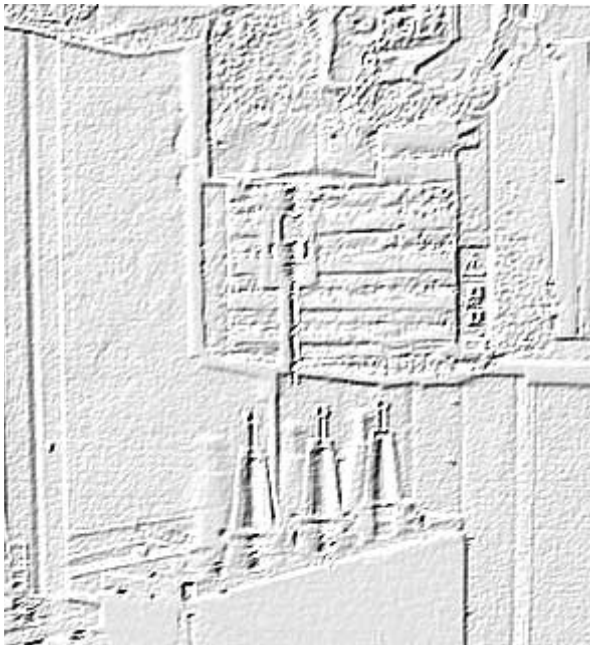


# *Automatic Tool Changer*

## ZAT-650

## User's Manual



---

Thank you very much for purchasing the product.

- To ensure correct and safe usage with a full understanding of this product's performance, please be sure to read through this manual completely and store it in a safe location.
  - Unauthorized copying or transferral, in whole or in part, of this manual is prohibited.
  - The contents of this operation manual and the specifications of this product are subject to change without notice.
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  - Roland DG Corp. assumes no responsibility for any direct or indirect loss or damage which may occur through use of this product, regardless of any failure to perform on the part of this product.
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# To Ensure Safe Use

## About ⚠️ WARNING and ⚠️ CAUTION Notices

 <b>WARNING</b>	Used for instructions intended to alert the user to the risk of death or severe injury should the unit be used improperly.
 <b>CAUTION</b>	Used for instructions intended to alert the user to the risk of injury or material damage should the unit be used improperly. * Material damage refers to damage or other adverse effects caused with respect to the home and all its furnishings, as well to domestic animals or pets.

## About the Symbols

	The ⚠️ symbol alerts the user to important instructions or warnings. The specific meaning of the symbol is determined by the design contained within the triangle. The symbol at left means "danger of electrocution."
	The ⚡ symbol alerts the user to items that must never be carried out (are forbidden). The specific thing that must not be done is indicated by the design contained within the circle. The symbol at left means the unit must never be disassembled.
	The ● symbol alerts the user to things that must be carried out. The specific thing that must be done is indicated by the design contained within the circle. The symbol at left means the power-cord plug must be unplugged from the outlet.

## ⚠️ WARNING



**Do not disassemble, repair, or modify.**  
Doing so may lead to fire or abnormal operation resulting in injury.



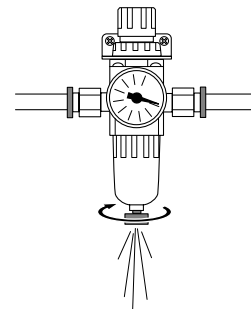
**Do not use while in an abnormal state (i.e., emitting smoke, burning odor, unusual noise, or the like).**  
Doing so may result in fire or electrocution.  
Immediately switch off the power, unplug the power cord from the electrical outlet, and contact your authorized Roland DG Corp. dealer or service center.



**Do not apply solvents such as thinner, cutting oils or direct rays of the sun to the bowl of the air regulator.**  
They may degrade the bowl, resulting in breakage when air pressure is applied.



**Let compressed air out of the air regulator before removing the bowl.**  
The bowl or the like may fly off, resulting in injury.



## CAUTION



**Fasten the spindle, tool, and material securely in place.**

Otherwise they may come loose during cutting, resulting in injury.



**Do not wear gloves, a necktie or wide-sleeved clothing.**

They may become caught in the tool, resulting in injury.



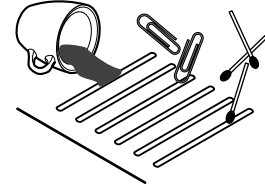
**Set the cutting area so that the tool does not contact the tool magazine, the rotary axis unit or the like.**

Pieces of the tool or workpiece may fly off, resulting in injury.



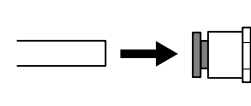
**Do not allow liquids, metal objects or flammables inside the machine.**

Such materials can cause fire.



**Insert the air hose firmly as far as it will go, and secure it in place with a band.**

Otherwise the air hose may fly loose and blow compressed air, resulting in injury.



---

In addition to these symbols, the symbols shown below are also used.



**Notice** : Indicates information to prevent machine breakdown or malfunction and ensure correct use.



**Point** : Indicates a handy tip or advice regarding use.

# ***Chapter 1***

## ***System Structure***

---

This chapter describes the possible configurations using this unit.

# 1-1 Features of the ZAT-650

The ZAT-650 is a automatic tool changer unit (ATC unit) that adds automatic tool-changing functions to the MODELA Pro. It makes it easy to perform cutting operations while using a number of tools of different types. The tool-length offset feature and the automatic measurement feature for tool length make it nearly unnecessary to modify programs even when using tools of different lengths. You can also combine the unit with the rotary axis unit, making it possible to perform multiple-surface cutting with automatic tool changes.

The ZAT-650 requires a separate device to supply compressed air, such as a compressor.

# 1-2 Possible System Configurations Using the ZAT-650

## Installable Combinations

The ZAT-650 can be combined with the following products.

MODELA Pro series	MDX-650A	Yes
	MDX-650	No
	MDX-500	No
Rotary axis units	ZCL-650A	Yes
	ZCL-650	No

\* Use with the dedicated spindle packed with the ATC unit. The ZS-650T, ZS-500SH, and the like cannot be used.

\* When the ZAT-650 is installed, the following optional equipment cannot be used: Vacuum adapters for chip cleaning (ZAD-500T, ZAD-500S, etc.), table spacers (ZA-500 series, etc.), or a vacuum table (ZV-500A).

## Programs Compatible with ATC

To perform automatic tool changes, you need to use a program that supports ATC, or to implement NC programming. Even with a program that does not support ATC, it's possible to perform cutting using a single tool, but continuous cutting with automatic tool changes is not possible. Check the compatibility of the program before you use it.

# ***Chapter 2***

## ***Implementing the ATC Unit***

---

This chapter describes what you need to implement the ATC unit and how to install it.

## 2-1 List of Included Items

Items		Number of pieces
ATC spindle unit		1
Air cylinder		1
Tool magazine		1
Control box		1
Air regulator		1
Z0 sensor base		1
Air hose		1
Air nozzle		1
Positioner		1
Cap screws	M4 x 8 mm	3
	M4 x 15 mm	4
	M4 x 25 mm	4
	M4 x 35 mm	2
	M6 x 12 mm	6
Screws (with a knob)		2
Square nuts		4
Washers		4
Wrenches	Hexagonal screw driver (for M4 cap screws)	1
	L-shaped hexagonal wrench (for M6 cap screws)	1
Retaining bands (black)		6
Retaining band (white)		1

\* A compressed-air supply must be procured separately. See "2-2 Conditions for Compressed Air" for the requirements.

\* A tool holder must be procured separately. See "2-3 Usable Tool Holders" for the requirements.

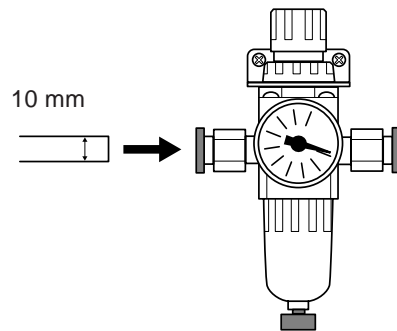
## 2-2 Conditions for Compressed Air

The ATC unit requires compressed air. Provide a compressor or other compressed-air supply that meets the following conditions.

- Air pressure 0.7 to 1 MPa
- Air volume 50 L/min. or more (at 0.7 to 1 MPa air pressure)

The piping from the ATC unit is as shown below. Provide suitable air hoses, joints, and the like.

- Hose outer diameter 10 mm (polyurethane tubing)



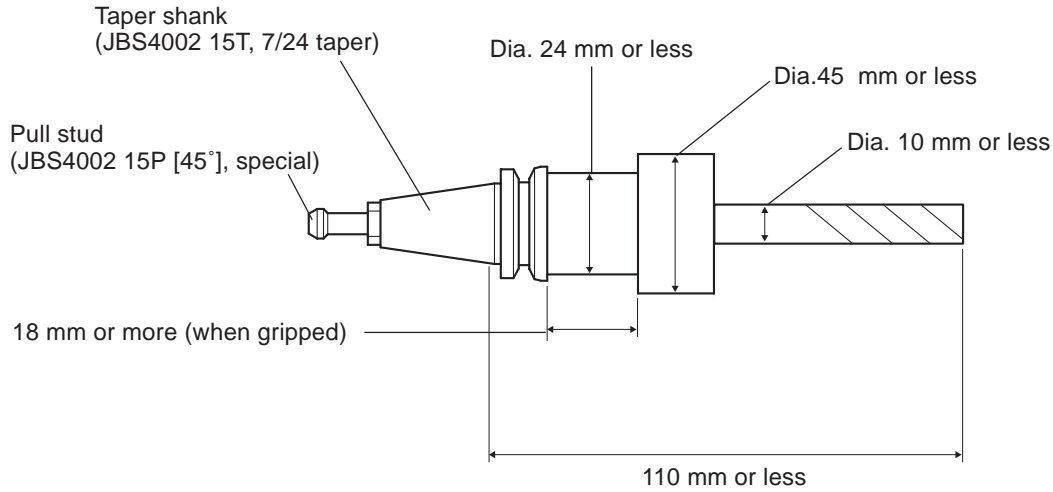
### Notice

Do not supply compressed air to the regulator at higher than 1 MPa. Doing so may damage the regulator.

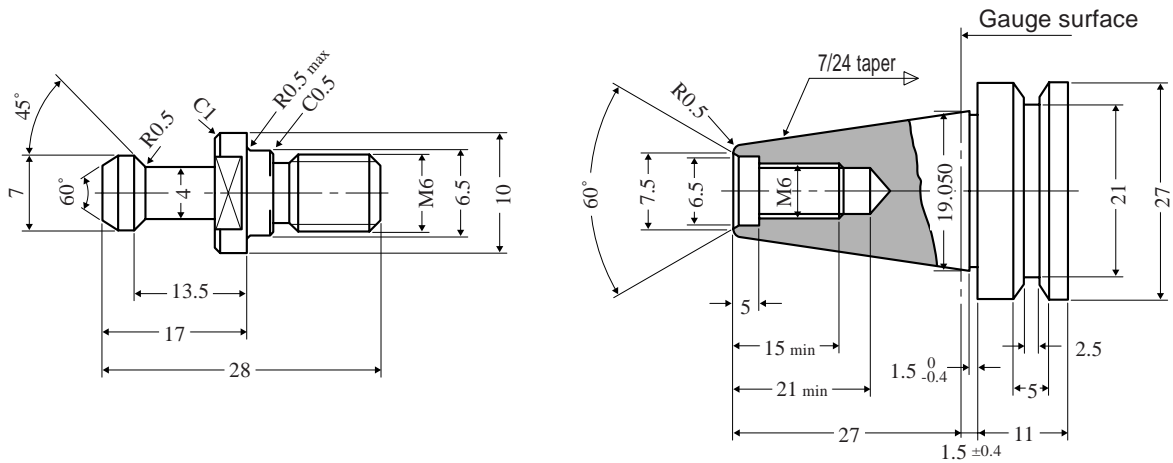
## 2-3 Usable Tool Holders

Use tools that meet the following conditions.

