ATI Radially-Compliant Robotic Deburring Tools
Flexdeburr™

(Models 9150-RC-660-ER and 9150-RC-660-ER-E)

Manual

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Engineered Products for Robotic Productivity

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Foreword

CAUTION: This manual describes the function, application, and safety considerations of this product. This manual must be read and understood before any attempt is made to install or operate this product. Failure to do so may result in personnel injury and/or damage to equipment.

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Glossary

Term	Definition
Adapter Plate	Device for attaching the deburring tool to either a robot flange or a stationary mounting surface.
Air Filter	Device for removing contamination from air supply lines. Typically refers to removal of particulates.
Burr	Any unwanted, raised protrusion on the work piece.
Bur	Cutting tool used to remove burs from the work piece. Alternatively referred to as a rotary file, cutter, or bit.
Climb Milling	Cutting method where the direction of cutter rotation and tool motion are the same.
Coalescing Filter	Device designed to remove liquid aerosols from the air supply lines.
Collet	Gripping device used to hold cutting tools in the spindle.
Compliance	The ability of the spindle to passively move in response to protrusions on or deviations of the work piece.
Conventional Milling	Method of cutting where the direction of tool motion is opposite that of tool rotation.
End-Effector	Tool used by the robot to perform a particular function.
Regulator	Device used to set and control the supplied air pressure to lower acceptable level.
Solenoid Valve	Electrically controlled device for switching air supplies on and off.
Spindle	The rotating portion of the deburring tool assembly.
Turbine	Air motor that drives the spindle.

1. Safety

The safety section describes general safety guidelines to be followed with this product, explanations of the notifications found in this manual, and safety precautions that apply to the product. More specific notifications are imbedded within the sections of the manual (where they apply).

1.1 Explanation of Notifications

The following notifications are specific to the product(s) covered by this manual. It is expected that the user heed all notifications from the robot manufacturer and/or the manufacturers of other components used in the installation.

DANGER: Notification of information or instructions that if not followed will result in death or serious injury. The notification provides information about the nature of the hazardous situation, the consequences of not avoiding the hazard, and the method for avoiding the situation.

WARNING: Notification of information or instructions that if not followed could result in death or serious injury. The notification provides information about the nature of the hazardous situation, the consequences of not avoiding the hazard, and the method for avoiding the situation.

CAUTION: Notification of information or instructions that if not followed could result in moderate injury or will cause damage to equipment. The notification provides information about the nature of the hazardous situation, the consequences of not avoiding the hazard, and the method for avoiding the situation.

NOTICE: Notification of specific information or instructions about maintaining, operating, installing, or setting up the product that if not followed could result in damage to equipment. The notification can emphasize, but is not limited to: specific grease types, best operating practices, and maintenance tips.

1.2 General Safety Guidelines

Prior to purchase, installation, and operation of the Flexdeburr product, the customer should first read and understand the operating procedures and information described in this manual. Never use the deburring tool for any purposes, or in any ways, not explicitly described in this manual. Follow installation instructions and pneumatic connections as described in this manual.

All pneumatic fittings and tubing must be capable of withstanding the repetitive motions of the application without failing. The routing of pneumatic lines must minimize the possibility of over stressing, pullout, or kinking the lines. Failure to do so can cause some critical pneumatic lines not to function properly and may result in damage to equipment.

1.3 Safety Precautions

WARNING: Never operate the Flexdeburr product without wearing hearing protection. High sound levels can occur during cutting. Failure to wear hearing protect can cause hearing impairment. Always use hearing protection while working in the proximity of the deburring tool.

WARNING: Never operate the Flexdeburr product without wearing eye protection. Flying debris can cause injury. Always use eye protection while working in the proximity of the deburring tool.

CAUTION: Do not use burs rated for less than the speed of the RC deburring tool being used. Using these may cause injury or damage equipment. Always use burs rated for at least the speed of the RC deburring tool being used.

CAUTION: Do not use spare parts other than original ATI spare parts. Use of spare parts not supplied by ATI can damage equipment and void the warranty. Always use original ATI spare parts.

CAUTION: Never be present near the deburring tool while it is started or in operation. Flying debris and rotating parts can cause injury. If it is necessary to approach the deburring tool while in motion, stand behind appropriate Plexiglas windows. Provide a barrier to prohibit people from approaching the deburring tool while in operation must secure the installation.

CAUTION: Do not perform maintenance or repair on the Flexdeburr product unless the tool is safely supported or placed in the tool stand and air has been turned off. Injury or equipment damage can occur with tool not placed and air on. Place the tool safely in the tool stand and turn off the air before performing maintenance or repair on the Flexdeburr product.

NOTICE: Turbine motors are not serviceable at this time. Refer to *Section 10—Terms and Conditions of Sale*. To maximize the life of turbine motor products the customer should follow closely the normal operating procedures outlined in the product manual. The air must be totally lube free and filtered to remove particulates and moisture. Exposing the turbine motors to oil in the air supply results in premature failure.

2. Product Overview

The Radially-Compliant (RC) deburring tool, also known as Flexdeburr, is a turbine-driven deburring unit for deburring aluminum, plastic, steel, etc. with a robot or CNC machine. The RC Deburring Tool is especially suited for removal of parting lines and flash from parts. However, its flexible design allows it to be used in a wide variety of applications.

The RC deburring tool's pneumatically controlled, articulated design allows the cutting bur to follow the part profile and compensate for surface irregularities while maintaining a constant, settable force. This allows high feed rates with uniform quality in any orientation. The tool also requires no oil, allowing clean exhaust air to be vented directly into the work environment.

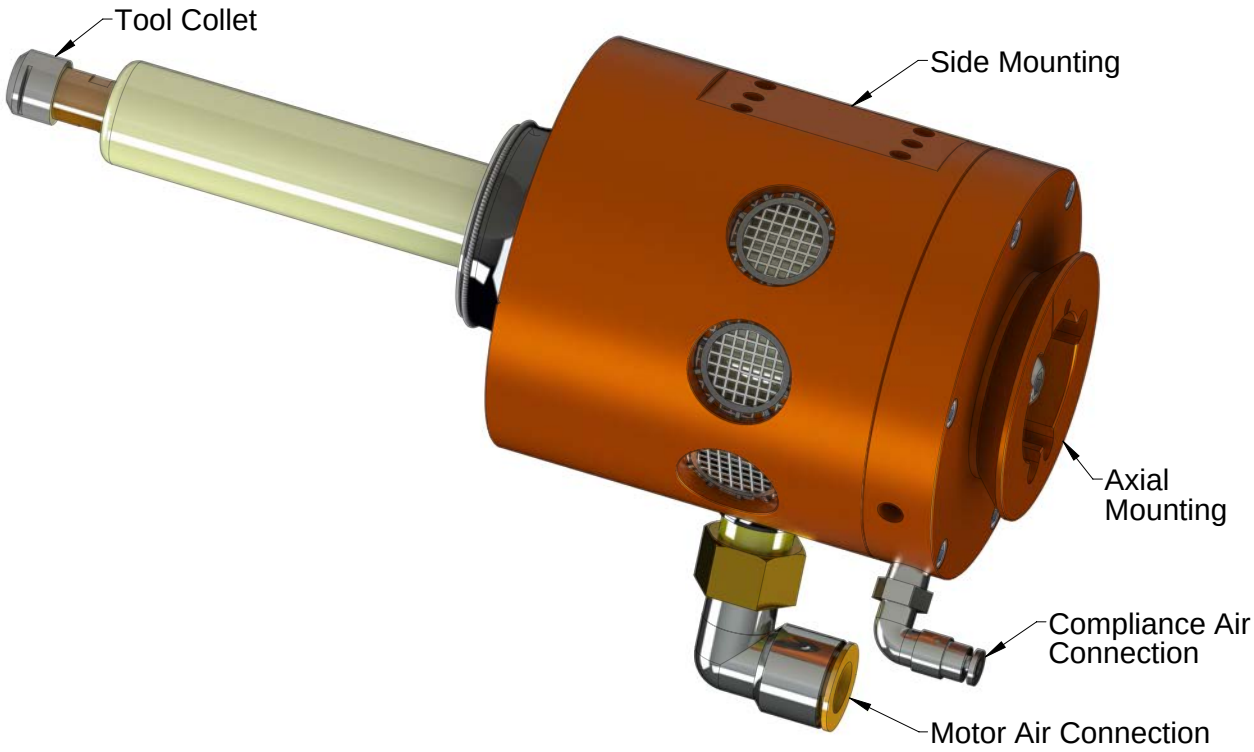
Compliance is supported by air pressure applied to the shaft of the unit. The RC deburring tool also utilizes standard industrial tungsten-carbide bits which allows for adaptation to changing assembly lines and part requirements.

The RC-660-ER provides for (2) mounting types; a side mounting and an axial mounting. The side mounting provides (2) locating dowel pins and (4) threaded holes. The axial mounting utilizes a tapered flange that requires an adapter plate. Custom adapter plates for both side and axial mounting are available from ATI. Refer to *Section 9—Drawings* for more information.

The RC-660-ER is equipped with a 1/2" Push-to Connect fitting to supply the motor air and a 5/32" [4 mm] Push-to Connect fitting to supply the compliance air.

A tool collet system secures the bur. Many collet sizes are available to accommodate a wide variety of applications.

Figure 2.1—RC-660-ER Deburring Tool



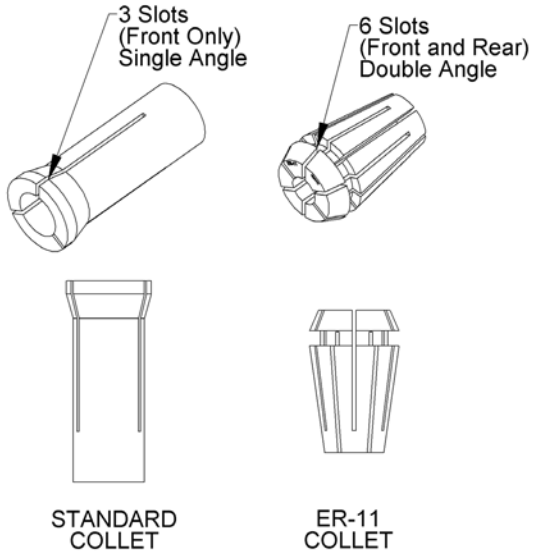
2.1 Tool Collet Systems

All Flexdeburr products utilize removable collets to grip customer-supplied cutting tools. Different collet diameters may be substituted to retain numerous cutter shank diameters. The collet retaining nut is loosened to open the collet allowing cutting tools to be removed and inserted. Once the tool is set to the desired depth, spanner wrenches are used to tighten the collet nut causing the collet to collapse and secure the cutting tool. The turbine motor design does not allow the installation of spindle brakes or Quick Change (drawbar) collet systems.

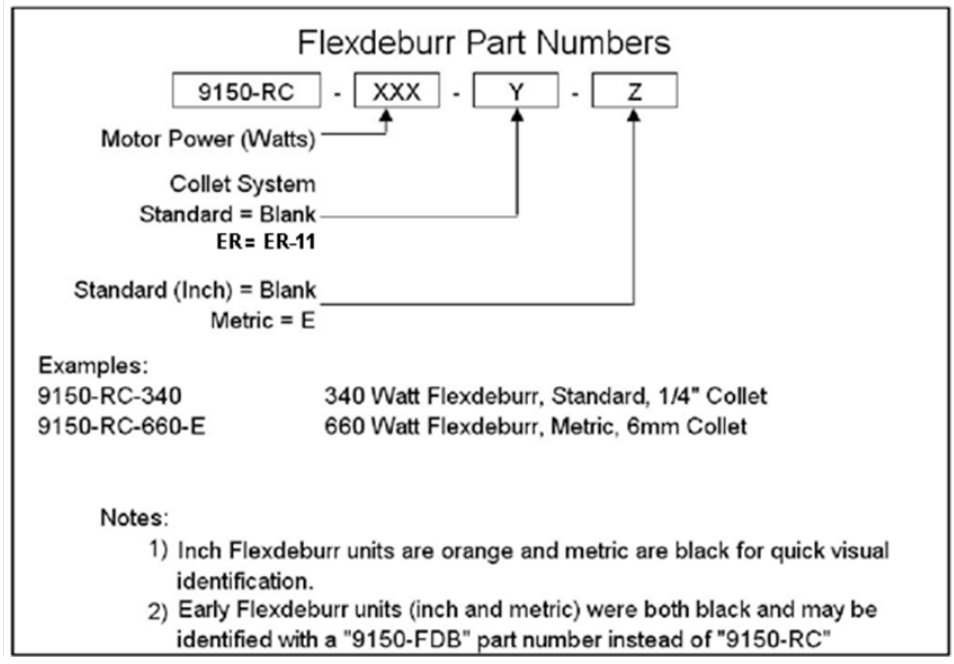
The ATI RC-660-ER uses an ER-11 collet system to hold cutting tools. The ER collet is a commercial, double-angle design offering greater tool gripping force, less tool runout and an extended grip range. The collets are available from many sources in many different gripping diameters. ER-11 collets can achieve runout tolerances below 0.0005" [0.013 mm] and provide a gripping range up to 0.040" [1 mm]. This allows a standard 1/4 inch ER-11 collet to safely and accurately hold a metric 6 mm diameter cutter. However, the ER-11 collet system represents a greater initial expense and its wrenches and collet nut are more delicate.

The ER collet system is not interchangeable with the collet design utilized on other ATI deburring tools. An ER-11 collet cannot be used in a standard Flexdeburr and the standard Flexdeburr collet cannot be used with a turbine motor designed for the ER-11 collet system. Flexdeburr units with "ER" appearing in their Part Number utilize only ER-11 collets.

Figure 2.2—Tool Collets



2.2 Deburring Tool Part Numbers



2.3 Technical description

The technical overview of the product is provided in the following tables and graphs. For additional technical specifications, refer to *Section 8—Specifications*.

2.3.1 Environmental Limitations

2.3.1.1 Operation

Table 2.1—Operation	
Installation position	Mounted to robot using the side mounting pattern or rear adapter flange. Refer to *Section 3.5—Side Mounting Installation* and *Section 3.6—Axial Mounting Installation*. The flange is specific to each type of robot. This optional flange is normally supplied by ATI in a blank form suitable for customer modification. Refer to *Section 9—Drawings*.
	Mounted to a table or stand by means of the bench adapter (the robot is carrying the work piece).
Temperature range	5° C–35° C (41° F–95° F)
Utilities	The tool requires the following: • Clean, dry, filtered, non-lubricated air. • A coalescing filter and filter elements rated 5 micron or better. • The motor spindle must be supplied air at 6.2 bar (90 psi). • The radial compliance (centering) air must be supplied from a regulated source between 1.0–4.1 bar (15–60 psi).

2.3.1.2 Storage

Table 2.2—Storage	
Temperature range	0° C–45° C (32° F–113° F)
Conditions	The tool should be stored in its crate and in a dry place. When not in use, keep the unit in its crate if possible. Consult *Section 3.4—Storage and Preventive Maintenance during Storage* of this manual.

