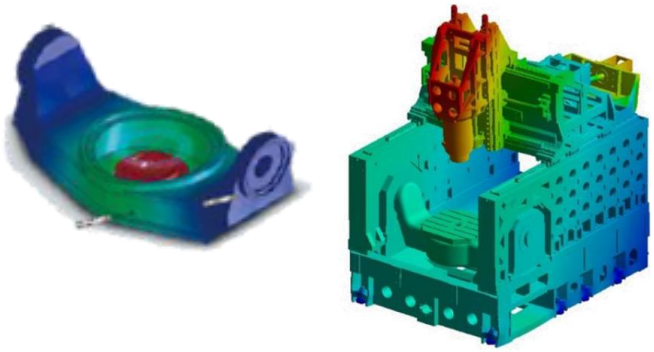
4. Mechanical structure

4-1 Compact U-frame design

- Gantry type structure, which are free from affect of work piece weight, and the driven centers of three axis are all on these gravity center. It significantly improves dynamic stability.
- The optimized force route design on spindle saddle, it minimizes spindle over and improves the stability and rigidity during machining.
- The column and base can be disassembled, and the whole machine can be transported by one container, which greatly reduces the installation time.

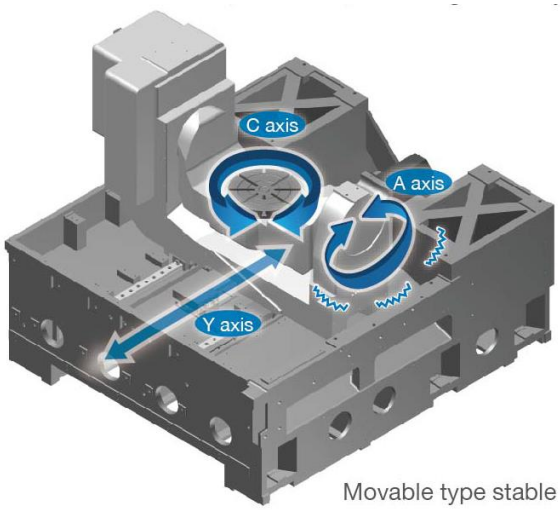


- The structure of the whole machine is analyzed by ANSYS structure to ensure the strength and satisfied the dynamic characteristics.

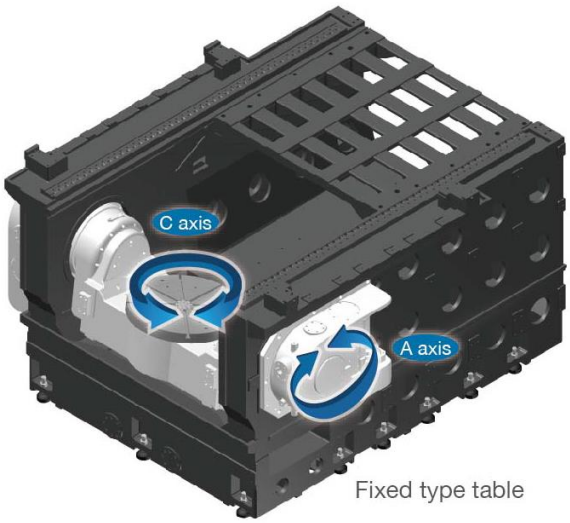


4-2 Fixed type table design

- X/Y/Z axis moving and table rotation are working individually to make sure machining is free from 3 axis inertia influences. Perfect servo driven design gives excellent machining stability
- The table of the A/C-axis is fixed in a position. Compared with movable type, the A-axis is not vibrated by feed axis movement. It improves the positioning accuracy in the A-axis.



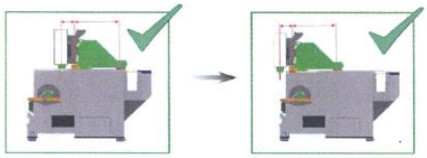
Movable type stable

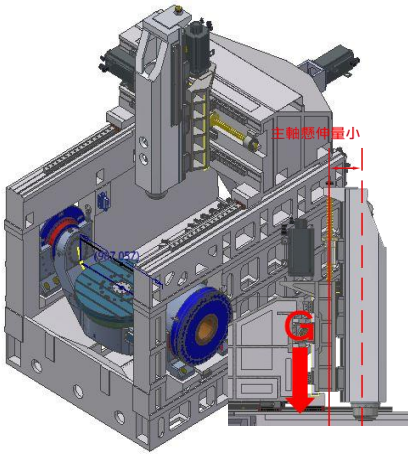


Fixed type table

4-3 The shortest force route between Z-axis and X-axis

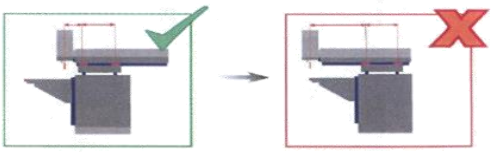
The shortest force route between Z-axis and X-axis to optimize the weight of structure and increase machining rigidity.

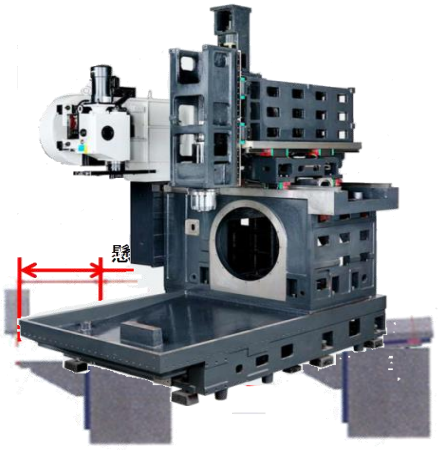




G800-TR design

The driven centers of three axis are all on these gravity center. It dramatically improves dynamic stability.





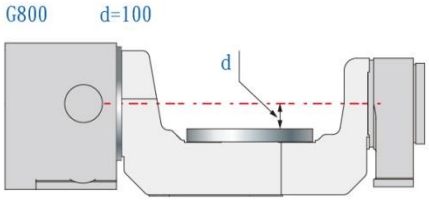
Other design

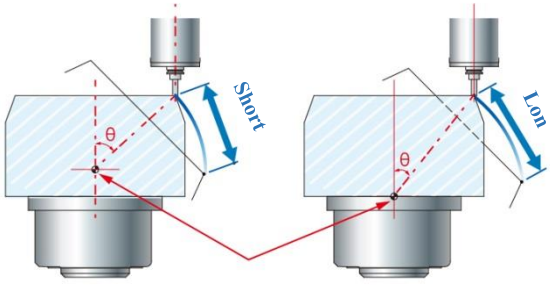
The gravity center of X axis is may offset at some position. It is not stable.

4-4 High precision rotary tilt table

- Rotating center of A-axis is 100 mm higher than table surface, that reduce the distance while tool moving and table rotation simultaneously to save the cycle time and gives perfect surface finishing in profile machining.

- The A-axis rotation angle can reach ±120 degrees, which can realize large negative angle machining.



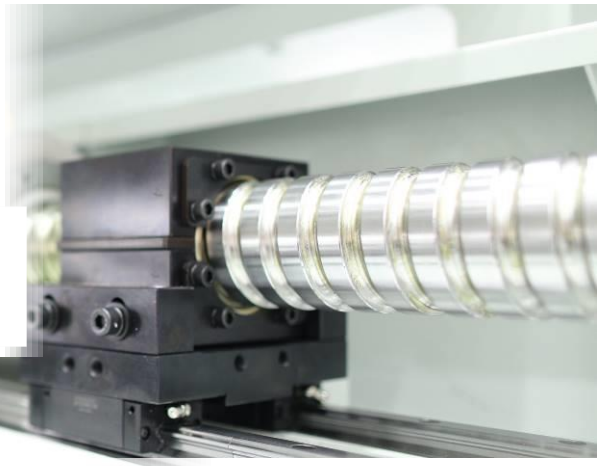


Rotation center

5. Drive system

XYZ axes are drove by precious ball screw which is low-noise, space-efficient and light design, high acceleration and deceleration, high-accuracy, high repeatability.

X/Y/Z -axis with Heidenhain optical linear/circular scale, which can effectively ensure the stability of each axis precision



Rapid feedrate： X/YZ=48m/min

Acceleration： X/Y/Z=6 m/sec^2

6. Automatic Tool Changer (ATC)

- The spindle contacts with the taper and flange, increase rigidity during machining.
- When HSK tool holders are subjected to thermal effects, the retention system cannot pull the HSK adapter from its place. This is due to the axial location of the HSK adapter and the flange-to-flange connection with the spindle nose. In addition, the HSK taper shank and the spindle taper tend to heat and grow evenly.

Tool shank	HSK100A
Tool capacity	60 pcs
Max. tool length	300 mm
Max. tool diameter-with adjacent tool	125 mm
Max. tool diameter-without adjacent tool	125 mm
Max. tool weight	15 kg

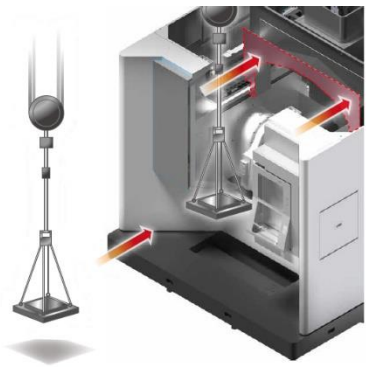
7. Operation

7-1 Door opening width

Wide door opening facilitates the operation and maintenance.

7-2 Manual opening / closing top roof sliding cover

The manual opening / closing top roof sliding cover of Y-axis helps the hanging work.



