・Inspection ・Evaluation ・Assembly	Instructions	Document form control No.		E592M0066A0	
		Issued on	November 30, 2006	Published by	Improvement Design Group INTEGREX-Product
Machine model	372, 373, 374	Page	1/14	Document No.	ED373LH017M00
Machine model name	INTEGREX-IV	Desired delivery date	When measures are practiced	Practice schedule	
Machine model (S/N)		Special order / Design change / Others		Instructed to	
Miscellaneous				Person in charge of inspection & evaluation	-
Title	**Procedure to restore precision of INTEGREX-IV**			Relevance Reference Distributed to	

< Figure >

< Purpose >

To aim at reduction of initial claims and improvement of qualities by increasing check items in installation of INTEGREX-IV

< Contents >

Installation procedure

- Leveling
- Homing
- Core convex compensation parameter check
- Tool eye parameter check

< Reference for inspection / evaluation / assembly instruction >

Refer to the attached materials (2/14) to (4/14).

Clarify judgement of pass and fail. If nonconformity is judged, take an action according to the "Nonconformity Control Standard".

	Inspection / Evaluation		
	Approved by	Checked by	Person in charge

No.	Revised on	Revised item	Revised by	Approved by
4				
3				
2				
1				

Design		
Approved by	Checked by	Prepared by
岩田 '06.12.01	日比野 '06.11.30	Nishiwaki & Murase

Flow of check items in installation

Tools to be used

MILLIMESS dial indicator

Magnet stand

Dial gauge

Level

Workpiece

Level table for Z-axis

Level table for W-axis

Swing tool

Milling test bar

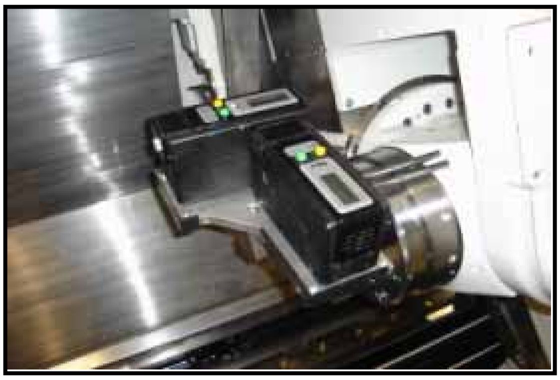
O.D. (cutting) tool / I.D. (cutting) tool

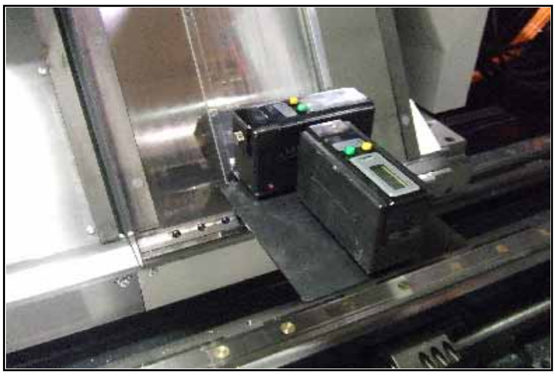
Turning tool holder

Micrometer

1. To measure and adjust a level so that the level is secured in allowance

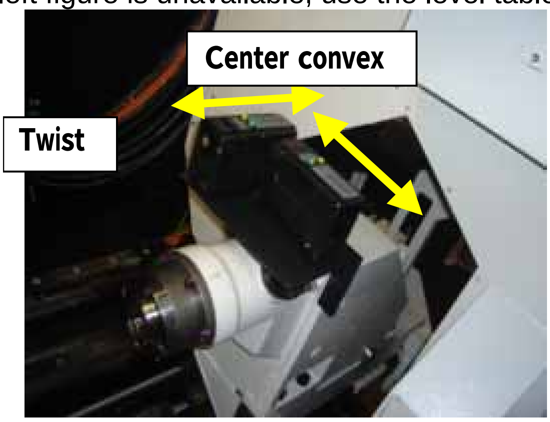
Level when a machine is installed (Unit: µm)						
Item		1st spindle side	Center	2nd spindle (tail) side	Allowance	Measured value
Z-axis	Center convex	→ ←	→ ←	→ ←	20	
	Twist	↑↓	↑↓	↑↓	10	
W-axis (tail) (INTEGREX 100 is excluded)	Center convex	→ ←	→ ←	→ ←	20	
	Twist	↑↓	↑↓	↑↓	10	





The Z-axial level is measured.

Note: If the level table in left figure is unavailable, use the level table as shown in right figure.



