

Gearbox Installation, Trouble shooting, Operation and Maintenance Manual



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1.0 Introduction

The gearbox installation, operation, and maintenance manual is the property of the ultimate owner of the gearbox, and therefore must be retained with the gearbox during continued transportation.

Whether the rated input torque, output torque, thrust, mechanical strength, and related accessories of the gearbox are suitable for the valve and actuator to be matched must be fully understood and responsible by the installation personnel.

This manual contains important safety information. Please ensure that you read and understand the equipment thoroughly before installing, operating, or maintaining it.

This manual aims to enable professionals to install, operate, and maintain gearboxes. Only qualified personnel with training or relevant experience can install, operate, and maintain the provided gearbox.

When installing, operating, and maintaining the gearbox, it is necessary to ensure that the gearbox is effectively supported or fixed in advance when unbalanced loads may occur.

Regarding handwheel operation, under no circumstances should any additional lever devices, such as extended sleeves or extended wrenches, be used on the handwheel to generate greater force when closing or opening the valve. This may cause damage to the valve or gearbox, or it may make the valve stuck in its current position and unable to operate again.

2.0 Health and Safety

All work carried out must follow the instructions in this manual and any other relevant manuals.

Users and personnel working on this device should be familiar with their responsibilities under any legal provisions related to the health and safety of their workplace, and appropriate consideration should be given to the additional hazardous situations when using other devices in combination.

Mechanical installation should be carried out in accordance with the overview of this manual and relevant standards such as national standard operation specifications.

3.0 Storage

If the gearbox cannot be installed in a timely manner, please immediately store it in a clean and dry place until you are ready to install it on the valve. Suggested storage temperature range: 0 °C to 40 °C.

4.0 Unpacking

Depending on the size, type, and quantity of the goods, the packaging of the gearbox comes in various configurations.

Before disassembling and handling the gearbox, a risk assessment should be conducted to ensure safe operation. Risk assessment is the responsibility of those engaged in this work. Please refer to Section 5.0 for handling.

The packaging materials used may include wood, cardboard, packing belt, pearl foam, etc. Packaging should be recycled in accordance with local regulations.

5.0 Loading and Unloading

Only trained and experienced personnel should carry out loading and unloading. At all times, it is necessary to ensure safe loading and unloading. Each packaging specification must be evaluated to determine all risks related to loading and unloading. The gearbox may generate unbalanced loads.

Before connecting the gearbox to the valve, it must be fully supported until it fully fits with the valve stem. Once connected to the valve, each component must be individually evaluated to ensure safe lifting or disassembly. Never lift the complete valve and gearbox components through the gearbox. If lifting equipment is required to lift the gearbox, it is recommended to use certified soft slings.

During loading and unloading, it is important to avoid damage to the gearbox caused by collisions. If there is slight damage to the coating, it should be repaired promptly and correctly, otherwise it may affect the warranty.

If the weight of the gearbox equals or exceeds the weight of the actuator, it is not allowed to lift the entire gearbox and actuator separately from the actuator. When the weight of the gearbox is less than the weight of the actuator, it is allowed to lift the entire gearbox and actuator from the actuator, but to maintain balance, it must be evaluated to ensure safe lifting.

6.0 Gearbox Installation and Debugging - ASNG Part Turn Series

6.1 Introduction

For the partial rotation gearbox ASNG part turn series, the gearbox limit bolts are already set to a nominal 90 ° open and close position at the factory. After the installation of the gearbox and valve, the gearbox limit bolts must be readjusted according to the actual stroke of the valve. If the gearbox is provided as an accessory to the actuator manufacturer, the actuator manufacturer must recalibrate the switch position of the actuator after installing the gearbox and actuator.

6.2 Disassembly, Processing and Reassembly of the Drive Sleeve

6.2.1 Disassembly of the Drive Sleeve

The output shaft holes of gearbox models SG80+ASNG50000/D are directly machined at the factory according to the order requirements and cannot be disassembled for further processing. Other models of gearboxes have a detachable drive sleeve that can be directly processed at the factory according to order requirements, or solid drive sleeves can be provided for customers to process on their own.