7-3 Swivel-type operation panel

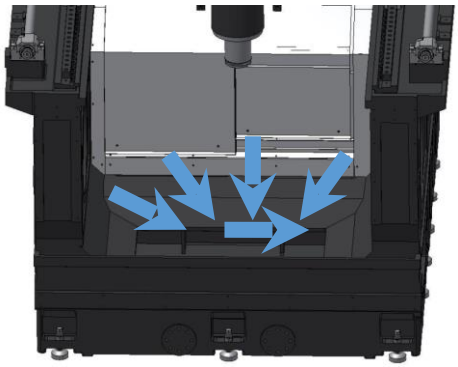
The swivel panel makes operator easy to operate and inspect during operation

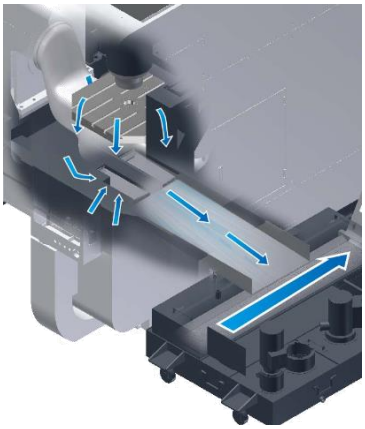
7-4 Easy maintenance

Through centralized management of air FIRL unit and lubricant pump, daily maintenance is made easily.

7-5 Well chip flow

Central chip flow design, chips can be carried out immediately while machining. It prevents casting structure from being affected by hot chips and main trains machining accuracy.





8. BLUM Laser Control Non-contact tool setting system for machine tools (opt.)

8-1 Extremely precise support system for tool setting and monitoring under harshest conditions.

- Tool setting at nominal spindle speed.
- Highest absolute accuracy due to focused laser beam.
- 100 % process reliability due to patented NT-Electronics.
- Blum pneumatic unit and shutter system provide superior protection.
- Pre-aligned laser for easy mounting.
- Programmable by integrated microprocessor.

8-2 Yout benefit:

- Increased productivity and production quality.
- No subsequent damage due to tool breakage.
- Reduced set-up time and unmanned operation.
- Reduced scrap rate.

8-3 Technical data

Laser safety classification	Class 2 acc. to IEC60825-1, 21 CFR 1040.10
Laser type	Visible red light laser | 630 ... 700 nm |<1 mW
Protection class	IP68
Power supply	24V DC / 160mA
Inputs/Outputs	24V DC / 0~5V DC analogue output *
Repeatability	Δ transmitter/receiver: <30 mm: 0,1 µm 2σ**
	Δ transmitter/receiver: <1,000 mm: 1,0 µm 2σ**
Minimum tool diameter	Δ transmitter/receiver: <30 mm: 5 µm**
	Δ transmitter/receiver: <1,000 mm: 125 µm**
Test speed (spindle)	200 rpm

* Option

** Depending on installation situation, stability of fixation, distance and measuring mode

Support systems provide highest precision even with micro-tools.

Fast detection of micro-wear at the cutting edge.

Absolutely reliable - patented NT-Electronics.

Non-contact monitoring of all kind of tool geometries.

9. BLUM Probe for Workpiece Measuring-Wireless Data Transmission (opt.)

9-1 High-Speed touch probe with latest BRC radio transmission technology and multidirectional measuring mechanism

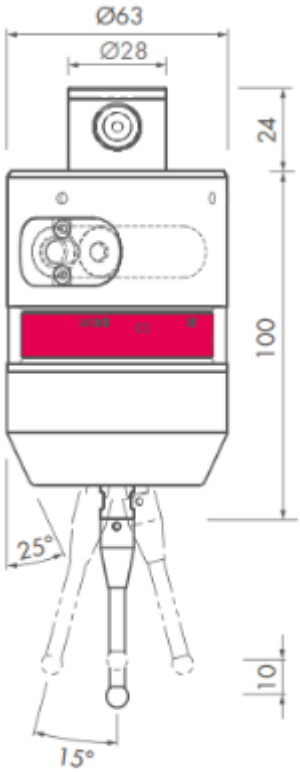
- Perfect for large 5-axis machines where line of sight between probe and receiver is blocked or intermittent
- Detection of workpiece position
- Correction of workpiece orientation
- Thermal compensation of the machine tool
- Contour measurement

9-2 Your benefit:

- Measuring speed up to 3 m/min
- Precise non-lubing touch characteristics
- No-wear, optoelectronic measuring mechanism
- Easy pairing procedure between probe and receiver
- Use of up to 6 measuring systems with one receiver
- Extended battery life
- Precise measurement even with coolant
- Proven and robust design BRC Radio Technology Sequential use of up to 6 measuring systems with one radio receiver.

9-3 Technical data

Protection class	IP68
Approach direction	±X, ±Y, -Z
Measuring force in XY | Z	2 N * / 7 N
Max. deflection in XY | Z	±15 / 10 mm
Max. acceleration	50 m/s^2
Repeatability	0.3 µm
Max. probing speed	3 m/min
Mass	925 g
Signal transmission	Radio (BRC tech)
Frequency band	2.4000 ~ 2.4835 GHz
Transmission power	0 dBm
Operating range	15 m
Battery (2 pieces)	Saft Lithium LS14500 (AA, 3.6 V) 2600 mAh
Tool holder	BTH 50 (HSK, SK, BT, VDI, ...)



11. Machine Installation Requirement

11-1 Power supply：80 KVA, 380V±5%, 50/60 Hz and 3-phrase & 5-wire(power supply needs an ground wire with neutral conductor and the voltage of three-phrase power supply must be equal).

11-2 Air pressure requirement：7±0.5 kg/cm^2 (4 pieces 12 mm above air tube needed)

11-3 Air flow requirement：1.0 m^3/min above

For reference

Flow rate (m^3/min)	0.565	0.85	2.4	3.15	7	9.5	13
Applicable Ranges(hp)	5	5~10	10~20	20~30	30~50	50~75	75~100

11-4 Water content：Level 4th = 3℃

- Oil content：Level 5th = 25 mg/m^3
- Compress air quality：ISO 8573-1 standard level：
- Solid particle：Level 5th = 40 μm

11-5 Environment temperature： + 5 ℃ ~ + 40 ℃

11-6 Relative humidity：30% ~ 95% (non-moisture congealment)

11-7 Environment limitation：

- Avoids the exterior vibration source, noise, and radiant influence.
- Indoor placement, without sunlight directly shining and avoid water leaking and immersing.
- Fluent air ventilation and far away from hear source.
- Avoid outside wind, gas and air conditioning directly blowing.
- Reduce dust and avoid the environment of parts casting, welding and machining.
- Without acidity, caustic gas influence.

11-8 Warranty period starts from completion of accuracy and function acceptance.

11-9 Foundation construction：Correspondent with APEC machine foundation construction drawing and machine foundation construction instruction manual (provided after contract signing).

11-10 Customers must configure the voltage regulator by themselves (according to the specifications recommended by APEC)

12. Functions of controller

Heidenhain TNC640 CNC controller with HR510 MPG.

五軸 5-AXIS	TNC640（MC8532）
Control Systems 控制系統	
Main computer CPU 主要電腦 CPU	Intel Core i7-3 1.7 GHz, dual-core
Random access memory 隨機處理記憶體	4GB
Visual display unit 顯示器	19" TFT Display 19 吋 TFT 彩色液晶螢幕
Keyboard 操作面板	TE745
Handwheel 手輪	HR510 (Opt. HR520 Opt.Wireless 無線手輪 HR550)
Axes and Spindle Control 軸向及主軸控制	
Max. controlled axes 最大可控制軸數	18
Max simultaneously controlled axes 最大可控制同步軸數	5
Spindles 最大主軸數	4
Max. spindle speed 最大主軸轉速	60,000 rpm
Synchronous axes 同步軸	Standard 標配
Tandem control 串聯控制	Standard 標配
PLC axes PLC 軸	Standard 標配
Input resolution 輸入解析度	0.1µm/0.0001° standard 標配
NC Program Memory NC 程式記憶容量	
Storage device 儲存裝置	21GB on Solid statue disk 固態硬碟 21GB
Interpolation 插補功能	
Linear interpolation 線性插補	In 4 axes; in 5axes with option 9 (APEC standard)
Circular interpolation 圓弧插補	In 2 axes; in 3 axes with option 8 (APEC standard)
Helical interpolation 螺旋插補	Standard 標配
Cylindrical interpolation 圓柱插補	Option 8
Cycle Times 循環時間	
Block processing time 單節處理時間	0.5 ms
Path interpolation 路徑插補	CC61XX：3 ms
Fine interpolation 細微插補	CC61XX：0.2 ms
Position controller 位置控制器	CC61XX：0.2 ms
Speed controller 速度控制器	CC61XX：0.2 ms
Current controller 電流控制器	5000 Hz 0.1 ms
Error Compensation 誤差補正	
Linear axis error 直線誤差補正	Standard 標配
Nonlinear axis error 非直線誤差補正	Standard 標配
Backlash. reversal peaks 背隙逆轉間點誤差補正	Standard 標配
Thermal expansion 熱膨脹誤差補正	Standard 標配

Static friction　靜壓摩擦力補正	Standard　標配
Sliding friction　滑動摩擦力補正	Standard　標配
Data Interfaces　資料介面	
Ethernet（100BaseT） 乙太網路介面	Standard　標配
USB interface(support USB1.1 and USB2.0) USD 支援	Standard　標配
RS-232-C/V.24	Standard　標配
Integral PLC	
Program format　程式格式化	Statement list
PLC cycle time　PLC 循環時間	9 ms to 30 ms (adjustable)
PLC window　PLC 窗口	Large/small window, soft keys　大/小視窗、軟鍵
PLC basic program　PLC 基本程式	Standard　標配
Commissioning and Diagnostic aids　診斷功能	
Diagnostics of digital drive systems 數位驅動系統診斷	TNCdiag
Pitting digital control loops into service 伺服調機	TNCopt
Programming and Operation Functions	
Program entry　程式輸入	ISO, DXF files and saving as conversational contouring programs
Coordinate transformation /rotation, mirror, scaling　座標轉換、旋轉、鏡射影像、比例縮放	Standard　標配
Polar coordinate　極座標	Standard　標配
Tilting the working plane　傾斜工作面	Standard　標配
Feedrate of rotary axes in length per minute(mm/min) 旋轉軸以每分鐘長度為進給單位	Standard　標配
Program of cylindrical contours as if in two axes 依二維平面方式編輯圓筒輪廓加工程式	Standard　標配
Tool Center Point Management（TCPM） 刀具中心點管理（TCPM）	Standard　標配
Tool Center Point Management（TCPM）: Superimposing handwheel position during program run　刀具中心點管理（TCPM）: 程式執行時，可用手輪插補刀具中心點位置	Standard　標配
3-D compensation through surface normal vector 透過表面垂直向量進行 3-D 刀具補正	Standard　標配
Tool perpendicular to contour 保持刀具垂直於輪廓	Standard　標配
Tool radius compensation normal to the tool direction　刀具半徑補正方向垂直於刀具方向	Standard　標配
Manual traverse in the active tool-axes system	Standard　標配

