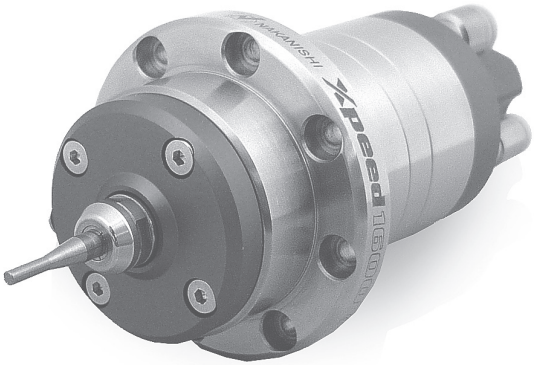
NAKANISHI

エアー軸受タービンスピンドル

Xpeed 1600

取 扱 説 明 書

OM-K0609 002



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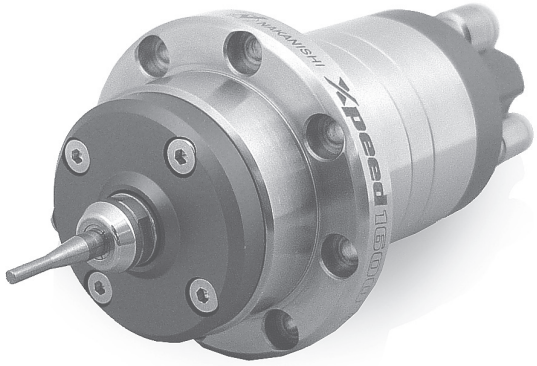
NAKANISHI

Air Bearing Turbine Spindle

Xpeed 1600

OPERATION MANUAL



CONTENTS

Thank you for purchasing our Xpeed1600. The Xpeed1600 is an ultra precision spindle which that is driven by a turbine and supported by an air bearing. In order to use this spindle properly and effectively as well as extending the life of the spindle, please fully understand this Operation Manual before use for sufficient care in handling. It is necessary for you to separately prepare related devices (such as an air line kit, piping connection hose and compressor) to supply highly clean compressed air .

1 CAUTIONS FOR HANDLING AND OPERATION

■ **Read these precautions carefully and correctly before using the device.**

■ **Safety precautions are intended to avoid potential hazards that could result in personal injuries or damage to the device. They are classified as follows in accordance with the seriousness of the risk.**

Class	Degree of Risk
⚠ **WARNING**	**Existence of a hazard that could result in bodily injury or damage to the device, if the safety instructions are not followed.**
⚠ **CAUTION**	**Possibility of a hazard that could result in light or middle degree of bodily injury or damage to the device, if the safety instructions are not followed.**

⚠ Warning

① This air bearing spindle (Xpeed1600) is not designed as a hand tool. Install it on your machine tool or special purpose machine.
② Do not touch the spindle during rotation, as the motor speed is very high.
③ Wear safety glasses and dust mask. Always use a protective surround on the machine to avoid flying debris.
④ Check that the cutting tool is securely tightened before each use.
⑤ Never operate or handle the product until you have thoroughly read the Operation Manual and safe operation is confirmed.
- •Handle or operate the product only after all precautions have been met and ensure safety has been confirmed.
- •Prior to operating the product, confirm that all of the above safety precautions have been taken. Do not connect the product to an energy source or supply compressed air until all safety checks have been confirmed.

⚠ Caution

① Use the spindle after running at its free speed for 5-10 minutes. Frictional heat caused by air can cause the spindle temperature to rise +20˚C above room temperature. Warm-up idling stabilizes spindle accuracy.
② Always drain the moisture condensation from the air filter to prevent it from rusting the spindle interior and causing premature failure.

2 FEATURES

① Adoption of the air bearing and turbine drive is suited for high speed mold cutting, and small diameter drilling and grinding of finely-shaped parts which require high precision machining.
② Optimal cutting conditions when mounted in a CNC Machine are achieved by making use of high speed rotation performance which exceeds 100,000 min^{-1}. The result will be an increased production performance and superior surface finish.
③ Run-out accuracy during rotation is minimized and high speed rotation accuracy is obtained by adaptation of a high precision collet and balance characteristics held to a minimum. As a result, a prolonged tool life can be expected.
④ For the air bearing, a rotating shaft is floated without contact by supplying dry compressed air from which oil is removed from the bearing gap. This prevents the bearing from being worn and reduces energy consumption to a minimal level. Therefore, use in as clean an environment is possible.
⑤ In the event of the bearing section comes in contact with the rotating shaft, and in order to suppress heat generation due to air resistance during rotation, a highly-functional bearing material has been used in the bearing section to increase the anti-seizing properties and cooling effect.
⑥ Electric wiring not used for this spindle. Operation is performed through the air piping.

3 SPECIFICATIONS AND DIMENSIONS

No.	Item	Standard value
1	Model	Xpeed 1600
2	Maximum rotation speed	160,000min^{-1}
3	Drive method	Compressed air turbine
4	Bearing type	Air Static Pressure Bearing
5	Rotating direction	Right Hand Rotation (FWD). Viewed from the rear of the Air Bearing Turbine Spindle toward the cutting tool.
6	Air Bearing Required Air Pressure	0.6MPa
7	Air Turbine Operating Air Pressure*	0.5MPa
8	Spindle Accuracy	1 μm or less
9	Weight	520 g

* For details on how to set the turbine air supply pressure, refer to the separately attached specification table.