### Required Tool Dimensions



### Dimension Drawing of the Taper-shank Area



Unit: mm

## 2-4 Installing the ATC Unit

The installation methods are partly different depending on whether the unit is to be used in combination with a rotary axis unit. When you are using the units in combination, finish installing the rotary axis unit before you install the ATC unit.

### Step 1: Install the Spindle and the Cylinder

#### Procedure

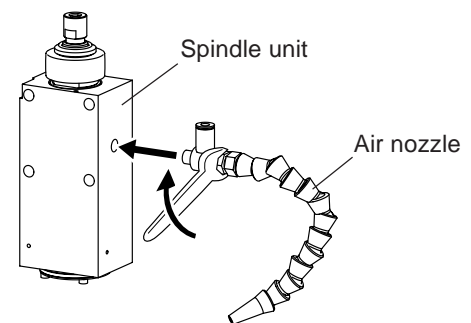
- 1 In the following operation, you move the spindle head to the left.
  - (1) Close the spindle cover on the main unit.
  - (2) Switch on the power to the machine, then press the [ENTER] key. The spindle head moves to the left.
- 2 Switch off the power and unplug the power cord.



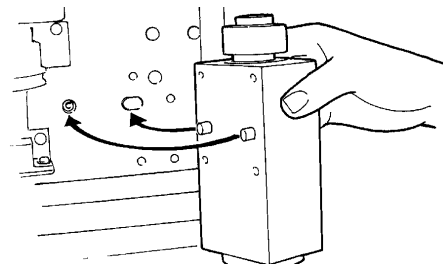
**Be sure to switch off the power before you attempt installation.**

Otherwise unintended operation of the machine may result in injury.

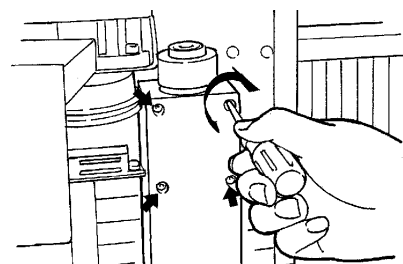
- 3 Install the air nozzle on the spindle unit.  
Tighten using a wrench (14 mm).



- 4 Align the pin on the back of the spindle unit with the pin-hole on the slider, and support it with your hand.



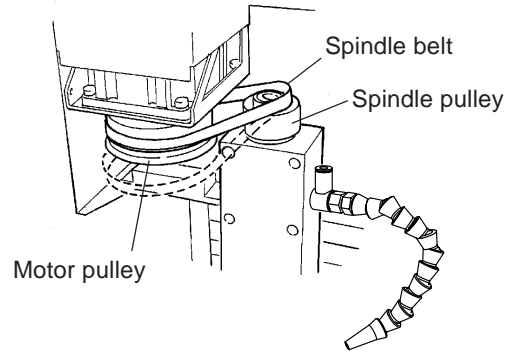
- 5 Insert the cap screw (M4 x 25 mm) at the location shown in the figure, then tighten using the hexagonal screwdriver.



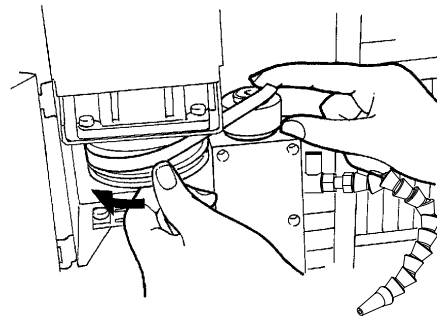
## 2-4 Installing the ATC Unit

- 6** Pass the belt through under the motor pulley and engage on the spindle pulley.

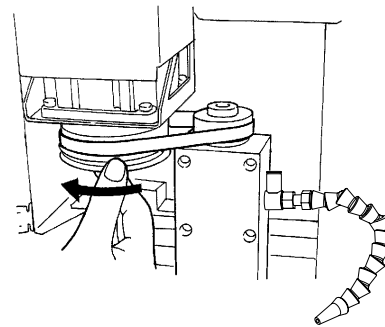
\* Note that the spindle belt is packed with the main unit.



- 7** While pressing down on the belt engaged on the spindle pulley, turn the motor pulley in the direction of the arrow to attach the belt.

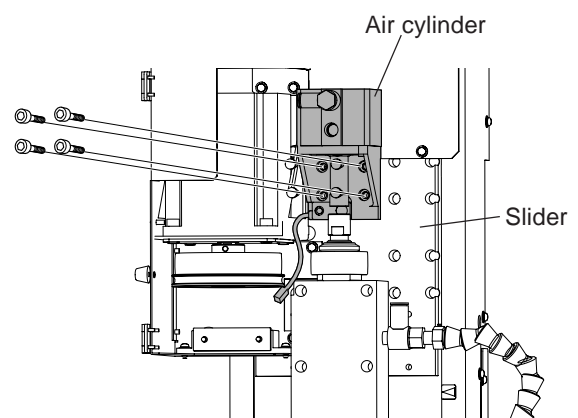
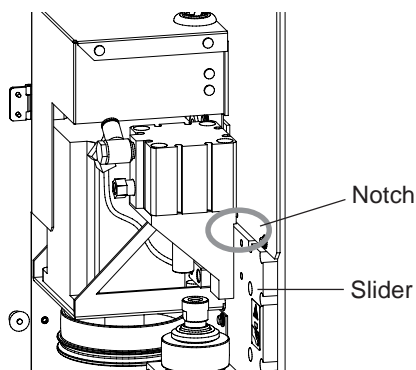


- 8** Turn the motor pulley several times so as to position the belt on the motor pulley and spindle pulley as shown in the figure.



- 9** Install the air cylinder.

Position the notch flush against the slider and secure in place with the four cap screws (M4 x 15 mm).

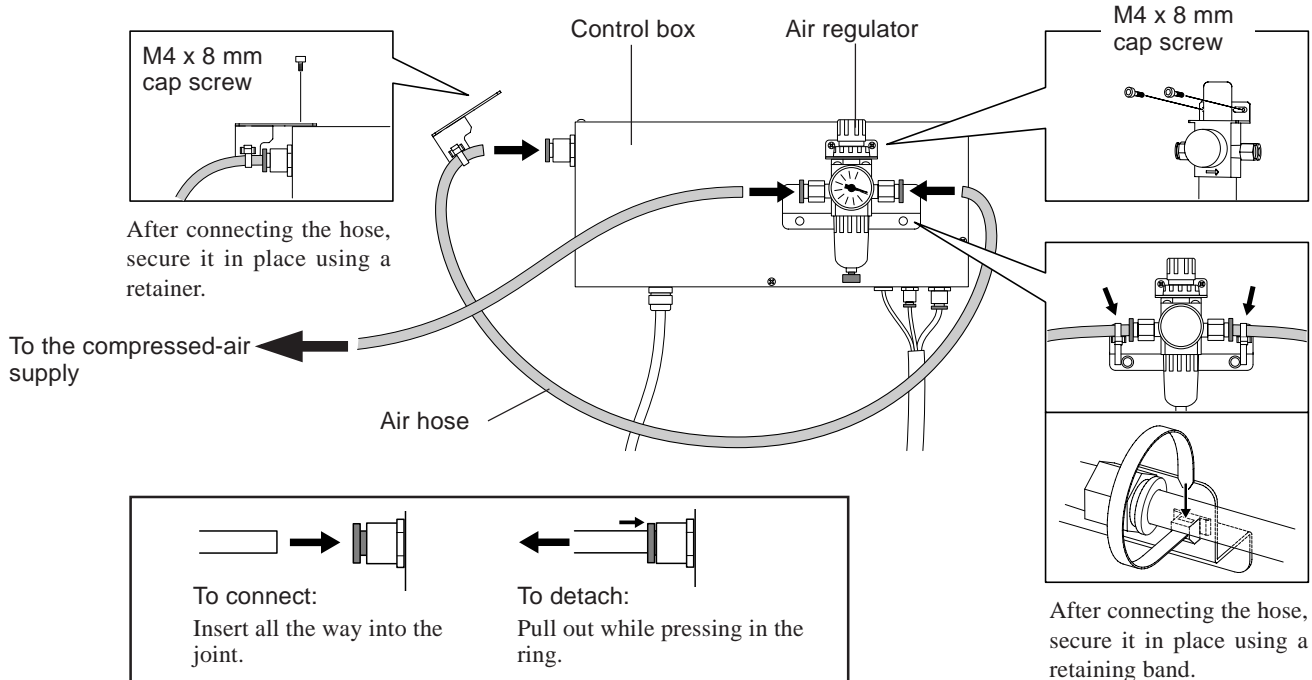
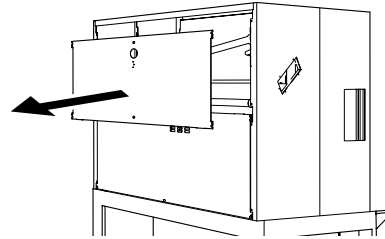


Next, go on to "Step 2: Install the Control Box."

## Step 2: Install the Control Box

### Procedure

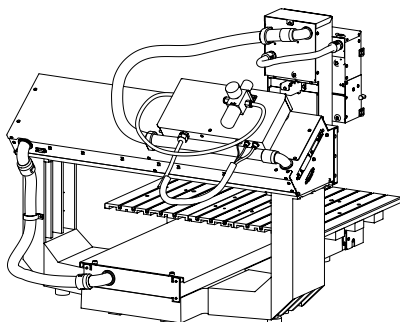
- 1 Make sure that the power to the main unit is switched off and its power cord is unplugged.
- 2 If you're using the optional safety cover, remove the back panel.
- 3 Install the air regulator and air hoses on the control box.



- 4 Mount the control box on the main unit.  
It is held in place by magnets. The mounting location is different when you're using the optionally available safety cover.

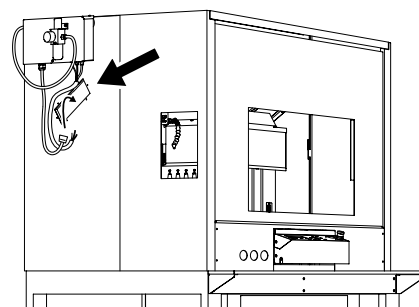
#### Without the safety cover

Mount it on the back of the machine.

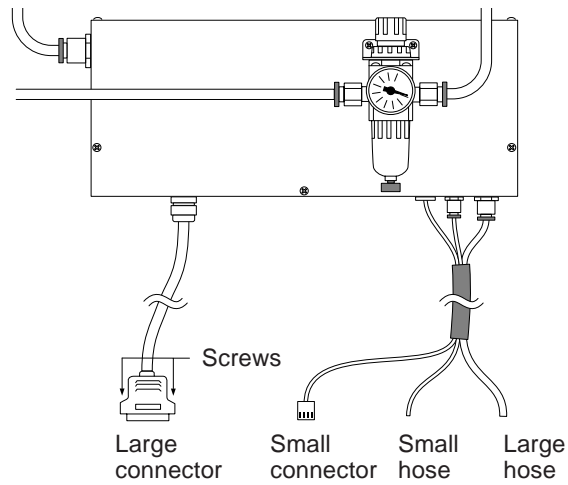


#### With the safety cover

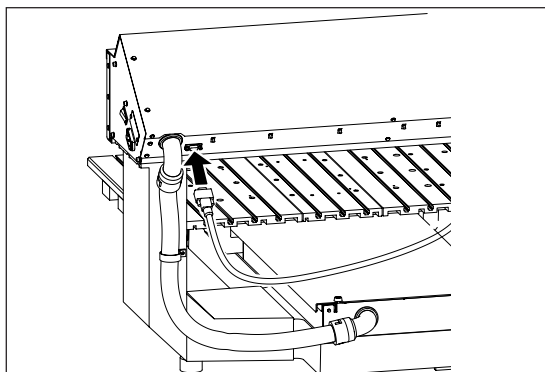
Mount it on the left side of the cover and pull the cables inside.