（tilting tool） 沿當前刀具軸手動移動	
KF free contour programming KF 自由輪廓程式編輯	Standard 標配
Program verification graphics（solid and 3D lines） 程式執行時模擬圖形（3-D 視圖）	Standard 標配
Graphical support for cycle programming 循环程式時的圖形支援	Standard 標配
Probe cycles 工件量測循環程式	Standard 標配
Cycle for boring, and conventional and rigid tapping 鏜孔、常規式、剛性攻牙循環	Standard 標配
Drilling cycle for pecking, reaming, boring, counterboring, centering 啄鑽、鉸孔、鏜孔、反向鏜孔、定心鑽孔循環	Standard 標配
Cycles for milling internal and external threads 內外螺紋銑削循环	Standard 標配
Multioperation machining of rectangular and circular pockets 粗銑及精銑長方形和圓形口袋	Standard 標配
Cycles for clearing level and inclined surfaces 修平平面和傾斜面	Standard 標配
Multioperation machining of straight and circular slots 直線和圓弧溝槽銑削的循環程式	Standard 標配
Linear and circular point patterms 圓弧和直線點排列	Standard 標配
Contour train, countour pocket-also with contour-parallel machining 口袋輪廓-同時使用輪廓組合加工	Standard 標配
Pallet management 交換工作台管理	Standard 標配
Tool management including tool life 刀具壽命管理	Standard 標配
TNCguide：The integrated helps system. User information available directly on the iTNC530 TNCguide：協助系統，用戶加工資訊可用於 iTNC530	Standard 標配
Graphic simulation before a program run, even while another program is running 程式執行前圖形預先模擬	Standard 標配
Working plane 工作平面選擇	Standard 標配
High Speed High Precision 高速高精度	
Jerk limitation 急衝力限制	Standard 標配
Smoother Jerk（low pass filter） 平穩急衝力(低通濾波器)	Standard 標配

Smoother Jerk（HSC filter） 平穩急衝力(高速切削濾波器)	Standard 標配
Look ahead blocks 預讀功能	5000
Path filter（smoothing） 路徑平滑	Standard 標配
Conversational Languages 對話式語文選擇	
Portuguese, Swedish, Danish, Finnish, Dutch, Polish, Hungarian, Russian（Cyrillic）, Chinese（traditional, simplified） 英文、中文、德文、捷克文、法文、義大利文、西班牙文、葡萄牙文、瑞典文、丹麥文、芬蘭文、荷蘭文、波蘭文、匈牙利文、俄羅斯文(西里爾)	Standard 標配 (Not included PLC Alarm) PLC Alarm for English , Chinese

13. Supplier

13-1 Standard accessories

Country	Supplier	Item	Spec.
TW/DE	AGA	Spindle	HSK100A, 12,000rpm, 50 / 76 kW (S1/S6), 200 / 302 Nm (S1/S6)
TW	AGA	Rotary tilt table	Table size Ø800 mm
DE	Heidenhain	CNC Controller	Heidenhain TNC640 CNC controller
DE	Heidenhain	optical scale	Heidenhain optical linear/circular scale
SCH	SCHNEEBRGER	Guide way	High rigidity roller type linear guide way
TW	HIWIN/PMI	Ball screw	
DE	IGUS	Cable chain	
DE/JP/TW	NITTA / Yokohama / PHOENIX / SC Kingflex	Oil-air lubrication device	For spindle lubrication
JP	NITTA	Water resistant oil/water pipe	
TW	Made in Taiwan	Pneumatic unit	
TW	Made in Taiwan	Waterproof working lamp	
DE/JP/ TW	OMRON/Heidenhain/ TE/ Made in Taiwan	Electrical material	
TW	Made in Taiwan	Tool magazine	HSK63A, 32T
TW	Made in Taiwan	Bellows cover	PUR material, grease proofing and Anti-embrittlement
TW	Made in Taiwan	Air conditioner	For electrical cabinet
TW	Made in Taiwan	Spindle chiller	For spindle
TW	Made in Taiwan	Main cast iron	

13-2 Option accessories

Country	Supplier	Item	Spec.
DE	BLUM	BLUM Laser tool measurement system	For tool measurement
DE	BLUM	BLUM Touch probe system	For workpiece measurement
TW	APEC	Coolant through spindle	70 bar
TW	Made in Taiwan	Isolation transformer	
TW	Made in Taiwan	Voltage stabilizer	

C. Documents

Documents with the machine as following：

· Electrical operation manual

· Machine operation and maintenance manual

· Electrical circuit diagram

· NC controller manual

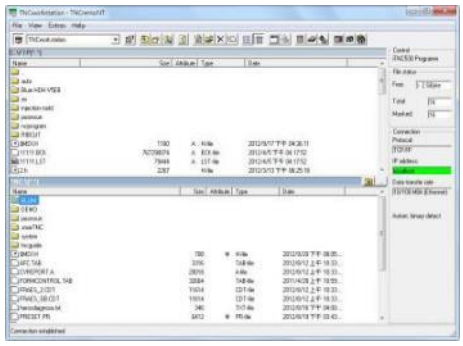
· Accuracy table

· Acceptance sheet

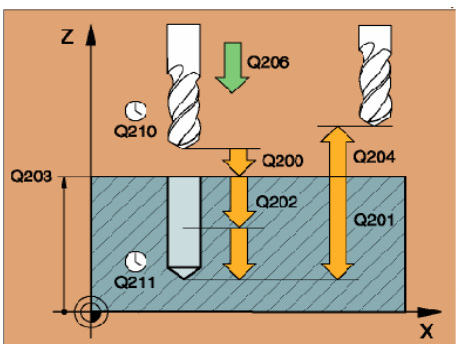
D. Training

1. Complete teaching material for course and seminar.

2. Controller simulation on PC and CAD/ CAM discussion.



3. Machine operation and workpiece machining test

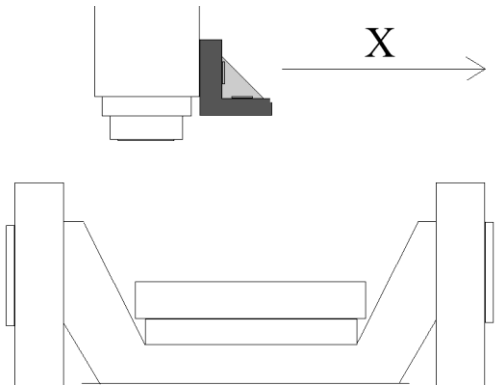


E. Acceptance criterion

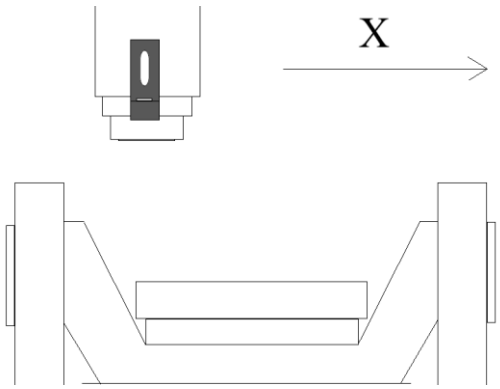
Accuracy acceptance contents:

1	**Check the deviation of angle when X axis moves:** **a) EBX:pitch b) EAX:roll**

a)



b)



Tolerance
0.02mm/ 800mm

Measured value (mm)

	X+400	X0	X-400	maximum
a)		0		
b)		0		

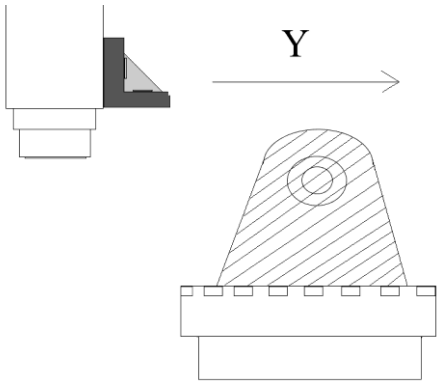
Measuring instruments
Precise level >||< = 0.02mm/m , 4’ ’

Specification reference ISO/WD XXXXX-2

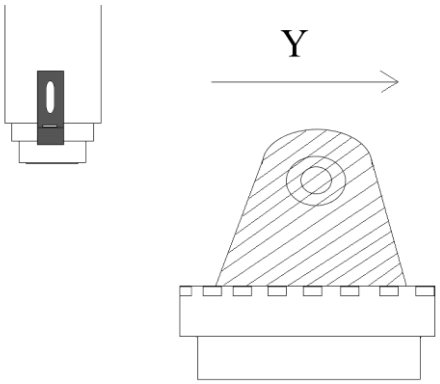
(1) Place precise level on the head in accordance with the instructions shown by diagram.
(2) Move X axis to origin and record the readings shown by precise level.
(3) Move X axis 400mm and record the readings shown by precise level. Then, move X axis another 100mm and record the readings shown by precise level, and so on.
(4) Measured value means the maximum difference among all readings shown by precise level when X axis moves.