	Temperature	Humidity	Atmospheric Pressure
Operation Environment	0 - 40°C	MAX.75% (No condensation)	800 - 1,060hPa
Transportation and Storage Environment	-10 - 50°C	10 - 85%	500 - 1,060hPa

<Option>

Collet (CHA - □□ AA)	Ø3.0mm, Ø3.175mm, Ø4.0mm
Collet Nut	CHN - 3A

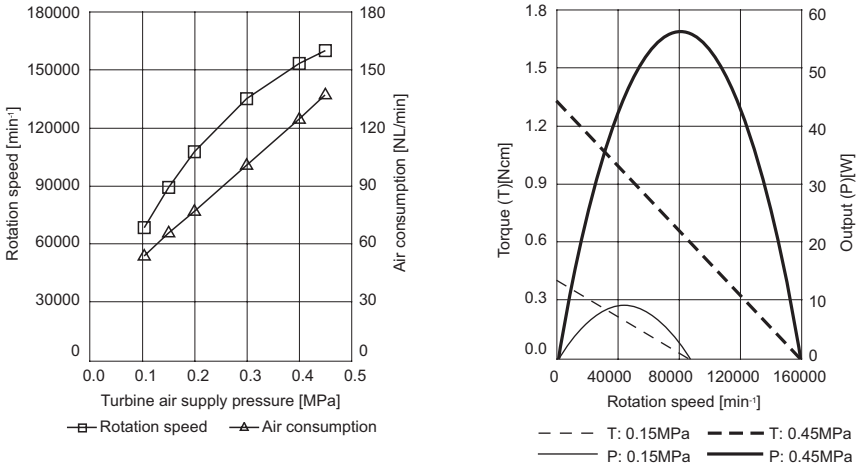


Fig.1 Xpeed1600 performance diagram

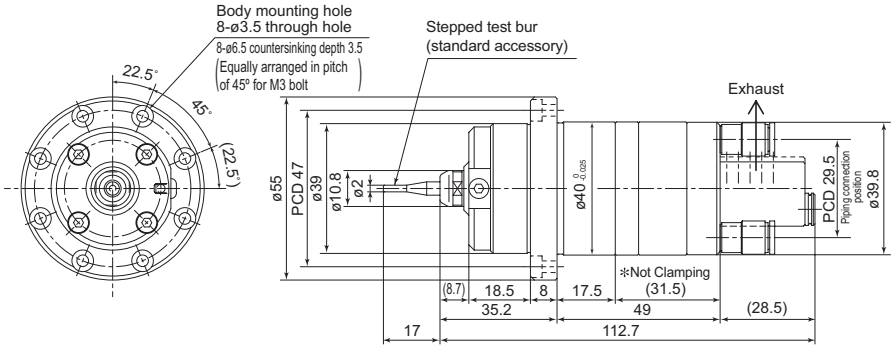


Fig.2 Detailed dimensional drawing

4 STANDARD ACCESSORIES

Standard accessories and attachments					
• Collet	CHA-4.0 AA	1pc.	• Plug KQ2P-06-GR	2pcs.
• Collet nut	CHN-3A	1pc.	• Plug KQ2P-04-GR	2pcs.
• Protect cover (for Xpeed1600)		1pc.	• Stepped test bur	1pc.
• Torque wrench (for tighting the collet nut)	10mm	1pc.	• Protect cap (for stepped test bur)	1pc.
• Bur wrench (for tightening the collet nut)	K-277	1pc.	• Operation manual	1set
• Hexagonal wrench (Silver)	2mm	1pc.	• Inspection record table	1set
• Hexagon socket button head bolt	M3x5L	1pc.	• ø4 transparence hose (1.5m) recommended SMC # TU0425C	1pc.
• Gasket	for M3 screw	1pc.		
• Air inlet joint KQ2S06-M5-X29 (for ø6 hose)		2pcs.	• ø6 blue hose (1.5m) recommended SMC # TU0604BU	1pc.
• Air inlet joint KQ2S04-M5-X29 (for ø4 hose)		2pcs.		

*The value of run-out is within 3µm

5 INSTALLATION OF THE Xpeed1600

When installing the Xpeed1600 in a holder, adaptation of the flange fixing method is recommended to minimize the risk of damage to the spindle. The advanced characteristics incorporated in this spindle are fully utilized when precautions are observed. Shown below is the proper installation, where high precision machining can be achieved.

① Remove the protect cover of the Xpeed1600.
② Insert the spindle housing diameter ø40 section into a holder (prepared by customer).
③ Secure the spindle to the countersunk holes (8 locations) on the flange using M3 bolts as shown in Fig.2 and Fig.3.

⚠ Caution

① Secure the main body so as not to block the exhaust holes (2 locations on the circumference) on the back of the spindle. Install the main body laterally so that the exhaust hole faces downward.
② If the spindle housing diameter (ø40 section) is tightened and fixed using bolts and a split sleeve or split holder arrangement, the main body will be geometrically deformed and assembly accuracy will be affected. Troubles such as rotation failure and heat generation may result. Absolutely never fix it with bolt and split type holders. (Refer to Fig.3).
③ Since the spindle housing section has been assembled by stacking some components with high precision, spindle damage can occur if the spindle receives shock by bumping while inserting it in the holder. Therefore, very carefully when performing the installation.