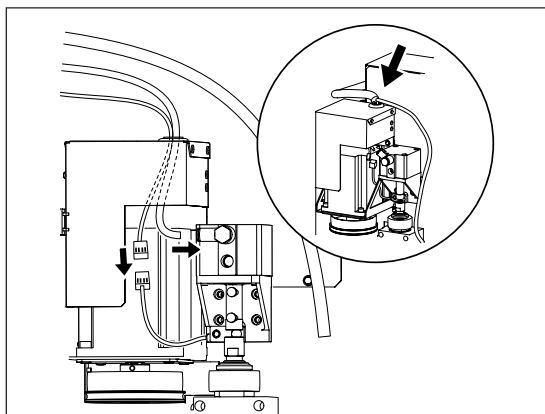
**5** Connect the hoses and cables.



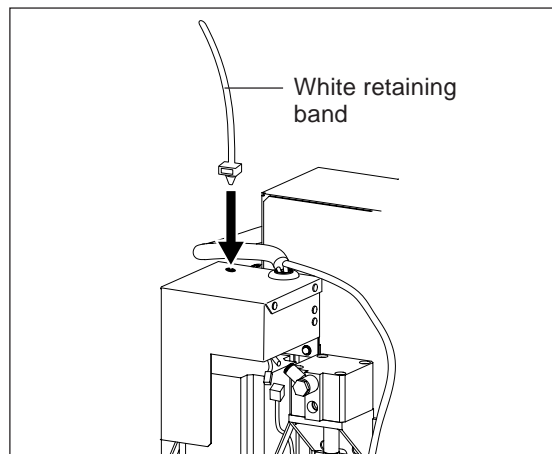
(1) Connect the large connector to the back of the machine.



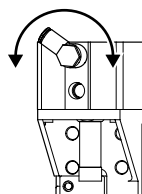
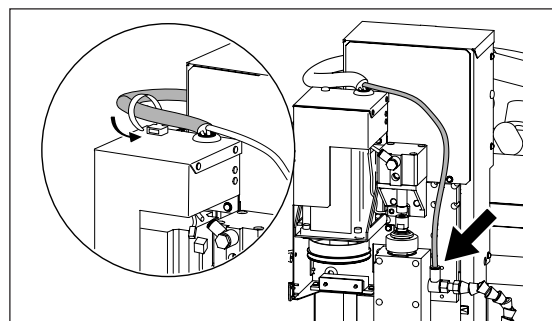
(2) Pull in the small connector and the small hose through the hole in the top of the spindle, and connect to the air cylinder.



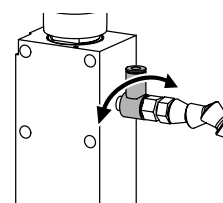
(3) Detach the rubber cap, and press the white retaining band into the hole to attach.



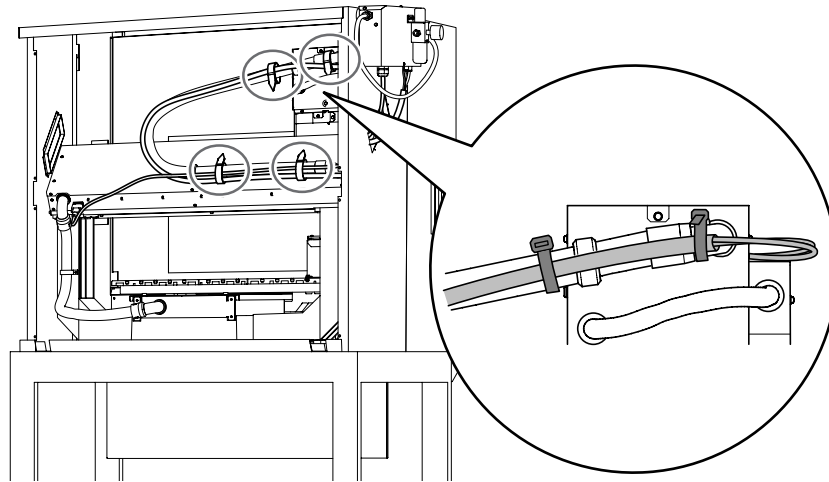
(4) Connect the large hose to the air nozzle and secure with the white retaining band.



The joint rotates freely.



- 6** Bundle the hoses and cables together and secure with the black retaining bands. Ensure enough slack that the hoses and cables do not catch or snag when the spindle head moves from side to side.



Next, go on to "Step 3: Install the Tool Magazine."

## Step 3: Install the Tool Magazine

The mounting location of the tool magazine differs depending on whether you're using the ATC unit in combination with a rotary axis unit.

### Procedure

**1** In the following operation, you move the spindle to the magazine-adjustment location.

- (1) Close the spindle cover on the main unit.
- (2) Switch on the power to the main unit, then press the [ENTER] key. After initialization, the coordinate-view screen appears.
- (3) Press the [ENTER] key to display the main menu. Use the dial to select [ATC], then press the [ENTER] key. Use the dial to select [MAGAZINE SETUP], then press the [ENTER] key.
- (4) Use the dial to select [MAGAZINE POS.1], then press the [ENTER] key.
- (5) Make sure there are no obstructions, then press the [ENTER] key again. The spindle moves to the magazine-adjustment location.

```
*X    0  Y    0
Z     0 5000 RPM
```

```
13> 6 MAGAZINE SETUP
7 NO. OF STOCKS
```

```
13-6> 1 MAGAZINE POS.1
2 VIEW POSITION
```

```
TAKE OFF TOOLS FROM
STOCKS, THEN ENTER
```

**2** Open the spindle cover and make sure that the screen shown at right is displayed.

```
CAUTION!
SP     COVER OPEN
```



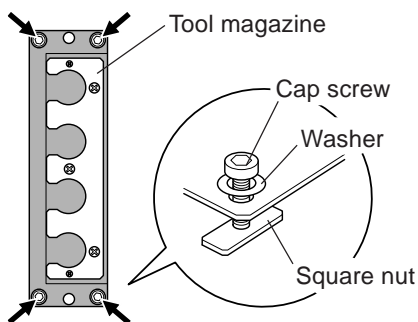
**Be sure to carry out installation with the spindle cover open.**

Performing the operation with the cover closed may result in injury due to unintended operation of the machine.

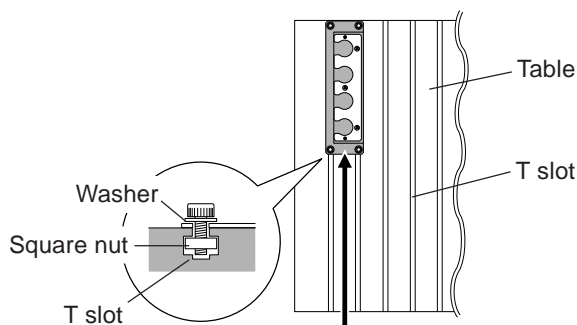
**3** Loosely secure the tool magazine.

#### When Using with No Rotary Axis Unit

- (1) Assemble a cap screw (M6 x 12 mm), washer, and square nut onto each of the four corners of the tool magazine. Tighten the cap screws loosely.

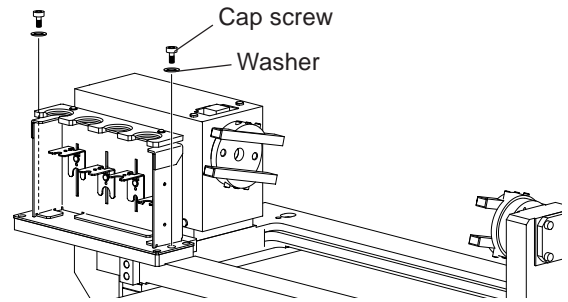


- (2) Slide the tool magazine to pass the square nuts into the T slots, and loosely tighten at the location on the table shown in the figure. Orient the magazine so that the openings face toward the left.



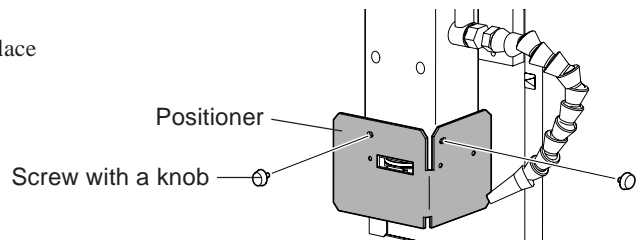
**When Using in Combination with a Rotary Axis Unit**

Place on the base of the rotary axis unit and loosely tighten using two cap screws (M6 x 12 mm) and washers. Orient the magazine so that the openings face toward the front.



**4** Install the positioner on the spindle unit.

Orient it as shown in the figure and secure it in place with two screws (with a knob).

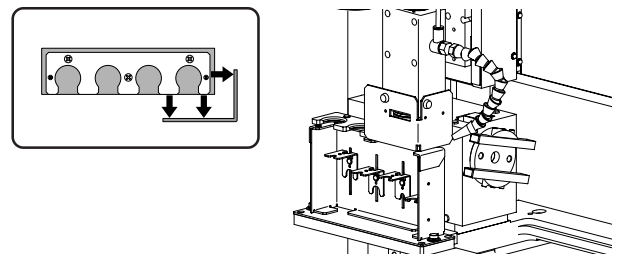
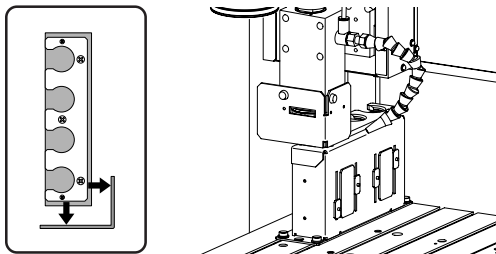


**5** Position the tool magazine flush against the positioner, then tighten the cap screws completely.

Perform positioning with the tool magazine standing straight up. Using excessive force to position the tool magazine flush against the positioner may cause the tool magazine to tilt, making correct positioning impossible.

**When Using with No Rotary Axis Unit**

**When Using in Combination with a Rotary Axis Unit**



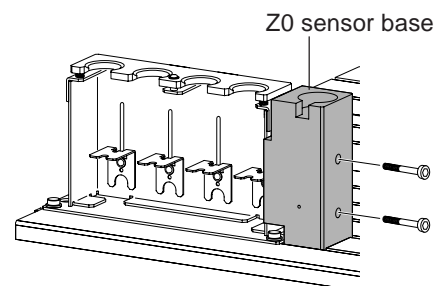
**6** Switch off the main unit and remove the positioner.

**! Notice**

After tightening the cap screws in step 5, be sure to switch off the power.

**7** When you are using the ATC unit with no rotary axis unit, mount the Z0 sensor base on the magazine.

Secure it in place using two cap screws (M4 x 35 mm). This is not necessary when you're using the ATC unit in combination with a rotary axis unit.



Next, go on to "Step 4: Make Settings and Adjust."

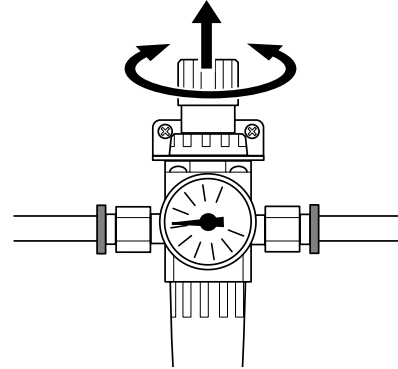
## Step 4: Make Settings and Adjust

### Procedure

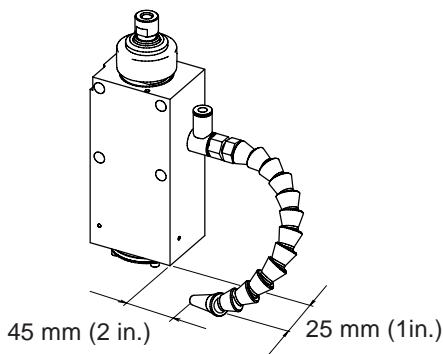
- 1 Supply compressed air to the ATC unit. Pull up the knob on the air regulator, then adjust so that the meter reads 0.5 to 0.65 MPa. After adjusting, press in the knob to return it to its original position.