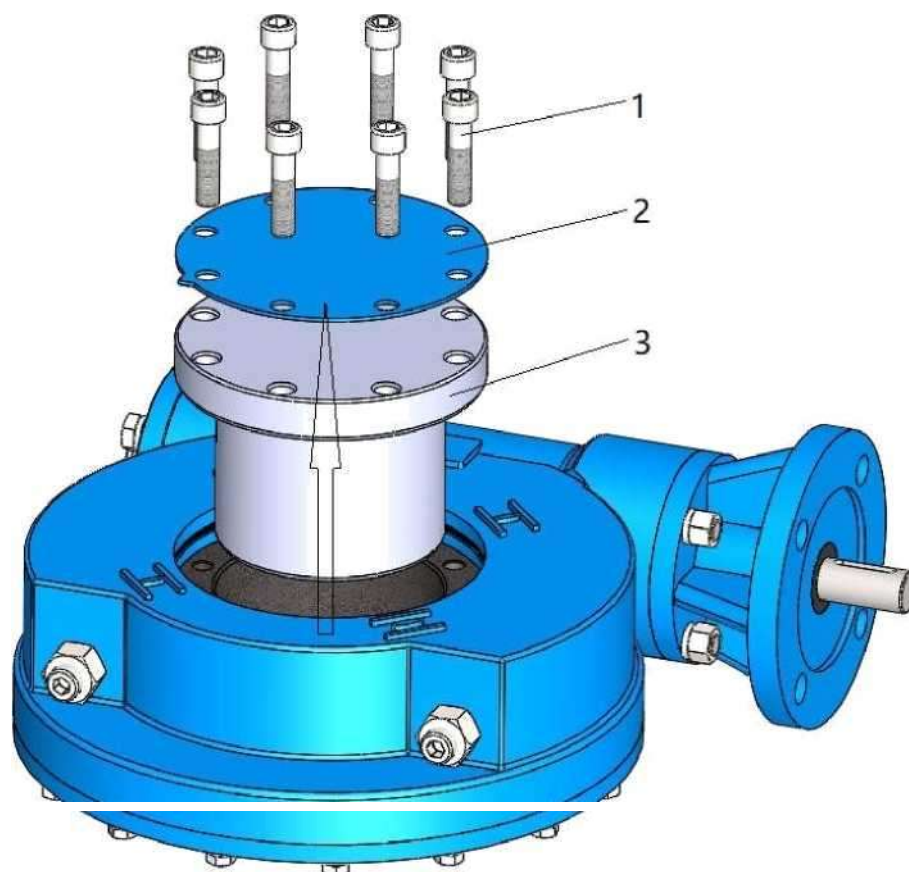


Figure 1 ASNG50/D~SG80/7+ASNG25000/D
Removal and Installation Drive Sleeve

1. Preparation before disassembling the drive sleeve: Manually operate to place the gearbox in the **fully closed** (fully open) **indicated position**, in order to ensure that the drive sleeve can be machined in a consistent position with the fully closed (fully open) position of the valve, ensuring smooth installation and error free operation.
2. Disassembly steps (as shown in Figure 1):
 - a. Loosen the fastening bolts (1) and remove all fastening bolts.
 - b. Remove the indicator cover (2).
 - c. Take out the drive sleeve (3) in the direction indicated by the arrow. It should be noted that when removing the drive sleeve (3) from the gearbox, it may be necessary to apply external force to the surface marked "B" on the drive sleeve (see Figure 5), but try to avoid direct tapping with steel products. Wood or plastic can be used as cushion blocks, or copper products can be used to directly strike.

6.2.2 Processing of the Drive Sleeve

Process the inner hole and keyway dimensions of the drive sleeve according to the size of the valve stem, and pay attention to the angle between the keyway and the bolt hole during processing (see Figure 2, Figure 3, and Figure 4).

When machining the drive sleeve, it should be noted that the surface marked with "A" is the sealing surface, and the surface marked with "D" is the guiding surface (see Figure 5). When clamping the "A" surface, try to use soft clamping claws and be careful not to damage the clamping surface. At the same time, it should be ensured that the machining inner hole is concentric with the outer circle to avoid damage to the gearbox or valve stem caused by non concentric machining.

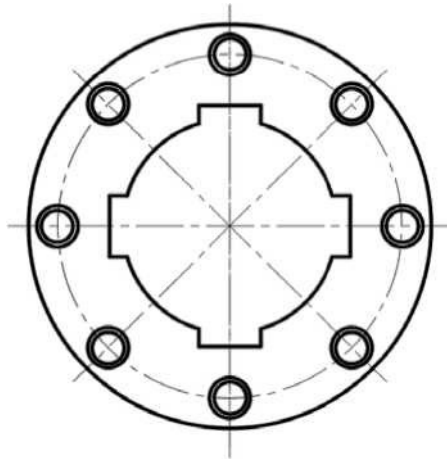


Figure 2 ASNG50/D~SG80/3+ASNG3500/D
Example of Drive Sleeve Keyway Position

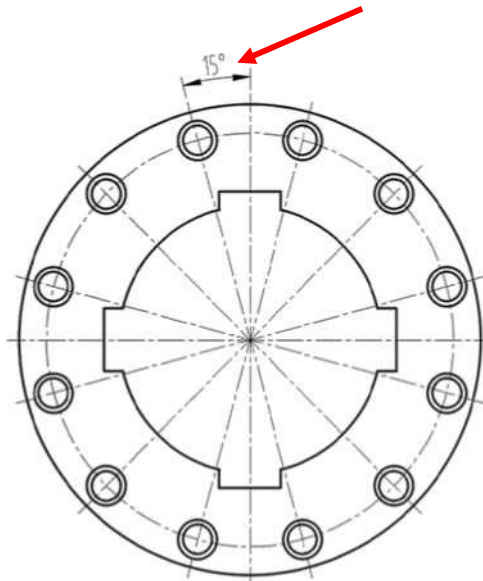


Figure 3 SG80/2+ASNG6500/D~SG80/7+ASNG13500/D
Example of Drive Sleeve Keyway Position

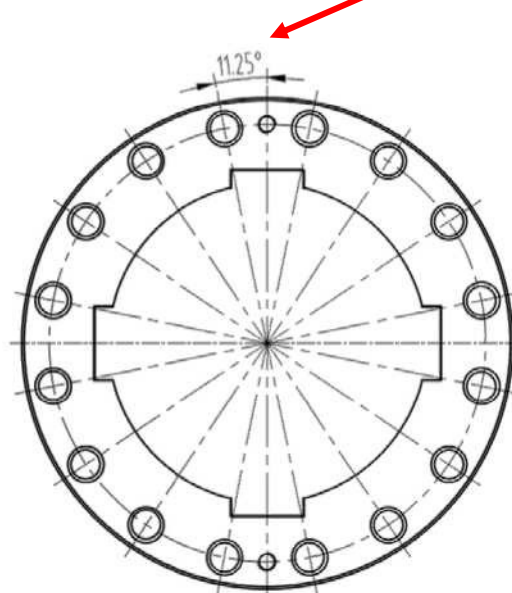


Figure 4 SG80/6+ASNG25000/D~SG80/7+ASNG25000/D
Example of Drive Sleeve Keyway Position