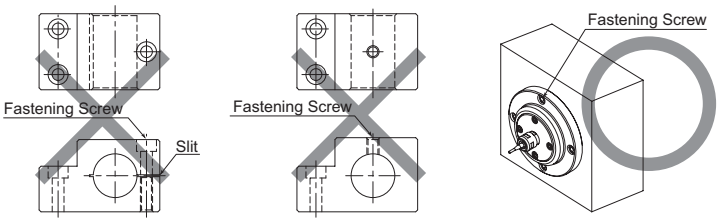


Fig.3

6 PIPING CONNECTION

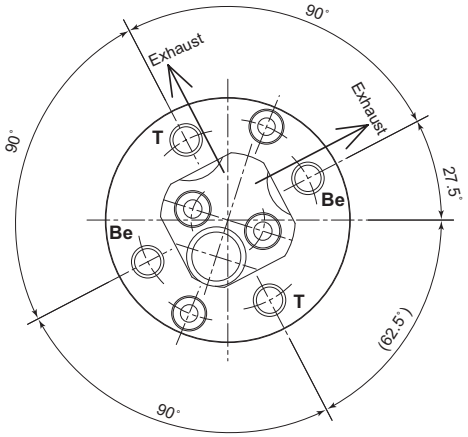
For connection of the piping to the Xpeed1600, there are several air supply pipes. For this reason, connect pipes to the predetermined positions without error to the reference markings on the piping connecting section on the rear of the spindle as shown in Fig.4. This will allow you to prepare for safe, successful operation. In most failures of air bearing spindles, contaminants, water and oil are mixed into the piping and cleanliness is impaired, causing bearing performance to deteriorate. Therefore, build a piping system shown in Fig.5 and Fig.6 or air supply to the spindle that supplies sufficient, clean and dry air.

⚠ Caution

① Various fittings for piping connection are available for spindles. Sufficiently clean the fittings and install them after air blowing so as to prevent mixture of contaminants, oil and water when connecting. Also clean tools and hoses used for piping connection in the same manner.

② Securely connect the hoses. If a hose is removed during operation, a large amount of air will suddenly jet out and the hose will swing wildly, which is very dangerous. Check the operating pressure for the air piping hose, and use products having specifications sufficiently permissible to pressure supplied from the compressor and pressure required for the spindle. Unless the allowable pressure for the hose satisfies the operating pressure, the hose may be ruptured, which is very dangerous.

③ If the air piping is connected to an improper connecting position, unintentional operation may occur, and this may result not only in incorrect operation, but also in failure, which is very dangerous. Pay sufficient attention so as not to connect improperly.



Be : Air bearing supply air piping
2-M5 screw at two locations

T : Air turbine supply air piping
2-M5 screw at two locations

Fig. 4
Piping connection portion detailed drawing

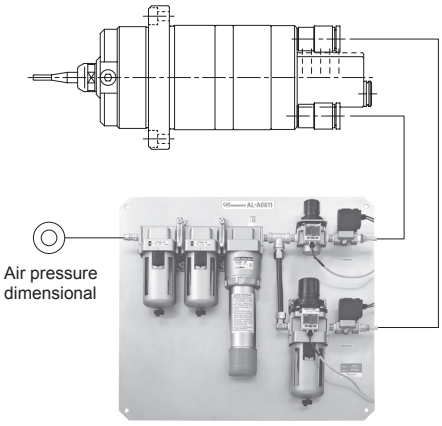


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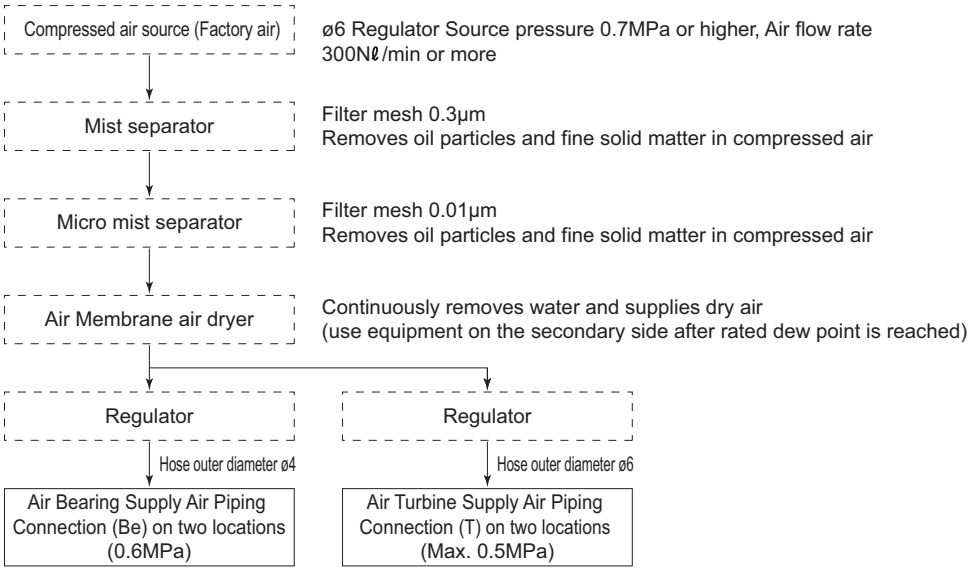
Fig. 5
Recommended piping system structure



* Note 1 : Devices in the broken lined frame are not included with Xpeed1600, therefore, these items should be prepared by the customer.
* Note 2 : For details and precautions of each air device, refer to the Operation Manual of the manufacturer from which you purchased the each product.
* Note 3 : Make sure the set air pressure at the Air Bearing Turbine Spindle piping connection port.