The W-axial level is measured.

Y-axis homing: Adjustment of M16 (Y)

1. Mount the test bar in the turret and mount the swing tool in the 1st spindle.
2. Apply the dial gauge pointer on the test bar under the condition of the B-axis at 90° and the Y-axis at home and find out the value that the dial gauge indicates the highest Z-axis position and the angle that the dial gauge indicates the lowest C-axis (Figure I in page 5).
3. Evacuate the X- and Z-axes under the condition of the Y-axis at home and the C-axis as is and turn the B-axis to 0°. Move the X-axis from home to the position specified in Table 1 in the minus (–) direction and apply the dial gauge pointer on the test bar. Set the dial gauge value to 0.
4. Turn the swing tool by 180° and read the dial gauge value (page 5, Fig. II).
5. The half of the dial gauge value becomes the Y-axis home shift amount. Input the difference amount into M16 (Y). (Refer to page 5, "Calculation example".)
6. Return the Y-axis home. (You do not have to return all axes home.) Check that the dial gauge reading when the swing tool is turned by 180° is the same.

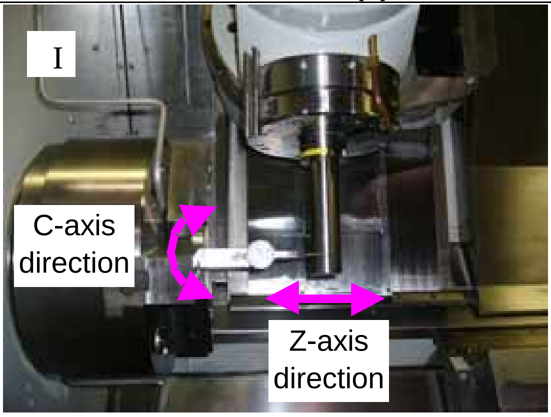
X-axis homing: Adjustment of M16 (X)

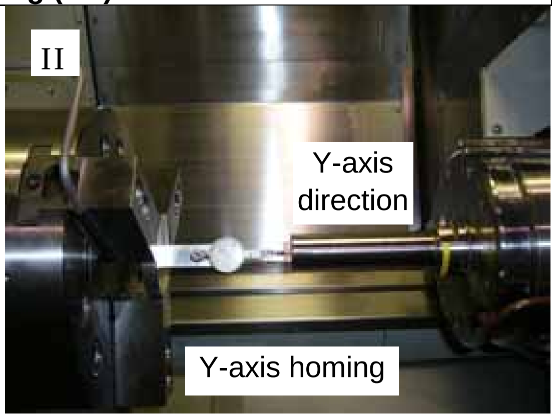
7. Turn the swing tool by 90° and apply the dial gauge pointer on the test bar from the X direction. Here, set the dial gauge value to 0 and read the dial gauge value when the swing tool is turned by 180° (page 5, Fig. III).
8. The half of the dial gauge value becomes the X-axis home shift amount. Input the difference amount into M16 (X). (Refer to page 5, "Calculation example")
9. Return the X-axis. (You do not have to return all axes home.) Check that the dial gauge reading when the swing tool is turned by 180° is the same.

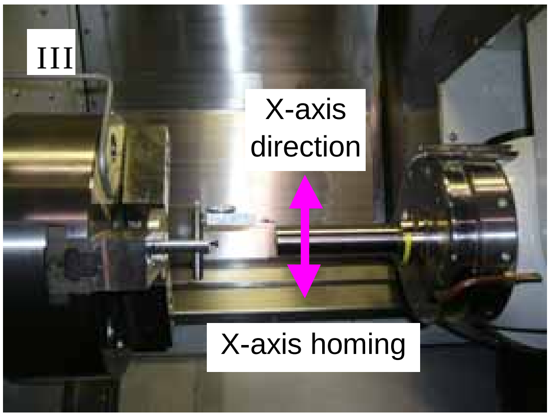
Note: The mean value of the runout shall be the measured value of the test bar.
Note: The parameter unit must be converted into 0.1 μm.