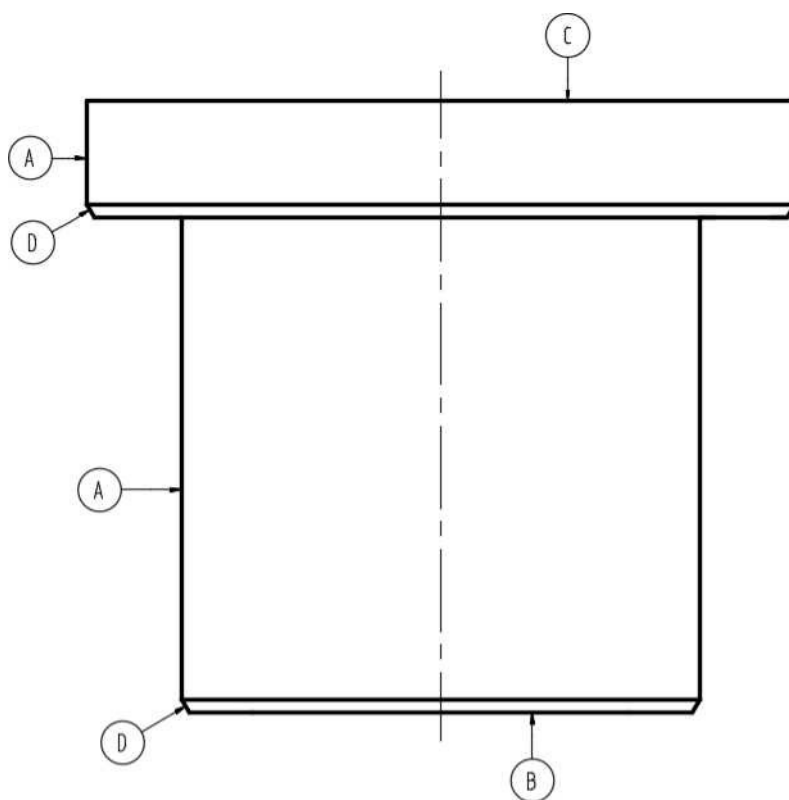


Figure 5 Drive Sleeve

6.2.3 Reassembly of the Drive Sleeve

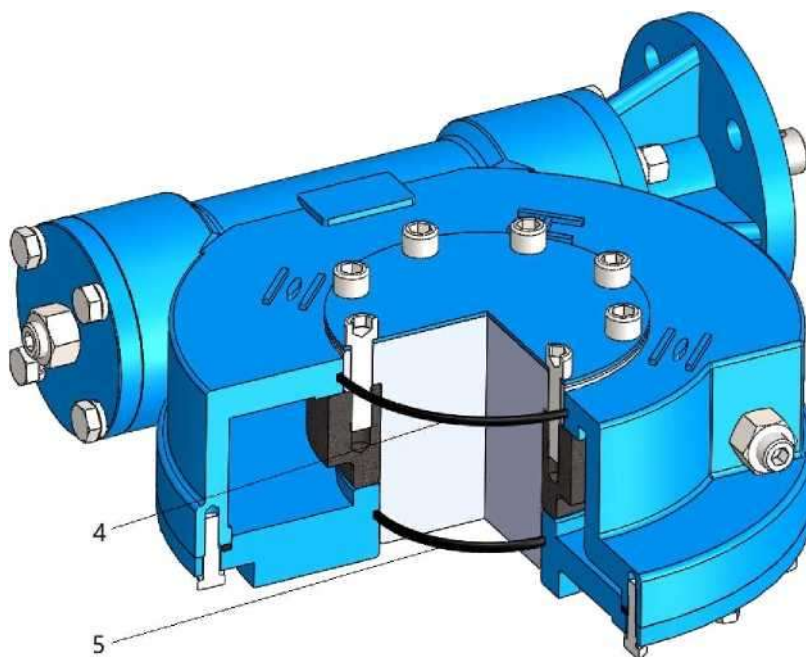


Figure 6 O-ring

Before reinstalling the drive sleeve, it is necessary to check whether the following components are damaged or kept clean.

1. O-rings "4" and "5" should be checked for damage, lubrication, and correct seating. If the O-ring is damaged, it should be replaced in a timely manner before installing the drive sleeve (see Figure 6).
2. The surface marked "A" in Figure 5 should be checked for damage. Damaged surfaces can damage the gearbox seals and cause water or grease leakage.
3. Apply a thin layer of lubricating grease on the surface marked "A" to make installation easier.
4. Clean the drive sleeve, the underside of the indicator cover, and the surface of the fastening screws.

If the above components are inspected and found to be correct, they can be installed in sequence as shown in Figure 1 (3), (2), and (1).

When assembling the drive sleeve (3), it should be noted that the **keyway position and indication position in the fully closed** (fully open) state of the valve should be consistent with the keyway position and indication position in the fully closed (fully open) state of the gearbox before installing the connecting bolts.

When assembling the indicator cover (2), it is recommended to apply silicone seal on the surface marked "C" (see Figure 5)

Glue to seal the indicator cover with the drive sleeve. At the same time, it should be ensured that the indicated arrow position is consistent with the actual gearbox fully closed (fully open) state.

6.3 Installation of Actuator

This section applies to gearbox inputs as actuators, manual inputs are not applicable.

1. Before installation, ensure that the gearbox/actuator is fully supported and able to withstand the weight increase and center of gravity changes caused by the addition of the actuator/gearbox.
2. Ensure that the position of the gearbox input shaft key is consistent with the position of the actuator output keyway. If there is inconsistency, it can be maintained by rotating the gearbox input shaft or manually operating the end of the actuator.
3. Place the actuator on the gearbox input shaft and rotate the manual operating end of the actuator to align the connecting hole between the actuator and the gearbox input flange. (If the flange holes are aligned together in step 2, this step can be omitted)
4. Disconnect the actuator from the input end of the gearbox, ensuring that the position adjusted in step 3 remains unchanged. Apply a bead of silicone sealant around the mounting surface of the gearbox input flange and each bolt hole. As shown in example "A" in Figure 7, ensure that the adhesive is evenly applied and not disconnected.

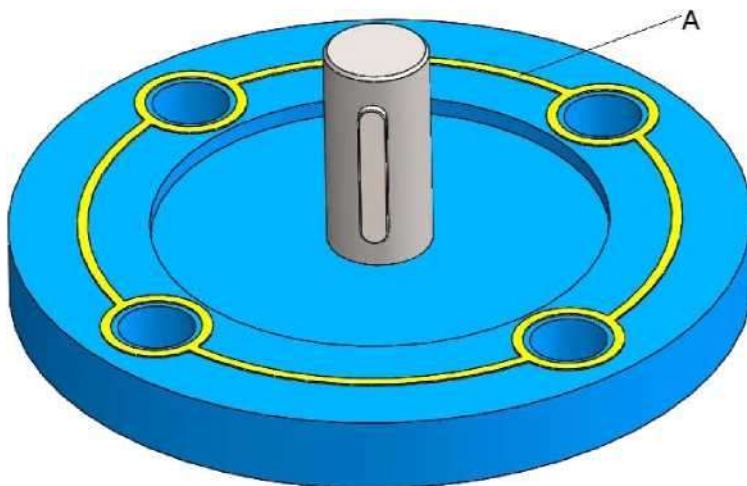


Figure 7 Schematic Diagram of Flange Gluing

5. Reinstall the actuator onto the gearbox input shaft, ensuring that the keyway position matches the flange hole position.
6. Choose appropriate fastening screws or studs/nuts with a performance level of 8.8 or higher. Fix the actuator on the gearbox. Please refer to Table 2 of Chapter 11.0 for the recommended tightening torque for installing bolts.