**! Notice**

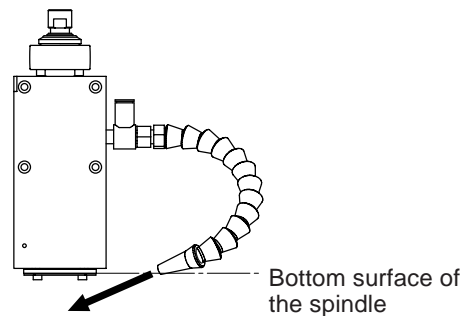
Do not adjust the regulator at higher than 0.7 MPa. Doing so may damage the ATC unit.



- 2 Adjust the orientation of the air nozzle to blow away any buildup of cutting waste from the stock area on the top surface of the magazine. Adjust the air nozzle as required so that it does not strike the tool, workpiece or other areas during operation.



Orient the nozzle tip toward the center of the spindle.



Align the nozzle tip with the height of the bottom surface of the spindle, then angle it downward.

- 3 In the following operation, set the spindle type to [HIGH TORQUE].

- (1) Close the spindle cover and switch on the power to the main unit. Press the [ENTER] key. After initialization, the coordinate-view screen appears.
- (2) Press the [ENTER] key to display the main menu. Use the dial to select [OTHERS], then press the [ENTER] key. Use the dial to select [SPINDLE UNIT], then press the [ENTER] key.
- (3) Use the dial to select [HIGH TORQUE], then press the [ENTER] key.

*X	0	Y	0
Z	0	5000 RPM	

10> 2 SPINDLE UNIT
3 BUZZER

10-2 SPINDLE UNIT
<HIGH TORQUE>

# ***Chapter 3***

## ***Basic Operation***

***(Common for RML-1 and NC Codes)***

---

This chapter describes the most basic operations that you should know before you try to use the unit. Be sure to read it before you start work.

## 3-1 Important Notes on Switching the Power On and Off

---

### Before You Switch Off the Power

Return the tool (tool holder) to the magazine before you switch off the power. As a rule, you should never power down while the spindle is gripping a tool.

### Important Notes When Switching On the Power

When the power is switched on while the spindle is gripping a tool, a forced release of the tool is performed. Inadvertent operation while in this state may result in the tool being dropped, so be sure to give attention to this point. Pressing the [ENTER] key after switching on the power performs a forced release immediately without a return to the magazine. Carry out this operation while securely supporting the tool by hand to keep it from being dropped.

# 3-2 Usage and Handling of the Tool Magazine

## Points to Observe When Loading Tools

Always make sure the machine is in the following state before performing tasks such as loading or changing a tool (tool holder). Performing such tasks incorrectly may result in injury or malfunction.

- The spindle must not be gripping a tool.
- Cutting operations must have ended and operation stopped.

## Loading a Tool

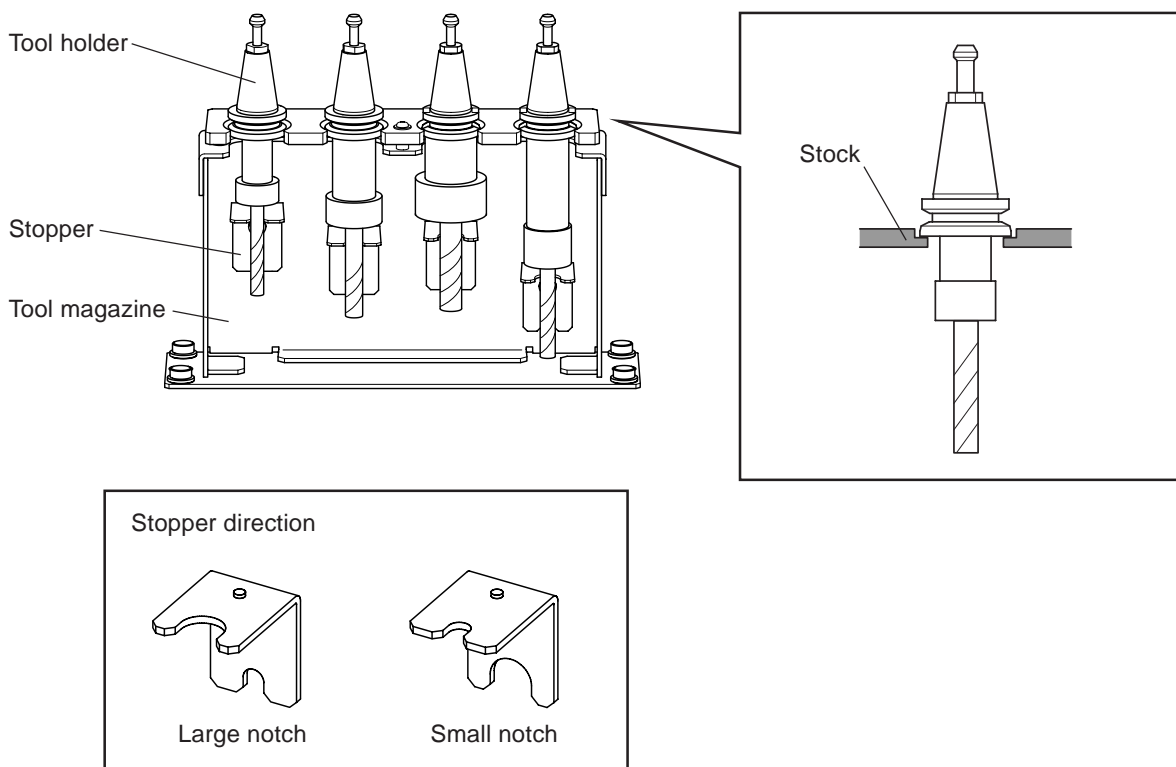
### Loading Location

Load the tool holder at the location on the magazine shown in the figure. You may load it in any stock, or load more than one. When loading, carefully clean away any buildup of cutting waste on the tool holder and magazine.

### Stopper Adjustment

Adjust the height of the stoppers to match the loaded tools. Lower it if it strikes the tool holder, and raise it if it does not reach the tool.

Also, the stopper has two notches, one large and one small. If the diameter of the end mill is 5 mm or less, reinstall the stopper, orienting it to use the small notch.



# 3-3 Selecting Tools Through Key Operations

When you want to select a tool using key operations, follow the steps below. The operation differs slightly depending on whether you are using the RML-1 or the NC code command set.

## Procedure

- 1 Display the main menu. Use the dial to select [ATC], then press the [ENTER] key.
- 2 Use the dial to choose [TOOL SELECT], then press the [ENTER] key.
- 3 Use the dial to select the number of the tool you want to grasp, then press the [ENTER] key. If you are in the NC code mode, then press the [ENTER] key a second time.

The unit moves to retrieve the tool from the stock number you selected. If a tool is already gripped, then it is changed. Also, compressed air is blown from the air nozzle and the chucking portion at this time to clean away cuttings.

### Point

If you are in the NC code mode, then tool-length offset is not enabled in this operation, and only the tool-selection operation is performed.

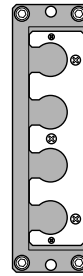
➔ See "5-1 Tool Selection and Tool-length Offset."

```
>13 ATC  
14 To Coordinate
```

```
13> 1 TOOL SELECT  
2 OFFSET NUMBER
```

```
13-1> 1 TOOL1  
2 TOOL2
```

Stock No.1  
No.2  
No.3  
No.4



- 4 Use the dial to select [RETURN], then press the [ENTER] key.

The gripped tool is returned to the magazine.

```
13-1> 5 RETURN  
6 RELEASE
```

### Notice

#### Important Note When [RELEASE] Is Selected

If [RELEASE] is selected in step 3 or 4 above, a forced release of the tool is performed immediately without returning the tool to the magazine. Inadvertent operation while in this state may result in the tool being dropped, so be sure to give attention to this point.

This operation is employed when it is necessary to detach a tool manually for some reason. Carry out this operation while securely supporting the tool by hand to keep it from being dropped.

# ***Chapter 4***

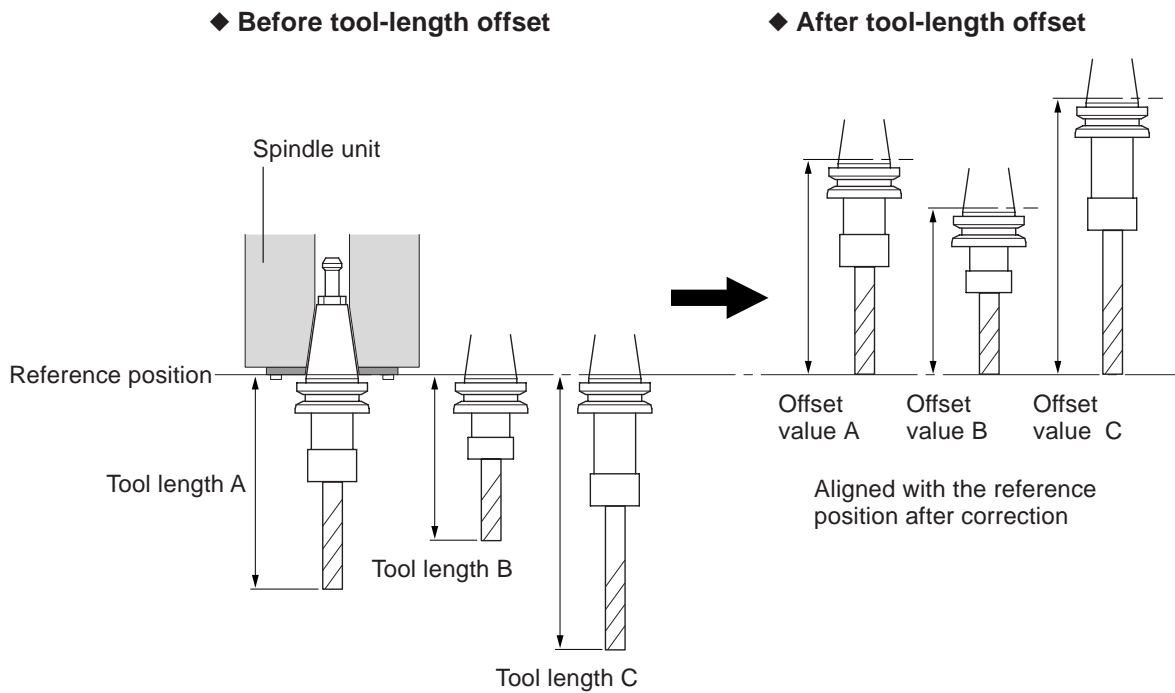
## ***Operation in the RML-1 Mode***

---

This chapter explains basic operations when the RML-1 command set is selected.

# 4-1 What Is the Tool-length Offset?

When a tool is changed and the tool length changes, the cutting position along the Z axis also changes. When the tool is changed, it is necessary to perform some operation that takes the tool length into consideration, such as, for example, resetting Z0 (the Z-axis origin point). The tool-length offset is a function that automatically adjusts the Z-axis position while taking the tool length into account. In short, it is sufficient to set Z0 only once, at the start. Then after the tool is changed, adjustment to keep the Z0 position the same is performed automatically.



To enable this, it is necessary to measure the length of each tool and register (save) these measurements in the machine ahead of time. There are two registration methods: one where the tool lengths are measured automatically, and one where you measure the tool lengths and register the values yourself.

In the RML-1 mode, tool-length offset is always performed according to the registered tool lengths. Tool-length offset is carried out when a tool-select operation is performed, regardless of whether it is performed by an instruction from the computer or by key operation.