Fig. 6 Recommended piping system structure

Procedures to supply air to air bearing

① Perform flushing of hose to be connected for piping for a few minutes and completely remove contaminants such as water, oil and dust in the piping.

② It normally takes some time from starting the flow air into air dryer, until reaching the rated dew point. It will be necessary to wait until the supplied air has been sufficiently dehumidified to reach the correct dew point.

③ Adjust the set pressure in each piping to 0 MPa in advance before supplying air for the first time after connecting the piping, and ensure that piping is routed to the correct predetermined position.
Keep in mind that, if piping is improperly connected to the air bearing, and air is supplied to the turbine and brake piping, and not supplied to the air bearing, the rotating shaft rotates without floating will cause damage to the bearing and the rotating shaft.

④ Supply air to the air bearing piping.

⑤ Adjust the set pressure for the air bearing to 0.6MPa at the piping connection port. Make sure to confirm the pressure at the piping connection port, since correct pressure may not be obtained due to pressure loss if the piping connection port is separated from the pressure detecting section.

⑥ Slightly rotate the rotating shaft by hand to check that the shaft smoothly rotates without an abnormal or sticking feeling. In this case, in order to avoid danger, never supply air to the turbine air supply piping.

⑦ Leave Xpeed1600 as it is without operating for approximately 30 minutes after supplying air to the air bearing piping. Wait until the inside of the spindle has been sufficiently cleaned and dehumidified. Continue this operation for approximately one hour especially if Xpeed1600 has not been used for an extended period of time.

⑧ Complete of supply air to the air bearing.
It is necessary to properly install the end tool to the collet section before operating Xpeed1600.

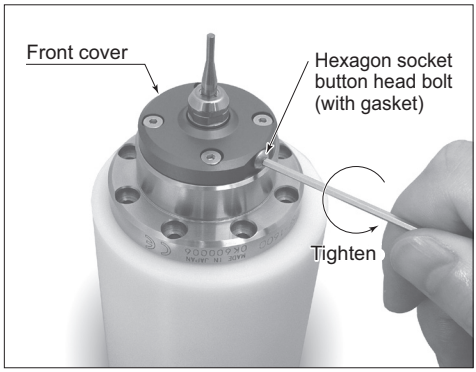
7 CHANGING CUTTING TOOLS

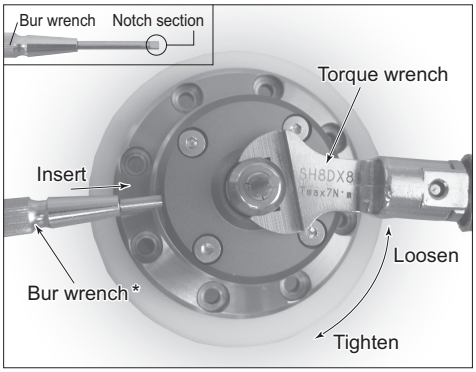
Replace cutting tools using the following procedures (refer to Fig.7).

① Supply air at the proper pressure to the air bearing.
② Remove the hexagon socket button head bolt (M3 x 5L) and the gasket at the front cover found on the outside diameter section using the included hexagonal wrench (Silver: 2mm).
③ Insert the included bur wrench into the threaded bore of the hexagon socket button bolt, insert and position its edge to the detent groove provided at the rotating shaft. At this time, insert the bur wrench with the concave portion at the edge portion facing the collet nut side.
④ Set the provided Torque wench (10mm) on the collet nut, turn it counterclockwise to loosen the collet nut and pull out the end tool. When the collet nut is turned by approximately one turn, it is tightened, and when further turned, the collet is opened.
⑤ Insert another cutting tool into the collet, and turn the collet nut clockwise to tighten.
(Tighten collet nut with provided torque wrench. The torque wrench should be set up 2N·m)
⑥ Use the included silver hexagon wrench (2mm) for the screw hole on the front cover outside diameter and re-install the gasket and the hexagon socket head button bolt.

⚠ Caution

① Never replace the cutting tool and collet without supplying air to the air bearing. If replacement operation is performed without air being supplied, the spindle shaft will contact the bearing, and the contact parts will all be damaged, which will cause a function in operation.
② When tightening the collet nut, make sure to insert the cutting tool into the collet nut. If the collet nut is tightened without inserting the cutting tool, the collet will be tightened more than necessary and the collet may be internally disengaged from the latch of the collet nut.
When the latch is disengaged, the collet remains in the spindle even if the collet nut is loosened and the collet may not be removed.
③ When tightening the collet nut, runout accuracy of cutting tool will deteriorate by over tightening and the collet may be damaged.
④ After installing the cutting tool, measure the runout accuracy at the outside diameter section and check that there is no abnormality or runout.
⑤ After replacing the cutting tools, make sure to install the front cover using the hexagon socket head button bolt and gasket on the front cover.
If it is left open, contaminants, water and oil may enter and result in spindle failure.





* Please locate tip notch section of the bar wrench chuck nut side.

Fig.7 Replacement of cutting tool

8 REPLACING THE COLLET

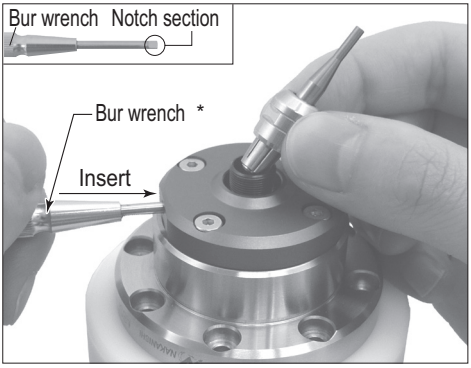
Replace the collet by the following procedures, refer to Fig.8.