X stroke amount
INTEGREX 100: 780
INTEGREX 200: 1120
INTEGREX 300/400: 1220

Address	Before setting parameters	After setting parameters
M16 (X)		
M16 (X)		







Calculation example

INTEGREX 200IV before changing parameters

M16 (X): 83000
M16 (X): 62000

Under the above condition, apply the dial gauge pointer on the test bar from the minus (–) Y direction (deep inside the machine) and set the value to 0. If the dial gauge indicates + 30 μm when the swing tool is turned to 180°, the shift amount is as follows:

M16(Y): 62000 – 30 ÷ 2 × 10 = 61850

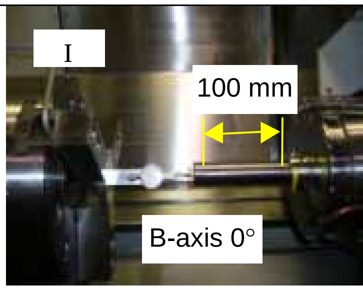
Apply the dial gauge pointer on the test bar from the minus (–) X direction (below the machine) and set the value to 0. If the dial gauge indicates – 50 μm when the swing tool is turned to 180°, the shift amount is as follows:

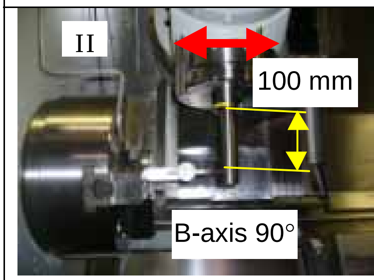
M16(X): 83000 – (– 50) ÷ 2 × 10 = 83250

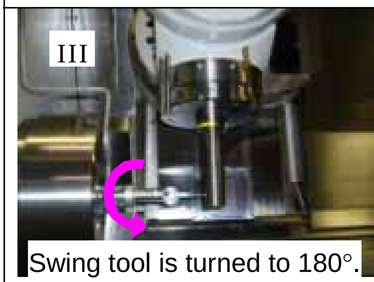
Note: The mean value of the runout shall be the measured value of the test bar.
Note: Apply the dial gauge pointer at 100 mm from the turret mouth where the test bar is mounted.
Note: As the parameter immediately becomes valid, carry out compensation with care and checking.
Note: Parameter unit is 0.1 µm. Refer to page 7 for details.
Note: RS11 and RS12 become valid under the conditions of the W-axis at home and the 2nd spindle selected.
Note: Be sure to measure RS12, RS16, and RS11 under the above conditions valid.

(1) Adjustment of RS15 (Measurement is carried out on the 1st spindle under the condition of the Y-axis compensated and the B-axis at 90°.)

1. Carry out this procedure after X-/Y-axis homing. Set the dial gauge value to 0 under the condition of the Y-axis at home, the B-axis at 0°, and the X-axis at the position of the stroke amount away from its home in the minus (–) direction (page 4, Table 1). (Fig. I) If it is not 0, carry out homing (page 4) again.
2. Then turn the B-axis to 90° and apply the dial gauge pointer on the test bar from the + Y-axis direction (Fig. II).
3. Turn the swing tool by 180°. Apply the dial gauge pointer on the test bar from the – Y-axis direction and measure the C-axial deflection from the Y-axis (Fig. III).
4. Input RS15 and carry out compensation (Refer to page 7, Example). → Check that the dial gauge value is 0.





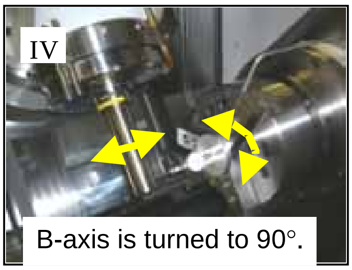


(2) Adjustment of RS12 (Measurement is carried out on the 2nd spindle under the condition of the Y-axis compensated and the B-axis at 90°.)

Note: Carry out this procedure after measurement of RS15.
Note: Carry out measurement under the condition of RS11 and RS12 valid.

5. Mount the swing tool on the 2nd spindle.
6. Apply the dial gauge pointer on the test bar under the condition of the B-axis at 90° and the Y-axis at home and find out the highest Z-axis position and the lowest C-axis angle by the dial gauge readings (Fig. IV).
7. Measure the Y-axial runout as done on the 1st spindle side.
8. Input RS12 and carry out compensation. → Check that the dial gauge value is 0.

Note: RS12 is a compensation for the Yt-axis. So it is necessary to input the Y-axial runout and then adjust it finely.



(3) Adjustment of RS16 (Measurement is carried out on the 2nd spindle under the condition of the Y-axis compensated and the B-axis at 180°.)

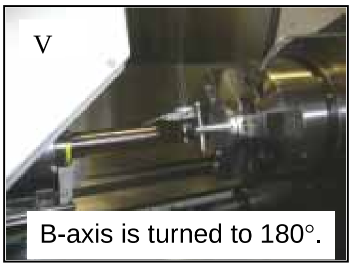
Note: Carry out this procedure after measurement of RS12.
Note: Carry out measurement under the condition of RS11 and RS12 valid.