6.4 Installation of Valves

1. Before installing the gearbox (actuator+gearbox), ensure that the valve is fully supported and able to withstand the weight increase and center of gravity change caused by the addition of the gearbox (actuator+gearbox).
2. If the gearbox is equipped with a handwheel, it is recommended to install it on the gearbox before installing it on the valve. Because when connecting to the valve stem, it is necessary to rotate the gearbox to align the direction of the valve stem key with the groove in the gearbox.
3. Ensure that the position of the shaft key in the fully closed (fully open) state of the valve is consistent with the keyway position in the fully closed (fully open) state of the gearbox (actuator+gearbox). If there is inconsistency, it can be maintained by rotating the input shaft, handwheel, or manually operating the end of the actuator.
4. Place the gearbox (actuator+gearbox) on the valve input shaft, rotate the input shaft, handwheel, or manual operating end of the actuator to align the gearbox (actuator+gearbox) with the valve input flange connection hole. (If the flange holes are aligned together in step 3, this step can be omitted)
5. Disconnect the gearbox (actuator+gearbox) from the valve input end, ensuring that the position adjusted in step 4 remains unchanged. Apply a bead of silicone sealant around the installation surface of the valve flange and each bolt hole. As shown in example "A" in Figure 7, ensure that the adhesive is evenly applied and not disconnected.
6. Reinstall the gearbox (actuator+gearbox) onto the valve input shaft, ensuring that the keyway position matches the flange hole position.

7. Choose appropriate fastening screws or studs/nuts with a minimum performance level of 8.8. Fix the gearbox (actuator+gearbox) on the valve flange, and refer to Table 2 of Chapter 11.0 for the recommended tightening torque of the installation bolts.

6.5 Debugging of Gearbox - Adjustment of limit Bolts

This procedure should be performed by the valve manufacturer/supplier and should be performed when the valve opening and closing operations can be clearly checked. Once installed in the pipeline, adjustments cannot be made without authorization from the valve manufacturer/supplier.

Although the gearbox limit bolts have been adjusted at the factory, after being connected to the valve, fine adjustments need to be made based on the actual opening and closing position of the valve to achieve optimal valve performance.

The limit and torque switch settings of the actuator should be set according to the recommendations of the actuator manufacturer. Then, limit bolts for opening and closing the gearbox should be set (see Figure 8).

Full closed indication is at valve closed

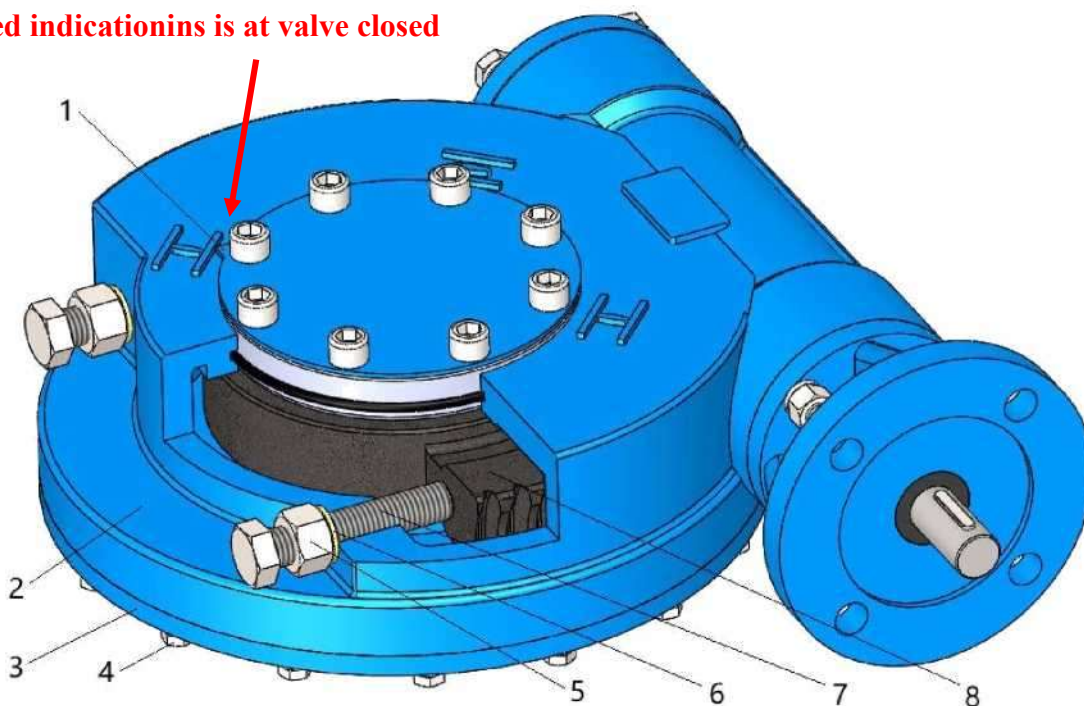


Figure 8 Schematic Diagram of Limit Bolt

Adjustment steps for limit bolts:

1. Loosen the locking nut (5) in the switch direction, then unscrew the combined sealing gasket (6), and then loosen the limit bolt (7) counterclockwise (backward) by 4-5 turns.
2. Use an appropriate actuator or handwheel to fully close the valve. As shown in Figure 8, use the pointer of the indicator disk (1) as a position indicator.
3. Screw in the limit bolt (7) until it contacts the gearbox worm gear (8). Rotate the limit bolt (7) counterclockwise (backward) one turn, then first screw in the combined sealing gasket (6), and then tighten the lock nut (5) to secure the limit bolt.