## 4-2 Measurement of Tool Length and Starting Cutting

This section describes the preparations up to starting cutting using a program that supports automatic tool changes. When the preparations are complete, you simply use the program to specify the tool numbers you want to use for cutting. There is no need to perform operations such as resetting Z0 after every tool change.

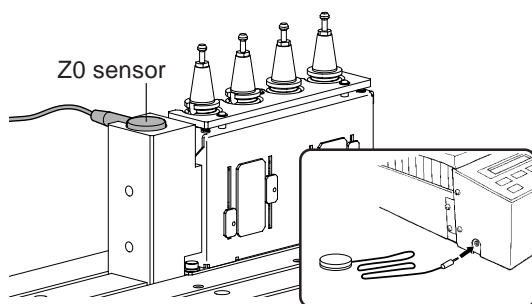
### Step 1: Measure the Tool Lengths

This section explains how to measure tool length automatically. The procedures are slight different depending on whether you are using the unit in combination with a rotary axis unit.

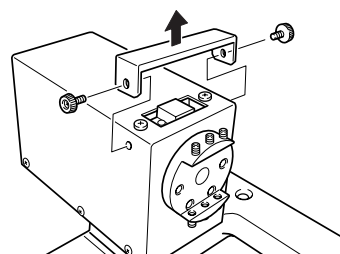
#### Procedure

**1** Load the magazine with the tools you want to use for cutting.

**2** When using with no rotary axis unit:  
Connect the Z0 sensor (included with the main unit), and then place the Z0 sensor on the sensor base.



When using in combination with a rotary axis unit:  
Detach the sensor cover on the rotary axis unit.



**3** Display the main menu. Use the dial to select [ATC], then press the [ENTER] key.

>13 ATC  
14 To Coordinate

**4** Use the dial to select [LENGTH SCAN], then press the [ENTER] key.

13> 3 LENGTH SCAN  
4 TOOL LENGTH

The machine sequentially grasps each tool, starting with stock No. 1, and brings it into contact with the sensor.

#### Point

If the sensor and the tool are far apart and making contact takes a long time, then hold down the [-Z] key. This makes the lowering speed faster. Release the [-Z] key before contact is made with the sensor.

#### Notice

If contact occurs while the [-Z] key is depressed, correct measurement is impossible. Be sure to release the key before contact is made.

**5** When all the tools have been measured and operation stops, the procedure has ended. Remove the Z0 sensor. Alternatively, attach the sensor cover.

#### Notice

After measuring the tool lengths, do not improperly replace a tool with a different one or change the sequence or the tools. Doing so destroys the correspondence between the actual tool lengths and the offset values, and may result in cutting-in at unexpected depths.

### Step 2: Set Z0 (the Z-axis Origin Point)

After you finish measuring the tool lengths, you make the setting for Z0.

#### Procedure

---

- 1** Operate the keys to grasp any tool.  
You may choose any tool whose tool length has been measured.
- 2** Make the Z0 setting with the grasped tool.  
Make the setting with any tool that has been measured. You do not need to set this individually for every tool to be used in cutting.
- 3** Return the grasped tool to the magazine.

This completes the preparations. When you send cutting data from a program, the tool specified by the program is automatically grasped, and cutting starts. Because tool-length offset is applied, the position of the tool tip remains uniform when one tool is changed for another.

# ***Chapter 5***

## ***Operation in the NC Code Mode***

---

This chapter explains basic operations when the NC command set is selected, and the basics of NC code programming.

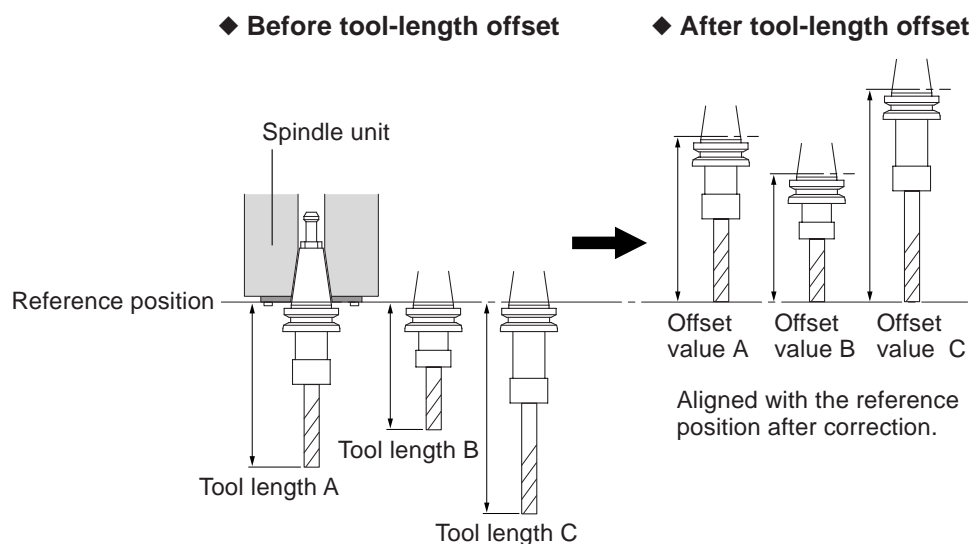
# 5-1 Tool Selection and Tool-length Offset

## Tool Selection

To grasp a desired tool or return it to the magazine, you use M06. This code only selects a tool. Tool-length offset is not enabled.

## Tool-length Offset

This function is used to correct for discrepancies between the tool length anticipated by a program and the actual tool length. Using this eliminates the need for the program to take changes in tool length into account when a tool change is performed, and makes it unnecessary to redo the setting for the workpiece origin every time the tool is changed. To start and cancel tool-length offset, you use G43 and G49.



To perform tool-length offset, you must register (save) the offset amount in the machine. You can register offset amounts from No.1 up through No. 16. There are two registration methods: one where the tool lengths are measured automatically, and one where you set the offset amounts manually.

Tool selections by M06 are not coordinated with offsets No. 1 through No. 16 in any way. The program must specify the number of the offset amount to assign to a selected tool (G43). This involves presetting the tool-length offsets corresponding to 16 tools in the machine.

## Offset Amounts for Tool Selections Made Using Key Operations

You can enable tool-length offset even when you select tools manually using the procedures in "3-3 Selecting Tools Through Key Operations." At the [TOOL SELECT] menu, specifying a tool number and pressing the [ENTER] key displays a screen for selecting an offset number. Selecting an offset number here achieves the same result as performing tool-length offset using G43. The display shows the coordinate values after tool-length offset.

Selecting offset No. 0 at this screen causes no tool-length offset to be applied here.

SELECT AND ENTER  
TOOL OFFSET No. <1>

Offset number

# 5-2 Preparations for Tool-length Offset

This section describes the preparations up to performing cutting using tool-length offset. There are tasks that you perform on the machine, and specifications you make in the programming.

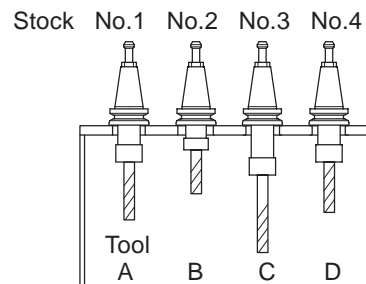
## Step 1: Perform Automatic Measurement of Tool Length

This section explains the basic operations of how to perform automatic measurement of tool length. The procedures are slight different depending on whether you are using the unit in combination with a rotary axis unit.

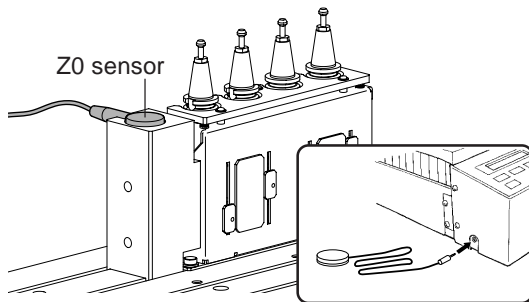
### Procedure

- 1 Load the tools you want to measure into the magazine.

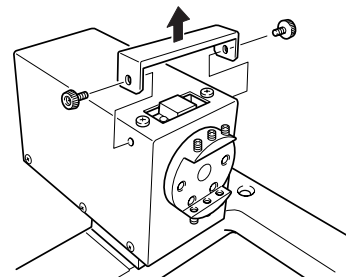
In this example, the tools are A through D.



- 2 When using with no rotary axis unit:  
Connect the Z0 sensor (included with the main unit), and then place the Z0 sensor on the sensor base.



- When using in combination with a rotary axis unit:  
Detach the sensor cover on the rotary axis unit.



- 3 Display the main menu. Use the dial to select [ATC], then press the [ENTER] key.

>13 ATC  
14 To Coordinate

- 4 Use the dial to select [LENGTH SCAN], then press the [ENTER] key.

13> 2 LENGTH SCAN  
3 TOOL LENGTH

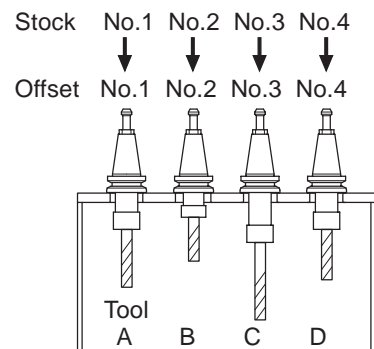
(Continued to on next page.)

### 5 Specify the tool length to register as a particular offset-amount number.

Use the dial to select the offset number. Pressing the [ENTER] key inputs it and moves the cursor to the next one. Repeat this procedure to make the settings for all the stocks.

In this example, tools A through D are registered as offsets No. 1 through No. 4.

STOCK	No. 1	2	3	4
OFFSET	No. 1	2	3	4



#### **Point**

If you select offset No. 0 for a stock, that stock is not measured. You can skip measurement of stocks where no tool is loaded.

### 6 When you have made the settings for all stocks and the screen shown at right appears, press the [ENTER] key.

The machine sequentially grasps each tool, starting with stock No. 1, and brings it into contact with the sensor.

TOOL LENGTH SCAN  
"ENTER" TO START

#### **Point**

If the sensor and the tool are far apart and making contact takes a long time, then hold down the [-Z] key. This makes the lowering speed faster. Release the [-Z] key before contact is made with the sensor.

#### **Notice**

If contact occurs while the [-Z] key is depressed, correct measurement is impossible. Be sure to release the key before contact is made.

### 7 When all the tools have been measured and operation stops, the procedure has ended. Remove the Z0 sensor. Alternatively, attach the sensor cover.

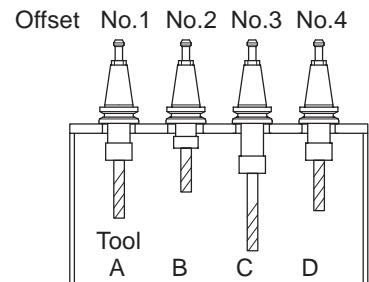
If necessary, replace the tools in the magazine with other tools and repeat steps 4 through 6. You can register a total of 16 offset amounts.

## Step 2: Make the Settings for the Workpiece Coordinate System

Load the magazine with tools that have already been measured and set the workpiece origin point (the cutting-start location).

### Procedure

- 1 Load the magazine with tools whose offset amounts have been registered.  
In this example, tools A through D that you measured in Step 1 are loaded.



- 2 Perform key operations to grasp any tool, then select the corresponding offset number.

In this example, tool A is grasped. The tool length of tool A is registered as offset No. 1, so here you select offset No. 1.

SELECT AND ENTER  
TOOL OFFSET No. <1>

- 3 Move the tool to the cutting-start location that the program expects, then set the workpiece origin point.



#### Point

There are a wide variety of ways to get the workpiece origin, depending on the program, but one example follows.

- (1) Move the tool to the lower left area of the workpiece.
- (2) Lower the tool and align the tool tip with the surface of the workpiece.
- (3) Use G54, EXOFS, or the like to set the workpiece origin (the origin point for the X and Y axes and for the Z axis) at this location.

- 4 Return the grasped tool to the magazine.