9. Evacuate the X- & Z-axes, turn the B-axis to 180°, and set the dial gauge. Turn the swing tool and measure the Y-axial error.
10. Input RS16 and carry out compensation. → Check that the dial gauge value is 0.

(4) Adjustment of RS11 (Measurement is carried out on the 2nd spindle under the condition of the X-axis compensated and the B-axis at 180°.)

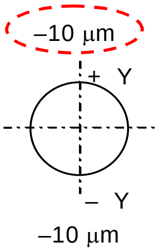
Note: Carry out this procedure after measurement of RS16.
Note: Carry out measurement under the condition of RS11 and RS12 valid.

11. Turn the swing tool and measure the X-axial error. (Fig. V).
12. Input RS11 and carry out compensation. → Check that the dial gauge value is 0.



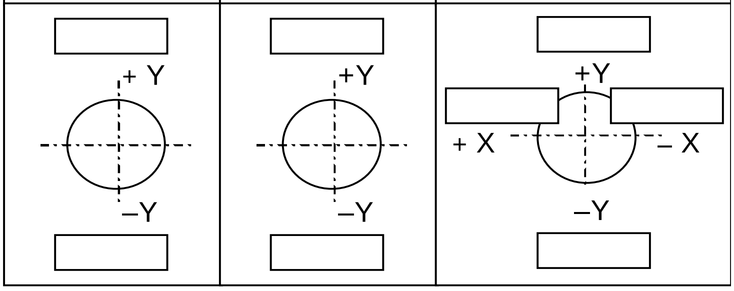
Example

Before parameter change, RS15 = 250 is supposed to have been entered.
If the right figure is alive, input RS15 = 350 [250 - (+10 x 10) = 350]

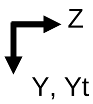


Address	Before parameter change	After parameter change
RS11		
RS12		
RS15		
RS16		

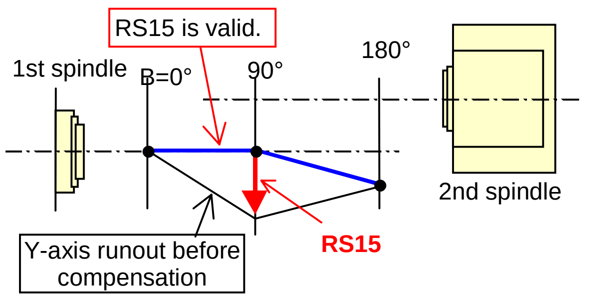
Degree of lean to one side after compensation (Allowance: 10)		
Based on 1st spindle	Based on 2nd spindle	
B-axis at 90°	B-axis at 90°	B-axis at 180°



RS11: Compensation of W-axis core convex (Compensate the X-axial runout of the 2nd spindle against the 1st spindle.)
RS12: Compensation of W-axis core convex (Compensate the Yt-axial runout of the 2nd spindle against the 1st spindle.)
RS15: Compensation of Y-axis core convex (Compensate the Y-axial runout against the 1st spindle at the B-axis 90°.)
RS16: Compensation of Y-axis core convex (Compensate the Y-axial runout against the 1st spindle at the B-axis 180°.)
Unit: 0.1 µm Symbol: If the axis runs out in the plus (+) direction, input plus (+).
Input area: RS11 or R12 → ±1000, RS15 or RS16 → ±500

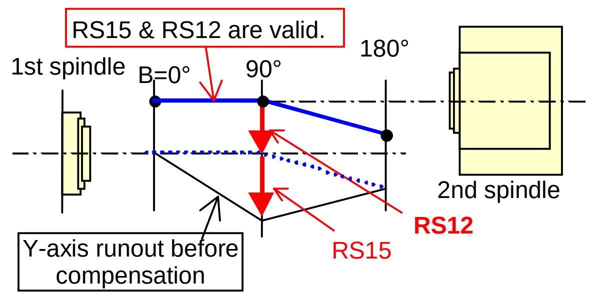


(1) After RS15 is adjusted



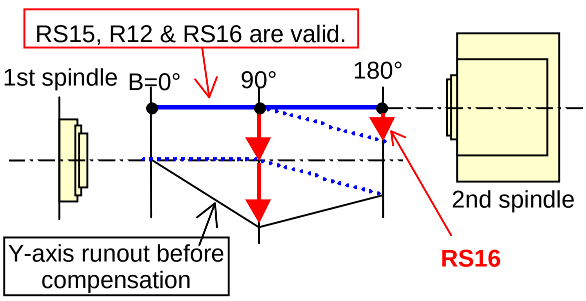
No upper turret runout from the 1st spindle in the Y-axis direction occurs between 0 and 90° of the B-axis.