4. Loosen the lock nut (5) in the open direction, then unscrew the combined sealing gasket (6) , and then rotate the limit bolt (7) counterclockwise (backward) to loosen it by 4-5 turns.
5. Use an actuator or handwheel to fully open the valve. As shown in Figure 8, use the pointer of the indicator disk (1) as a position indicator.
6. Screw in the limit bolt (7) until it contacts the gearbox worm gear (8). Rotate the limit bolt (7) counterclockwise (backward) one turn, then first screw in the combined sealing gasket (6), and then tighten the lock nut (5) to secure the limit bolt.
7. Operate the gearbox and run it once or twice in both the open and close directions to check if the limit is correct. If there is a valve leakage or a large indication error, the limit bolt may have been adjusted incorrectly, and the above steps need to be repeated.

Matters needing attention:

1. When screwing in or out the combination sealing gasket (6), try to rotate it one circle at a time like a nut, and do not directly pull out or push it in, as this will damage the sealing surface between the combination sealing gasket and the thread.
2. After adjusting the switch position, the locking nut (5) must be fully tightened with a wrench to prevent loosening under force.
3. Movement between the base plate (3) and the gear box (2) may occur when operating near the rated torque or over torque. It is recommended to perform regular maintenance to verify the correct torque of the bottom plate screws (4).

6.6 Gearbox Output Flange Thread Depth

The depth of the thread connecting the gearbox and valve flange is 1.5 times the standard outer diameter of the thread. For example, the thread specification is M10, and the thread depth is $10 \times 1.5 = 15\text{mm}$.

7.0 Gearbox Installation and Commissioning - PG/PGZ Multi-turn Series

7.1 Introduction

For the multi turn gearbox PG/PGZ multi-turn series, after the gearbox and valve are installed, only the switch position of the actuator needs to be calibrated based on the actual stroke of the valve.

The drive sleeve and valve of a multi rotation gearbox are mostly threaded connections, and when threaded connections are used, the material of the drive sleeve is usually copper alloy. Therefore, people tend to refer to the threaded drive sleeve as a copper nut. But the drive sleeve connected by shaft keys is still commonly referred to as the drive sleeve. The drive sleeve mentioned below in this section is also applicable to copper nuts.

7.2 Disassembly, Processing and Reassembly of the Drive sleeve

7.2.1 Disassembly of the Drive Sleeve (Copper Nut)

All gearboxes have a detachable drive sleeve. Unless specifically requested during the ordering phase, the connection size with the valve will be machined at the factory according to the order requirements. Otherwise, the drive sleeve will be provided with a solid body, and customers must process it themselves to fit the valve stem size.

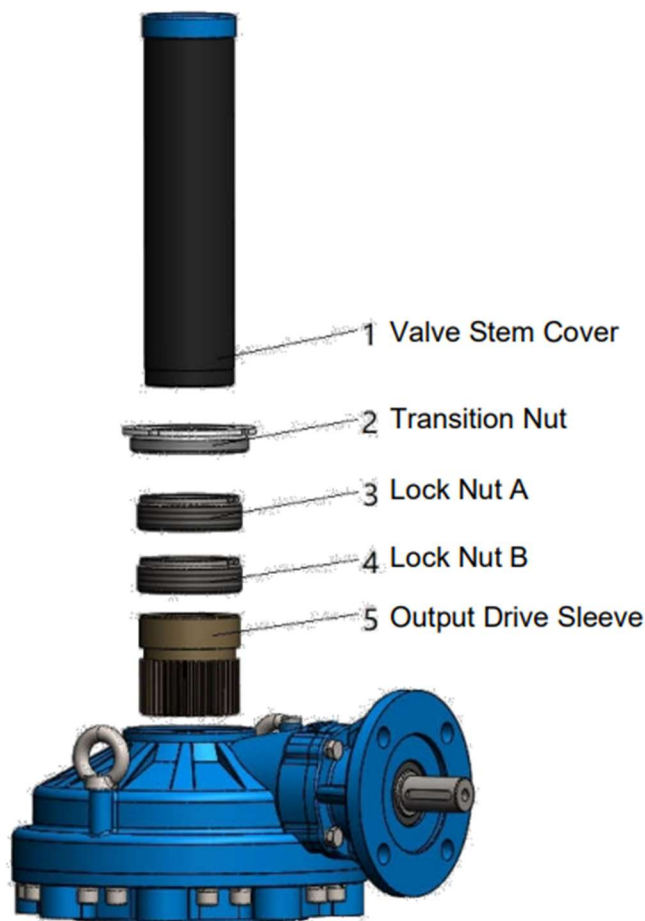


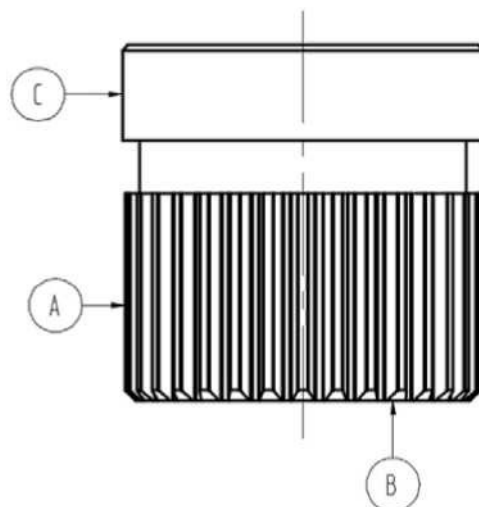
Figure 9 PG/PGZ Drive Sleeve Removal and Installation

The disassembly sequence of the drive sleeve is shown in Figure 9. Except for the PG80 gearboxes that do not have (2), the disassembly sequence of the drive sleeve for all other gearboxes is the same.