## Step 3: Make the Preparations in the Program

In the program, specify the tool number you want to select (M06). Also specify the offset number corresponding to the tool in the program (G43). For example, if you want to use tool A for rough cutting and tool B for finishing, specify offset No. 1 for the rough cutting and offset No. 2 for the finishing.

This completes the preparations. When you send the program to the machine, the specified tool is automatically grasped and cutting starts. The tool-length offsets of the specified offset numbers are applied, and so even when one tool is changed for another the position of the tip remains uniform.

# 5-3 Tool-length Adjustment and Manual Setting

## Tool-length Adjustment

You can adjust the results of the automatic measurement you carried out earlier in "Step 1: Perform Automatic Measurement of Tool Length."

### Procedure

- 1 Display the main menu. Use the dial to select [ATC], then press the [ENTER] key.
- 2 Use the dial to select [TOOL LENGTH], then press the [ENTER] key.
- 3 Turn the dial to select the offset number you want to adjust. Press the [ENTER] key.
- 4 Use the dial to adjust the value, then press the [ENTER] key.  
When the actual tool length is longer than the registered value, cutting-in is deeper than intended. In such cases you increase the value. Conversely, when cutting-in is too shallow, you reduce the value.

>13 ATC  
14 To Coordinate

13> 3 TOOL LENGTH  
4 AIR PRESS.

13-3> 1 OFFSET NO.1  
2 OFFSET NO.2

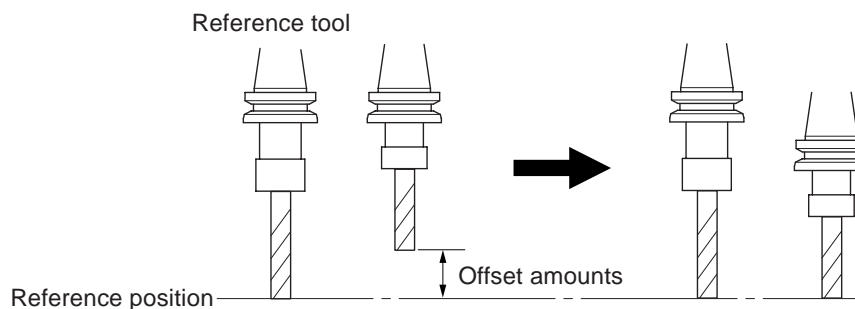
13-3> 1 OFFSET NO.1  
< 0.00mm>

## Setting the Offset Value Manually

You can enter tool lengths (offset amounts) you measured yourself by using a procedure similar to the one in the preceding "Tool-length Adjustment."

Measure the length to the tool end, referenced from a particular location on the tool holder. You may use any location on the tool holder as the reference, but it must be consistent for all tools. In this way, you register the measured lengths as offset amounts.

You can also get the same results by deciding on any one tool as a reference tool, and entering the differences from this tool. For instance, if there is a tool that is 15 mm shorter than the reference tool, you make the corresponding offset amount -15 mm. Also, you make the offset amount for the reference tool itself 0 (no tool-length offset). The reference position in this case is the tip of the reference tool.



# ***Chapter 6***

## ***NC Code Reference***

---

This chapter describes in detail the extended NC codes that become available through the addition of the ATC unit.

# G43, G49 Tool-length Offset

## Format

**G43 H** *number*

**G49**

Parameter	Function	No-error range	Effective range
<i>number</i>	Offset number	0 through 16	0 through 16

## Description

This moves the Z axis by the specified offset amount. It is used to correct for a change in tool length due to a tool change, to keep the position of the tip uniform, and so on.

G43 starts tool-length offset. You set the offset amount (offset No. 1 through No. 16) in the machine ahead of time, and specify the offset number with *number*. G49 cancels tool-length offset. Specifying 0 (zero) for *number* with G43 similarly cancels tool-length offset.

If an axis-movement command is present within the same block as a G43 command, the end point for axis movement is the Z-axis coordinate for the movement destination plus the offset. When no axis-movement command is present, the command is taken to be for a movement distance of zero, and movement along the Z axis by only an amount equal to the offset is performed. This is the same for both absolute and incremental coordinates.

G43 and G49 are commands in the same group. These commands remain in effect even outside the block until a new G43 or G49 command is received.

The offset amount for offset No. 0 is always 0 (zero). You cannot register any value for offset No. 0.

## Registering an Offset Amount

Registration of offset No. 1 through No. 16 is performed by key operations on the machine. Specification by a program is not possible. For more information, see chapter 5.

## Sample Program

<b>%</b>	Data start
<b>00001</b>	Program number
<b>G90</b>	Specify absolute coordinates
<b>G49 M06 T2</b>	Get tool in stock No. 2
<b>G00 X1000 Y1000</b>	Positioning
<b>G43 H1 Z-1000</b>	Start tool-length offset with offset No. 1 and move to corrected position
<b>F10 S5000 M03</b>	Rotate spindle
<b>G01 X2000 Y2000</b>	Linear-interpolation movement
<b>M05</b>	Stop spindle
<b>G49 M06 T0</b>	Cancel tool-length offset and return tool
<b>M30</b>	Program end
<b>%</b>	Data end

# M06 Tool Selection

## Format

**M06 T** *number*

Parameter	Function	No-error range	Effective range
<i>number</i>	Stock number	0 through 4 or 0 through 8*	0 through 4 or 0 through 8*

\* When expansion magazine is installed

## Description

This gets, changes, or returns a tool loaded in the magazine. You specify the stock number where the tool you want to get or change is loaded with number. Specifying 0 (zero) returns the tool.

Here, number signifies a stock number in the magazine. It does not directly specify the tool itself. Also, M06 has no tool-length offset function.

Do not specify more than one M06 or T code in the same block. Also, specifying M06 alone or a T code alone results in an error. Specify M06 and a T code together, as a pair.

Any command to get or change a tool that is already grasped is ignored.



# ***Chapter 7***

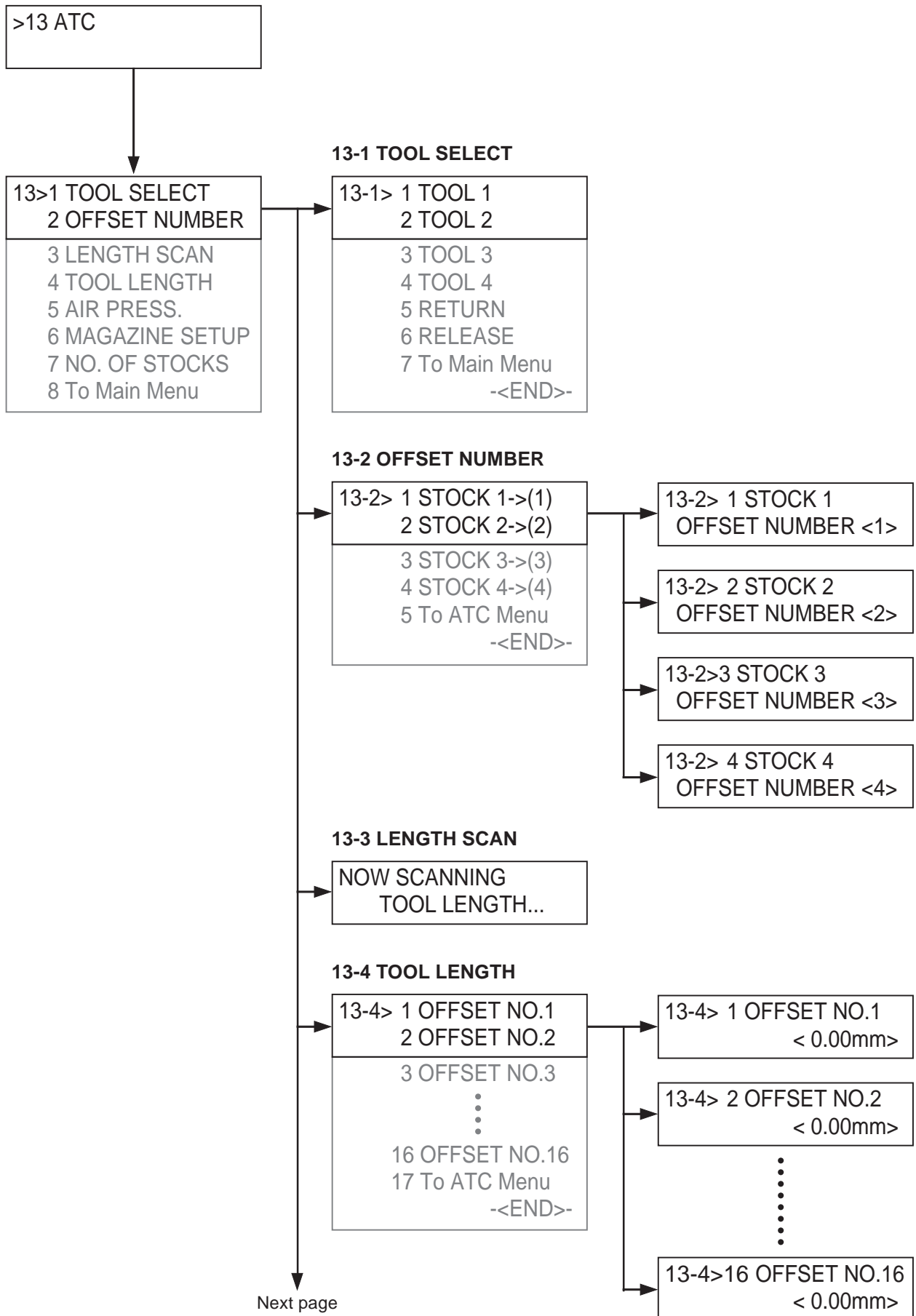
## ***Menu Reference***

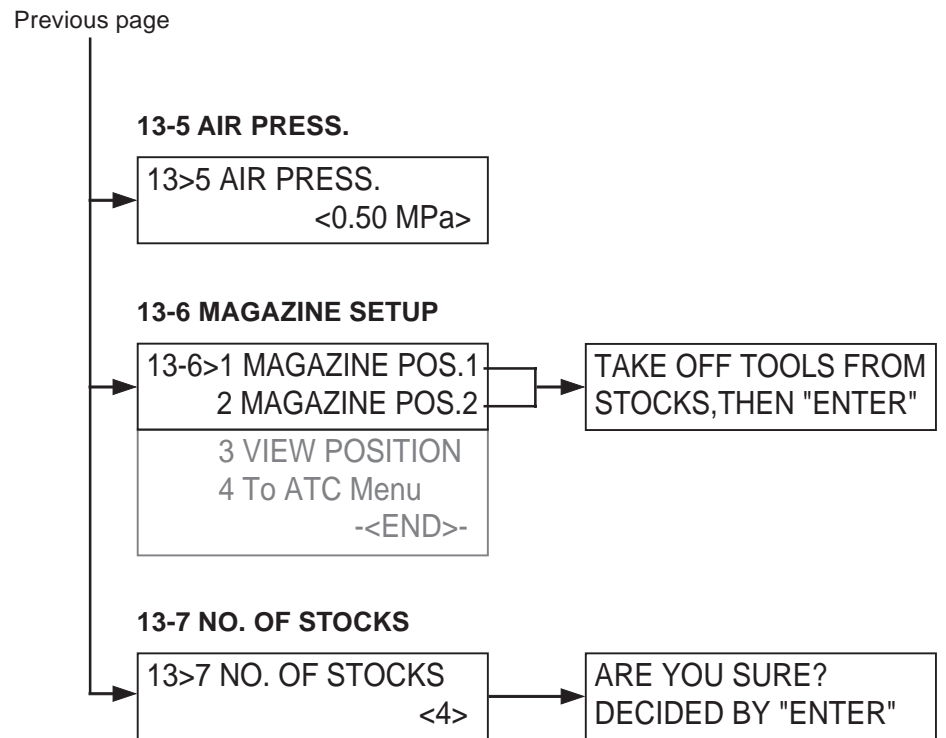
---

This chapter describes in detail the extended menus codes that become available through the addition of the ATC unit.