(2) After RS12 is adjusted



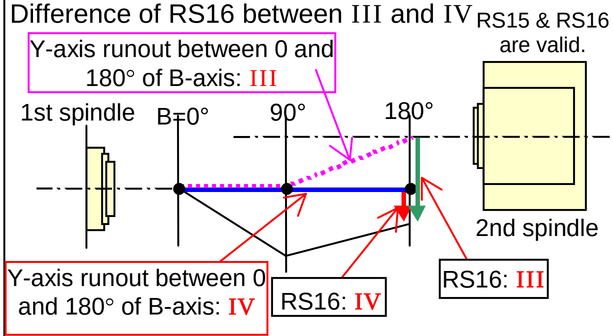
No upper turret runout from the 2nd spindle in the Y-axis direction occurs between 0 and 90° of the B-axis.

(3) After RS16 is adjusted



No upper turret runout from the 2nd spindle in the Y-axis direction occurs between 0 and 90° of the B-axis.

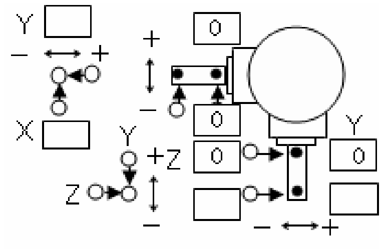
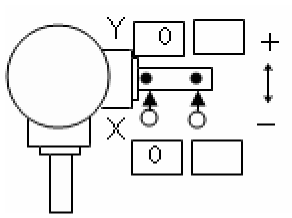
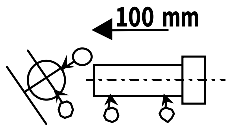
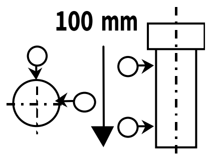
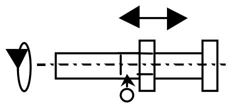
Difference of RS16 between III and IV



III requires adjustment of RS16 based on the 2nd spindle but IV requires it based on the 1st spindle.

(4) Parallelism of milling test bar	

1. To mount the test bar in the milling spindle and measure parallelism and runout

Accuracy of the test bar in the milling axis center (Unit: μm)						
Parallelism (X, Y & Z) (10 per 100 mm)						
Parallelism of the test bar in the upper turret between tool axis and X-/Z-axis motion	Horizontal position	Transversely place the turret, mount the test bar in the turret and apply a dial gauge pointer on the test bar in the Y- and X-axis directions respectively. Under this condition, move the Z-axis by 100 mm and read the dial gauge. The difference of the readings shall be the measured value.		10 per 100 mm	Y	
				10 per 100 mm	X	
	Vertical position	Perpendicularly place the turret, mount the test bar in the turret and apply a dial gauge pointer on the test bar in the Y- and Z-axis directions respectively. Under this condition, move the X-axis by 100 mm and read the dial gauge. The difference of the readings shall be the measured value.		10 per 100 mm	Y	
				10 per 100 mm	Z	
Accuracy of tools in the upper turret	Runout of tool mounting face	Fit the test bar in the tool axis hole and apply a dial gauge pointer at the mouth and the end respectively. Rotate the tool axis and read the dial gauge. The maximum difference shall be the measured value.	 X-axial measurement	5 at mouth	H	
				10 per 100 mm	H	

The data gained from these measurements must be left for use in machine installation.

(5) If Tool Eye positioning (BA97/BA99) and actual O.D. machining check are carried out (recommendation 1)	9/14

Tool nose measuring sensor reference position in the X-axis direction: Adjustment of BA97

1. Mount an O.D. tool in the milling spindle and a bar workpiece (aluminum or the like) in the chuck.
2. Register the tool data and measure the tool length at B-axis 90° (Fig. I).
3. Create an O.D. cutting program and carry out machining. (Note: Manual cutting is also possible. Refer to page 13.)
4. Measure the O.D. and see if the deviation between the O.D. size and the programmed one is less than 10 μm.
5. If the deviation between the O.D. size and the programmed one is bigger then 10 μm, adjust the BA97 value and carry out steps 2 to 4 again. (Refer to page 14, Example of “BA99” parameter adjustment.)