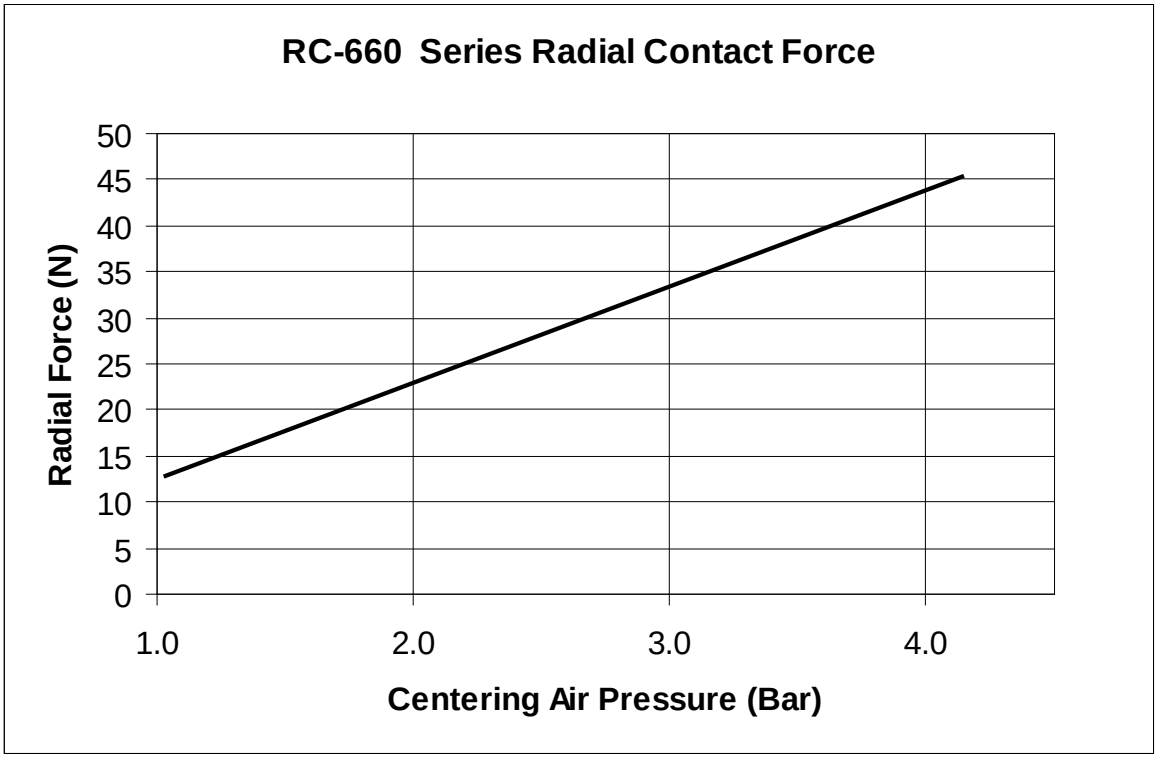
2.3.2 Compliance Unit Performance

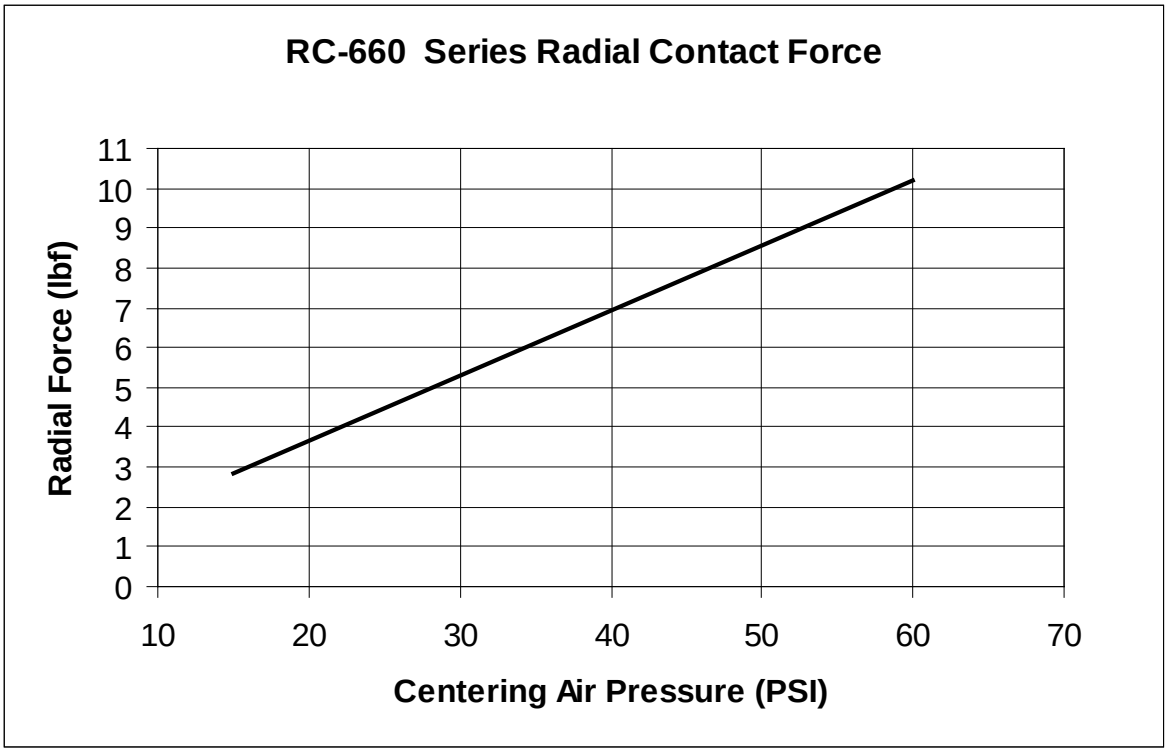
The graphs in *Figure 2.3* illustrate the variation of compliance force with applied air pressure in the vertical orientation with the collet pointed toward the ground. Measurements may vary from one product to another and should only be treated as nominal.

The actual force characteristics are dependent on mounting orientation and condition of the unit. In applications, where the deburring tool is mounted horizontally, additional compliance air pressure is required to overcome the weight of the motor. Compliance pressure is also dependent upon the material of the work piece, type of bur tool, and the amount of material that is removed.

The turbine motor attempts to maintain its full rated speed even under loaded conditions. However, when extremely heavy cuts are taken, the motor may eventually stall. Therefore, multiple, light passes are preferred over slow, heavy cuts.

Figure 2.3—RC-660-ER Series Radial Compliance Force Curves (Measured at the Spindle Tip)





3. Installation

The RC-660-ER Deburring Tool is delivered fully assembled. Optional equipment such as: mounting adapter plates, burs, and additional collets are separate.

3.1 Transportation and Protection During Transportation

The RC deburring tool is packaged in a crate designed to secure and protect it during transportation. Always use the crate when transporting the deburring tool in order to minimize the risk of damage.

3.2 Inspection of Condition When Delivered

Upon receipt, the following should be checked:

- Delivery in accordance with freight documents.
- Packaging in good condition.

If there is damage to any of the packaging, or if any of the goods have been exposed to abnormal handling, unpack those parts that may have been damaged for a closer inspection. If necessary, notify ATI for assistance in evaluation of the product condition.

3.3 Unpacking and Handling

The deburring tool should always be placed inside the accompanying box (crate) during transportation, storing, and handling.

Pneumatic lines and electrical cables are attached, bundled, and must be strain-relieved in a manner that allows for freedom of movement during operation.

3.4 Storage and Preventive Maintenance during Storage

The deburring tool should be stored in its crate when it is not in use. The deburring tool should also be stored in a dry place.

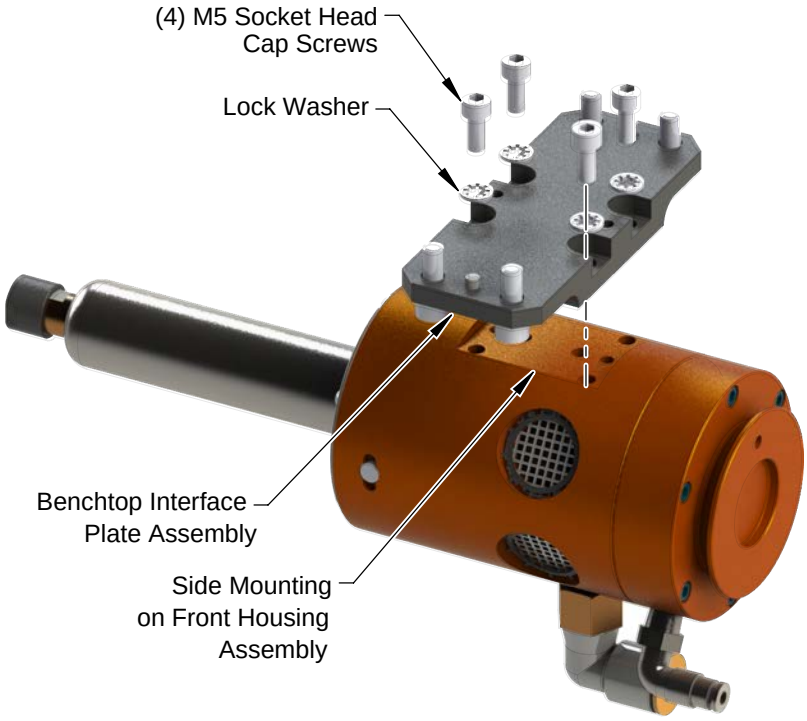
For long-term storage, the deburring tool should be thoroughly cleaned of any burrs or debris. It should not be disassembled. Place the deburring tool inside a sealed, plastic bag inside the crate.

3.5 Side Mounting Installation

The side mounting pattern of the RC deburring tool consists of (2) dowel pin holes and a number of threaded holes as shown in the following figure. The maximum fastener length specified must not be exceeded, or the fasteners interfere with the compliant motion of the turbine motor spindle. Refer to *Section 9—Drawings* for more information.

CAUTION: Lock washers are recommended on all mounting fasteners. Do not use liquid thread lockers on the mounting fasteners as this may damage or remove thread inserts during disassembly.

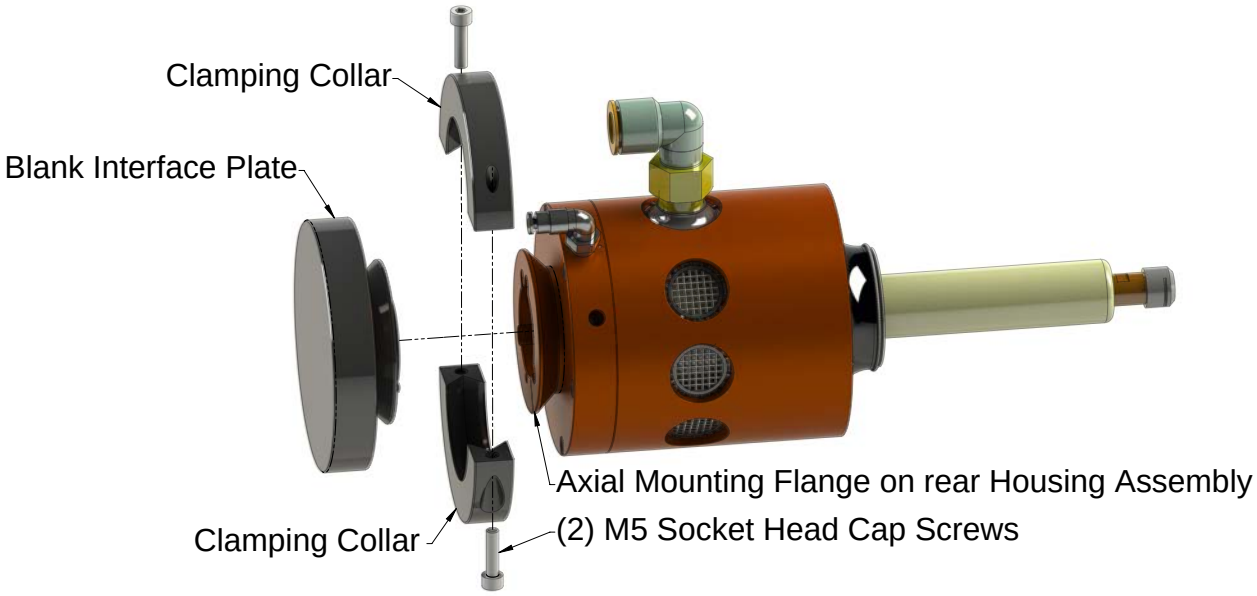
Figure 3.1—Bench (Side) Installation (The Model Is Shown for Reference).



3.6 Axial Mounting Installation

A blank robot adapter plate is also available to allow axial mounting off the rear of the deburring tool housing. This plate may be modified by the system integrator or by the owner/user of the Flexdeburr. ATI can provide custom interface plates and adapters upon request. An optional bench mount adapter plate allows the deburring tool to be permanently attached to a bench or other work surface (refer to the following figure). If the RC deburring tool is permanently mounted to a work surface, the robot carries the part to be deburred to the deburring tool. Refer to *Section 9—Drawings* for more information.

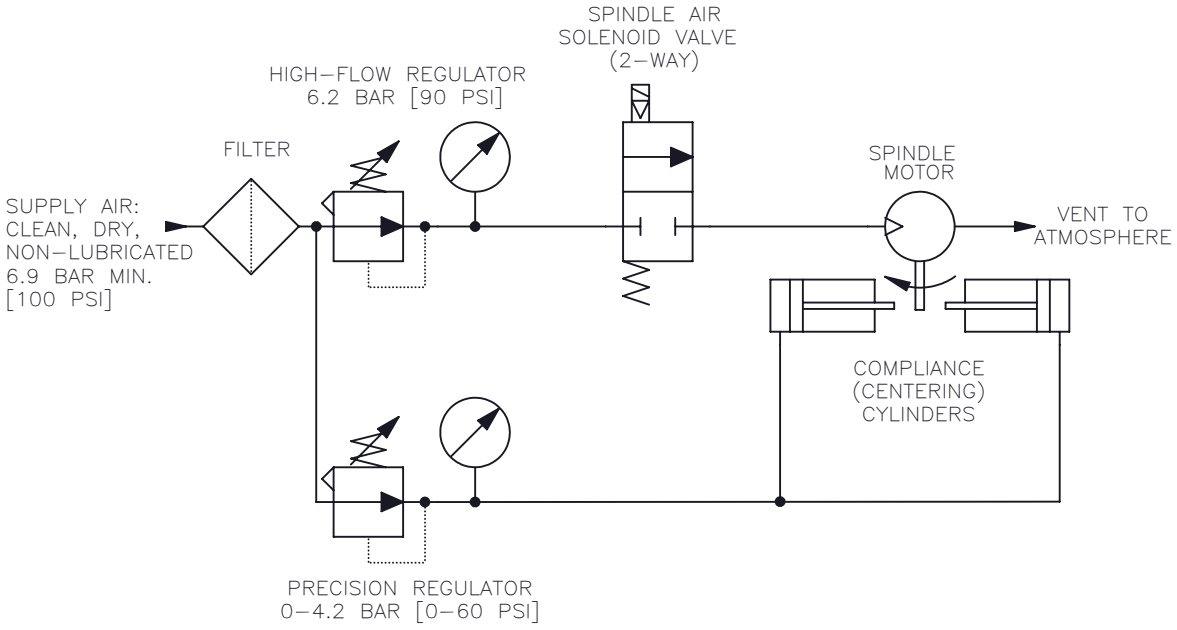
Figure 3.2—Axial Installation



3.7 Pneumatics

Connect the RC deburring tool as shown in *Figure 3.3*.

Figure 3.3—Pneumatic Connections



WARNING: All pneumatic fittings and tubing must be capable of withstanding the repetitive motions of the application without failing. The routing of pneumatic lines must minimize the possibility of over stressing, pullout, or kinking the lines. Failure to do so can cause some critical pneumatic lines not to function properly and may result in damage to equipment.

The air supply should be dry, filtered, and free of oil. A coalescing filter with elements rated for 5 micron or better is required.

A high-flow air pressure regulator is required to supply the spindle motor at 6.2 bar (90 psi). A second, precision, self-relieving regulator supplies air for the compliance or centering force.

The compliance force is applied radially and is adjusted until the desired cut is made. The robot's traversing speed will also be adjusted to achieve the desired finish.

CAUTION: Pneumatic components used for the motor drive circuit must be capable of meeting the air consumption requirements (See *Section 8—Specifications*). Poor performance will result if the correct components are not used.

Conventional, customer-supplied, pneumatic components are used to control the air supply to the deburring tool. ATI recommends that the user install a high-flow pneumatic pressure regulator (ATI Part #9150-FFR-90, or equivalent. See *Section 8—Specifications* for the maximum flow requirements) and a high-flow valve to properly supply a stable air supply of 6.2 bar (90 psi) to the spindle motor. The RC deburring tool will not operate properly if supplied air below 6.2 bar (90 psi).

A second, precision, self-relieving regulator (ATI Part # 9150-PPR-60, or equivalent) is used to supply the compliance (centering) mechanism. This pressure corresponds to the side force on the rotary bur. Very little airflow is required for the compliance mechanism. As a result, a significantly smaller valve to be used (Consult the valve and regulator supplier's literature when selecting these components).

If the complete work piece can be deburred with equal force, a conventional, manual pressure regulator can be used for compliance. If the burrs to be removed vary from place to place on the work piece, and this variation is repeatable for all work pieces of the same type, it may be necessary to adjust the force using an analog pressure regulator controlled from the robot. An analog output port in the robot or logic controller will be needed.

Solenoid valves are actuated from the robot or program logic controller by means of a digital output signal.

Table 3.1—Pneumatic Connections

Function	Connection Type	Pressure
Motor Inlet		
9150-RC-660-ER	1/2" Quick Connect Tube	6.2 bar (90 psi)
9150-RC-660-ER-E		
Compliance (Radial) Force Inlet		
9150-RC-660-ER and 9150-RC-660-ER-E	5/32” (4 mm) Quick Connect Tube Alternate: Remove Supplied Fitting to use 1/8-NPT Port	1.0–4.1 bar (15–60 psi) (Maximum)
Exhaust	Vented to Atmosphere through the Housing	Not Applicable

It is recommended that flexible plastic tubing be used for the motor air supply and the compliance force air supply. The installed fittings can be removed to expose tapped supply ports thus allowing the use of alternate, customer-supplied components. The turbine motor is extremely quiet and vents dry air to the environment through the screen-covered ports on the side of the housing. No mufflers are required. Information on the sound intensity is provided in *Section 8—Specifications*. To reduce the sound from the cutting operation in neighboring working areas, a customer-supplied barrier surrounding the installation may be installed (Plexiglas® or Lexan® is preferred, see *Section 8—Specifications*).

The compliance force air supply pressure regulator should have a 0-4.1 bar [0–60 psi] range. When testing for the proper contact force, start with a very low pressure and increase slowly until the desired cut is achieved.