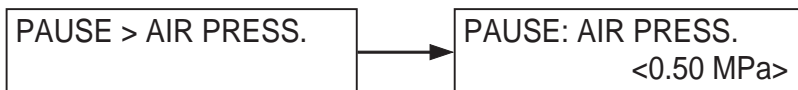
# 7-1 RML-1 Menu Flowchart

## Main menu



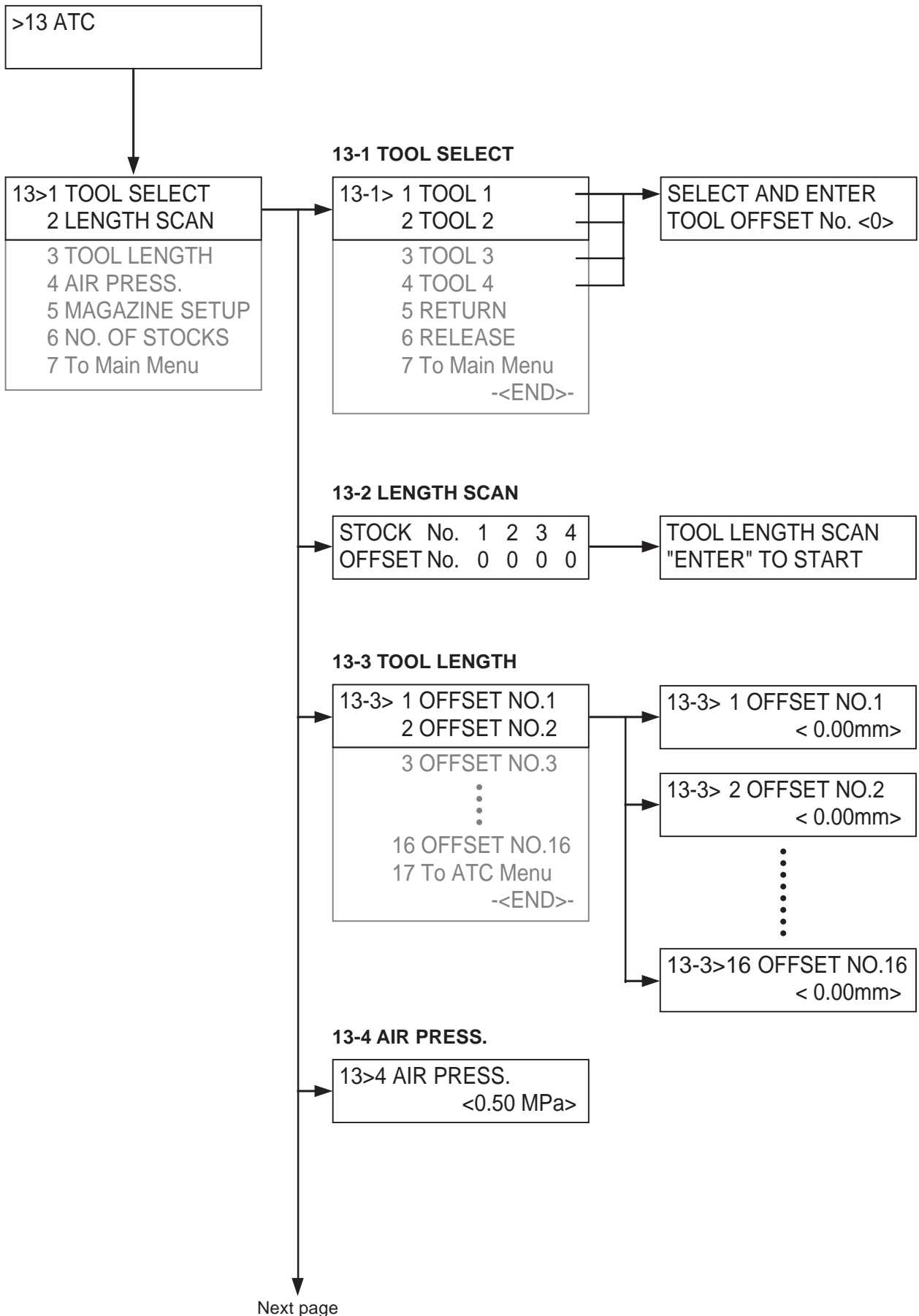


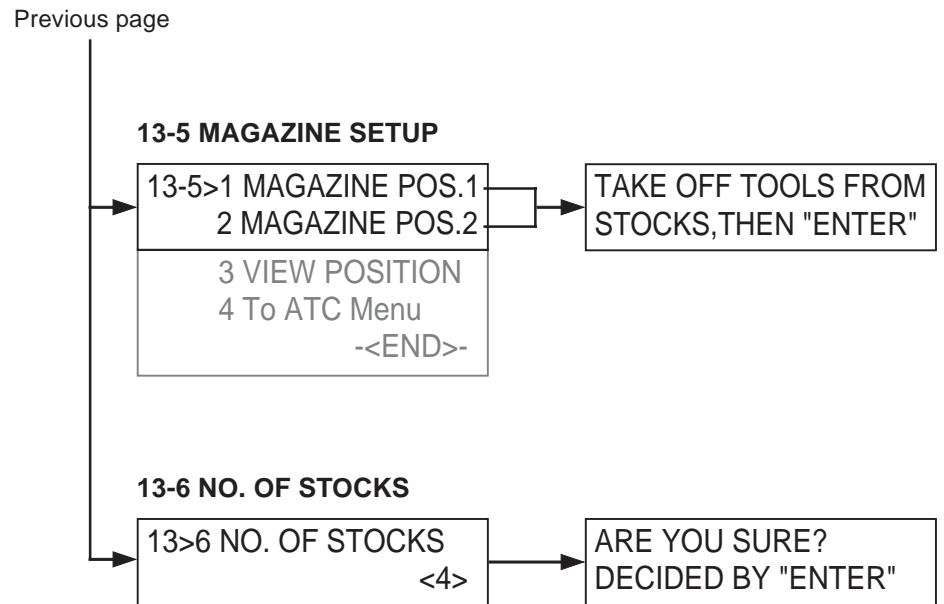
**Pause menu**



# 7-2 NC Code Menu Flowchart

## Main menu



**Pause menu**

# 7-3 Descriptions of RML-1 Menu Items

## 13>1 TOOL SELECT

This grasps or releases a tool.

### [TOOL 1], [TOOL 2], [TOOL 3]...

These get or change the tool loaded in the magazine. You specify the stock number where the tool you want to grasp is loaded. Performing tool selection applies tool-length offset with the offset amount corresponding to the tool.

### [RETURN]

This returns the acquired tool to the magazine.

### [RELEASE]

This performs a forced release of the acquired tool. No operation to return the tool to the magazine is performed, so take care to keep the tool from being dropped. You use this when you want to remove a tool by hand.

## 13>2 OFFSET NUMBER

Saved: Yes

Default: STOCK 1: 1, STOCK 2: 2, STOCK 3: 3...

Setting range: 0 through 16

This sets the associations between stock numbers and tool-length offsets (offset numbers). Selecting a stock number and pressing the [ENTER] key displays the screen for specifying the offset number you want to associate with the stock number. This makes it possible to set 16 offset amounts in advance and call up the appropriate one according to the tool you're using. Note that setting an offset number to [0] causes tool-length offset not to be applied.

The amount of tool-length offset corresponding to the selected tool is determined by [13>2 OFFSET NUMBER], [13>3 LENGTH SCAN], and [13>4 TOOL LENGTH].

## 13>3 LENGTH SCAN

This automatically measures the lengths of the tools loaded in the magazine and registers the values as offset amounts. Measurement uses the Z0 sensor and sensor base (which are not required when the ATC unit is combined with the rotary axis unit). The length from the spindle end to the tool tip is measured.

The offset number where a measured tool length is registered depends on the setting for [13>2 OFFSET NUMBER]. You can check and adjust the measurement results with [13>4 TOOL LENGTH].

## 13>4 TOOL LENGTH

Saved: Yes

Default: 0 mm

Setting range: -115.00 through +115.00 mm

This manually sets the offset amount for tool-length offset. You can make individual settings for offset No. 1 through No. 16. You enter the length to the tool tip referenced from any desired height. Positive values correct upward, and negative values correct downward. It is also acceptable to anticipate a reference tool and enter a positive value if longer than the reference tool, or a negative value if shorter.

The settings made with [13>2 OFFSET NUMBER] determine which offset-amount numbers are assigned to which tools.

The 16 registered offset amounts are shared by the RML-1 mode and the NC code mode.

## 13>5 AIR PRESS.

This displays the pressure of the compressed air supplied to the control box.

The machine pauses while this menu is displayed.

## 13>6 MAGAZINE SETUP

This moves the spindle to the reference position when installing a magazine. The reference position changes automatically depending on whether a rotary axis unit is installed.

After movement to the magazine adjustment position, the machine goes offline and does not accept data. Also, you cannot quit this menu by pressing the [EXIT] key. When you have finished installing the magazine, turn off the power or execute [VIEW POSITION].

### [MAGAZINE POS.1]

This moves the spindle to the magazine adjustment position.

### [MAGAZINE POS.2]

This moves the spindle to the magazine adjustment position. This is displayed only when [13>7 NO. OF STOCKS] is set to [8]. It is used when an expansion magazine is installed.

### [VIEW POSITION]

This moves the spindle to the VIEW position.

## 13>7 NO. OF STOCKS

Saved: Yes

Default: 4

Setting range: 4 or 8

This sets the number of tools housed. Set this to [8] when the number of tool magazines is expanded to two. Note that when the ATC unit is used in combination with the rotary axis unit, the setting is fixed at [4].

The number of stocks and the like displayed by [13>1 TOOL SELECT], [13>2 OFFSET NUMBER], and [13>3 LENGTH SCAN] changes according to this setting. It also affects [13>6 MAGAZINE SETUP].

## PAUSE > AIR PRESS.

This is added to the menu that appears when you press the [PAUSE] key. Like [13>5 AIR PRESS.], this displays the supplied air pressure.

The machine pauses while this menu is displayed.

# 7-4 Descriptions of NC Code Menu Items

## 13>1 TOOL SELECT

This grasps or releases a tool.

### [TOOL 1], [TOOL 2], [TOOL 3]...

These get or change the tool loaded in the magazine. Specifying the stock number where the tool you want to grasp is load makes [SELECT AND ENTER] appear, so specify the offset number you want to apply to the tool. A tool-select operation is performed, and tool-length offset with the specified offset amount (equivalent to G43) is applied. Specifying offset No. 0 causes no tool-length offset to be performed.

### [RETURN]

This returns the acquired tool to the magazine.

### [RELEASE]

This performs a forced release of the acquired tool. No operation to return the tool to the magazine is performed, so take care to keep the tool from being dropped. You use this when you want to remove a tool by hand.

## 13>2 LENGTH SCAN

This automatically measures the lengths of the tools loaded in the magazine and registers the values as offset amounts. Measurement uses the Z0 sensor and sensor base (which are not required when the ATC unit is combined with the rotary axis unit). The length from the spindle end to the tool tip is measured.

Executing this menu item displays a screen for specifying which offset number to register the measured tool length. You can check and adjust the measurement results with [13>3 TOOL LENGTH].

## 13>3 TOOL LENGTH

Saved: Yes

Default: 0 mm

Setting range: -115.00 through +115.00 mm

This manually sets the offset amount for tool-length offset. You can make individual settings for offset No. 1 through No. 16. The menus cannot be used to assign offset-amount numbers to tools. This is specified by the program.

The 16 registered offset amounts are shared by the RML-1 mode and the NC code mode.

## 13>4 AIR PRESS.

This displays the pressure of the compressed air supplied to the control box.

The machine pauses while this menu is displayed.