Tool nose measuring sensor reference position in the Z-axis direction: Adjustment of BA99

6. Memorize the tool length A value (measured at B-axis 90°) of the tool used for O.D. cutting.
7. Measure the tool length A at B-axis 0° (Fig. II).
8. Compare the tool length a memorized in 6 with the one measured in 7. Check if the error is less than 10 μm.
9. If the error is big, adjust BA99 (refer to page 14) to be under 10 μm.
10. Carry out O.D. cutting and see if the error between the O.D. size and the programmed one is less than 10 μm.
11. If the error is bigger than 10 μm, carry out O.D. cutting and adjust BA99 so that the error between the tool length a measured in 6 and the tool length a measured at B-axis 0° becomes much smaller.

Note: If BA97 is changed, adjust BA95. If BA99 is changed, adjust BA96. (Refer to pages 11 & 12).

Tool length measured at B-axis 90°

Tool length measured at B-axis 0°

When tool length is measured at B-axis 90°

	Before setting parameters	Error	Before setting parameters	Error
Programmed size				
Measured value				

When tool length is measured at B-axis 0°

	Before setting parameters	Error	Before setting parameters	Error
Programmed size				
Measured value				

	Before setting parameters	Before setting parameters
BA97		
BA99		

Parameters
BA95: Tool nose measuring sensor in the X-axis direction
BA96: Tool nose measuring sensor in the Z-axis direction
BA97: Tool nose measuring sensor reference position in the X-axis direction
BA99: Tool nose measuring sensor reference position in the Z-axis direction

(6) If Tool Eye positioning (BA97/BA99) and actual O.D. machining check cannot be done

Tool nose measuring sensor reference position in the X-axis direction: Adjustment of BA97

1. Input 0 into BA97 and BA99.
2. Register the tool data (Note 1) and set the tool No. registered as the current tool.
3. Mount the test bar (the milling coupling is unclamped).
4. Orient the B-axis to 0° and the milling spindle to 0° and measure the tool length B in an arbitrary Z-coordinate from above the Tool Eye (Fig. I). (= T1)
5. Orient the milling spindle to 180° and measure the tool length B in the same Z-coordinate as done in 4 from below the Tool Eye (Fig. II). (= T2)
6. Add T1 and T2 and divide the total by 2 (refer to the example). [BA97 = (T1 + T2) ÷ 2 × 10000 (Note 2)]

Tool nose measuring sensor reference position in the Z-axis direction: Adjustment of BA99

7. Carry out tool length measurements at B-axis 90° from the right and left sides of the Tool Eye as done in 3 and 4 (be cautious of the oriented angles). Calculate as in 5. [= BA99 (Note: 2)]

Note 1: Register the tool name "GENERAL" in “TOOL”, the machining part “OUT” in “PART”, and the tool nose “0.” in “NOSE-R” as shown below.

Note 2: The parameter unit must be converted into 0.1 μm.

Example (BA97)