4. Operation

These operating instructions are intended to help system integrators program, start up, and complete a robotic deburring cell containing a deburring tool. The system integrator should be familiar with the task of deburring, in general, and should have extensive knowledge relating to robots and automation incorporating robots.

4.1 Safety Precautions

DANGER: Never use the Flexdeburr for purposes other than robotic deburring. If used in any other way, serious injury or damage to equipment may occur.

WARNING: All personnel, who are involved in operation of the RC deburring tool, should have a thorough understanding of the operating procedures. Failure to follow these procedures or neglecting safety precautions can create hazardous situations that may injure personnel or damage the deburring installation and the RC deburring tool.

WARNING: Never operate the Flexdeburr product without wearing hearing protection. High sound levels can occur during cutting. Failure to wear hearing protection can cause hearing impairment. Always use hearing protection while working in proximity of the deburring tool.

WARNING: Never operate the Flexdeburr product without wearing eye protection. Flying debris can cause injury. Always use eye protection while working in the proximity of the deburring tool.

CAUTION: Do not use burs rated for less than the speed of the RC deburring tool being used. Using lower rated burs may cause injury or damage equipment. Always use burs rated for at least the speed of the RC deburring tool being used.

CAUTION: Do not use spare parts other than original ATI spare parts. Use of spare parts not supplied by ATI can damage equipment and void the warranty. Always use original ATI spare parts.

CAUTION: Never be present near the deburring tool while it is started or in operation. Flying debris and rotating parts can cause injury. If it is necessary to approach the deburring tool while in motion, stand behind appropriate Plexiglas windows. Provide a barrier to prohibit people from approaching the deburring tool while in operation.

CAUTION: Never use or start the deburring tool without first reading and understanding the operating procedures described in this manual. Never use the deburring tool for any purposes, or in any ways, not explicitly described in this document. Using the deburring tool without fully understanding the installation and operating procedures may cause injury to personnel or damage to equipment. Mount the deburring tool and connect the pneumatic control equipment as described in this manual. Operate the deburring tool as described in the manual.

4.2 Normal Operation

The following sections describes the normal operating conditions for RC deburring tools.

4.2.1 Air Quality

The air supply should be dry, filtered, and free of oil. A coalescing filter with elements rated for 5 micron or better is required. The air must be supplied at 6.2 bar (90 psi).

Air quality affects tool performance more than almost any other factor. Particulate can block airflow or impede vane motion. If deburring tools do receive proper air pressure, the tool stalls. Any water in the system damages the housing and blades.

4.2.2 No Lubrication

No lubrication is required.

Turbine motors cannot have any oil in the motor air supply. Oil damages the speed regulator and causes the motor speed to fluctuate out of tolerance.

4.2.3 Bur Selection, Design, and Maintenance

Use a carbide media.

RC tools have higher operating speeds and the media must be rated to RC idle speed at a minimum.

Check media quality regularly to ensure it is not dull or worn. Using worn media causes a poor surface finish and increased wear on the bearings that results in premature tool failure.

Do not use shank extensions because the large moment loads combined with the high speed can be dangerous.

Brushes are not recommended because the maximum rated speed of the brush is less than the ideal speed of the deburring tool.

Do not use a tool that requires axial loading.

4.2.4 Deburring Tool Approach Path Should be Slow and at an Angle

The deburring tool should approach the workpiece slowly and at an angle.

When beginning a deburring pass, try to minimize the initial impact on the work piece by slowly approaching the tool at an angle while maintaining a slightly parallel path with the surface.

If the tool quickly approaches perpendicularly to the workpiece, the result is gouging and premature wear of the tool bearings and cutting bit. Additionally, collisions could result and create a hazardous situation for both personnel and equipment.

4.2.5 No Axial Loading

Do not apply axial loads that are parallel to the axis of the tool's rotation.

Do not deburr shallow edges where the cutter contacts the parent material below the edge; otherwise, axial loading is applied on the tool and bearings and results in premature failing of the unit.

When deburring holes, interpolate the perimeter. Do not use a countersink tool; otherwise, axial loading occurs and causes premature wear on the bearings.

4.2.6 Program the Robot to Incorporate 50% Compliance Travel of the Tool

Program the robot to have the tool's compliance at 50% travel when on the nominal path.

As the part's edge deviates from the perfect path, the cutting bit can use compliance to follow along high and low spots without losing contact or hitting the positive stop and gouging.

Do not "bottom out" the compliance and hit the positive stop.

Repeated impacts on the positive stop create slop in the compliance and reduce recentering repeatability.

4.3 Flexdeburr Working Environment

As described in previous sections, the RC deburring tool should only be used in conjunction with a robot in a secured work cell/chamber.

The work cell must be secured by means of barriers to prohibit personnel from entering the cell. A lockable door should be included as a part of the barrier in order to facilitate access to the cell for authorized personnel only. The barrier could consist partly or fully of Plexiglas to facilitate observation of the deburring operations.

During system or deburring tool maintenance, make sure the RC deburring tool and robot are stopped before entering the robot cell. When installing and testing, Never be present in the cell when the Deburring tool is running.

Be aware of rotating parts. Use eye-protection while working around the deburring tool.

Be aware of high sound levels. While the Flexdeburr air motor is not loud, the cutting action associated with deburring frequently is loud. Always use hearing protection while working in the neighborhood of the deburring cell.

The deburring tool should not be used to deburr materials that are prone to fracture. A fracturing work piece may result in pieces of material damaging surrounding working environment and personnel. Material removed correctly should be in the form of chips.

4.4 Tool Center Point (TCP) Position and Programming

Figure 4.1 shows the RC deburring tool dimensions. The Flexdeburr provides radial compliance and performs best when the cuts taken are not excessively deep. The deburring tool spindle must Never be running while programming the robot. During teaching, the compliance air must be on and supplied above a minimum of 0.35 bar (5 psi).

Two programming methods are suggested but others are possible. In the first method, a dowel pin of suitable diameter is inserted in place of a cutting tool (simulating the cutter shank diameter) when teaching the robot path. For example, 6 mm collets require a 6 mm diameter pin of suitable length. The dowel pin should extend sufficiently from the collet to reach the surface on the bur where cutting is desired (see *Figure 4.1*). The diameter of the cutter should not exceed that of the dowel pin by more than the compliance of the RC deburring tool.

Another programming method is to teach the path using the centerline of the bur as a guide, following the edge of the part, and then manually or automatically adding offsets to the robot path points to achieve the final correct bur path (see *Figure 4.2*). The programming method used depends on the robot's capabilities and programmer preferences.

Figure 4.1—Flexdeburr Dowel Teaching Tool

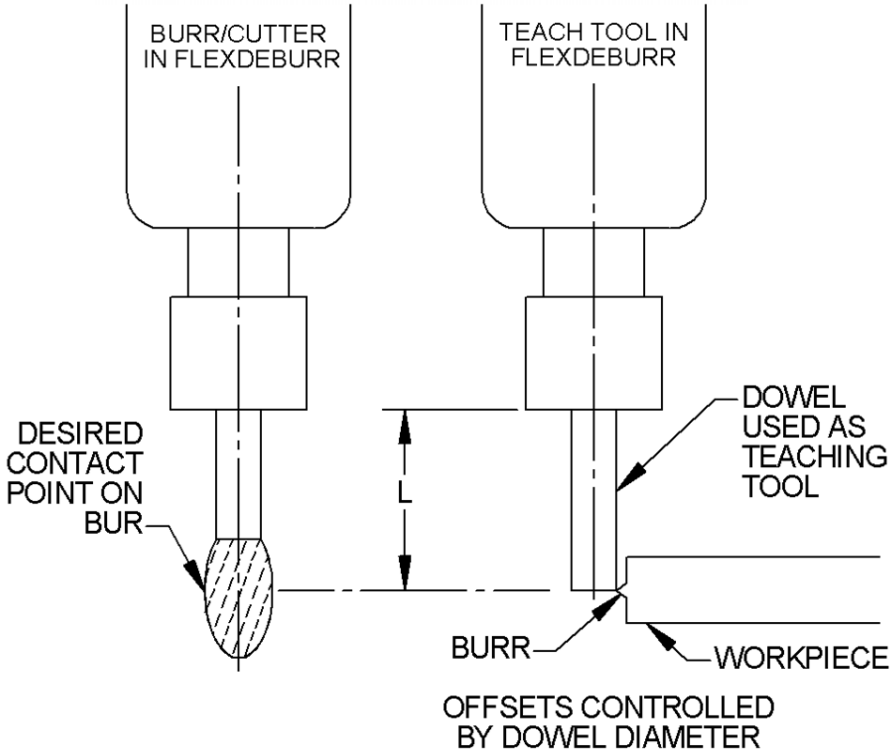
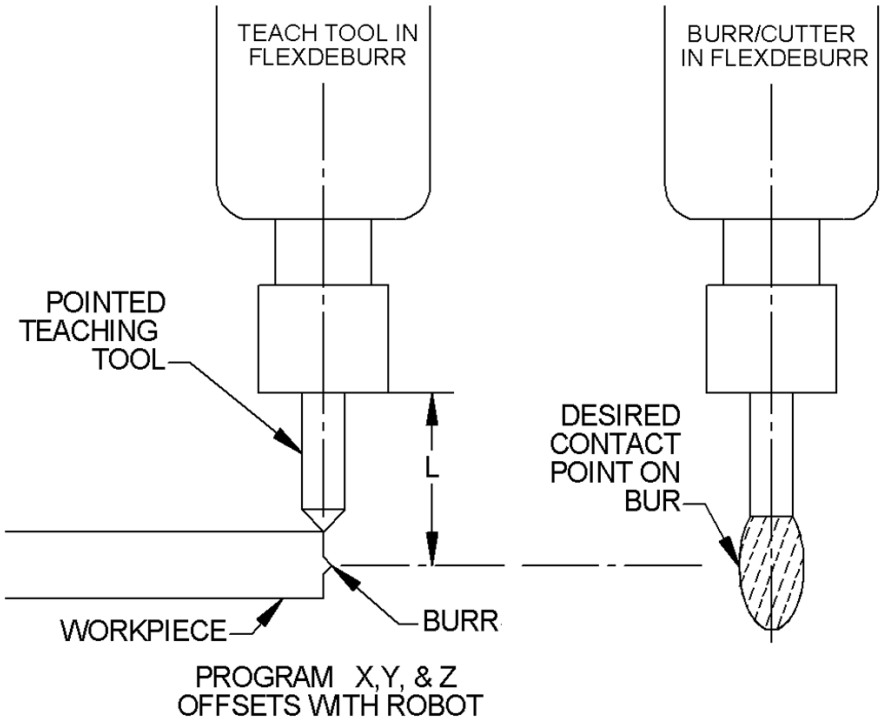


Figure 4.2—Flexdeburr Pointed Teaching Tool



Interior corners represent a complex situation for compliant deburring tools. In general, the cutter must not be allowed to simultaneously contact both perpendicular surfaces of an interior corner. The resulting force imbalance in two planes will cause severe tool chatter. The customer is advised to create a tool path that prevents the cutter from simultaneously contacting two perpendicular surfaces. A tapered cutter may reach further into such an interior corner if the tool is presented in an inclined orientation and closer to the tip of the tool (Note: When working near the tip of a tapered cutter, the surface cutting speed is reduced.)

When deburring interior radii, a similar situation may arise. The customer is advised that no attempt should be made to deburr an interior radius less than 1.5 times the diameter of the desired cutter (Rmin = 1.5 x Cutter diameter). Depending on the depth of cut, failing to follow these guidelines may result in excessive cutter contact resulting in excessive tool chatter.

When running the robot program the first time, observe the path with the radial compliance air supply turned down to approximately 0.35 bar (5 psi). When the robot path speed is increased, it is important to notice that robot may deviate from the programmed path. Verify that at operational robot path speed, the bur is deflected but contacts the work surface. Once the robot path has been confirmed, the compliance force of the bur should be adjusted, as described in *Section 3.7—Pneumatics*, in order to achieve a correct depth of cut.

4.5 Cutter Operation and Bur Selection

The RC deburring tool performs best in “climb milling”, a scenario where direction of travel and bur rotation are the same. In the case of the RC deburring tools, the bur rotation is clockwise when viewed from above. Climb milling therefore involves clockwise motion around the part being deburred. In climb milling, the heaviest cut is made as the tool enters the work piece and the chip becomes narrower as the cut is completed. In “conventional milling”, the bur travels in a direction opposite of bur rotation. This may aid in bur stability for some operations; however, the cutting edge of the tool is subjected to higher friction and cutting forces. Tool wear is accelerated in this mode and surface finish quality will generally be reduced. When “conventional milling”, extra care must be taken around corners. This poses a potential hazard where the cutting force can deflect the bur causing the bur to break as the robot continues along its path.

The selection of a bur is highly dependent upon the part material and geometry, and the depth of cut. It is not practical to present all the possibilities in this document. Please see *Section 4.5.1—Bur Selection* for a short list of burs and suitable applications. It is worth mentioning here that a specific family of burs is available for working with die cast alloys, aluminum, and plastics. These burs have fewer teeth and increased relief to minimize chip loading.

Plastics represent the most difficult deburring challenge due to the phenomenon of chip re-welding. In this process, if the bur is dull or the feeds and speeds are not correct for the material removed, chips will melt and weld to the cutter or the work piece. This problem can quickly load a bur and produce unacceptable results. In general, the traverse or feed rate of the deburring tool will be higher for plastics to minimize this behavior. This solution results in larger cuts, which more effectively remove heat from the bur-tool interface.

4.5.1 Bur Selection

Standard length commercial burs are used with Flexdeburr products. The length of these tools is typically around 2 inches for 1/4” shank diameter burs (50 mm for 6 mm diameter). Avoid using longer shank burs are available from industrial suppliers and appear in their catalogs with descriptions such as “long” or “extended” shank. Using extended or long shank burs in the Flexdeburr place higher loads and vibrations on the motor bearings resulting in reduced motor life. Bearing failure caused by the use of extended shank burs is not covered under warranty.

CAUTION: Do not use long or extended shank burs with the Flexdeburr. Long shank tools can lead to premature failure of the turbine motor and is not covered under warranty. Use standard length commercial burs with the Flexdeburr.

ATI can provide guidance in bur selection; however, only experimentation will yield the results desired. The following table is presented to assist in bur selection.

This following table is not comprehensive but includes many common bur types and burs recommended for particular applications.

Table 4.1—Bur Selection

	Materials/Application	Features/Benefits:
	**9150-RC-B-24033 - Diamond Cut, 1/4" Bur Diameter, 5/8" Bur Length, 1/4" Shank**	
	• For hardened and tough materials, super alloys, and stainless steel, alloyed cast steel and fiber reinforced plastics. • Edge and surface working. • Built up welds of high-tensile strength in mold and die making.	• Higher cutting capacity than standard cuts. • Smoother finish for surface treatments. • Lower axial force than ADC.
	**9150-RC-B-24061 - Standard Cut, 3/8" Bur Diameter, 3/4" Bur Length, 1/4" Shank**	
	• For steels of high tensile strength, die steels, cast steel, built up welds, tough materials, and welds. • For beveling. • For chamfering. • For deburring.	• Without chip breaker, for scratch-free surfaces.
	**9150-RC-B-24063 - Diamond Cut, 3/8" Bur Diameter, 3/4" Bur Length, 1/4" Shank**	
	• For hardened and tough materials, super alloys, and stainless steel, alloyed cast steel, and fiber reinforced plastics. • Edge and surface working. • Built up Welds of high-tensile strength in mold and die making. • Higher cutting capacity than standard cuts.	• Smoother finish for surface treatments. • Lower axial force than ADC.
	**9150-RC-B-24065 - Aluminum Cut, 3/8" Bur Diameter, 5/8" Bur Length, 1/4" Shank**	
	• For greasy aluminum alloys, soft non-ferrous metals, and thermoplastics. • For cast aluminum.	• Easy chip flow through positive rake angle, rounded base of tooth, convex tooth back. • No loading of the flutes while cutting sticky metals. • Smooth operation due to the peeling effect of the teeth.
	**9150-RC-B-24645 - Aluminum Cut, 3/8" Bur Diameter, 5/8" Bur Length, 1/4" Shank**	
	• For greasy aluminum alloys, soft non-ferrous metals, and thermoplastics. • For cast aluminum.	• Easy chip flow-through positive rake angle, rounded base of tooth, convex tooth back. • No loading of the flutes while cutting sticky metals. • Smooth operation due to the peeling effect of the teeth.

Table 4.1—Bur Selection		
	Materials/Application	**Features/Benefits:**
	**9150-RC-B-26408 - Cut FVK, 1/4” Bur Diameter, 5/8” Bur Length, 1/4” Shank**	
	• For trimming and contour milling of all glass and carbon fiber reinforced plastics.	• Special cut geometry allows high feed rates due to low cutting forces.
	**9150-RC-B-24862 - Alt Diamond Cut, 1/4” Bur Diameter, 3/4” Bur Length, 1/4” Shank**	
	• Universal use, for ferrous and non-ferrous metals, plastics. • Rough finishing of castings. • Surface working. • Weld removal. • Brazed welds.	• Smoother operation, improved tool control. • High cutting action. • Non-clogging. • Smaller chips, reduced slivers. • Even, smooth surfaces.