① Supply air at proper pressure to the air bearing.

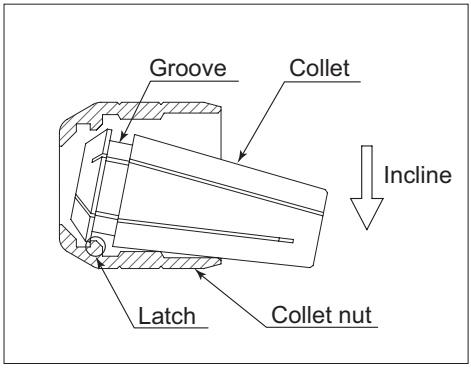
② Loosen the collet nut with the cutting tool installed according to the "**7 CHANGING CUTTING TOOIS**" as described above. Turn until the collet nut is removed from the spindle shaft. Then pull it together with the end tool from the spindle shaft. Then, pull out the cutting tool from the collet.

③ Hold the collet nut by hand and incline the collet in either one of the spanner engaging directions, then the collet can be removed. If the collet cannot be removed, incline it in the opposite spanner engaging direction.

④ When installing the collet, incline it in either one of the spanner engaging directions.



* Please locate tip notch section of the bur wrench collet nut side.



* When install the collet, make sure to correctly engage the inside diameter latch of the collet nut to the groove on the collet outer circumferential section.

Fig. 8 Replacement of collet

⚠ Caution

To install the collet, make sure to fully engage the inside diameter latch of the collet nut to the groove on the collet outer circumference section. Keep in mind that if the collet has been incompletely installed, the cutting tool cannot be properly gripped, and this may result in a dangerous situation. In addition, remember that if the collet is attached without being engaged with the latch of the collet nut, the collet cannot be removed and this may cause impairment of both parts.

9 OPERATION OF Xpeed1600

Never rotate Xpeed1600 at high speed to speed to avoid a dangerous situation. It is necessary to observe the following precautions and warnings to ensure safe operating conditions and operate in a state that the operation can be stopped whenever necessary.
When operating for the first time after purchase, or if Xpeed1600 has not been used for one week or longer, operate Xpeed1600 according to the operating procedures shown in Fig.9, and perform a subsequent break-in operation according to the operation stop procedures shown in Fig.10.

⚠ Caution

① Remove the protect cap of the stepped test bur. Do not operate with a protection cap on the stepped test bur.
② When not air bearing to air supply, please observe the following.
- Never rotate the spindle shaft unnecessarily.
- Never apply air pressure to the turbine air supply piping.
- Never splash or flood coolant on Xpeed1600.
- Never directly blow air on Xpeed1600.

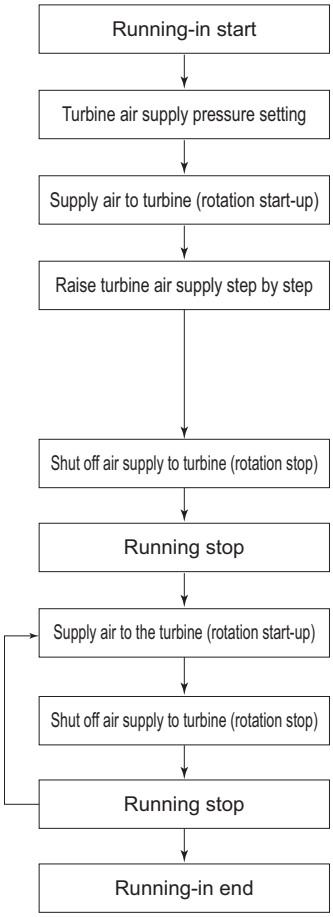
*Remember that the sealing effect will not be obtained when air is not supplied to the air bearing and turbine. Contaminants, water and oil may enter into the spindle and cause air bearing and rotating shaft seizing or galling.

③ Re-check whether piping has been properly connected, and air has been air supply to the air bearing. Also check that the cutting tool has been properly installed.
④ In a case where air supply pressure of the air bearing is low or air supply to the air bearing is incorrectly shut off during operation due to a mistake in operation method, not only does the air bearing abnormally operate, but also the rotating shaft and the bearing come into contact with each other to cause it to seize. Please observe the correct pressure.
⑤ When using in an adverse environment which allows cutting oil or chips to be mixed, keep supplying air to the air bearing even if the spindle is not used.

⚠ Warning with regard to operating procedures and operation / stop

① Check that the spanner or wrench used for tightening of the collet nut and used as a detent for the rotating shaft has been completely removed from the spanner engagement area. Always keep in mind that the tool will fly off, and this may cause injury and damage to property or operator if the shaft is rotated with the tools engaged.
② Acceleration at start up of running is very fast and dangerous. Make sure to install a protective cover, which ensures safety around Xpeed1600 as well as complete safety for the operator and those around the Xpeed1600.
③ Adjust the rotating speed by adjusting the regulator with reference to the turbine air supply pressure and measured values of the rotating speed described in the inspection table. Never perform operations exceeding the maximum rotation speed, as it is very dangerous and may result in damage to the spindle. In addition, when setting the turbine pressure, confirm the pressure at the spindle piping connection port is similar to the pressure setting of the air bearing and make any necessary adjustments.
④ Check that there is no excessive vibration, generation of abnormal sounds or abnormal heat generation during running.
⑤ If you sense anything abnormal, immediately shut off the turbine air supply pressure to stop rotation.
⑥ Remember that rotation is not completely stopped when air flow to the air bearing is removed, even if rotation is stopped by shutting off air supply to the turbine.
⑦ Since the cutting tool and collet during rotation are very dangerous, absolutely never touch them by hand and never bring your face close to them.