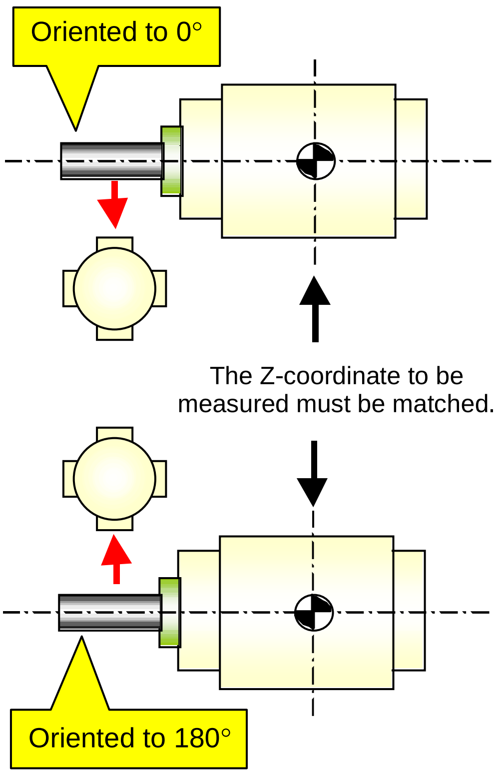
$T_1 = -479.9562$

$T_2 = -514.7078$

$(-479.9562 - 514.7078) \div 2 = -497.3320$

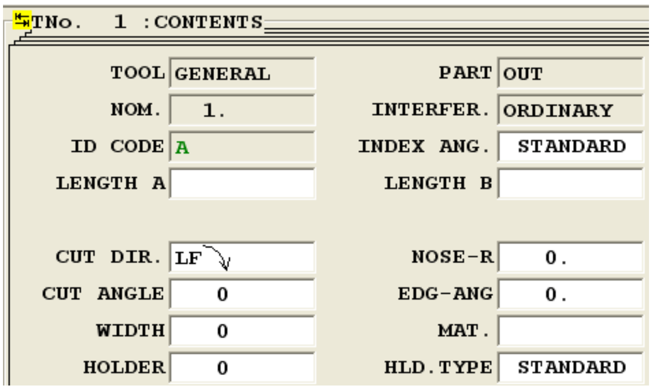
BA97 = – 4973320

I



II

Address	Before parameter change	After parameter change
BA97		
BA99		



Example of tool data registration

(7) If adjustment of BA95/BA96 and actual cutting check (I.D. machining) are carried out (recommendation 1)	11/14

Note: If BA97 is changed, adjust BA95. If BA99 is changed, adjust BA96.

Tool nose measuring sensor in the X-axis direction: Adjustment of BA95

→ Carry out adjustment by machining workpiece I.D.

1. Mount an I.D. tool, register the tool in the horizontal direction, and carry out tool length measurements.
2. Carry out actual I.D. cutting.
3. If there is an error between the actually cut diameter and the programmed diameter, adjust BA95 in following the next example:

> Example : BA95
>
> If the a actually cut diameter is +50 μm compared with the programmed one,
>
> BA95 = (BA95 before compensation) – 50/2 × 10 (Be cautious of the unit.)
>
> = (BA95 before compensation) – 250

<u>Tool nose measuring sensor in the Z-axis direction: Adjustment of BA96</u>

1. Mount the test bar. Orient the B-axis to 90° and unclamp the B-axis. Orient the milling spindle to 0° and measure the tool length B from the right side of the Tool Eye. (= T_{V1})
2. Orient the milling spindle to 180° and measure the tool length B from the left side of the Tool Eye. (= T_{V2})

	Measured value	Difference of absolute value	Allowance
Z+: (T_{V1})			10 μm
Z+: (T_{V2})			

3. If the value is not less than the allowance, adjust BA96 so that the tool length becomes the same value. The parameter unit must be converted into 0.1 μm.

> Example : BA96
>
> Suppose that BA96 = 338821 has already been inputted, then the tool length measured result becomes as follows:
>
> T_{H1} = 17.4853
>
> T_{H2} = –17.4602
>
> The parameter BA95 becomes as follows:
>
> BA95 = 338821 – (17.4853 – 17.4602) × 10000 = 338570

O.D. machining	Before setting parameters	Error	After setting parameters	Error
Program				
Measured value				

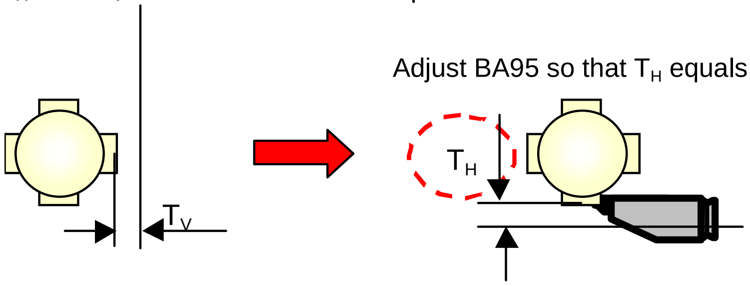
Address	Before setting parameters	After setting parameters
BA95		
BA96		

(8) If adjustment of BA95/BA96 and actual cutting check (I.D. machining) are unavailable (recommendation 2)	12/14

Note: If BA97 is changed, adjust BA95. If BA99 is changed, adjust BA96.

Tool nose measuring sensor in the X-axis direction: Adjustment of BA95

1. Mount an O.D. tool. (I.D. tool is also available.)
2. Register tool data other than the tool lengths A and B. (Register the machining part and the nose R without fail.)
3. Measure the tool length B (= T_V) in the vertical direction.
4. Measure the tool length B (= T_H) in the horizontal direction and adjust BA95 so that the error between T_H and T_V fit in the area of +/- 5 μm.



Example : BA95

TV = 17.4850

TH = 17.4350

If the results of the tool length measurement are as above, the BA95 becomes as follows:

BA95 = (BA95 before compensation) – (TV – TH) × 10000 (Note the unit.)