5. Maintenance

The RC deburring tool provides long life with regular maintenance. The preventive maintenance of the deburring tool consists of cleaning the unit and regular inspection for wear or damage to the pneumatic lines, filter element, spindle boot, and bur. Refer to *Section 6—Troubleshooting and Service Procedures* to assist with service.

For all service, the air supply (before the solenoid valves) must be disconnected. Drain any trapped air pressure in the lines. It is suggested that the air supply be "locked out" to prevent accidental operation of the spindle. Refer to *Section 6.2—Service Procedures* for maintenance instructions. Service and repair parts are identified in *Section 7—Serviceable Parts* and *Section 9—Drawings*.

5.1 Pneumatics

The air lines to the deburring tools must routinely inspected for their general condition and replaced as required. The air to the Flexdeburr must be filtered, dry, and non-lubricated. Inspect air filters and replaced as required to maintain optimum performance. The life of the filter elements is dependent on the quality of compressed air at the customer's facility and therefore cannot be estimated.

5.2 Lubrication

Lubrication systems are not to be used. The Flexdeburr air motor must be supplied with clean, dry, filtered air. Oil in the air stream will cause the air motor to fail prematurely. Failure of the motor due to oil in the air stream is not covered under the warranty. See *Section 3.7—Pneumatics* for details on air supply and quality.

CAUTION: Do not use lubricated air with the Flexdeburr. Oil in the air stream will result in the premature failure of the air motor and is not covered under warranty. It is recommended that the customer use a coalescing filter and filter elements rated 5 micron or better.

5.3 Spindle Boot Inspection

The spindle boot prevents debris from entering the housing and protects internal components. Inspect the spindle boot regularly for damage and replace if necessary. Refer to *Section 6.2.5—Spindle Boot Replacement.*

5.4 Bur Inspection

The bur wear depends on cut depth, feed rate, and material being deburred. Inspect the bur regularly for wear and refer to *Section 6.1—Troubleshooting* for symptoms of worn bur.

5.5 Spindle Motion Inspection

The pivot bearing allows articulation of the motor assembly. The pivot bearing is subject to wear and must be replaced when excessive spindle motion is observed. Contact between the motor air supply fitting and the main housing indicates pivot bearing wear and must be corrected. Refer to *Section 6.2.4—Rear Housing Assembly and Pivot Bearing Replacement*.

6. Troubleshooting and Service Procedures

For all service, the air supply (before the solenoid valves) must be disconnected. Drain any trapped air pressure in the lines. It is suggested that the air supply be "locked out" to prevent accidental operation of the spindle. Refer to *Section 6.2—Service Procedures* for maintenance instructions. Service and repair parts are identified in *Section 7—Serviceable Parts* and *Section 9—Drawings*.

6.1 Troubleshooting

Deburring process development is an iterative, learning task. The following table is presented to assist in solving deburring issues.

Table 6.1—Troubleshooting

Symptom	Cause	Resolution
Bur Wear	Hard work material	Use better grade bur material, add coating (TiAlN).
	Too heavy a cut	Decrease width of cut/make multiple passes.
	Feed rate is too slow	Increase feed rate.
Bur Breakage	Too heavy a cut	Decrease width of cut/make multiple passes.
	Deflection at corner	Climb mill/Do not begin path at sharp corner.
	Impacting part	Decrease feed rate at contact/ enter part at an angle.
Unequal compliance	Worn ring cylinder	Replace ring cylinder. Refer to *Section 6.2.3—Ring Cylinder Assembly Replacement*.
	Pivot bearing worn	Replace the pivot bearing. Refer to *Section 6.2.4—Rear Housing Assembly and Pivot Bearing Replacement*.
	Pivot bearing components (axial, radial, preload set screw) are not set correctly.	Reinstall the axial and preload set screw and verify the preload set screw is correctly adjusted. Refer to *Section 6.2.4—Rear Housing Assembly and Pivot Bearing Replacement*.
Poor finish on work piece	Feed rate is too fast	Reduce feed rate.
	Bur is worn	Inspect bur. If worn, replace. Refer to *Section 6.2—Service Procedures*
	Motor bearings are worn	Inspect the motor spindle shaft. If the shaft feels loose or has play, replace. Refer to *Section 6.2.2—Turbine Motor Replacement.*
Bur is chattering during cut	Feed rate is too fast	Reduce feed rate.
	Lack of rigidity	Increase radial compliance pressure.
	Too heavy a cut	Decrease width of cut/make multiple passes.
	Improper Bur selection	Choose bur designed for work material. Refer to *Section 4.5.1—Bur Selection*.
	Bur is worn	Inspect bur. If worn, replace. Refer to *Section 6.2.1—Bur and Collet Replacement*.
	Motor bearings are worn.	Inspect the motor spindle shaft. If the shaft feels loose or has play, replace the motor. Refer to *Section 6.2.2—Turbine Motor Replacement.*

Table 6.1—Troubleshooting		
Symptom	**Cause**	**Resolution**
Secondary burrs are created on work piece after cut	Incorrect feed rate	Reduce feed rate.
	Too heavy a cut	Decrease width of cut/make multiple passes.
	Improper Bur selection	Choose bur designed for work material. Refer to *Section 4.5.1—Bur Selection*.
	Bur is worn	Inspect bur if worn, replace. Refer to *Section 6.2.1—Bur and Collet Replacement*.
	Motor bearings are worn.	Inspect spindle shaft, if shaft feels loose or has play, replace. Refer to *Section 6.2.2—Turbine Motor Replacement.*
Chip packing of bur	Too heavy a cut	Decrease width of cut/make multiple passes.
	Not enough chip clearance	Use a bur with less flutes.
The bur stalls	Not enough or no drive air	Check drive air regulator for 90 PSI (6.2 Bar) and for leaks.
	Bur is not secure in the collet.	Properly tighten bur in collet. Refer to *Section 6.2.1—Bur and Collet Replacement*.
	Too much side load	Decrease width of cut and make multiple passes.
	The turbine motor needs to be replaced.	Replace the turbine motor. Refer to *Section 6.2.2—Turbine Motor Replacement*
The motor spindle is sticking.	The motor bearings are worn.	Replace the turbine motor. Refer to *Section 6.2.2—Turbine Motor Replacement*

6.2 Service Procedures

Component replacement and adjustment procedures are provided in the following section.

CAUTION: Thread locker applied to fasteners must not be used more than once. Fasteners might become loose and cause equipment damage. Always apply new thread locker when reusing fasteners.

6.2.1 Bur and Collet Replacement

In normal operation, the bur can become worn. If improper feeds and speeds are used, the bur may become "loaded" with material. In both instances, the bur must be replaced. During initial production, inspect the bur and the work piece often in order to determine when the bur needs to be replaced. Replacing the collet is not required, when the bur is replaced, but a different collet may be required, if a different sized bur is used.

The following steps detail replacing the bur and or collet:

Refer to *Figure 6.1*.

Parts required: *Refer to Section 7—Serviceable Parts.*

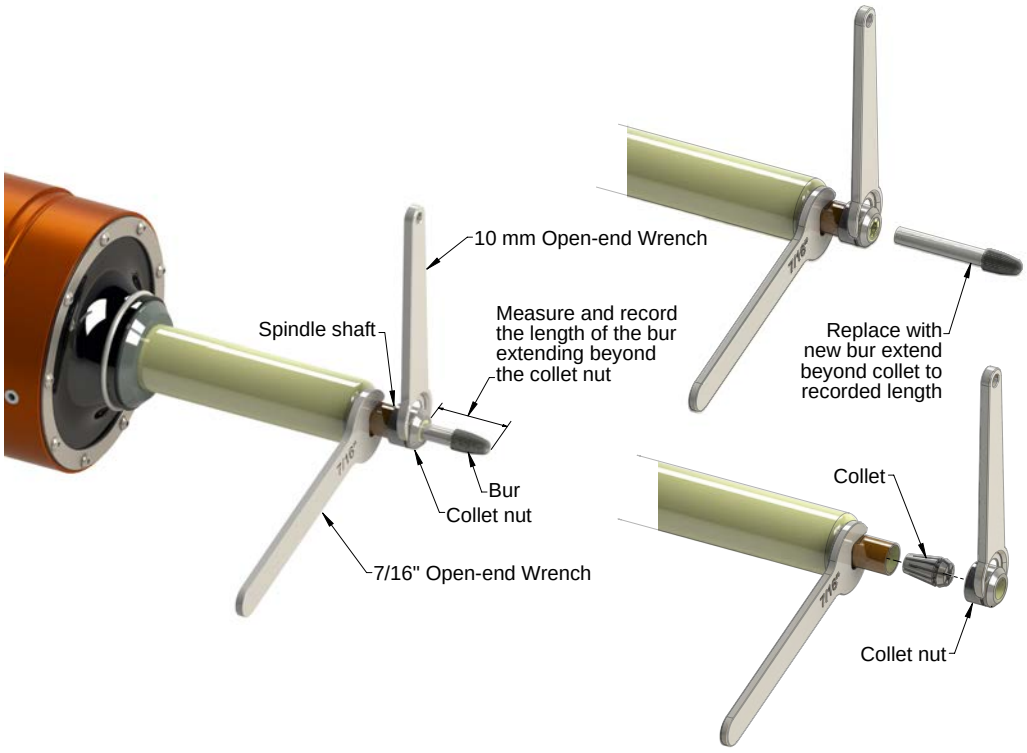
Tools required: *7/16" (11 mm) and ER-11 (10 mm) open-end (collet) wrench*

1. Remove and/or lock-out the spindle motor air supply for safety.
2. If the bur is to be replaced with one of an identical type, measure and record the bur length extending beyond the collet lock nut. Alternatively, the optional ATI 9150-RC-T-4230 bur setting tool accessory can be used to duplicate tool exposure length.
3. Use the 7/16" open-end wrench to hold the spindle behind the collet nut.
4. Use the 10 mm collet wrench to turn the collet locknut counterclockwise (when viewed from the bur tip) to loosen the collet.

CAUTION: During operation of the deburring tool, the bur reaches high temperatures. Failure to wear proper personal protection equipment or not allowing the bur to cool could result in serious injury. Be aware that during operation, the bur becomes very hot, and when removing the bur, take necessary safety precautions to avoid injury.

5. To remove a worn bur, pull the bur out of the loosened collet.
6. If the collet is being replaced, completely remove the nut and extract the old collet. Insert the new collet and install the nut leaving it loose.
7. If an identical new bur is replacing a worn one, insert the new bur, measure, and adjust the length of its exposed portion according to the measurement taken in Step *1*.
8. Use the 7/16" open-end wrench to hold the spindle behind the collet nut.
9. Use the 10 mm collet wrench to turn the collet locknut clockwise (when viewed from the bur tip) to tighten the collet.
10. Restore the air supply.

Figure 6.1—Bur and Collet Replacement



6.2.2 Turbine Motor Replacement

If the turbine motor is operated using oil-laden or dirty air, it will fail and require replacement. Failure of the motor due to contamination in the spindle air is not covered under warranty. The motor may also require replacement after an extended operating life or following a severe collision. To minimize possible downtime, the pivot bearing should be replaced wheNever the turbine motor is replaced; refer to *Section 6.2.4—Rear Housing Assembly and Pivot Bearing Replacement*. There are no user serviceable parts in the turbine motor. Flexdeburr units with defective motors should be returned to ATI during the warranty period. Motors are sold as complete, modular assemblies to simplify and speed user installation. Should the customer wish to replace the motor after the warranty period, perform the following steps:

Refer to *Figure 6.2* through *Figure 6.6*.

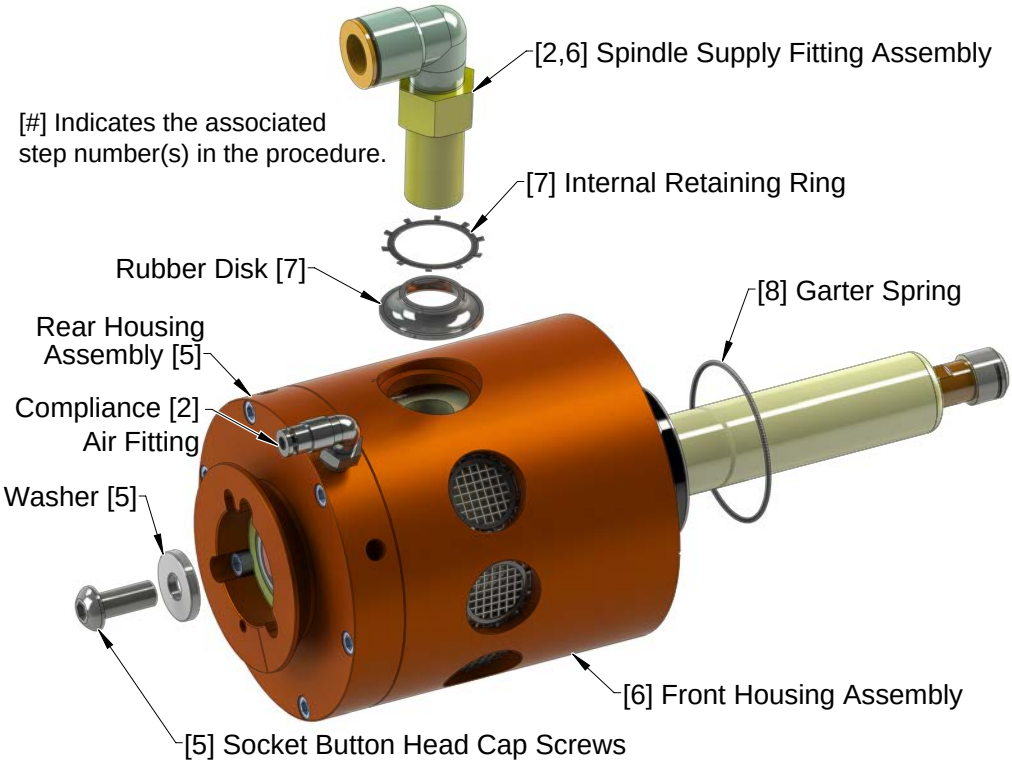
Parts required: *Refer to Section 7—Serviceable Parts.*

Tools required: *Small flat blade screw driver, 3 mm and 5 mm hex key, crescent wrench, torque wrench*

Supplies required: *Clean lint free rag, Magnalube, Loctite® 222, Loctite 242, Loctite 569*

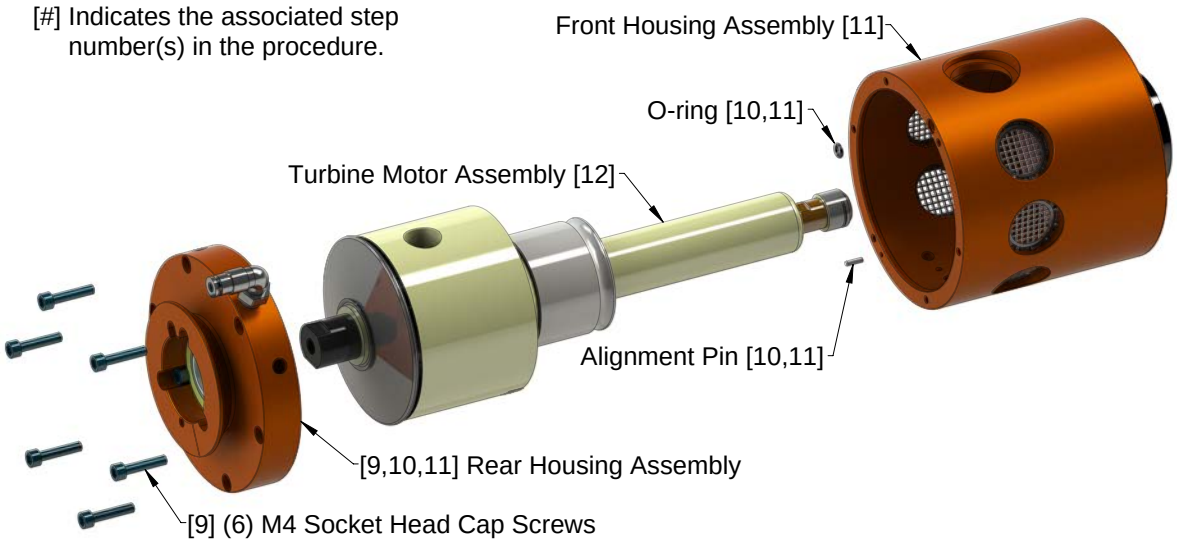
1. Remove and/or lock-out the spindle motor air supply for safety.
2. Disconnect the air hose from the spindle supply fitting and the compliance air fitting.
3. Remove the deburring tool from the robot or work location.
4. Clean the debris from the deburring tool using compressed air and a clean rag to wipe any grease from the outer surfaces.
5. Using a 5 mm hex key, remove the M8 socket button head cap screw and washer from the center of the deburring unit's rear housing assembly and discard. This hardware is supplied with the new motor assembly.
6. Using a crescent wrench, remove the spindle air supply fitting from the side of the front housing assembly by rotating the fitting counter-clockwise.
7. Using a small screw driver, remove the internal retaining ring and rubber boot. ATI recommends replacing the internal retaining ring and rubber disk at the spindle supply fitting when the motor is replaced.
8. Ease the garter spring off the front spindle boot.