2	**Check the deviation of angle when Y axis moves:** **a) EAY:pitch b) EBY:roll**

a)



b)



Tolerance
0.02mm/ 800mm

Measured value (mm)

	Y+400	Y0	Y-400	maximum
a)		0		
b)		0		

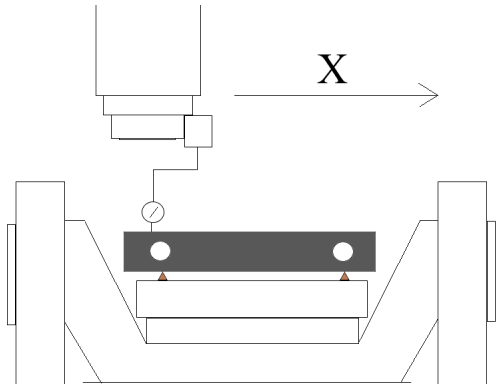
Measuring instruments
Precise level >|< = 0.02mm/m , 4’ ’

Specification reference ISO/WD XXXXX-2

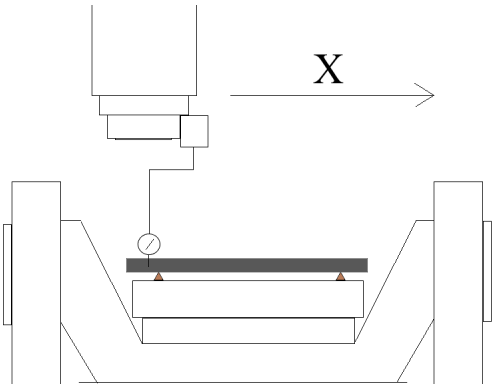
(1) Place precise level on the head in accordance with the instructions shown by diagram.
(2) Move Y axis to origin and record the readings shown by precise level.
(3) Move Y axis 400mm and record the readings shown by precise level. Then, move Y axis another 100mm and record the readings shown by precise level, and so on.
(4) Measured value means the maximum difference among all readings shown by precise level when Y axis moves.

3	Measure straightness when X axis moves： a) EZX.　b) EYX;

a)



b)



Tolerance	**Measured value** (mm)	
a) EZX 0.005mm/400mm	a)	
b) EYX 0.005mm/400mm	b)	

Measuring instruments

Straightedge (AA), test indicator (2μm) and adjustable jig

Specification reference　ISO/WD XXXXX-2

(1) Set up straightedge on workbench in accordance with the instructions shown by diagram.

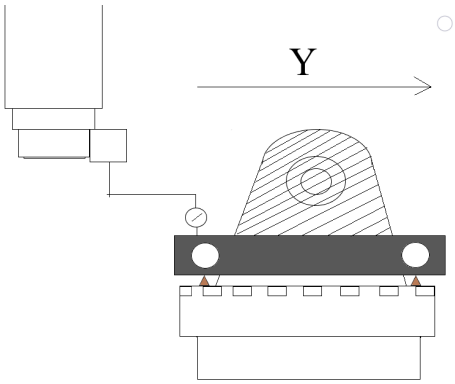
(2) Set up test indicator on spindle and make sure that the test indicator’ s hand contacts the straightedge.

(3) Move X axis, adjust straightedge, and make sure that the test indicator shows 0 on both ends of test indicator (straightness means the maximum reading in the center)

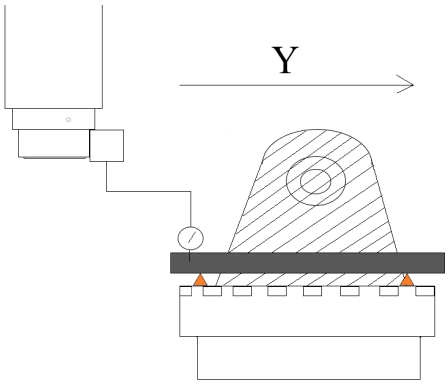
(4) If measuring instruments are not available when the machine is delivered, please use the inspection results obtained in APEC factory.

4	Measure straightness when Y axis moves： a) EZY; b) EXY.

a)



b)



Tolerance	**Measured value** (mm)	
a) EZY 0.05mm/400mm	a)	
b) EXY 0.05mm/400mm	b)	

Measuring instruments

Straightedge(AA), test indicator (2μm) and adjustable jig

Specification reference ISO/WD XXXXX-2

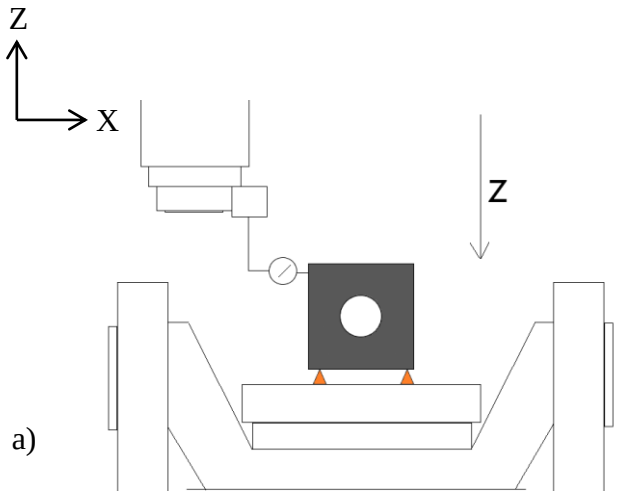
(1) Set up straightedge on workbench in accordance with the instructions shown by diagram.

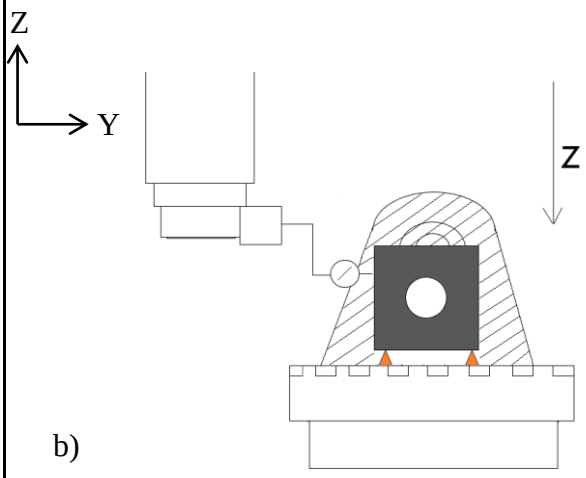
(2) Set up test indicator on spindle and make sure that the test indicator’ s hand contacts the straightedge.

(3) Move Y axis, adjust jig, and make sure that the test indicator shows 0 on both ends of straightedge (straightness means the maximum reading in the center).

(4) If measuring instruments are not available when the machine is delivered, please use the inspection results obtained in APEC factory.

5	Measure straightness when Z axis moves： a) EXZ; b) EYZ;





Teolrance	**Measured value** (mm)	
a) EXZ 0.005mm/400mm	a)	
b) EYZ 0.005mm/400mm	b)	

Measuring instruments

Four-face square master (AA) , adjustable jig and test indicator (2μm)

Specification reference ISO/WD XXXXX-2

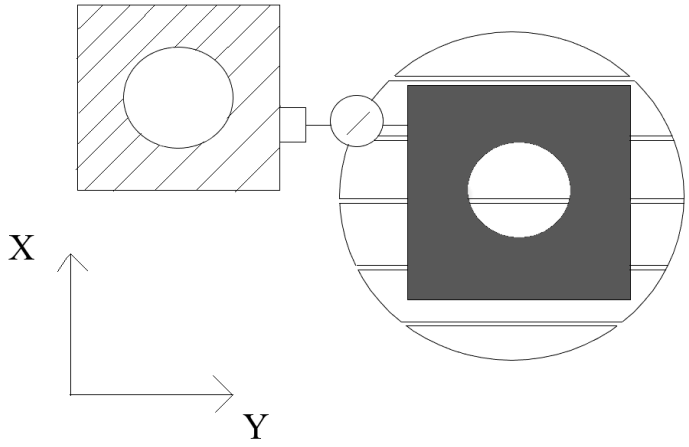
(1) Set up four-face square master and adjustable jog on bench in accordance with the instructions shown by diagram.

(2) Set up test indicator on spindle and make sure that the test indicator’ s hand contacts the four-face square master.

(3) Move Z axis, adjust jig, and make sure that the test indicator shows 0 on both ends of straightedge (straightness means the maximum reading in the center).

(4) If Measuring instruments are not available when the machine is delivered, please use the inspection results obtained in APEC factory.

6	Check the squareness when X axis and Y axis move simultaneously



Tolerance 0.015mm/400mm	**Measured value** (mm)

Measuring instruments
Four-face square master (AA) and test indicator (2μm)

Specification reference ISO/WD XXXXX-2

(1) Set up four-face square master on workbench in accordance with the instructions shown by diagram.

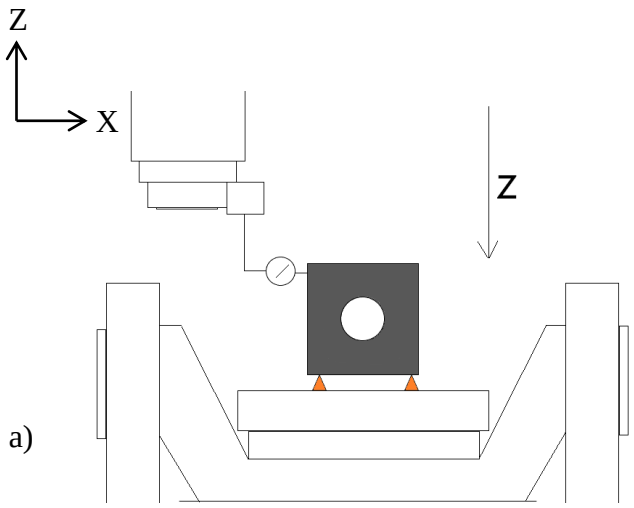
(2) Place test indicator on spindle and make sure that the indicator’ s hand contacts the four-face square master’ s side which is parallel to X direction.

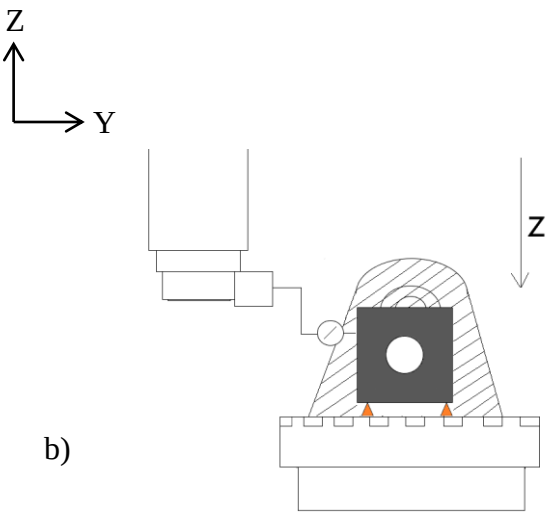
(3) Move X axis and adjust test indicator until it shows 0 on both ends of four-face square master.