= (BA95 before compensation) – 500

↓

TV = 17.4850

TH = 17.4850

Tool nose measuring sensor in the Z-axis direction: Adjustment of BA96

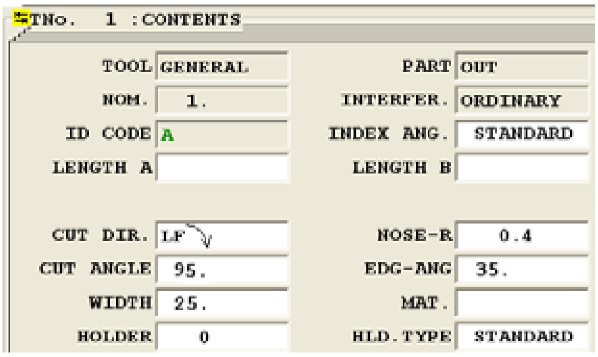
1. Procedure is the same as for actual cutting check. (Refer to page 11.)

Address	Before setting parameters	After setting parameters
BA95		
BA96		

<u>Tool nose measuring sensor reference position in the X-axis direction: Adjustment of BA97</u>

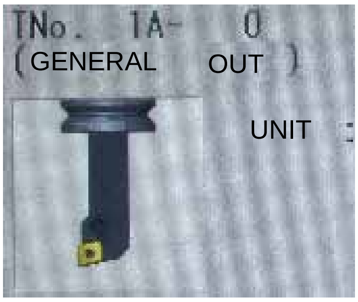
(Workpiece can be iron.)

1. **Mount a tool in the milling spindle and a workpiece in the chuck. The chuck pressure can be 1 MPa or so.**
2. **Create tool data like the example shown below.**



Note: It is necessary to correctly input tool data in cutting.

3. Push "MDI" and then "SET CURRENT TOOL No." to specify the previously created data number. Here, check that the current tool No. shown at the bottom left of the POSITION display is as shown below:



The “TNo.” here is the created tool data number 1.

Note: Unless a tool is specified, tool length cannot be measured.

4. Turn the B-axis to 90° and carry out tool length measurement from above the Tool Eye sensor. Check that a value is in the tool length A. Then, measure the tool length B.

5. Prepare O.D. cutting under the condition of the milling axis in the vertical direction (B-axis at 90°). First push the RESET button to let the POSITION display indicate the tool nose coordinates at the current "POSITION". Bring the tool nose closer to the workpiece so see that current position is close to the workpiece diameter.
6. Move the Z-axis to bring the tool nose to the terminal of cutting and enter "0" in the current position Z on the POSITION display so that the cutting amount can be seen easier.

7. Cut the workpiece at about 700 min^{-1}. Here be cautious of the rotational direction. Move the Z-axis by the manual handle at the feedrate "×100" (Note). Or push the "Z" button in the manual mode (×100 or so) at the feedrate 55 mm/min or so (Note).

Note: Move the Z-axis once to leave from the workpiece and see if the feedrate is correct. Then start machining.

8. Compare the current position X with the cut workpiece diameter and check the difference is less than 10 µm. If the difference is not under10 µm, adjust BA97.

Example of adjusting parameter BA97

Measured value: 49.014
Current position: 49.0
Current BA97 value: – 3950000
BA97 after adjustment = – 3950000 + (49.014 – 49.0) ÷ 2 × 10000 = – 3949930

9. After the parameter has been changed, carry out tool length measurement again.
10. Then push the "RESET" button to update the current position without fail.
11. Carry out cutting and compare the current position X with the cut workpiece diameter again. Adjust the error to be under10 µm.

<u>Tool nose measuring sensor reference position in the Z-axis direction: Adjustment of BA99</u>

1. After the BA97 has been adjusted, memorize the tool length A.
2. Put the milling axis in the horizontal direction and measure the tool length A from the right side of the Tool Eye sensor.
3. Here, check that the difference between the tool length and the one memorized in 1 is less than 10 µm. If it is over 10 µm, adjust BA99.

Example of adjusting parameter BA99

Tool length A in the vertical direction (B-axis 90°): 182.3238
Tool length A in the horizontal direction (B-axis 0°): 182.2966
Current BA99 value: – 3930000
BA99 after adjustment = – 3930000 – (182.3238 – 182.2966) × 10000 = – 3930272

4. When the difference has become less than 10 µm, carry out O.D. cutting at B-axis 90° using the tool length A.
5. Compare the programmed size with the cut workpiece diameter and see the error is less than 10 µm.

If BA97 is changed, adjust BA95. If BA99 is changed, adjust BA96.