Figure 6.2—Spindle Supply Fitting and Garter Spring Removal



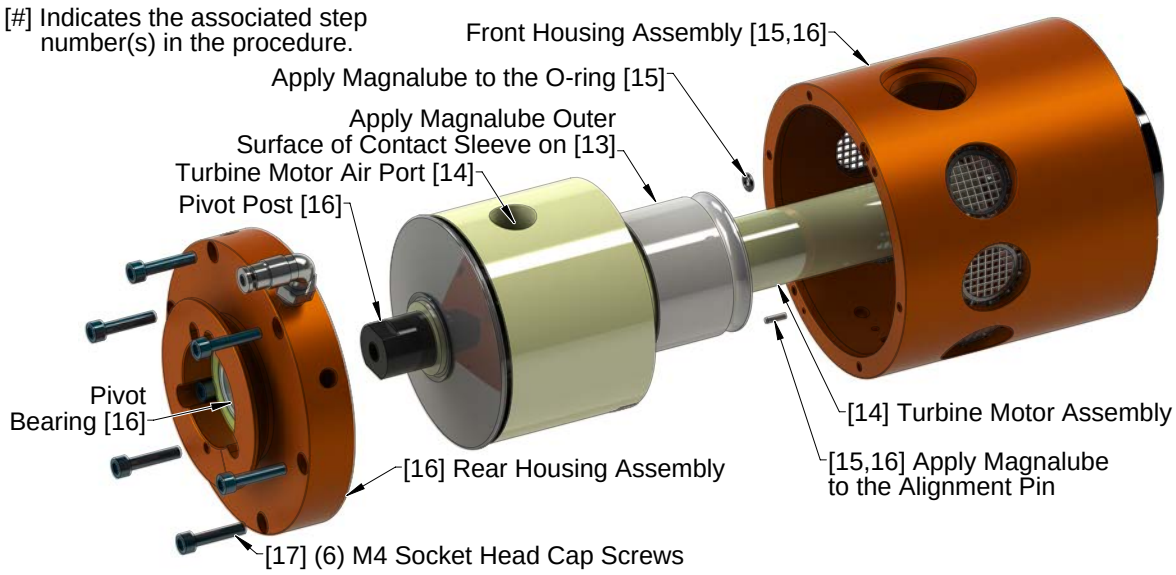
9. Using a 3 mm hex key, remove the (6) M4 socket head cap screws holding the rear housing assembly to the front housing assembly.
10. Remove the rear housing assembly, also remove the O-ring and alignment pin from the back of the turbine motor.
11. Clean debris and lubrication from the alignment pin, O-ring, rear and front housing assemblies using a clean lint free rag.
12. Gently pull the turbine motor out of the front housing assembly and discard.

Figure 6.3—Rear Housing and Turbine Motor Removal



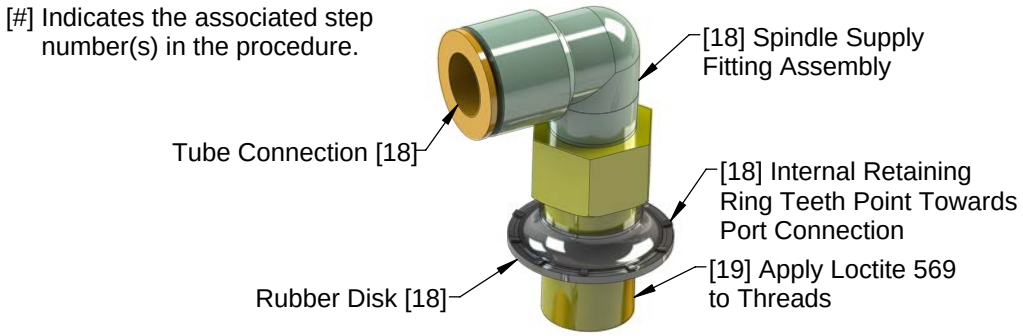
13. To install the new motor, apply a thin coating of Magnalube or equivalent to the outer surface of the motor contact sleeve.
14. Gently insert the new turbine motor assembly into the front housing assembly and through the ring cylinder. Orient the turbine motor so that the air port in the turbine motor lines up with the opening in the front housing assembly.
15. Apply a thin coating of Magnalube to the alignment pin and O-ring. Insert the pin and O-ring into the front housing as shown in the following figure.
16. Align the pivot bearing in the rear housing to the pivot post on the back of the turbine motor. Assemble the rear housing to the front housing using the alignment pin for proper orientation.
17. Apply Loctite 222 to the (6) M4 socket head cap screws, and using a 3 mm hex key, install the (6) M4 socket head cap screws that secure the rear housing to the front housing. Tighten to 12 in-lbs (1.4 Nm).

Figure 6.4—Rear Housing and Turbine Motor Installation



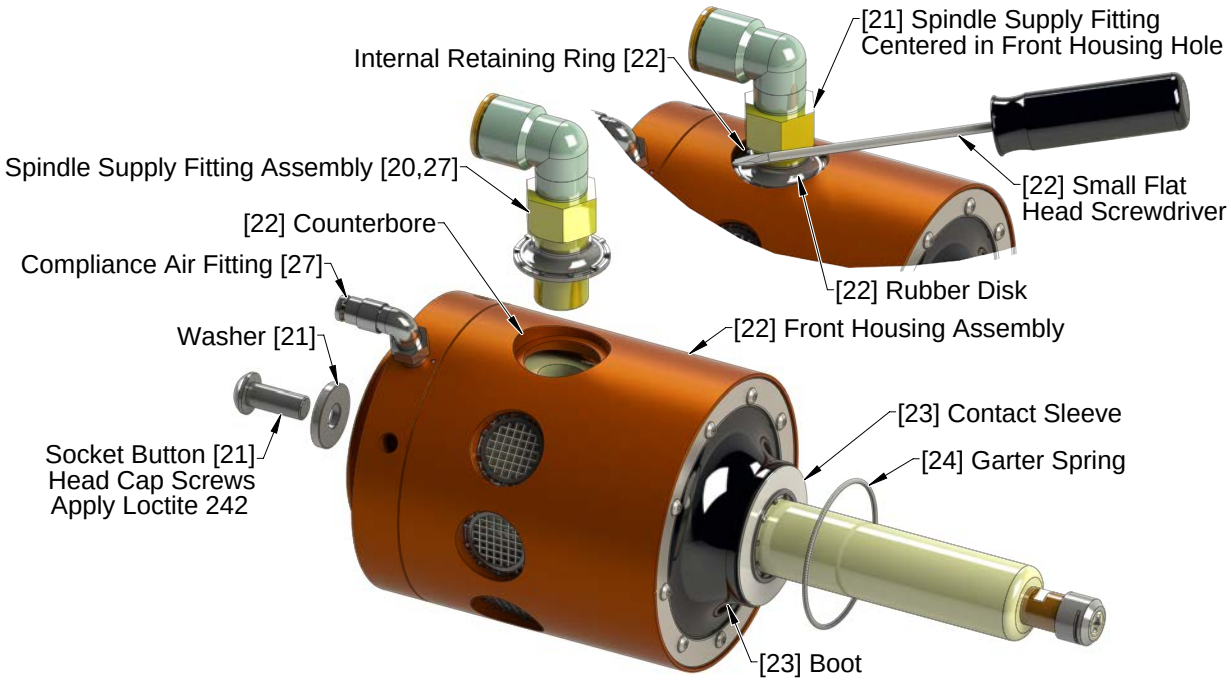
18. Fit the retaining ring and rubber disk over the spindle supply fitting assembly. Point the teeth on the retaining ring toward the tube connection side of the fitting.
19. Apply Loctite 569 to the threads of the spindle supply fitting.
20. Thread the spindle supply fitting assembly into the turbine motor. Tighten it hand tight plus an additional 1/2 turn.

Figure 6.5—Spindle Supply Fitting Assembly



21. Apply Loctite 242 to the threads of the M8 socket button head cap screw.
22. Insert the washer and using a 5 mm hex key, thread the M8 socket button head screw into the rear of the turbine motor. While holding the turbine motor to center the air supply fitting in the front housing hole, tighten the button head cap screw to 110 in-lbs (12.4 Nm).
23. Use a small flat head screw driver to seat the (spindle supply fitting) rubber disk and retaining ring into the bottom of the counterbore in the front housing assembly.
24. Slide the boot onto the turbine motor and align the edge of the boot to the edge of the contact sleeve.
25. Stretch the garter spring over the boot, it seats in the groove on the contact sleeve.

Figure 6.6—Spindle Supply Fitting and Garter Spring Installation



26. Install the deburring tool to the robot or work location.
27. Connect the air hose to the spindle supply fitting and the compliance air fitting.
28. When the replacement procedure is complete, all circuits (for example: air and power) may be placed into normal operation.

6.2.3 Ring Cylinder Assembly Replacement

The compliant motion of the turbine motor spindle is accomplished using an array of pistons (ring cylinder) installed inside the front housing. After extended operation, this component may need to be replaced to ensure free motion of the pistons. The unit may be replaced as an assembly but its subcomponents are not user serviceable.

To replace the ring cylinder assembly, perform the following steps (The ring cylinder is available as a complete assembly with new O-ring seals.)

Refer to *Figure 6.7* through *Figure 6.10*.

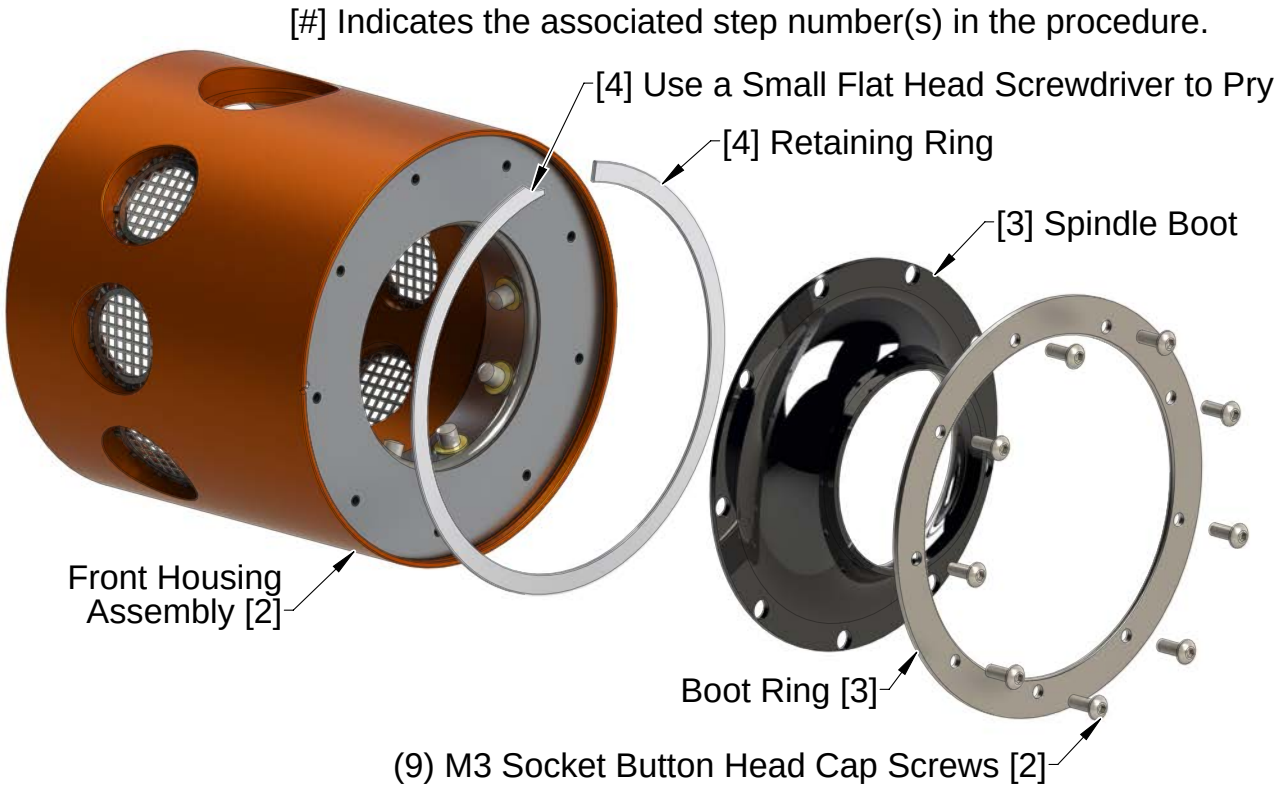
Parts required: *Refer to Section 7—Serviceable Parts.*

Tools required: *Small flat head screw driver, 2 mm hex key, non-metallic drift or arbor press*

Supplies required: *Clean rag, Magnalube, Loctite 222*

1. Remove the turbine motor assembly as described in *Section 6.2.2—Turbine Motor Replacement* steps *1* through *12*.
2. Using a 2 mm hex key, remove the (9) M3 socket button head cap screws that secure the boot ring to the front housing assembly.
3. Remove the boot ring and spindle boot.
4. Using a small flat head screw driver, pry the retaining ring out of the groove in the front housing assembly and remove the retaining ring.

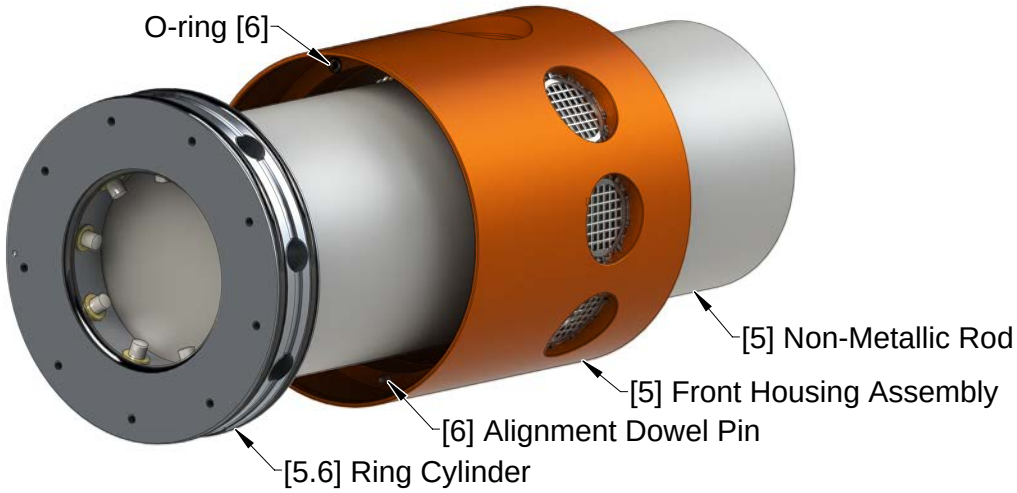
Figure 6.7—Boot Ring, Spindle Boot, and Retaining Ring Removal



5. Press the ring cylinder out of the front housing using a non-metallic drift (plastic or wooden rod).
   Note: After prolonged periods of use, the O-ring seals may impede removal of the compliance unit. If this occurs, support the front of the housing on a suitable plate with a clearance hole for the ring cylinder and use an arbor press for extraction.
6. Make sure to retain the small O-ring and alignment dowel pin for reuse. Discard the old ring cylinder.
7. Use a clean lint free rag, to remove any debris and lubrication from the alignment pin, O-ring, rear, and front housing assemblies.

Figure 6.8—Ring Cylinder Removal

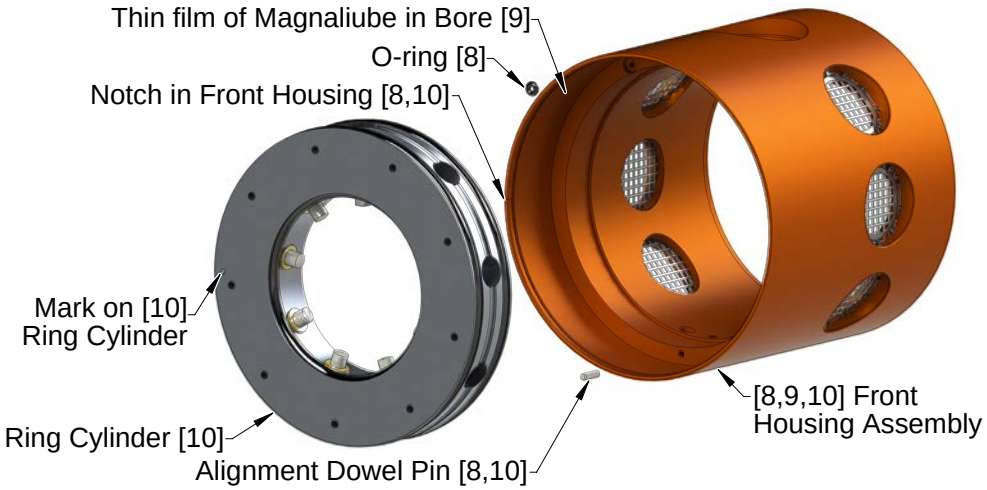
[#] Indicates the associated step number(s) in the procedure.