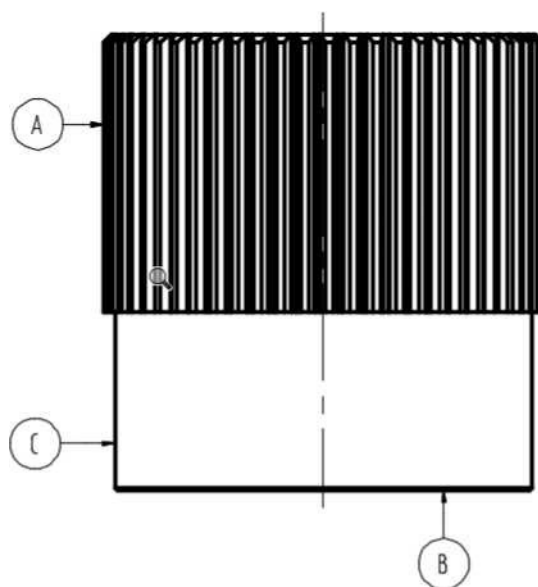
Generally, when leaving the factory, the valve stem cover (1) is shipped separately. When disassembling the drive sleeve (5), rotate out (2), (3), and (4) from top to bottom, and finally take out the output drive sleeve (5).

It should be noted that when removing the drive sleeve (5) from the gearbox, it may be necessary to apply external force to the surface marked "B" on the drive sleeve (see Figure 10), but try to avoid direct tapping with steel products. Wood or plastic can be used as a cushion block, or copper products can be used for direct tapping.

7.2.2 Processing of the Drive Sleeve (Copper Nut)



PG80、PGZ/3、PGZ/4



PGZ/6、PGZ/8、PGZ/12、PGZ/14

Figure 10 Drive Sleeve (Drive Nut)

Refer to the above figure. When there are no special instructions for the drive sleeve, it is solid (or reserved for casting small holes) at the factory, and the customer needs to process it according to the actual size of the valve stem.

When machining the drive sleeve, it should be noted that the surface marked with "A" (see Figure 10) is a spline and is strictly prohibited from being used as the clamping surface for machining the inner hole. During machining, it is best to use soft claws to clamp the "C" surface, and be careful not to damage the clamping surface. At the same time, it should be ensured that the machining inner hole is concentric with the outer circle to avoid damage to the gearbox or valve stem caused by non concentric machining.

Process the inner hole thread or shaft key size of the drive sleeve according to the size of the valve stem to ensure necessary fit clearance.

7.2.3 Reassembly of the Drive Sleeve (Copper Nut)

Before reinstalling the drive sleeve, it is necessary to check whether the following components are damaged or kept clean.

1. The threads in Figure 9 (1), (2), (3), and (4) should be checked for damage, as damaged threads may prevent smooth installation.
2. The surface of the spline marked "A" in Figure 10 should be checked for damage, as damaged splines may not be able to be reinstalled.
3. Clean the threaded surface of (1), (2), (3), (4), and the outer surface of (5).

If none of the above components are found to be faulty during inspection, they can be installed in sequence as shown in Figure 9 (5), (4), (3), and (2)). Note that there are machined grooves on the upper ends of (4) and (3) for applying torque, (4) for locking (5), and (3) for preventing (4) from loosening. Therefore, when installing (4) and (3), attention should be paid to fully tighten them in sequence, so as to withstand the thrust of the upward and downward movement of the valve stem. Finally, screw in (2) and tighten it with the flat surface of the box.

Special reminder:

1. Before screwing in (4) and (3), apply silicone sealant to the internal thread area of the box that matches it, and then screw in (4) and (3) one by one and lock them tightly. This can completely eliminate the nut loosening problem caused by vibration or impact on the valve.
2. When installing the lock nut, it is necessary to lock it tightly to avoid jamming caused by not locking it. The correct operation (see Figure 11) and incorrect operation (see Figures 12,13) are listed below.

Correct operation:

The locking nut b next to the drive sleeve must be locked tightly before installing another locking nut a. The locking nut a plays a role in preventing loosening and should also be tightened. This ensures that the drive sleeve will not loosen when subjected to upward thrust.

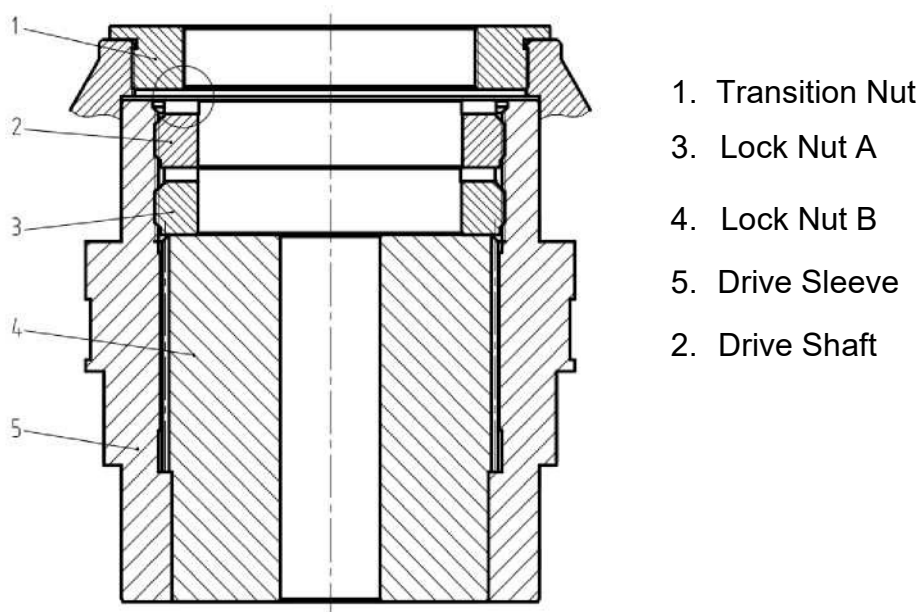


Figure 11 Correct Operation of Locking Nuts

Incorrect operation:

Both locking nuts were not tightened, causing the locking nut to move up. The gap between the locking nut a and the transition nut is occupied. When the transition nut is tightened, it is actually interlocking with the locking nut a. However, the transition nut is stationary, while the lock nut, drive sleeve, and drive shaft are rotating as a whole. By mistakenly biting the stationary transition nut and rotating lock nut together, the input end cannot drive the output end normally, and in severe cases, it can cause unpredictable damage to the gearbox.