(4) Change the direction contacted by the test indicator’ s hand. Make sure that the hand contacts one side of the four-face square master and that side is parallel to Y direction.

(5) Move Y axis. The maximum shown by the test indicator means the squareness.

7	Check the squareness among Z axis, X axis and Y axis when Z axis moves





Tolerance	**Measured value** (mm)	
a) 0.015mm/400mm	a)	
b) 0.015mm/400mm	b)	

Measuring instruments

Four-face square master (AA), adjustable jig and test indicator (2μm)

Specification reference ISO/WD XXXXX-2

(1) Set up four-face square master and adjustable jig on workbench in accordance with the instructions shown by diagram.

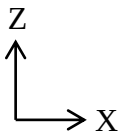
(2) Place test indicator on spindle. Make sure that the test indicator’ s hand contact one side of the four-face square master that is parallel to X/Y direction.

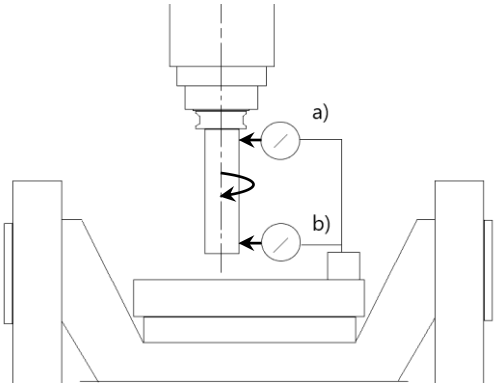
(3) Move X/Y axis, adjust jig, and make sure that the test indicator shows 0 on both ends of four-face square master

(4) Change the direction contacted by the test indicator’ s hand. Make sure that the hand contacts one side of four-face square meter and that side is parallel to Z direction.

(5) Move Z axis. The maximum reading shown by the test indicator means the squareness.

8	**Check the deflection of spindle hole：** **a) Close to spindle nose; 50mm** **b) 300 mm to spindle nose**





Tolerance	**Measured value** (mm)	
a) 0.005mm	a)	
b) 0.02mm	b)	

Measuring instruments

Test indicator (2μm) and standard test bar

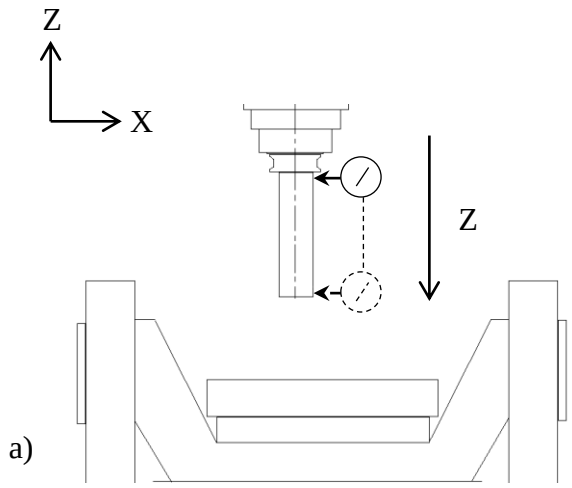
Specification reference ISO/WD XXXXX-2

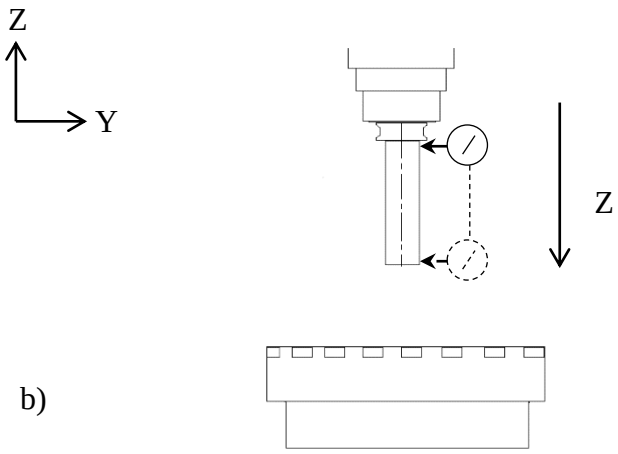
(1) Install standard test bar in spindle in accordance with the instructions shown by diagram.

(2) Set up test indicator and make sure that the test indicator’ s hand contact the standard test bar.

(3) Turn spindle manually. The maximum reading shown by test indicator means the deflection of spindle hole (upper deflection is found at 50mm from spindle nose and lower deflection is found at 350mm from spindle nose)

9	Check the parallelism between spindle center and Z axis： a) X direction; b) Y direction.





Tolerance	**Measured value** (mm)	
a) 0.02mm/300mm	a)	
b) 0.02mm/300mm	b)	

Measuring instruments

Test indicator (2μm) and standard test bar

Specification reference ISO/WD XXXXX-2

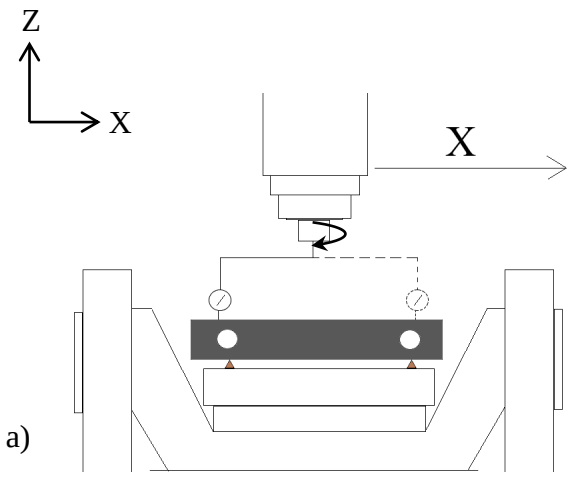
(1) Install standard test bar in spindle in accordance with the instructions shown by diagram.

(2) Mount test indicator and make sure that the indicator’ s hand contacts the X/Y direction of standard test bar.

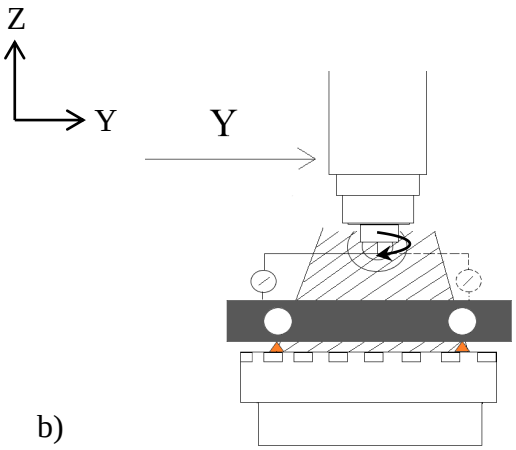
(3) Indicator needle hits the standard test bar. Spindle rotates and stops at the medium of runout value. Set the indicator to zero.

(4) Move Z axis. The maximum reading shown by indicator is the result.

10	**Check the squareness between spindle center and XY plane：** **a) X axis; b) Y axis.**



a)



b)

Tolerance	**Measured value** (mm)	
a) 0.02mm/300mm	a)	
b) 0.02mm/300mm	b)	

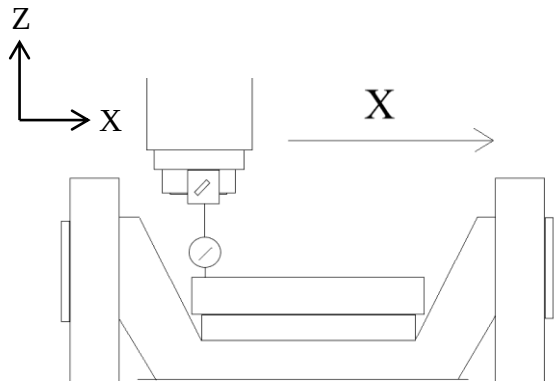
Measuring instruments

Test indicator (2μm), Four-face square master (AA) and adjustable jig

Specification reference ISO/WD XXXXX-2

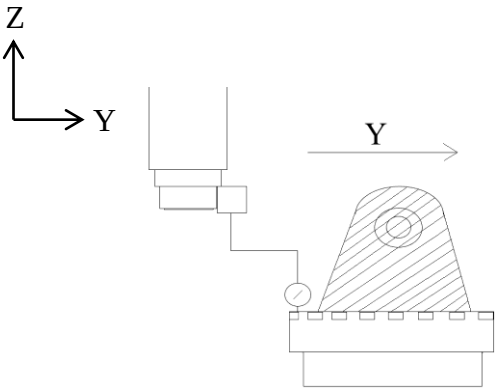
(1) Mount straightedge and adjustable jig on workbench in accordance with the instructions shown by diagram.
(2) Mount test indicator on spindle and make sure that the test indicator’ s hand contacts the straightedge.
(3) Move X/Y, adjust the jig, and make sure that the test indicator shows 0 on both ends of straightedge.
(4) Then, turn spindle 180° and record the difference between the readings shown by both measuring points.

11	Check the parallelism of workbench when X and Y axis moves



a)

A axis 0°



b)

A axis 0°

Tolerance	**Measured value** (mm)	
a) 0.03mm/800mm	a)	
b) 0.03mm/800mm	b)	

Measuring instruments

Test indicator (2μm)

Specification reference ISO/WD XXXXX-2

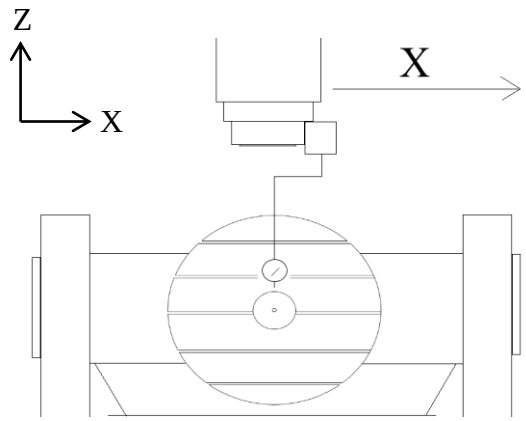
(1) Set up test indicator on spindle in accordance with the instructions shown by diagram.