## 13>5 MAGAZINE SETUP

This moves the spindle to the reference position when installing a magazine. The reference position changes automatically depending on whether a rotary axis unit is installed.

After movement to the magazine adjustment position, the machine goes offline and does not accept data. Also, you cannot quit this menu by pressing the [EXIT] key. When you have finished installing the magazine, turn off the power or execute [VIEW POSITION].

### [MAGAZINE POS.1]

This moves the spindle to the magazine adjustment position.

### [MAGAZINE POS.2]

This moves the spindle to the magazine adjustment position. This is displayed only when [13>6 NO. OF STOCKS] is set to [8]. It is used when an expansion magazine is installed.

### [VIEW POSITION]

This moves the spindle to the VIEW position.

## 13>6 NO. OF STOCKS

Saved: Yes  
Default: 4  
Setting range: 4 or 8

This sets the number of tools housed. Set this to [8] when the number of tool magazines is expanded to two. Note that when the ATC unit is used in combination with the rotary axis unit, the setting is fixed at [4].

The number of stocks and the like displayed by [13>1 TOOL SELECT] and [13>2 LENGTH SCAN] changes according to this setting. It also affects [13>5 MAGAZINE SETUP].

## PAUSE > AIR PRESS.

This is added to the menu that appears when you press the [PAUSE] key. Like [13>4 AIR PRESS.], this displays the supplied air pressure.

The machine pauses while this menu is displayed.



# ***Chapter 8***

## ***Other Information***

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This chapter describes maintenance procedures, error messages and remedies, specifications, and other matters.

# 8-1 Daily Maintenance

## Cleaning and Lubrication

Carefully clean away cutting waste using a vacuum cleaner and brush. Buildup of cuttings on the taper shank may affect runout precision and the like, clean thoroughly on a daily basis. If there is buildup of grease or other grime, wipe it away thoroughly using a soft, dry cloth.

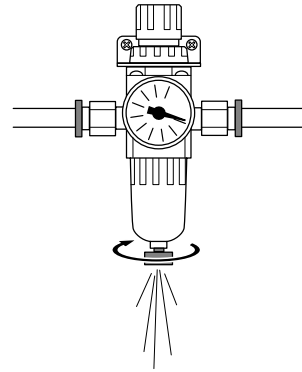
In user-performed maintenance, no lubrication is necessary.

## Maintenance for the Air Regulator

The air regulator is equipped with a filter on which water and dust collect over time.

Drain off water before it becomes full. Stop the supply of compressed air, then loosen the knob at the bottom of the bowl a little at a time. Remaining pressure may cause water to spray out below, so use cloths or the like to contain the spray.

If the inside of the bowl is dirty with dust, then remove the bowl and clean it. Stop the supply of compressed air, loosen the knob at the bottom of the bowl a little at a time. Then turn the bowl to remove it, wash it with a neutral detergent. Do not use solvents such as paint thinner. They may degrade the bowl, resulting in breakage when air pressure is applied.



## Inspection of the Spindle Unit

The service life of the spindle for the ATC unit is around 5,000 hours (total rotation time). We recommend early inspection and replacement. For replacement parts, contact your Roland DG Corp. service center.

## 8-2 Corrective Action for Error Messages

If an error message appears on the machine's display, take action as described below. If this action does not correct the problem, or if another error message appears, contact your Roland DG Corp. service center.

### NO ATC UNIT

**The [ATC] menu item was executed, but no ATC unit is installed.**

The [ATC] menu item can be executed, only when an ATC unit is installed. After a short interval, the machine automatically returns to the original screen.

### NOW CATCHING TOOL "ENTER" TO RELEASE

**The power was switched on while a tool was in a gripped state.**

When the power is switched on while a tool is gripped, the tool is released to ensure safety. Pressing the [ENTER] key immediately performs a forced release and clears the error. No operation to return the tool to the magazine is performed, so support the tool with your hand as you perform this operation to keep the tool from being dropped.

(1) Press the [ENTER] key. A forced release is performed, and the message [IF TOOL IS RELEASED, THEN PUSH "ENTER"] appears.

(2) If the tool was released, then press the [ENTER] key to clear the error.

If the tool was not released, then switch off the power. Make sure the air pressure is within the specified range and that no air hoses or cables have come loose, then switch on the power. If the error message appears again, press the [ENTER] key. If this operation fails to release the tool, then contact your Roland DG Corp. service center.

If this message does not appear even though a tool is grasped, then immediately switch off the power and contact your Roland DG Corp. service center.

### CAN'T CATCH TOOL \*\* SET TOOL THEN ENTER

**The specified tool cannot be grasped.**

Here, "\*\*\*" indicates the stock number. This appears when an attempt to get a tool fails because the tool is not loaded in the magazine, or is not loaded at the appropriate location in the magazine, or for similar reasons.

If the tool is not loaded in the magazine, then load it and press the [ENTER] key. The machine clears the error and again performs the operation for getting the tool. If the error occurred for some other cause, then switch off the power, eliminate the cause, then carry out the procedure again.

### NO Z0 SENSOR SET SENSOR THEN ENTER

**An attempt was made to carry out automatic measurement of tool length while the Z0 sensor was not connected.**

The Z0 sensor is required in order to execute [LENGTH SCAN] (although this is not required when the rotary axis unit is installed). Connect the Z0 sensor, place it on the sensor base, then press the [ENTER] key. The machine clears the error, then restarts measurement.

### TOOL LENGTH TOO LONG SHORTEN IT AND ENTER

**Automatic measurement cannot be performed because the tool is too long.**

On executing [LENGTH SCAN], if the tool is too long and measurement cannot be performed, this message appears and the tool is returned to the magazine. Replace the tool with one of the specified length, then press the [ENTER] key. The machine clears the error, then restarts measurement.

### AIR PRESSURE SHORT

**Operation was interrupted because the pressure of the compressed air was lower than permitted.**

This appears when the pressure of the compressed air is insufficient. First, readjust the air pressure to 0.5 to 0.65 MPa. When the display changes to ["ENTER" TO CONTINUE], press the [ENTER] key. The error is cleared and the operation resumes.

### AIR PRESSURE TOO HIGH

**Operation was interrupted because the pressure of the compressed air was higher than permitted.**

This appears when the pressure of the compressed air is excessively high. First, readjust the air pressure to 0.5 to 0.65 MPa. When the display changes to ["ENTER" TO CONTINUE], press the [ENTER] key. The error is cleared and the operation resumes.

### OPERATING ERROR CAN'T RELEASE TOOL

**The tool cannot be released.**

This appears when the grasped tool could not be released for some reason.

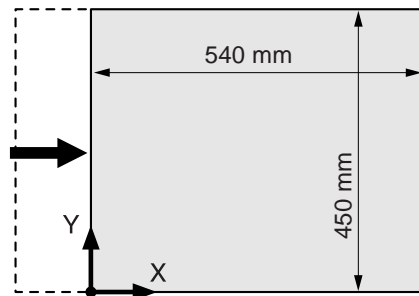
Switch off the power and make sure the air pressure is within the permitted range. Also make sure that no air hoses or cables have come loose. Switch on the power again. When [NOW CATCHING TOOL "ENTER" TO RELEASE] appears, press the [ENTER] key to try performing a forced release. (Be careful not to let the tool fall at this time.) If this operation fails to release the tool, then contact your Roland DG Corp. service center.

## 8-3 X-, Y- and Z-axis Travels

When the ATC unit is installed, the MDX-650A's axis travels are as follows.

### When Using with No Rotary Axis Unit

The X-axis travel changes.



### When Using in Combination with a Rotary Axis Unit

When the MDX-650A is equipped with both an ATC unit and a rotary axis unit, the XYZ-axis travels are the same as when no ATC unit is installed. The actual cutting area is restricted by such factors as the size of the workpiece that can be loaded in the rotary axis unit.

#### **Notice**

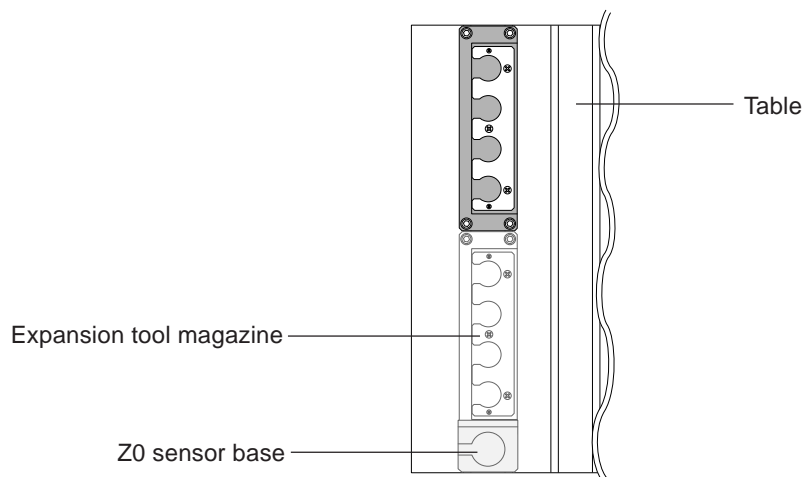
When you are using the unit in combination with a rotary axis unit, position the tool magazine and the rotary axis unit within the axis movement area. Take this into account in the programming to ensure that the tool does not collide with these.

## 8-4 Tool-magazine Expansion

Expansion of the installed tool magazines is possible, and you can install a total of two tool magazines. (However, expansion is not possible when you are using the ATC unit in combination with a rotary axis unit. The expansion tool magazine is an optionally available item.)

To install another, follow the steps below.

- (1) Remove all tools loaded in the magazine.
- (2) Remove the sensor base.
- (3) Display the main menu. Use the dial to select [ATC], then press the [ENTER] key.
- (4) Use the dial to select [NO. OF STOCKS], then press the [ENTER] key.
- (5) Use the dial to select [8], then press the [ENTER] key.
- (6) Follow the procedure in "2-4 Installing the ATC Unit," under "Step 3: Install the Tool Magazine," to install the expansion magazine. However, select [MAGAZINE POS.2] for the adjustment position of the magazine.
- (7) Mount the Z0 sensor base on the expanded magazine.



## 8-5 Extended RML-1 Commands

Installing the ATC unit extends the RML-1 command set as follows.

### mode 1

Command: J Tool change  
Format: Jt J  
Parameter: t Tool number  
Range: 0 through 4, or 0 through 8 (when expansion magazine is installed)

### mode 2

Command: SP Tool change  
Format: SPt; SP;  
Parameter: t Tool number  
Range: 0 through 4, or 0 through 8 (when expansion magazine is installed)

## 8-6 Specifications

	<b>ZAT-650</b>
Number of tools housed	4 or 8 (when optional expansion magazine is installed)
Maximum tool length	110 mm (4-5/16 in.)
Maximum tool diameter	Diameter 10 mm (3/8 in.)
Tool-holder format	Taper shank: JBS4002 15T 7/24 taper Pull stud: JBS4002 15P (45°), special
Tool-selection method	Direct-changing type, fixed-address specification
Compatible compressed air	0.7 to 1 MPa and 50 L/min. or more
Spindle speed	3,000 to 12,000 rpm
Operating temperature	5 to 40 °C (41 to 104 °F)
Operating humidity	35 to 80% (no condensation)
Packed dimensions	785 (W) x 310 (D) x 235 (H) mm (31 (W) x 12-1/4 (D) x 9-1/4 (H) in.)
Packed weight	12.5 kg (27.6 lb.)

\* The cutting range of the MDX-650A when installed with the ATC unit is as follows.

No rotary axis unit installed:

540 (X) x 450 (Y) x 155 (Z) mm (21-1/4 (X) x 17-11/16 (Y) x 6-1/16 (Z) in.)

When combined with the rotary axis unit:

When the MDX-650A is equipped with both an ATC unit and a rotary axis unit, the XYZ-axis travels are the same as when no ATC unit is installed. The actual cutting area is restricted by such factors as the size of the workpiece that can be loaded in the rotary axis unit.



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