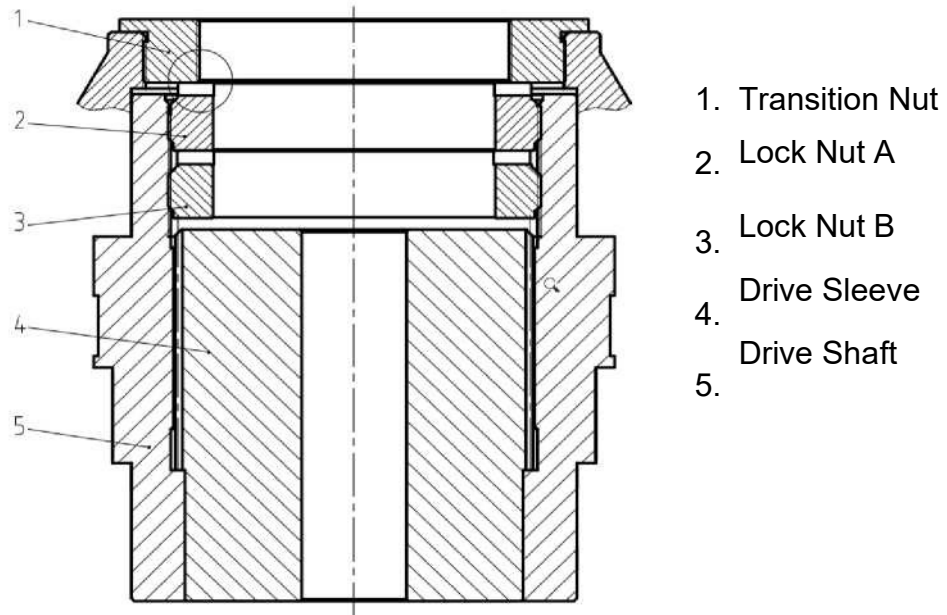


Figure 12 Incorrect Operation of Locking Nuts

Incorrect operation:

Lock nut b is tightened, but lock nut a is not tightened, which can also cause lock nut a to move up. The gap between the locking nut a and the transition nut is occupied. Resulting in the same result as Figure 12.

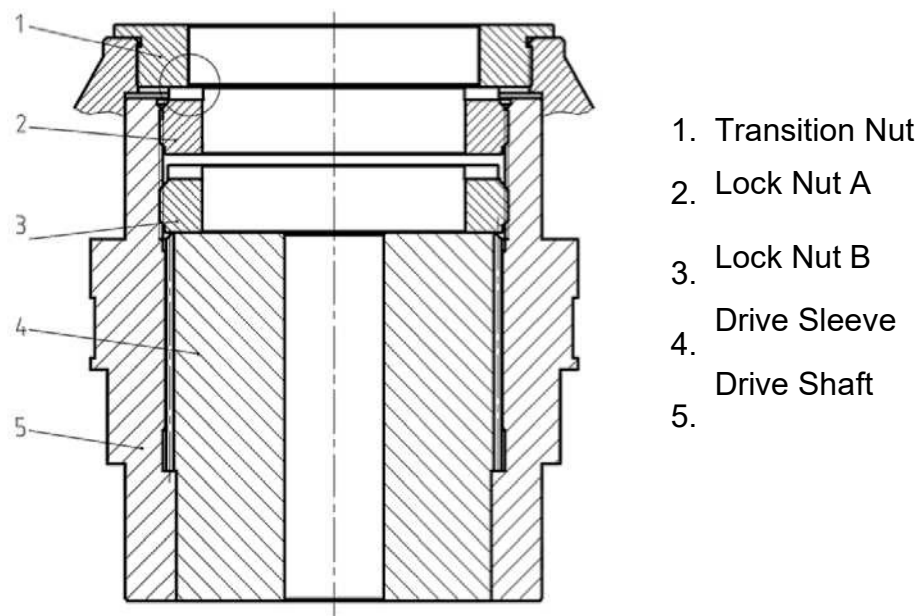


Figure 13 Incorrect Operation of Locking Nuts

7.3 Installation of Valve Stem Cover

For valve stems that will protrude from the gearbox, a valve stem cover can be installed to protect the valve stem. Thread the valve stem cover into the gearbox or transition nut and seal with a suitable sealant to prevent water ingress.

Be careful not to add the lubricating grease that should have been added to the valve stem to the valve stem cover for convenience, as this will increase the pressure inside the valve stem cover.

The valve stem cover is an extension of the gearbox, and damage to the valve stem cover can cause damage to the gearbox. The valve stem cover must be protected or supported to avoid side loads caused by environmental changes or improper application.

7.4 Installation of Actuator

This section is consistent with section 6.2.4, please refer to section 6.2.4.

7.5 Installation of Valves

1. Before installing the gearbox (actuator+gearbox), ensure that the valve is fully supported and able to withstand the weight increase and center of gravity change caused by the addition of the gearbox (actuator+gearbox).
2. If the gearbox is equipped with a handwheel, it is recommended to install it on the gearbox before installing it on the valve. Because when connecting to the valve stem, it is necessary to rotate the gearbox to ensure that the valve stem threads are correctly aligned with the gearbox drive sleeve threads, or that the valve stem key aligns with the direction of the hole groove in the gearbox.
3. For valves with threaded valve stems, the gearbox (actuator+gearbox) and valve stem should be thoroughly lubricated with appropriate grease before installation. Skip this step for shaft key connections or jaw connections.
4. Apply a bead of silicone sealant around the installation surface of the valve flange and each bolt hole. As shown in example "A" in Figure 7, ensure that the adhesive is evenly applied and not disconnected.
5. Lift the gearbox (actuator+gearbox) onto the valve input shaft, ensuring that the bottom surface of the gearbox (actuator+gearbox) is parallel to the valve flange.