Running-in method



Check the set pressure for the air bearing (0.6MPa) and supply air if it is insufficient.
Properly install the cutting tool.

Set the turbine air supply pressure to 0 MPa by the regulation advance.

Apply air supply pressure to the turbine.

Raise the air supply pressure in the following order.
(Stand by for 3 minutes after rotation stop at each pressure, and stand by for 10 minutes at maximum rotation pressure)
0.1MPa→0.2MPa→0.3MPa→0.4MPa→Set pressure at maximum rotation
For the set pressure at the maximum rotation, refer to the inspection record table.

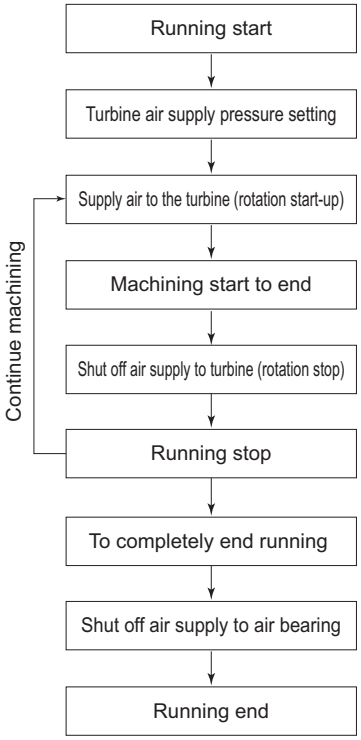
Shut off air supply to the turbine
(Allowed to stop suddenly. Stop time about 90 seconds.)

Start up immediately to the maximum rotation and stand by for 3 to 5 minutes. (Accelerating time about 20 seconds.)

Repeat start-up and stop a few times to check that rotation is normal performed.
Stop rotation.

Fig. 9 Running-in procedures

Operation of Start/Stop



Check the set pressure for the air bearing (0.6MPa) and supply air if it is insufficient.
Properly install the cutting tool.

Set the rotation speed necessary for running or machining in advance.
Set it not to exceed maximum rotation speed.

Apply air supply pressure to the turbine.
Stand by until for a set rotation reaches from rotation start-up.

Shut off air supply to the turbine (allowed to stop suddenly)

Stop rotation and replace the tool if necessary.
[Normally, keep supplying air to the air bearing after the operation has ended. Keep the right state of the air bearing.]

Reconfirm the rotating stop state.

Completely stop rotation.
Then shut off air supply to the air bearing.

Fig. 10 Running / Stop procedures

10 DETECTION OF ROTATION SPEED

The Xpeed1600 rotation speed can be controlled by adjusting the air pressure supplied to the turbine with reference to the separately attached inspection table. However, since rotation speed during running cannot be accurately measured, the spindle body housing allows a sensor to be installed at the rear of the spindle as shown in Fig.11 for detection. This product is not equipped with a sensor, however, this product can employ a method to apply reflected light to an identification indication mark (range of 180˚) set on the end of the rotating shaft on the rear of the spindle for speed detection. Therefore, in order to select the correct sensor to be used, select a sensor having a sufficient responsiveness to a rotation frequency of 2,667Hz (output of one pulse/rev) which is reached at 160,000 min^{-1}. This will enable reading of the rotation speed.

Installation

① Remove the cap fixed on the rear cover by loosening the Cap / Sensor securing screw (M3 set screw).
② When the cap is removed, locate the stepped hole of ø6.5 x 22.5L and ø4.5 x 12.5L passing through to the rear end of the rotation shaft. Install an insertable rotation detecting sensor to this section.
③ The rotation detecting sensor is should be inserted to a depth of approximately 35mm. If the end of the sensor comes in contact the rotating shaft, damage will occur. Therefore, avoid contact between the sensor and the rotational shaft.
④ Slightly tighten the Cap / Sensor fixing screw (M3 set screw) to affix. (For recommended tightening torque, refer to the operation manual from the manufacturer of the sensor being used.)
⑤ Rotate the spindle to check the rotation speed according to **.** Running / Stop procedures. Then replace and tighten the cap/sensor fixing screw (M3 set screw) without fall. If the rotation cannot be detected, perform readjustment of the sensor position. If the rotation speed can be correctly detected, installation is complete.
Remember, since trouble may result when the sensor contacts the rotation shaft, carefully adjust the sensor position.