8. Apply a thin film of Magnalube to the small O-ring and alignment dowel pin and insert into the front housing.
9. Apply a thin film of Magnalube to the front housing bore where the ring cylinder seats.
10. Insert the new ring cylinder into the front housing assembly. Use the alignment dowel pin, alignment mark on the ring cylinder, and the alignment notch in the front housing for proper orientation. Make sure the small O-ring is in place.

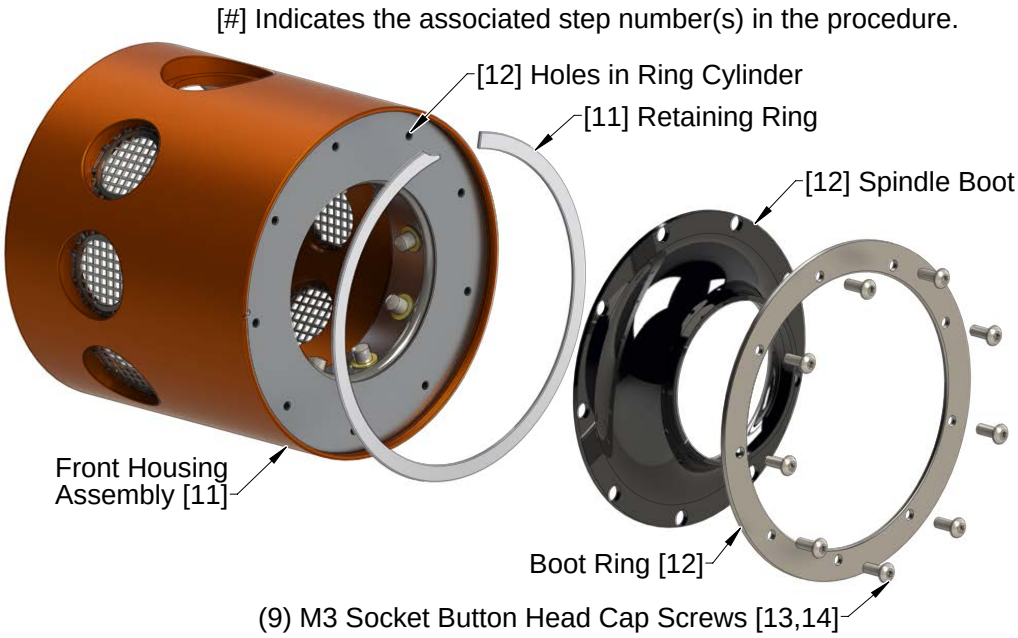
Figure 6.9—Ring Cylinder Installation

[#] Indicates the associated step number(s) in the procedure.



11. Fit the retaining ring into the groove in the front housing assembly to secure the ring cylinder.
12. Align the spindle boot and the boot ring with the holes in the ring cylinder.
13. Apply Loctite 222 to the threads of the (9) M3 socket button head cap screws.
14. Using a 2 mm hex key, install the (9) M3 socket button head cap screws that secure the spindle boot and boot ring to the housing. Tighten to contact plus one additional flat.
15. Install the turbine motor assembly as described in *Section 6.2.2—Turbine Motor Replacement* steps *13* through *28*.

Figure 6.10—Boot Ring, Spindle Boot, and Retaining Ring Installation



6.2.4 Rear Housing Assembly and Pivot Bearing Replacement

The pivot bearing allows articulation of the motor assembly. The pivot bearing is subject to wear and should be replaced when excessive spindle motion is observed. Contact between the motor air supply fitting and the main housing indicates pivot bearing wear, which should be corrected. To minimize possible downtime, the pivot bearing should be replaced any time the turbine motor is replaced.

The pivot bearing may be replaced in one of two ways. For quick repairs with minimal downtime, the user is encouraged to replace the entire rear housing assembly. When a spare unit can be placed into service or downtime is not an issue, a new pivot bearing can be installed in an existing rear housing.

Refer to *Figure 6.11* through *Figure 6.17*.

Parts required: *Refer to Section 7—Serviceable Parts.*

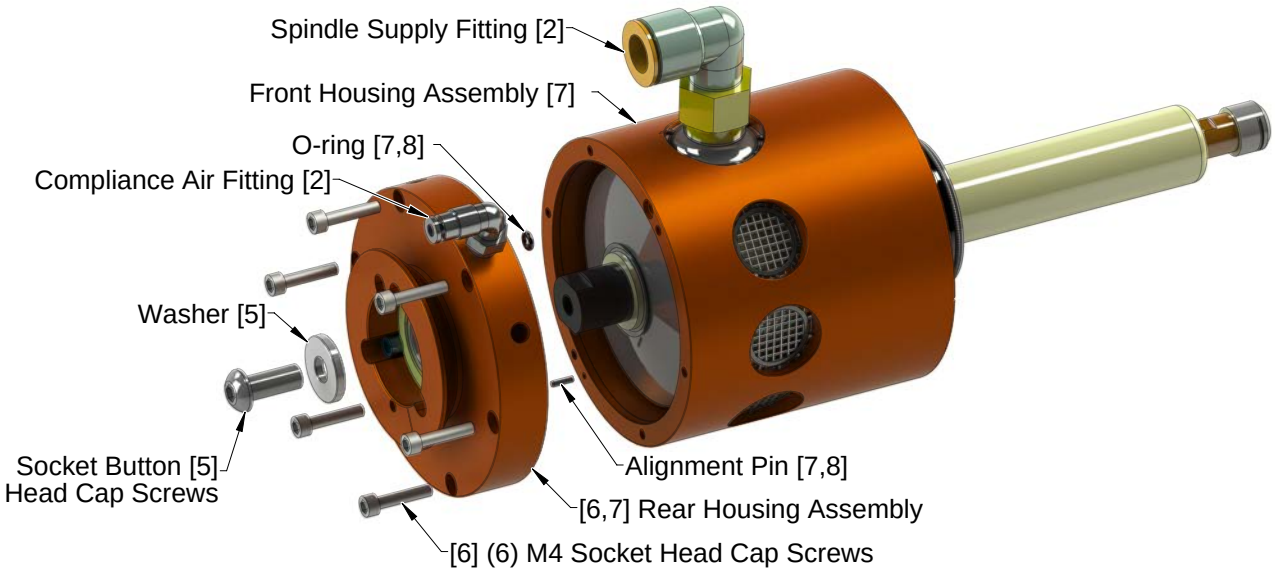
Tools required: *2.5 mm, 3 mm, and 5 mm hex key, torque wrench, small diameter magnet*

Supplies required: *Clean rag, Magnalube, Loctite primter 7649, Loctite 222 and 569*

1. Remove and/or lock-out the spindle motor air supply for safety.
2. Disconnect the air hose from the spindle supply fitting and the compliance air fitting.
3. Remove the deburring tool from the robot or work location.
4. Clean the debris from the deburring tool using compressed air and a clean rag to wipe any grease from the outer surfaces.

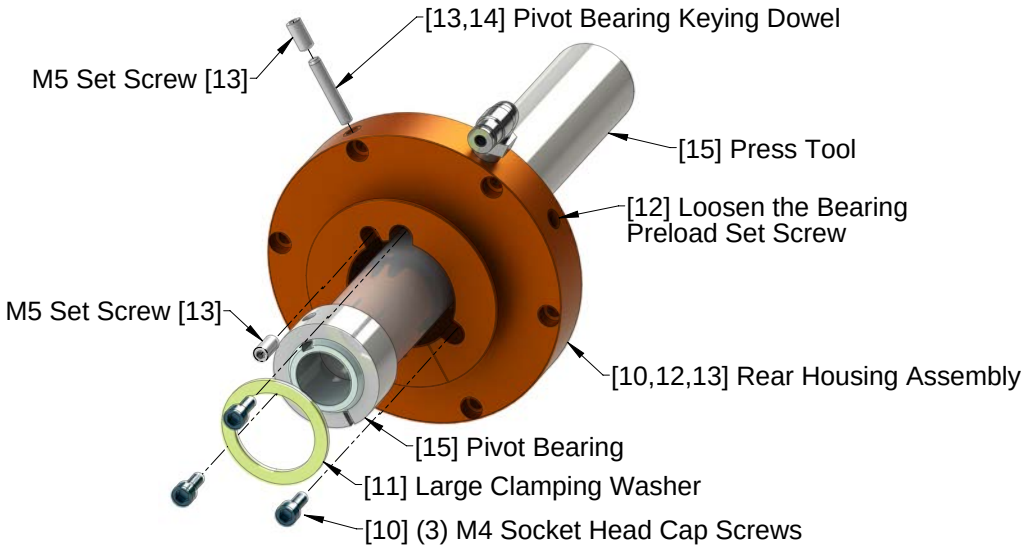
5. Using a 5 mm hex key, remove the M8 socket button head cap screw and washer from the center of the deburring unit's rear housing assembly. Refer to *Figure 6.11*.
6. Using a 3 mm hex key, remove the (6) M4 socket head cap screws that secure the rear housing assembly to the front housing assembly.
7. Remove the rear housing assembly; also remove the O-ring and alignment pin from the back of the front housing.
8. Use a clean lint free rag to remove debris and lubrication from the alignment pin, O-ring, rear, and front housing assemblies.

Figure 6.11—Rear Housing Removal



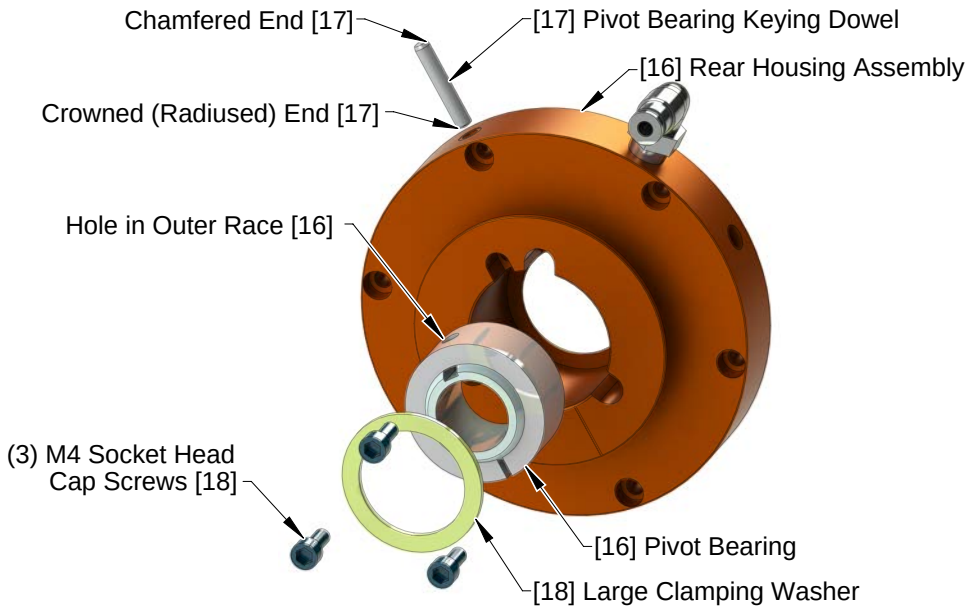
9. If replacing the replacing the pivot bearing, go to step *10*.
   If replacing the entire rear housing, go to step *23*.
10. Using a 3 mm hex key, remove the (3) M4 socket head cap screws that secure the pivot bearing in the center of the rear housing.
11. Remove the large clamping washer that rests on top of the pivot bearing.
12. Loosen the bearing preload set screw in the rear housing.
13. Using a 2.5 mm hex key, remove the (2) M5 set screws that secure the pivot bearing keying dowel in the rear housing.
14. Use a small diameter magnet or a powerful magnet attached to the side of a hex key to reach inside the keying dowel pin hole and remove the keying dowel pin from the rear housing.
15. With the keying dowel pin removed, the old pivot bearing can be pressed from the rear housing using a press tool.

Figure 6.12—Pivot Bearing Removal



16. Insert the new pivot bearing into the rear housing, making sure the hole in the outer race of the new pivot bearing aligns with the keying dowel pin hole in the rear housing.
17. Always use a new keying dowel pin. Insert the keying dowel pin with its crowned end first so it rests in the slot machined in the pivot bearing's ball (visible from the end of the pivot bearing).
18. Apply Loctite 222 to the threads of the (3) M4 socket head cap screws used to secure the large clamping washer. Insert the large clamping washer. Using a 3 mm hex key, install the (3) M4 socket head cap screws that secure the clamp. Tighten to 12 in-lbs (1.4 Nm).

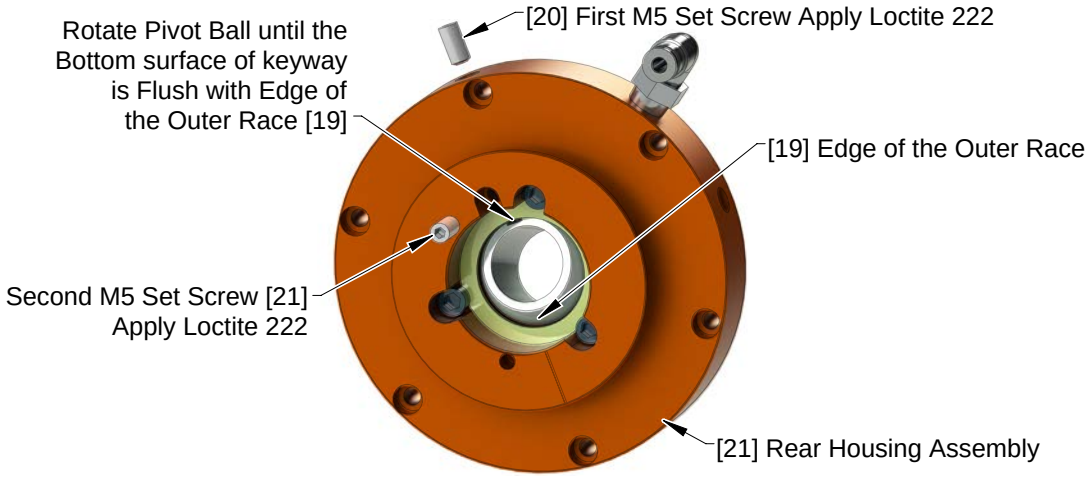
Figure 6.13—Pivot Bearing Installation



19. Rotate the pivot ball until the bottom surface of the keyway is flush with the edge of the outer race.
20. Apply Loctite 222 to the (2) M5 set screws used to retain the keying dowel pin. While holding the pivot ball in the rotated position, use a 2.5 mm hex key to thread the first M5 set screw that secures the keying dowel pin in the rear housing until it contacts the top of the pin.

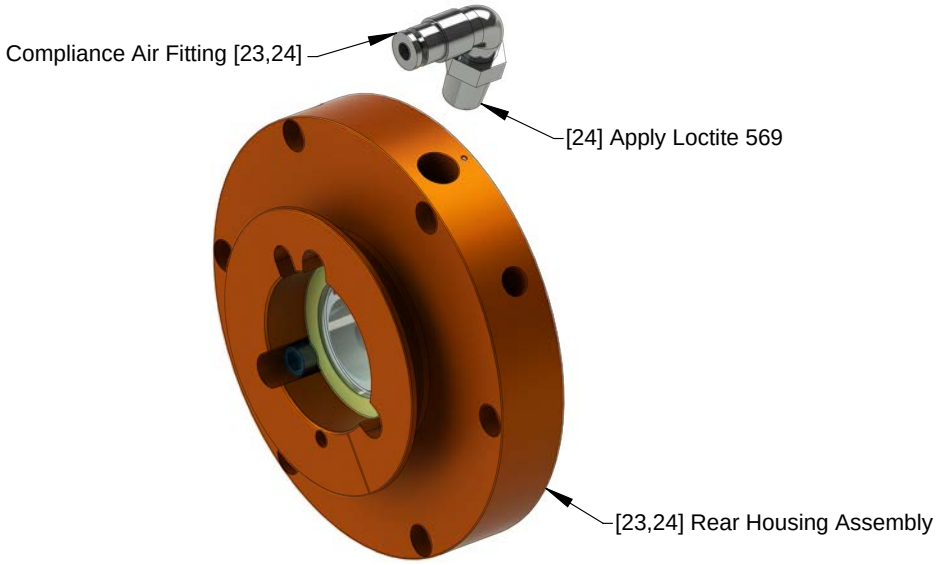
21. Still holding the pivot ball in the rotated position, use a 2.5 mm hex key to insert the second M5 set screw into the rear housing to secure the keying dowel pin in place.
22. To assemble the rear housing to the front housing, go to step *26*.