(2) Move X axis and Y axis, and measure.

(3) Find the maximum difference among all readings shown by the strokes. It is the result.

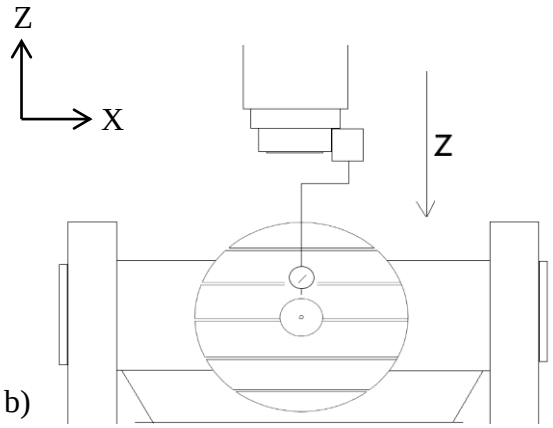
12	Check the parallelism of workbench when X and Z axis moves

a)



A axis ± 90°

b)



A axis ± 90°

Tolerance

a) 0.03mm/800mm

b) 0.02mm/500mm

Measured value (mm)

	A+90	A-90
a)		
b)		

Measuring instruments

Test indicator (2μm)

Specification reference ISO/WD XXXXX-2

(1) A axis rotates to + 90 degrees.

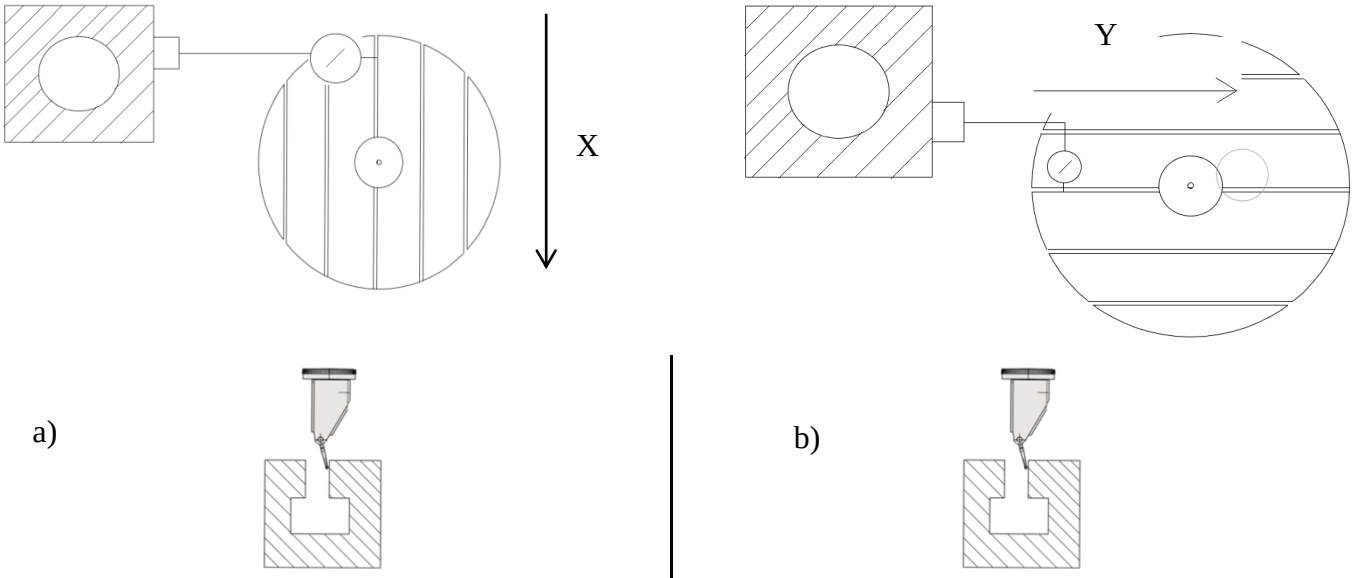
(2) Set up test indicator on spindle in accordance with the instructions shown by diagram.

(3) Move X axis and Z axis, and measure.

(4) Find the maximum difference among all readings shown by the strokes. It is the result.

(5) A axis rotates and stops at – 90 degrees, using the procedure stated above to measure.

13	Check the parallelism of X and Y axis t-slot



Tolerance	**Measured value** (mm)	
a) 0.03mm/800mm	a) C0。	
b) 0.03mm/800mm	b) C90。	

Measuring instruments

Test indicator (2μm)

Specification reference ISO/WD XXXXX-2

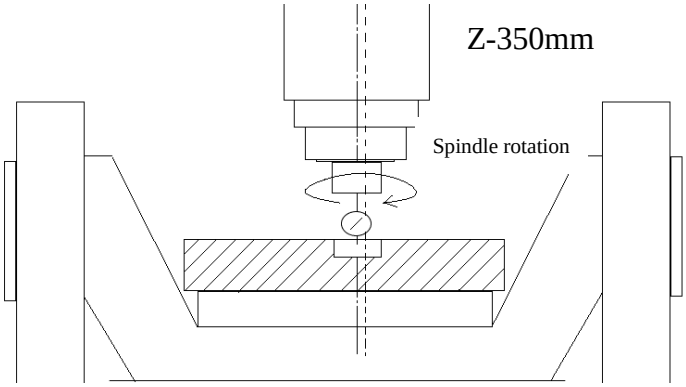
(1) Turn C axis to 0 degree. If you intend to run b) measurement, you should turn C axis to 90 degrees.

(2) Follow the instruction shown by diagrams and mount the level-type dial indicator on the spindle.

(3) Follow the instructions shown by diagrams and move the level-type dial indicator needle to hit the t-slop on the center of workbench, then set the dial indicator to zero.

(4) Move X axis / Y axis and measure. The maximum value shown by the stroke is the result of the measurement.

14	Check the concentricity between spindle axle and the center hole of workbench



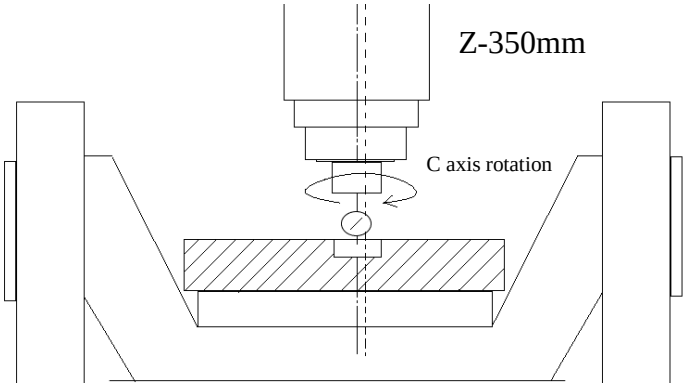
Tolerance ≤ 0.02mm	**Measured value** (mm)

Measuring instruments
Test indicator (2μm)

Specification reference ISO/WD XXXXX-2

(1) Follow the instructions shown by diagram and mount level-type dial indicator on spindle nose, about -350mm to Z axis.
(2) Remove cover from the reference hole in the center of turntable.
(3) Move X axis and Y axis to original point.
(4) Follow the instructions shown by diagrams and move level-type dial indicator needle to hit the reference hole.
(5) Use handwheel to turn spindle for one revolution and check the dial indicator. The maximum value shown by the dial indicator is the result of measurement.

15	Check the deviation of workbench’ s reference hole when C axis is rotating



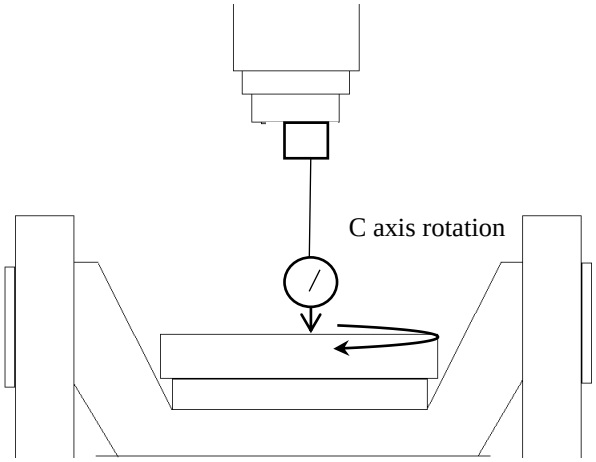
Tolerance	**Measured value** (mm)
≤ 0.02mm	

Measuring instruments
Test indicator (2μm)

Specification reference ISO/WD XXXXX-2

(1) Follow the instructions shown by diagrams and mount level-type dial indicator on spindle nose, about -350mm to Z axis.
(2) Remove cover from the reference hole in the center of turntable.
(3) Move X axis and Y axis to original point.
(4) Follow the instructions shown by diagrams and move level-type dial indicator needle to hit the reference hole.
(5) Fasten the spindle and make sure the spindle is unable to rotate.
(6) Turn C axis for one revolution and check the dial indicator. The maximum value shown by the dial indicator is the result of measurement.