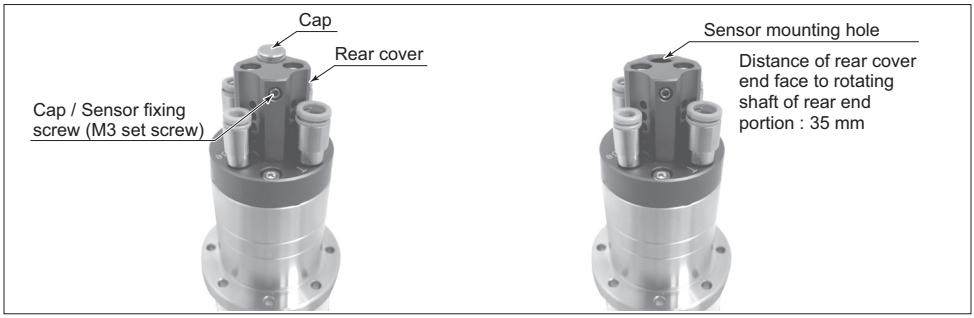


Fig.11　Sensor installing section details

⚠ Caution

① Make sure to install the rotation detecting sensor with the rotation of the turbine completely stopped.
② Keep in mind that if the rotation detection sensor end portion is made to contact with the rotating shaft, not only does this cause impairment of the sensor but also damage to the air bearing and rotating shaft, and the rotation sensor and spindle may not operate properly.
③ Make sure to tighten the M3 set screw on the side of the rear cover securing the rotation detecting sensor.
④ When not using the rotation sensor, without failure, reinstall the provided cap into the ø6.5 hole. Keep in mind that if the air bearing is used without the cap, contaminants, water, or oil may enter into the spindle, and this may cause seizing or galling.

11 CAUTIONS WHEN USING CUTTING TOOLS

Use a tool whose length and diameter can be accommodated into an area Refer to maximum protrusion dimension details (refer to Fig.12) for the cutting tool used for Xpeed1600. High speed operation in an area exceeding the allowable range will cause excessively large vibration and this will result in damage to the cutting tool, spindle and or operator, which is very dangerous. Since all items described above relate to safety, never fail to observe these items and use according to the correct method.

① Use the cutting tool within the specified maximum allowable speed. For example, in the case of a grindstone with a shaft for drilling inside, the general correct use peripheral speed is 600 to 1800 m/min, therefore, use within this range is recommended. Before use of the cutting tool, calculate the peripheral speed according to the following formula to confirm the proper range.
Calculation Formula method of correct use peripheral spindle speed

$$\text{Peripheral speed (m/min)} = \frac{3.14 \times \text{tool diameter (mm)} \times \text{rotation speed (min}^{-1})}{1000}$$

② The maximum protrusion length of the used tool is basically within the range of the “Maximum protrusion dimensions detailed diagram.” If the tool is used exceeding the range, reduce the rotation speed and the protrusion length whenever possible before use.
Maximum use rotation speed in a range exceeding the maximum protrusion range

ø4 x 17L N x 0.9 or less
ø4 x 25L N x 0.6 or less

N : Maximum use rotation speed in the range of “Maximum protrusion dimensions detailed diagram” (160,000 min^{-1})

③ If a grindstone is used, use it only after dressing whenever possible or after measuring the run-out accuracy to confirm that there is no problem with run-out.

④ Pay attention to the degree of reduction in the rotation speed depending on the load condition during machining, which is exerted on the tool being used. We recommend that the cutting tool be used in a reduction range of -5% with respect to the command rotation by use of the rotation speed detection function. In addition, if machining is performed without use of the rotation speed detection function, the actual rotation speed during machining will be unknown. However, the rotation sound will noticeably different if the machining load becomes larger. Therefore, perform machining so that the rotation sound does not drastically change.

⑤ The correct pressure of the air bearing during operation of the spindle is 0.6 MPa. The cutting tool can be used with a reduced bearing pressure, however, this may cause reduction in spindle rigidity and requires a reduction in the rotation speed of the tool being used.
Maximum use rotation speed in the case of bearing pressure set to 0.5MPa

Maximum protrusion dimensions detailed diagram range N x 0.9 or less
ø4 x 17L N x 0.85 or less
ø4 x 25L N x 0.55 or less

N: Maximum use rotation speed in the range of “Maximum protrusion dimensions detailed diagram” (160,000 min^{-1})

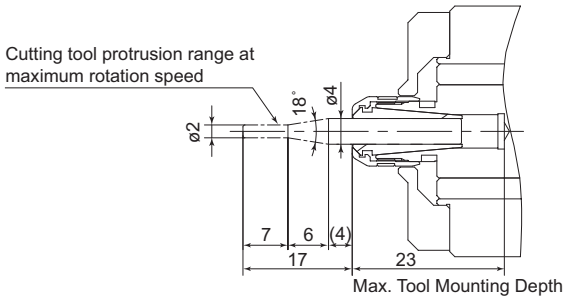


Fig. 12 Maximum protrusion dimension details

⚠ Warning

① Never use a cutting tool which is flawed, broken, cracked or bent.
② Use a drill, end mill and grindstone in the allowable speed range as determined and recommended by the tooling manufacturer.
③ It is necessary to lower the rotation speed in consideration of shape and material. Always observe precautions when carrying out operations.
④ Use cutting tools with sufficient balance characteristics. For the balance state during operation of the spindle, operation exceeding JIS G2.5 grade (2.5 mm/sec vibration speed) cannot be performed.
⑤ Do not use cutting tools with excessive run-out of the grind stone, or with flaws or cracks.
⑥ Operation exceeding 2000 m/min of a peripheral speed of the grind stone with shaft is very dangerous. Never perform such operation.

⚠ Caution

① When installing the cutting tool, wipe off contaminants and fit the cutting tool in the collet in a extremely clean condition.
② Use a cutting tool whose shank diameter is within a tolerance of ø4 $^{+0}_{-0.01}$. Keep in mind that use of the tool outside the recommended tolerance results in nonconformities including runout and a reduction in the gripping force.
③ If a machining load drastically increases and the rotation speed decreases, the rotation will suddenly stop due to the load exceeding the drive torque of the turbine, and this may cause damage or break the cutting tool and impair the spindle. Since this is very dangerous, pay attention to the state of the machining load.