Figure 6.14—Pivot Bearing Keying Dowel Installation



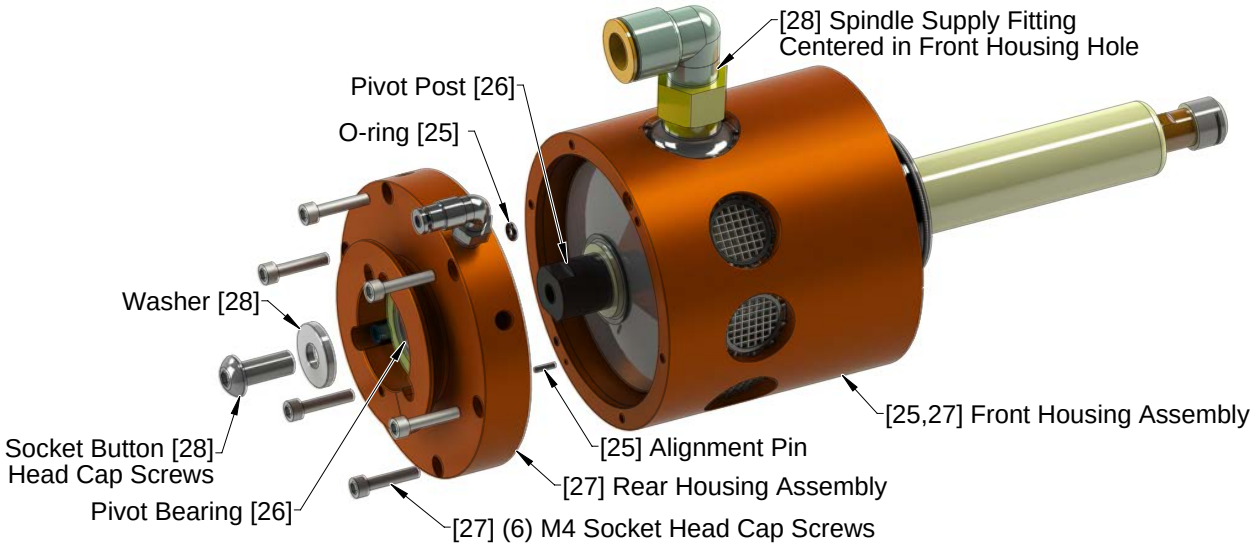
23. Remove the compliance air fitting from the rear housing assembly. Discard the old rear housing assembly.
24. Clean the threads of the compliance air fitting.
25. Apply Loctite 569 to the threads of the compliance air fitting and thread into new rear housing assembly. Tighten hand tight plus an additional 1/2 turn.

Figure 6.15—Install the Compliance Air Fitting to the Rear Housing



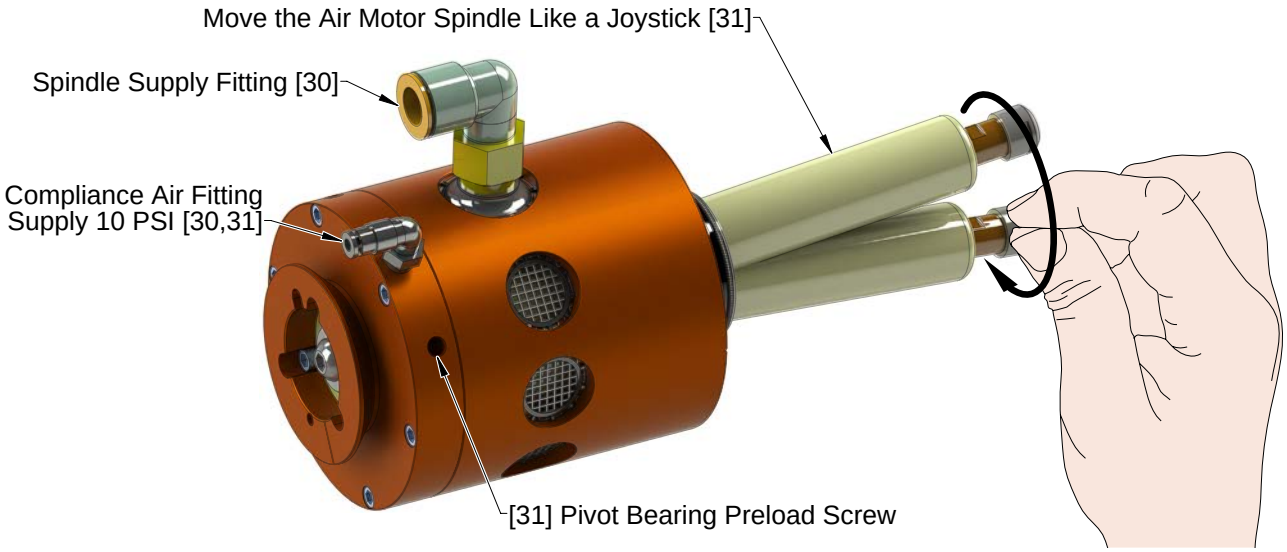
26. Apply a thin coating of Magnalube to the alignment pin and o-ring included with the new rear housing assembly. Insert the pin and o-ring into the front housing as shown in *Figure 6.16*.
27. Align the pivot bearing in the rear housing to the pivot post on the back of the air motor. Assemble the rear housing to the front housing using the alignment pin for proper orientation.
28. Apply Loctite 222 to the (6) M4 socket head cap screws, and use a 3 mm hex key to install the (6) M4 socket head cap screws that secure the rear housing to the front housing. Tighten to 12 in-lbs (1.4 Nm).
29. Apply Loctite 242 to the thread of the socket button head cap screw, insert the washer and thread the screw into the rear of the turbine motor. Hold the turbine motor to center the air supply fitting in the front housing hole, use a 5 mm hex key to install the M8 button head cap screw. Tighten to 110 in-lbs (12.4 Nm).

Figure 6.16—Rear Housing Installation



30. Install the deburring tool to the robot or work location.
31. Connect the air hose to the spindle supply fitting and the compliance air fitting.
32. Adjust the pivot bearing preload set screw if necessary. Supply 10 psi to the compliance air fitting. Move the turbine motor spindle like a joystick and loosen or tighten the pivot bearing preload set screw until a slight resistance to motion can be felt.
33. Apply and/or unlock the spindle motor air supply.

Figure 6.17—Pivot Bearing Adjustment



6.2.5 Spindle Boot Replacement

The spindle boot prevents debris from entering the housing and protects internal components. Replace the spindle boot if damaged.

Refer to *Figure 6.18* and *Figure 6.19*.

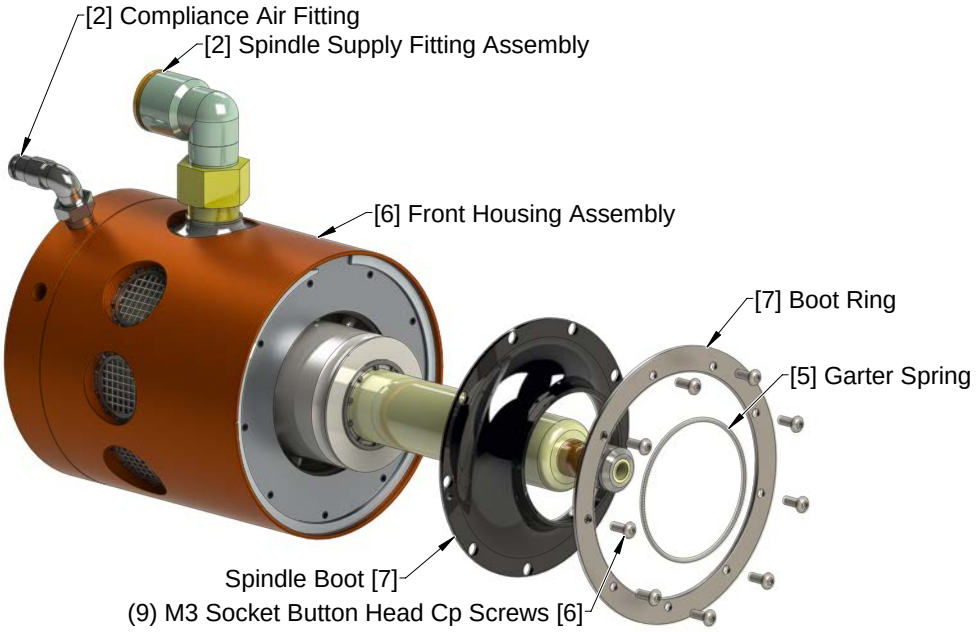
Parts required: *Refer to Section 7—Serviceable Parts.*

Tools required: *2 mm, 3 mm, and 5 mm hex key, torque wrench, small diameter magnet*

Supplies required: *Clean rag and Loctite 222*

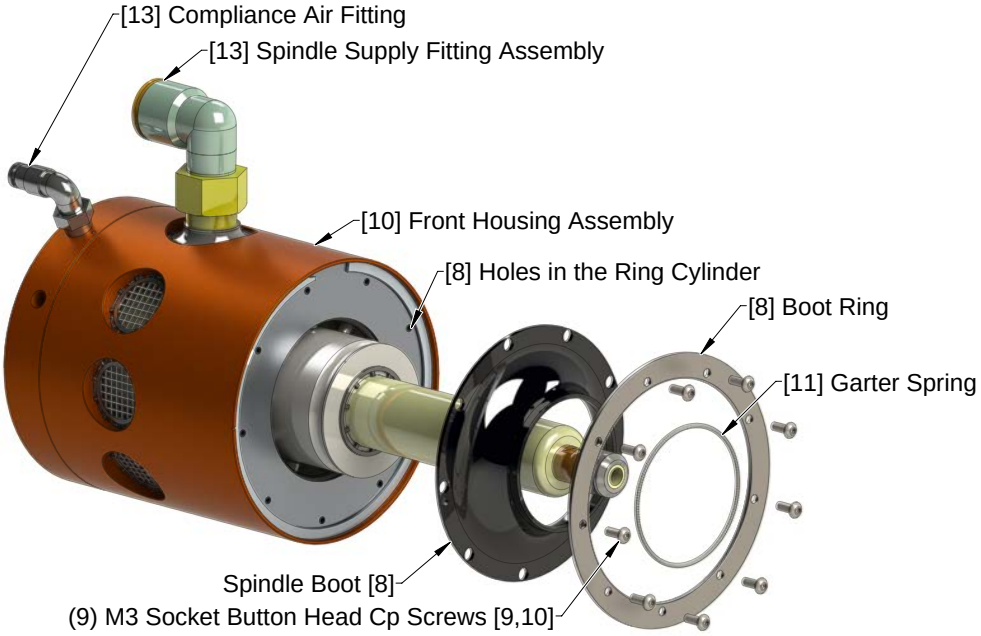
1. Remove and/or lock-out the spindle motor air supply for safety.
2. Disconnect the air hose from the spindle supply fitting and the compliance air fitting. Refer to *Figure 6.18.*
3. Remove the deburring tool from the robot or work location.
4. Clean the debris from the deburring tool using compressed air and a clean rag to wipe any grease from the outer surfaces.
5. Ease the garter spring off the front spindle boot.
6. Using a 2 mm hex key, remove the (9) M3 socket button head cap screws that secure the boot ring to the front housing assembly.
7. Remove the boot ring and spindle boot.

Figure 6.18—Garter Spring, Boot Ring, and Spindle Boot Removal



8. Align the spindle boot and the boot ring with the holes in the ring cylinder.
9. Slide the boot onto the turbine motor and align the edge of the boot to the edge of the contact sleeve.
10. Apply Loctite 222 to the threads of the (9) M3 socket button head cap screws.
11. Use a 2 mm hex key to install the (9) M3 socket button head cap screws that secure the spindle boot and boot ring to the front housing assembly. Tighten to contact plus one additional flat.
12. Stretch the garter spring over the boot, and seat it in the groove on the contact sleeve.

Figure 6.19—Boot Ring, Spindle Boot, and Garter Spring Installation



13. Install the deburring tool to the robot or work location.
14. Connect the air hose to the spindle supply fitting and the compliance air fitting.
15. Apply and/or unlock the spindle motor air supply.

7. Serviceable Parts

For repair and spare parts, please contact ATI. Refer to *Section 9—Drawings* for exploded drawings showing all the user replaceable components of the Flexdeburr. Available accessories, tools, and optional replacement parts are listed in *Section 7.1—Accessories Tools, and Optional Replacement Parts*. All other repairs must be performed by ATI.

7.1 Accessories Tools, and Optional Replacement Parts

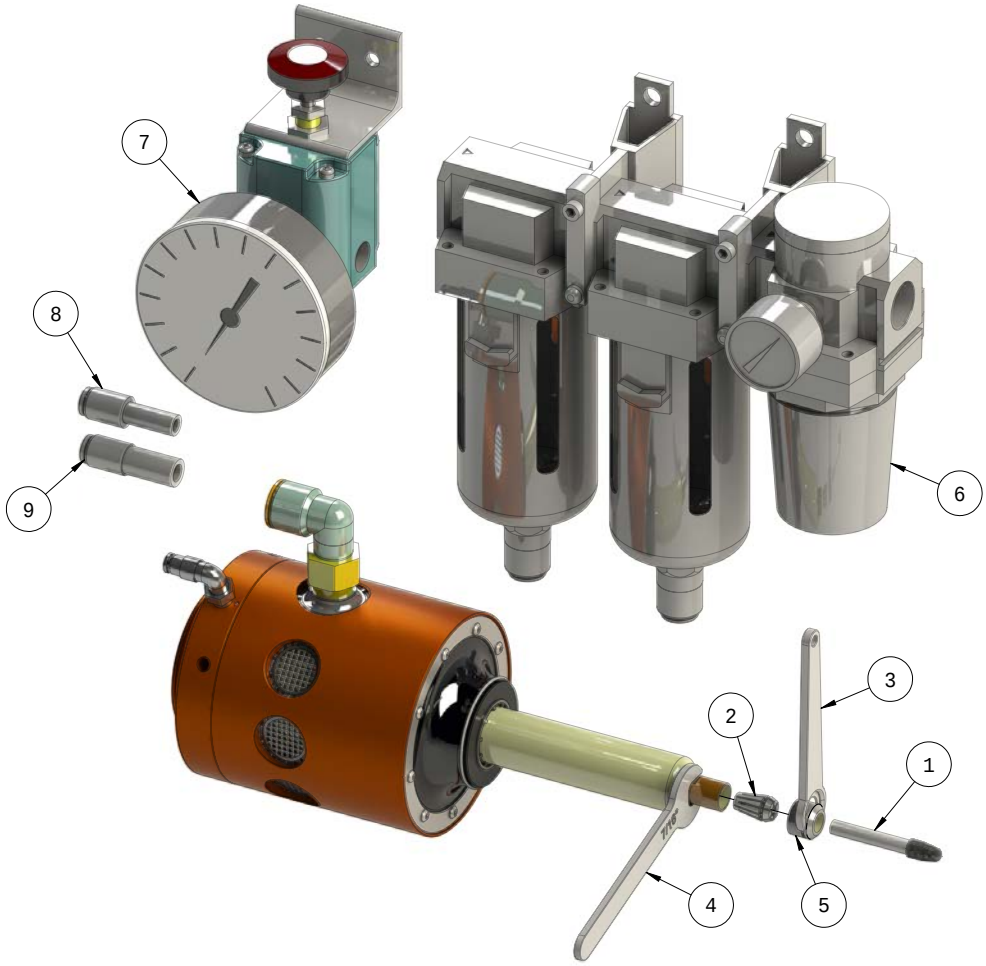


Table 7.1—Serviceable Parts

Item No.	Qty	Part Number	Description
1	1	9150-RC-B-XXXXX	Refer to *Table 4.1* for bur Part Numbers and descriptions
2	1	9150-RC-C-11048	Ø 4 mm ER-11 Collet for ER series RC
		9150-RC-C-87694477	Ø 6 mm-1/4” ER-11 Collet for ER series RC
		9150-RC-C-22768	Ø 6 mm ER-11 Collet
3	1	9150-RC-T-11058	10 mm Wrench for ER-11 Collet
4	1	9150-RC-T-12475	7/16” [11 mm] Open End Wrench
5	1	9150-RC-C-11057	Collet Nut, ER-Collet
6	1	9150-FFR-90	High-Flow Filter/Regulator Assembly
7	1	9150-PPR-60	Precision Regulator
8	1	3405-1210010-01	Spindle Tubing Adapter, 3/8" to 5/16" [8 mm]
9	1	3405-1210011-01	Spindle Tubing Adapter, 1/2" to 5/16" [8 mm]