16	**Confirm the deviation in Z direction of C axis' rotation and spindle axle**



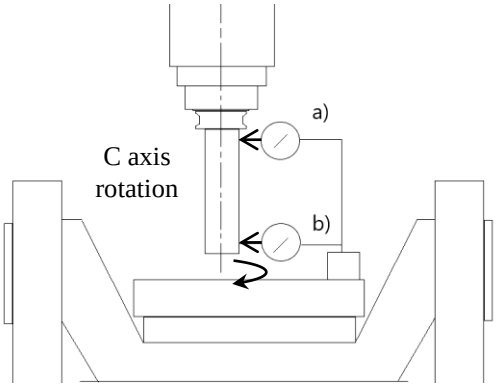
Tolerance 0.01mm	**Measured value** (mm)

Measuring instruments
Test indicator (2μm) and ball-type standard test bar

Specification reference ISO10791-6 BK2

(1) Follow the instructions shown by diagram and mount ball-type standard test bar on spindle.
(2) Move X axis and Y axis to original point.
(3) Mount level-type dial indicator and make sure the indicator needle hits the flat area of workbench (outer side of workbench' s reference hole).
(4) Fasten the spindle and make sure the spindle is unable to rotate.
(5) Turn C axis for one revolution and check the dial indicator. The maximum value shown by the dial indicator is the result of measurement.

17	**Confirm the deviation in X direction of C axis' rotation and spindle axle when RTCP is in use**



a) 50mm to spindle nose

b) 300mm to spindle nose

Tolerance	**Measured value** (mm)	
a) 0.015mm	a)	
b) 0.02mm	b)	

Measuring instruments

Test indicator (2μm) and standard test bar

Specification reference ISO10791-6 BK2

(1) Follow the instructions shown by diagram and mount standard test bar on spindle.

(2) Move X axis and Y axis to original point.

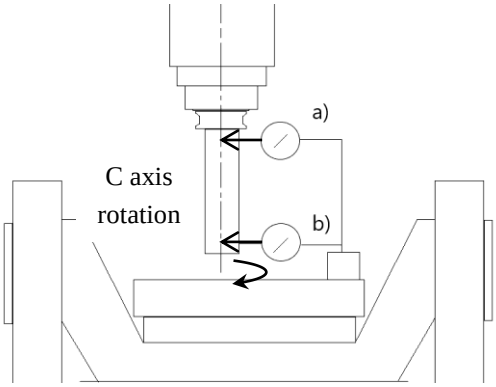
(3) Follow the instructions shown by diagrams and mount level-type dial indicator.

(4) Dial indicator needle hits the standard test bar. Turn spindle and stop it at the medium of runout value, then set the indicator to zero.

(5) Activate RTCP (M128, TRAORI)

(6) Turn C axis for 180 degrees and check the dial indicator. The maximum value shown by dial indicator is the result of measurement.

18	**Confirm the deviation in Y direction of C axis' rotation and spindle axle when RTCP is in use**



a) 50mm to spindle nose

b) 300mm to spindle nose

Tolerance	**Measured value** (mm)	
a) 0.015mm b) 0.02mm	a)	
	b)	

Measuring instruments

Test indicator (2μm) and standard test bar

Specification reference ISO10791-6 BK2

(1) Follow the instructions shown by diagram and mount standard test bar on spindle.

(2) Move X axis and Y axis to original point.

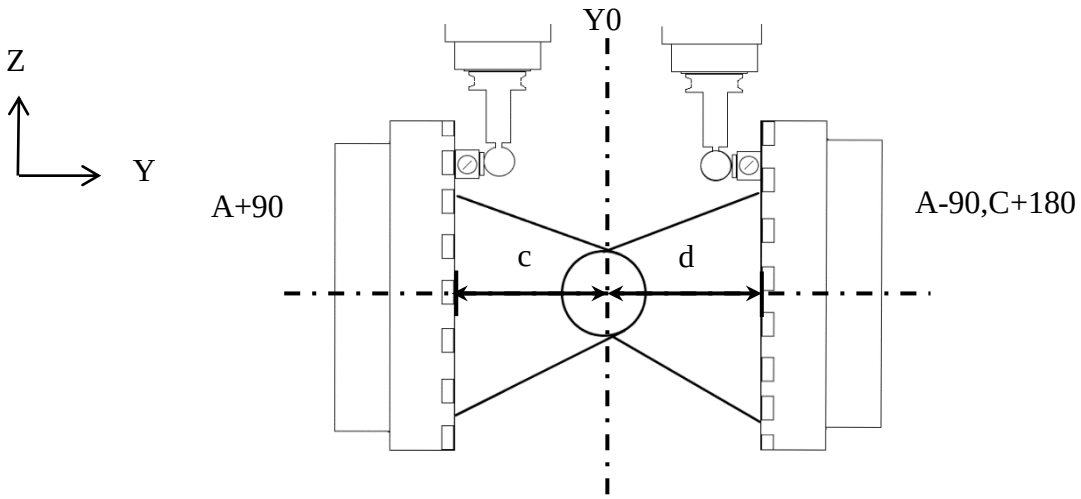
(3) Follow the instructions shown by diagrams and mount level-type dial indicator.

(4) Dial indicator needle hits the standard test bar. Turn spindle and stop it at the medium of runout value, then set the indicator to zero.

(5) Activate RTCP (M128, TRAORI).

(6) Turn C axis for 180 degrees and check the dial indicator. The maximum value shown by dial indicator is the result of measurement.

19	Measure the deviation in Y direction when A axis is rotating, and measure the distance between A axis' rotation center and table top



Tolerance	**Measured value** (mm)
When A axis is rotating, deviation in Y direction c – d = less than 0.01mm	

Measuring instruments

Z axis setter and ball-type standard test bar

Specification reference ISO10791-6 BK1

(1) Follow the instructions shown by diagrams and mount ball-type standard test bar on spindle.

(2) Move Y axis to original point.

(3) Follow the instruction shown by diagrams and mount Z axis setter on workbench.

(4) Turn A axis to 90 degrees.

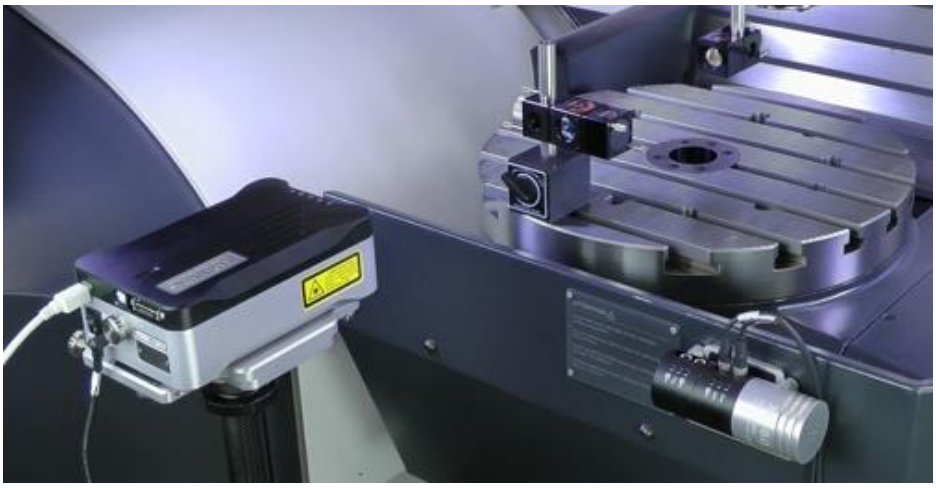
(5) Move Y axis and make sure the ball-type standard test bar hits Z axis setter, then record the current coordinate of Y axis.

c distance = | current coordinate of Y axis + spherical radius of ball-type standard test bar + height of Z axis setter |

(6) Turn A axis to -90 degrees and C +180 degrees, then repeat step (5) to obtain d distance.

(7) c minus d equal to the deviation in Y direction when A axis is rotating.

20	**X axis linear laser**



Tolerance		**Measured value** (mm)	
Positioning accuracy P	0.008mm	Positioning accuracy P	
Repeated positioning accuracy Ps max	0.005mm	Repeated positioning accuracy Ps max	

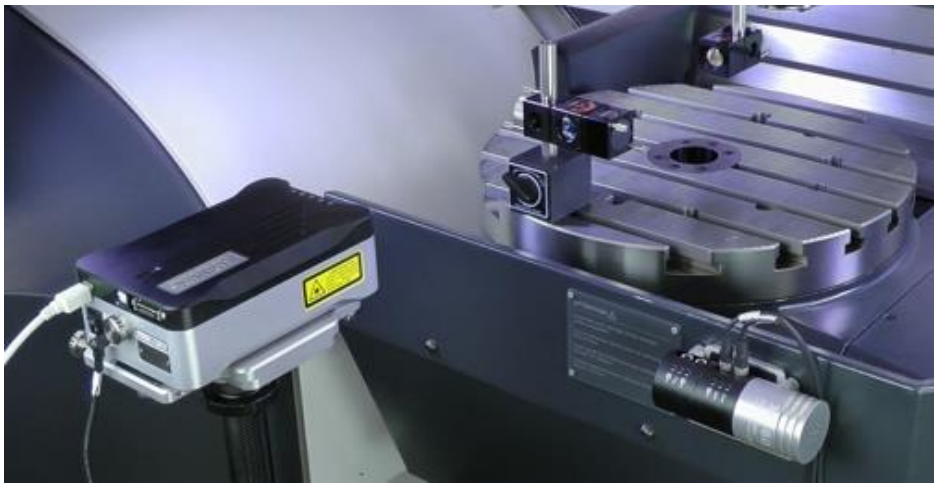
Measuring instruments: Renishaw xl80

Regulation reference VDI3441

(1) Set up laser interferometer.

(2) Move full-stroke back and forth 5 times every 200mm and measure positioning accuracy to validate the positioning accuracy.