12 CAUTIONS WHEN HANDLING AND STORING

Handling method

Handling as shown below. Failure due to handle properly can couse poor rotation, heat generation, deformation of sheath or deterioration of accuracy. Pay attention to following when handing.

① Do not drop or hit the spindle.
② Do not tap the spindle with a hammer, causing excessive shock.
③ Do not loose and tighten bolts on any part of the spindle.
④ Do not disassemble, overhaul modify or attempt to repair the spindle as it will damage the internal components. There are no user serviceable parts available, so do not attempt to repair it. (refer to 13) **MAINTENANCE AND INSPECTION** (3) and (4).

Original Packaging / Shipping Material Form Delivery

As a packaging method, the Xpeed1600 body is wrapped with a vapor phase corrosion inhibitor wrapping film and packaged in a quilting structured corrugated box. Therefore, this packaging method minimizes influence of outside atmosphere and external shock, this for allows optimum secure packing. Various standard attachments are stored in the packaging box as well. Keep all original packing materials for future storage purposes.

For long-term storage

① Clean so as to prevent contaminants or foreign matter from entering into the piping, air lines and spindle bearing gap. Do not allow rust inhibitor from entering any portion of the spindle or operating accessories. Rust inhibitors will damage internal surfaces causing poor performance.

② Insert the standard attachment plugs (4 locations) into the joints of the piping connecting locations. These plugs prevent contaminants or foreign matter from intruding through the connectors.

③ When fitting the stepped test bur to store, attach the protective cap to eliminate the chance of damaging the test shaft.

④ Wrap the spindle with a vapor phase corrosion inhibitor wrapping film in which the spindle was packaged from the factory. Wrap the spindle quilting material and store in the factory corrugated box.

⑤ Store the packaged spindle in a secure place so as not to allow vibration, high temperature and high humidity. In particular, pay attention so as to prevent condensation due to a temperature difference and select a dehumidified location for storage.

13 MAINTENANCE AND INSPECTION

(1) **Routine Pre-operation Checks**

Please check the following daily as pre-operation checks:

- Cleanliness of supplied air
- Air supply pressure to the air bearing and brake
- Breakage of the cutting tool, collet, collet nut, piping fitting and air hose
- Excessive vibration, abnormal sound or heat generation during test or operation

(2) **Cleaning**

The spindle uses an air bearing which functions by supplying compressed air into a narrow gap between the rotating shaft and bearing section, floating them without contact between each other. For this reason, cleaning is performed with air supplied to the air bearing shut-off. However, if compressed air or coolant is blown onto the spindle, contaminants, oil or water will invade into the bearing gap, causing interference. Therefore, do not use compressed air for general cleaning. When cleaning is required, keep supplying air to the air bearing, and completely wipe away debris with a soft cloth. At this time, be careful so as not to supply air to the turbine. Never clean with the cutting tool rotating.

(3) **Disassemble, repair**

Never disassemble or try to repair this spindle for any reason. All warranties will be voided.

(4) **Overhaul**

The spindle uses an air bearing that rotates without contact between the spindle shaft and bearing section. The Xpeed1600's precision and performance can be maintained for long period of time by the using proper methods of cleanliness.

If any abnormalities occur, please contact Nakanishi immediately.

(5) **Spare**

When using this spindle for mass production, please purchase a spare spindle to eliminate the risk of downtime.

(6) **Troubleshooting**

If a problem occurs, please use the following table to diagnose the symptom to the corrective action before sending to Nakanishi for repair.

Trouble	Cause	Inspect/Corrective Action
Tool Slippage	Contaminants inside the collet or the spindle	Clean the collet and spindle taper. Replace the collet nut or collet if there are any flaws on them.
	Collet is not properly positioned.	Re-install the collet correctly.
	Air pressure for Air Bearing is too low.	Set air pressure for Air Bearing correctly.
	Deformation due to excessive tightening of the collet nut	Replace the collet nut and collet then tighten with proper torque. Send to NAKANISHI for repair, if the spindle has incurred any damage.
	Bent tool.	Replace the cutting tool immediately.
Noise or vibration during rotation	Air pressure for the air bearing is not set correctly.	Reset air pressure correctly.
	The run-out of the tool is excessively large	Reset the cutting tool in the collet to eliminate the run-out, or replace the cutting tool.
	Protrusion amount of the cutting tool is too long.	Shorten the protrusion amount of the cutting tool into the allowable range.
Poor rotation speed or Rotation speed cannot be increased	Pressure in the air supply source is too low.	Set the air supply source to the proper operating pressure.
	Diameter of a hose used for air supply piping is too small.	Replace the air input hose to one with the correct diameter.
	Contaminants, oil or water is mixed into the air supply piping (such as a bearing, turbine, brake piping)	Send to NAKANISHI for Repair.
	When the spindle shaft is rotated by hand, there is some abnormal feeling or sticking.	Send to NAKANISHI for Repair.
	Excess load or contact with the bearing resulted in a reduction in the rotation speed or stopping of the spindle shaft.	Reduce the excessive load. If the spindle shaft is sticking or seizing, send to NAKANISHI for Repair.
	There is continuity with air supplied.	Send to NAKANISHI for Repair. (Because the spindle shaft is damaged.)

14 DISPOSAL OF THE AIR BEARING TURBINE SPINDLE

When disposal of an Air Bearing Turbine Spindle is necessary, follow the instructions from your local government agency for proper disposal of industrial components.

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