When the valve stem is threaded, rotate the input shaft, handwheel, or manual operating end of the actuator to ensure that the internal thread of the gearbox (actuator+gearbox) is in contact with the external thread of the valve stem. Once the rotation is successful, continue to rotate the handwheel to continuously lower the gearbox (actuator+gearbox) until the gearbox (actuator+gearbox) and valve flange are about to come into contact.

When the valve stem is a shaft key, rotate the input shaft, handwheel, or manual operating end of the actuator to ensure that the inner hole and keyway of the gearbox (actuator+gearbox) are aligned with the valve stem shaft and keyway. Slowly lower the gearbox (actuator+gearbox) until the gearbox (actuator+gearbox) and valve flange are about to come into contact.

6. When the gearbox (actuator+gearbox) and valve flange are about to come into contact, rotate the gearbox (actuator+gearbox) angle to the desired position and align the gearbox (actuator+gearbox) with the valve flange connection hole. Slowly rotate the

input shaft, handwheel, or manual operating end of the actuator to make complete contact between the gearbox (actuator+gearbox) and the valve flange.

7. Choose appropriate fastening screws or studs/nuts with a minimum performance level of 8.8. Fix the gearbox (actuator+gearbox) on the valve flange, and refer to Table 2 of Chapter 11.0 for the recommended tightening torque of the installation bolts.

7.6 Gearbox Output Flange Thread Depth

The depth of the thread connecting the gearbox and valve flange is 1.5 times the standard outer diameter of the thread. For example, the thread specification is M10, and the thread depth is $10 \times 1.5 = 15\text{mm}$.

8.0 Maintenance of Gearbox

Under normal operating conditions, maintenance of the gearbox does not require the addition of lubricating grease. However, the PG/PGZ multi-turn series gearboxes are still designed with oil filling holes for users to add lubricating grease. When leaving the factory, the gearbox is filled with appropriate lubricating grease (depending on the usage situation, the amount of grease filling varies, and the normal filling amount is 1/3 of the gearbox cavity).

If the valve is discontinued for major repairs, users can replenish lubricating grease through the reserved oil filling hole. You can also remove the gearbox bottom cover or upper cover (ASNG series) and replace it with the grease from Table 1. For gearboxes that require dismantling and adding lubricating grease, when reassembling the bottom or upper cover, all sealing positions designed with "O" rings should be checked for integrity before reinstalling, and new "O" rings should be replaced if necessary. All surfaces sealed with sealant must be removed from the original sealant residue and reapplied with new silicone sealant.

Gearbox	Manufacturer	Name	Temperature Range
ASNG/PG/PGZ	Fuchs	Renolit CL-X2	-60°C to +120°C
ASNG/PG/PGZ	Fuchs	Renolit CL-X2	-40°C to +120°C
ASNG/PG/PGZ	GB7324	General lithium based grease 3#	-20°C to +120°C

Table 1 Recommended Lubricating Greases for Gearboxes

9.0 Operation of Gearbox

9.1 Manual Operation

Manual operation, usually using a handwheel to apply torque. Facing the handwheel, unless otherwise specified, it should be clockwise closed and counterclockwise open. Unless otherwise specified, the handwheel rim force shall not exceed 360N according to API 6D requirements, and the maximum handwheel diameter shall generally not exceed the length of the valve structure.

Under no circumstances should any additional lever devices, such as extended sleeves or extended wrenches, be used on the handwheel to generate greater force when closing or opening the valve. This may cause damage to the valve or gearbox, or it may make the valve stuck in its current position and unable to operate again.

For gearboxes with manual inputs of DS (dual speed input) and DSS (dual speed input lockable), there are two speed ratios to choose from, 1:1 (fast) and 4.28:1 (slow). Simply push in (slow) or pull out (fast) the input gear shaft to switch between two speed ratios. 4.28:1 (slow speed) is used for valve start or end states, where the valve torque is relatively high. 1:1 (fast) is used in the middle operation state of the valve, where the valve torque

will significantly decrease. Fast ratio can reduce the required number of input turns, but the output torque is reduced. The slow ratio increases the number of input revolutions, but the output torque increases. It should be noted that during the process of pushing in (slow) or pulling out (fast) the input gear shaft, as it needs to mesh with the gear, it needs to be gently rotated left and right when pushing in or pulling out, so that the input gear shaft can smoothly mesh with the internal gear and cannot be pulled hard or forcefully. Moreover, it is not allowed to forcefully drive in or pull out the input gear shaft without the gear pair being engaged (in a stuck state), which will completely damage the gear pair.

9.2 Manual Operation

Automatic operation, usually through an actuator to apply torque. Please refer to the actuator operation manual for the operation of the actuator.

10.0 Coating Repair Procedure

The damage to the coating should be repaired correctly within the first time. If not repaired for a long time, it may cause corrosion in the damaged area, thereby increasing the difficulty of repair. Damage to the coating may invalidate the warranty.

If coating repair is required, the following procedures should be followed:

1. If necessary, use solvent to clean the surface.
2. Rinse the surface with clean fresh water to remove any foreign substances and trace solvents.
3. Use sandpaper to polish the damaged area of the coating, ensuring that it is also polished clean and smooth within 2 centimeters of the damaged area.
4. Use the same paint as the original coating of the gearbox, completely following the paint manufacturer's data parameters. The coating must meet a certain thickness requirement within a certain period of time to ensure dry film thickness.

Cleaning or repair shall not be carried out under the following circumstances:

1. Relative humidity exceeds 85%
2. The metal temperature is 3 °C below the dew point.
3. The environmental conditions are not within the range specified in the paint manufacturer's coating data sheet.
4. The paint can only be used or cured at ambient and box temperatures above 10 C or other temperatures recommended by the paint supplier.

11.0 Tightening Torque

Refer to Table 2 for the recommended tightening torque for installing bolts. The performance level of bolts must comply with ISO 8.8 level.

Metric Thread	Torque	
	N.m	Ft-lbf
M5	5	4
M6	9	6
M8	21	15
M10	41	30
M12	71	53
M16	177	131
M20	346	255
M24	598	441
M30	1189	877
M36	2079	1533

Table 2 Reference Table for Tightening Torque of Bolts



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