21	**Y axis linear laser**



Tolerance		**Measured value** (mm)	
Positioning accuracy P	0.008mm	Positioning accuracy P	
Repeated positioning accuracy Ps max	0.005mm	Repeated positioning accuracy Ps max	

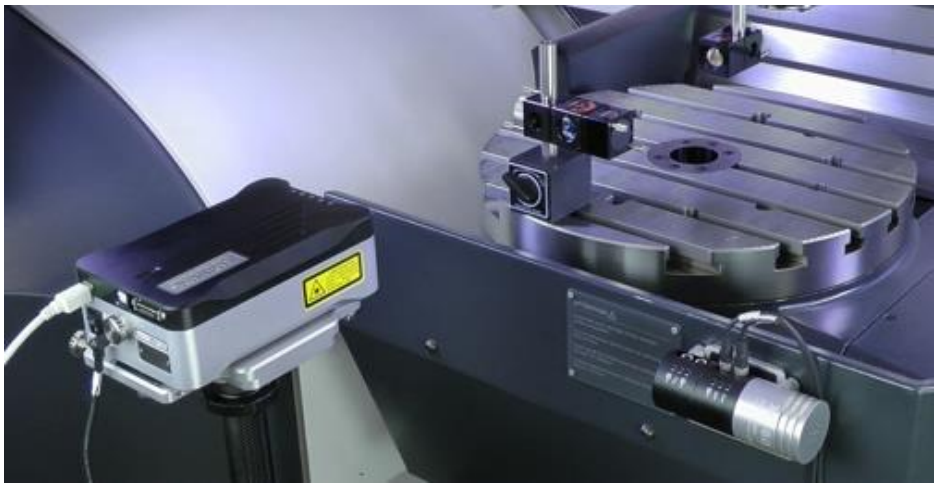
Measuring instruments: Renishaw xl80

Regulation reference VDI3441

(1) Set up laser interferometer.

(2) Move full-stroke back and forth 5 times every 200mm and measure positioning accuracy to validate the positioning accuracy.

22	**Z axis linear laser**



Tolerance		**Measured value** (mm)	
Positioning accuracy P	0.008mm	Positioning accuracy P	
Repeated positioning accuracy Ps max	0.005mm	Repeated positioning accuracy Ps max	

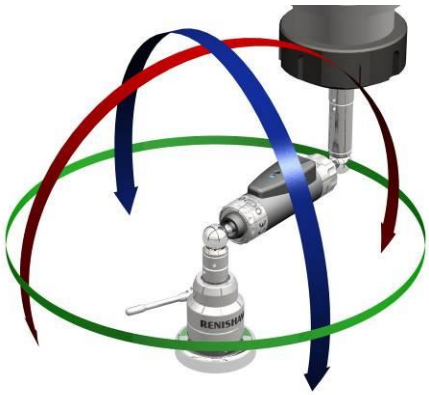
Measuring instruments: Renishaw xl80

Regulation reference VDI3441

(1) Set up laser interferometer.

(2) Move full-stroke back and forth 5 times every 100mm and measure positioning accuracy to validate the positioning accuracy.

23	**Renishaw ballbar test**



Tolerance XY:0.02mm/ roundness/R150mm XZ:0.02mm/ roundness/R150mm YZ:0.02mm/ roundness/R150mm	**Measured value** (mm)	
	XY	
	XZ	
	YZ	

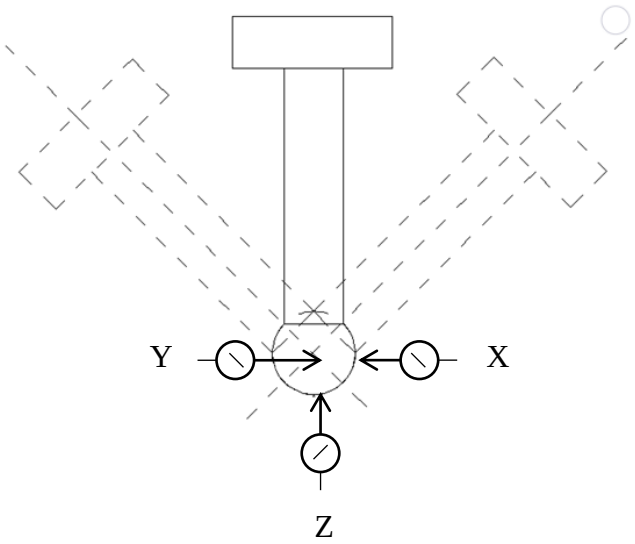
Measuring instruments
Renishaw ballbar QC20

Specificaiton reference ISO10791-6

(1) Mount Renishaw ballbar QC20 on the machine and set ball rod length at 150mm.

(2) Run program F3000mm/min to draw a full circle of XY/XZ/YZ.

24	**Five axis dynamic TCPM measurement**



Tolerance
Tool center point (TCP) error:±0.03mm

	Measured value (mm)	
	Minimum	Maximum
X		
Y		
Z		

Measuring instruments
Comparator (1μm) and ball-type standard test bar

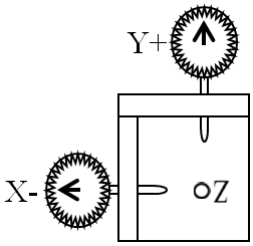
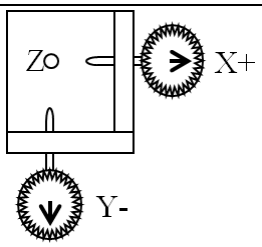
Specification reference ISO10791-6 BK4

(1) Mount ball-type standard test bar on spindle in accordance with the instructions shown by diagram.

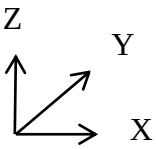
(2) Mount comparator on workbench. Make sure that the comparator’ s hand contacts the ball, and then return the ball to zero.

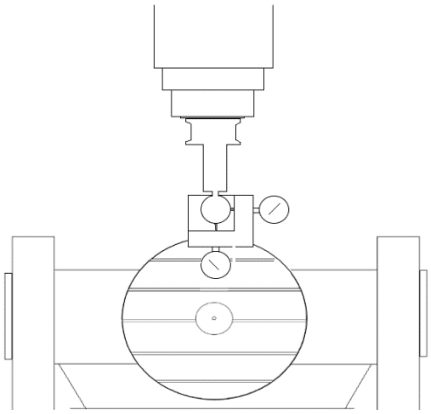
(3) Complete measurement procedure in accordance with the instructions shown by the attachment as follows.

Attachment	Five axis dynamic TCPM measurement (μm)

Measurement direction						Measurement direction					
Axial direction	Angle position		X	Y	Z	Axial direction	Angle position		X	Y	Z
Y-	A0	C0				Y+	A0	C0			
	A60	C0					A-60	C0			
	A90	C0					A-90	C0			
	A0	C180					A0	C-180			
	A-60	C180					A60	C-180			
	A-90	C180					A90	C-180			
Axial direction	Angle position		X	Y	Z	Axial direction	Angle position		X	Y	Z
X+	A0	C90				X-	A0	C-90			
	A60	C90					A60	C-90			
	A90	C90					A90	C-90			
	A0	C-90					A0	C90			
	A-60	C-90					A-60	C90			
	A-90	C-90					A-90	C90			

25	**Errors of three direction – X, Y and Z – on tool center point (TCP) when measurement machine stops for emergency reason**





Tolerance X/Y/Z < 0.07mm	**Measured value** (mm)	
	X	
	Y	
	Z	

Measuring instruments

Comparator (1μm) and ball-type standard test bar

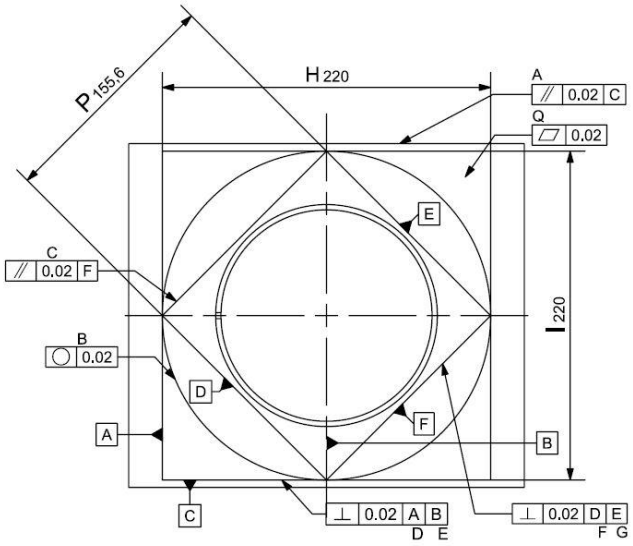
(1) Mount ball-type standard test bar on spindle in accordance with the instructions shown by diagram.

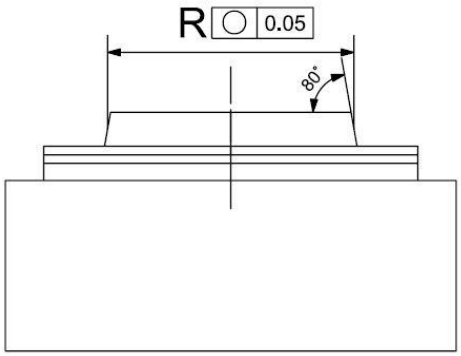
(2) A axis sways to +45 degrees.

(3) Mount comparator on workbench, make sure the comparator’ s hand contacts the ball, and then return the comparator to zero.

(4) Press the emergency stop of machine and record the readings shown by the measuring instrument.

26	Standard part (CONE +NASA) machined by 5-axis move simultaneously





量測方法 Machining Method：

使用可量測輪廓之三次元量床量測 Use CMM measurement.

量測位置 Position	標準尺寸 Stand Size	許可差 Tolerance	實測值 Value	備註 Remark
A	Parallelism	0.02mm		CMM
B	Roundness	0.02mm		CMM
C	Parallelism	0.02mm		CMM
D	Verticality	0.02mm		CMM
E	Verticality	0.02mm		CMM
F	Verticality	0.02mm		CMM
G	Verticality	0.02mm		CMM
Q	Flatness	0.02mm		CMM
R	Roundness	0.05mm		CMM

E. Warranty

Warranty period starts from completion of accuracy and function acceptance.

1. Machine warranty period is 12 months for normal use
2. Controller warranty period is 12 months for normal use
3. Spindle warranty period is 12 months for normal use
4. Peripheral equipment warranty period is 12 months for normal use

F. Accessories list

Tools delivery with machine

No.	Item/ Spec	amount
1	Tool box / TB350	1
2	Open-end wrench set / 8*9、10*12、12*14、14*17、17*19、21*23	1
3	Philips-head screwdrivers / 4 "	1
4	Slotted-head screwdrivers / 4 "	1
5	Allen wrench set	1