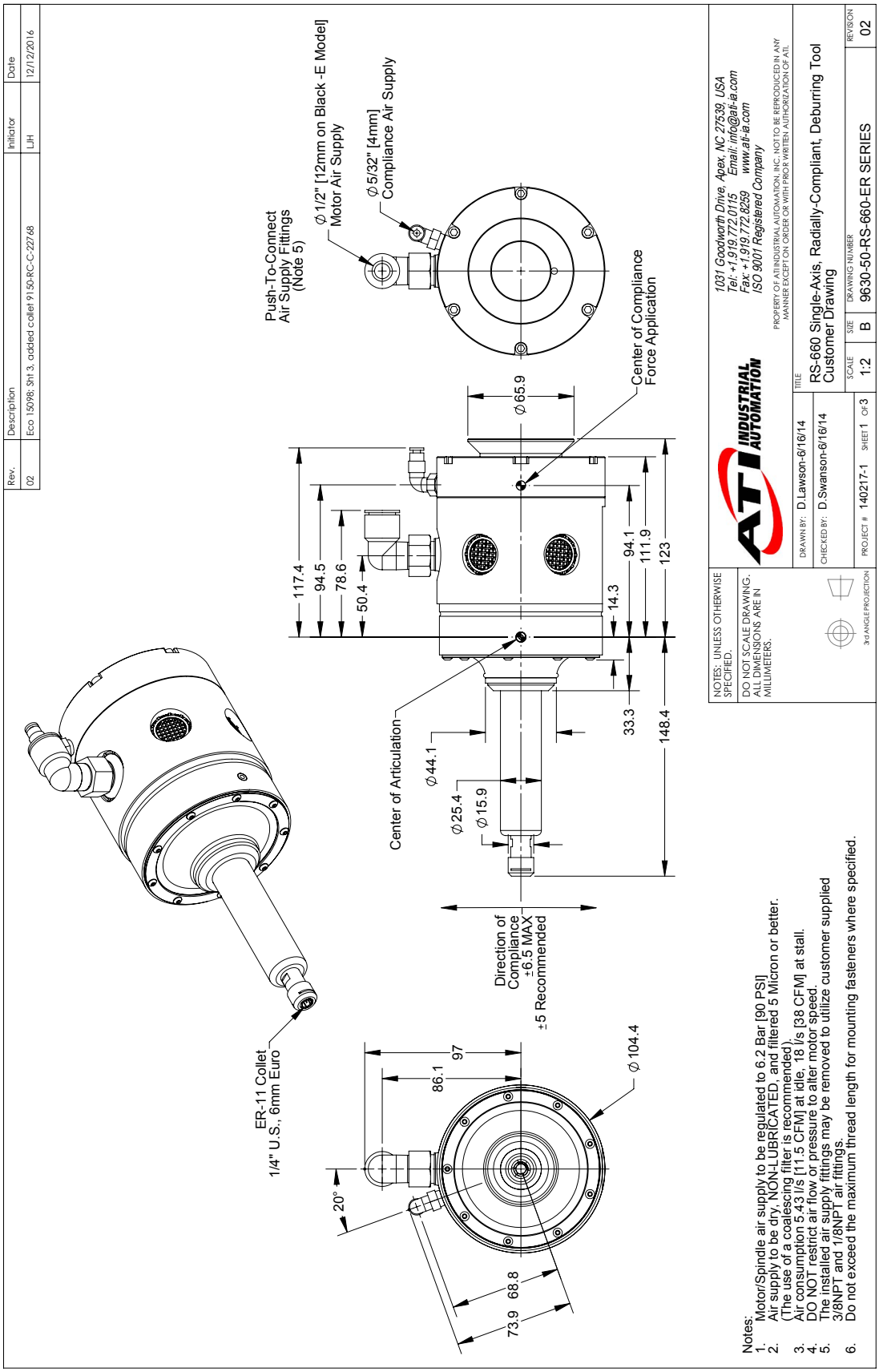
8. Specifications

Table 8.1—Specifications	
Parameter	**Rating**
Motor	Turbine
Motor Part Number	3490-0001038-02
Motor Series	210JSL
Idle Speed (RPM)	40,000 (44,000 Max.)
Torque (Max. Power)	0.16 N-m (1.4 lb-in)
Power	(0.88 hp) @ 40,000 RPM
Weight (without Adapters)	2.2 kg (4.9 lb)
Compensation (Radial)	+/- 9 mm max., +/- 4.5 mm recommended
Compliance Force (Measured at Collet)	12.8-45.4 N (2.8–10.2 lb) @ 1.0-4.1 bar (15–60 psi)
Bur Surface Speed	Dependent on Cutter Geometry and Motor Speed
Spindle Air Pressure	6.2 Bar (90 PSI)
Air Consumption (Idle)	9.4 l/s (20 CFM)
Air Consumption (Stall)	17.9 l/s (38 CFM)
Sound Pressure Level[2]	78 dBa
Collet Size, Standard[3]	1/4" (6 mm) (ER-11 Type with Large Grip Range)
Rotary Burs [4]	Commercial Units Rated 40,000 RPM or Higher
Special Tools	Open End Wrenches (1 Pair Supplied) 7/16” (11 mm) Open End 10 mm Narrow (Only for use with ER11 Collets)

Notes:

1. Specifications applied to a series of models cover the basic “inch” designs and metric -E models.
2. All noise emission measurements were taken under no load idle conditions without a cutting tool. Because the working environment is unknown, it is impossible to predict the noise that will occur during a deburring operation.
3. Optional Sizes Available, See *Section 7—Serviceable Parts*.
4. ATI Can Supply Burs, See *Section 4.5.1—Bur Selection*.

9. Drawings


Rev. | Description | Initiator | Date
02 | Eco 15098; Sht 3, added collet 9150-RC-C-22768 | LJH | 12/12/2016
Push-To-Connect Air Supply Fittings (Note 5)
Ø 1/2" [12mm on Black -E Model] Motor Air Supply
Ø 5/32" [4mm] Compliance Air Supply
Center of Compliance Force Application
Center of Articulation
ER-11 Collet 1/4" U.S., 6mm Euro
Direction of Compliance ±6.5 MAX ±5 Recommended
117.4
94.5
78.6
50.4
14.3
94.1
111.9
123
33.3
148.4
Ø 65.9
Ø 44.1
Ø 25.4
Ø 15.9
Ø 104.4
97
86.1
20°
73.9
68.8
NOTES: UNLESS OTHERWISE SPECIFIED.
DO NOT SCALE DRAWING. ALL DIMENSIONS ARE IN MILLIMETERS.
3rd ANGLE PROJECTION
1031 Goodworth Drive, Apex, NC 27539, USA
Tel: +1.919.772.0115 Email: info@ati-ia.com
Fax: +1.919.772.8259 www.ati-ia.com
ISO 9001 Registered Company
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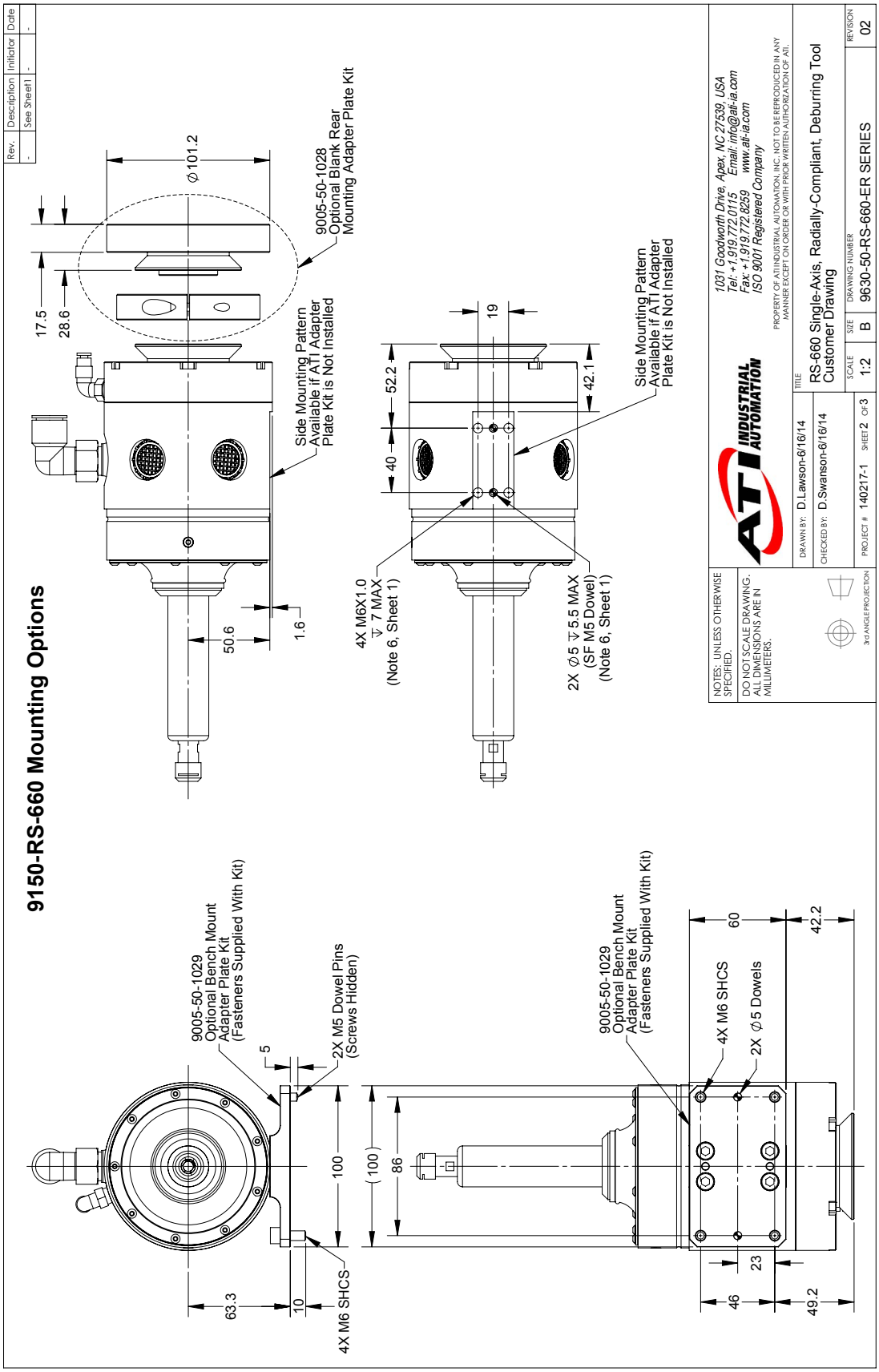
DRAWN BY: D.Lawson-6/16/14
CHECKED BY: D.Swanson-6/16/14
PROJECT # 140217-1 SHEET 1 OF 3
TITLE
RS-660 Single-Axis, Radially-Compliant, Deburring Tool Customer Drawing
SCALE 1:2
SIZE B
DRAWING NUMBER 9630-50-RS-660-ER SERIES
REVISION 02
Notes:
1. Motor/Spindle air supply to be regulated to 6.2 Bar [90 PSI]
2. Air supply to be dry, NON-LUBRICATED, and filtered 5 Micron or better. (The use of a coalescing filter is recommended).
3. Air consumption 5.43 l/s [11.5 CFM] at idle, 18 l/s [38 CFM] at stall.
4. DO NOT restrict air flow or pressure to alter motor speed.
5. The installed air supply fittings may be removed to utilize customer supplied 3/8NPT and 1/8NPT air fittings.
6. Do not exceed the maximum thread length for mounting fasteners where specified.


9150-RS-660 Mounting Options
Rev. | Description | Initiator | Date
- | See Sheet 1 | - | -
Ø101.2
9005-50-1028
Optional Blank Rear
Mounting Adapter Plate Kit
17.5
28.6
Side Mounting Pattern
Available if ATI Adapter
Plate Kit is Not Installed
50.6
1.6
4X M6X1.0
↧ 7 MAX
(Note 6, Sheet 1)
19
52.2
42.1
40
Side Mounting Pattern
Available if ATI Adapter
Plate Kit is Not Installed
2X Ø5 ↧ 5.5 MAX
(SF M5 Dowel)
(Note 6, Sheet 1)
9005-50-1029
Optional Bench Mount
Adapter Plate Kit
(Fasteners Supplied With Kit)
5
2X M5 Dowel Pins
(Screws Hidden)
100
(100)
86
63.3
10
4X M6 SHCS
9005-50-1029
Optional Bench Mount
Adapter Plate Kit
(Fasteners Supplied With Kit)
4X M6 SHCS
2X Ø5 Dowels
60
42.2
23
46
49.2
NOTES: UNLESS OTHERWISE SPECIFIED.
DO NOT SCALE DRAWING. ALL DIMENSIONS ARE IN MILLIMETERS.
3rd ANGLE PROJECTION
DRAWN BY: D.Lawson-6/16/14
CHECKED BY: D.Swanson-6/16/14
PROJECT # 140217-1 SHEET 2 OF 3
TITLE
RS-660 Single-Axis, Radially-Compliant, Deburring Tool
Customer Drawing
SCALE 1:2
SIZE B
DRAWING NUMBER 9630-50-RS-660-ER SERIES
REVISION 02
1031 Goodworth Drive, Apex, NC 27539, USA
Tel: +1.919.772.0115 Email: info@ati-ia.com
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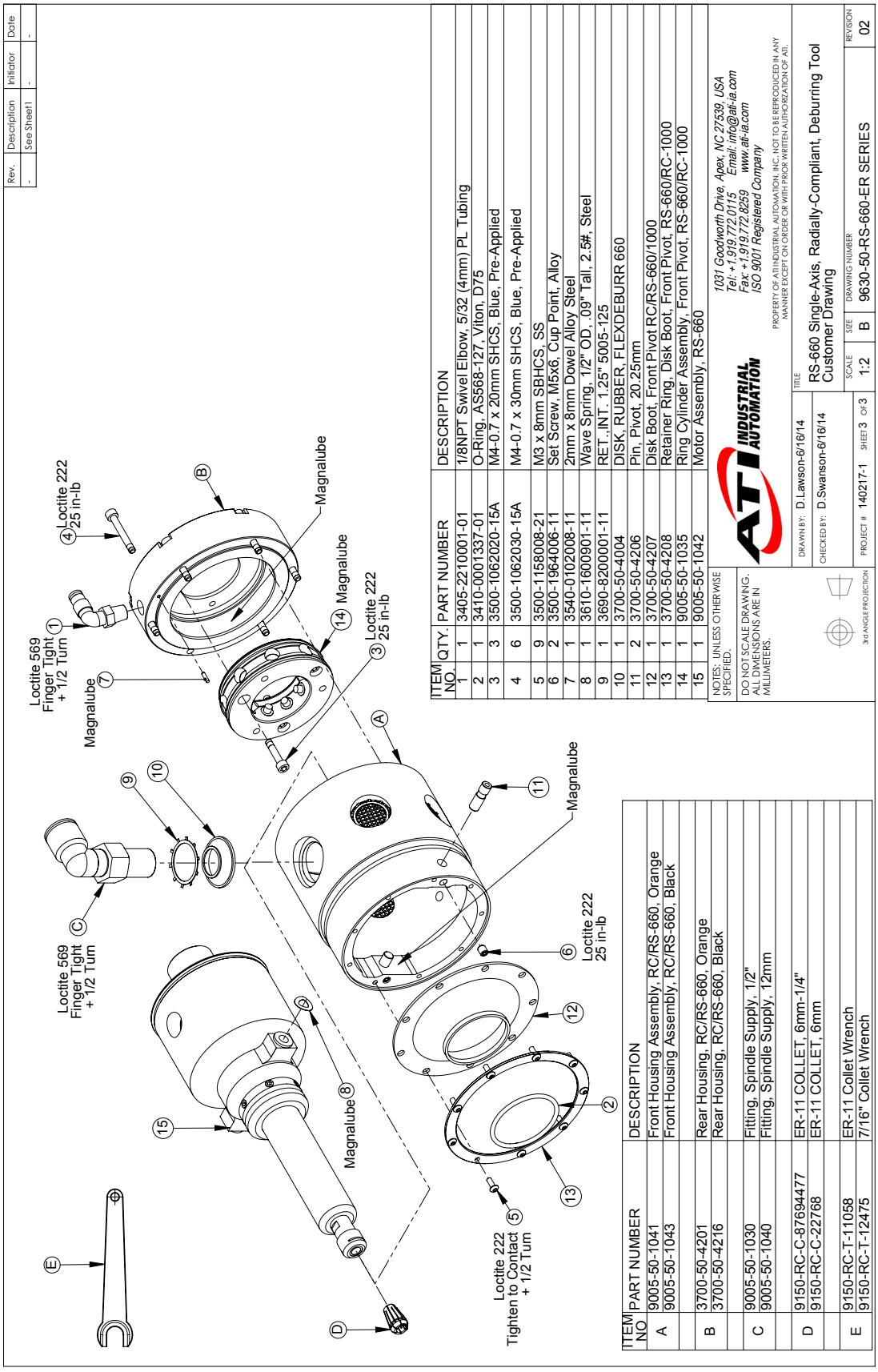

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	3405-2210001-01	1/8NPT Swivel Elbow, 5/32 (4mm) PL Tubing
2	1	3410-0001337-01	O-Ring, AS568-127, Viton, D75
3	3	3500-1062020-15A	M4-0.7 x 20mm SHCS, Blue, Pre-Applied
4	6	3500-1062030-15A	M4-0.7 x 30mm SHCS, Blue, Pre-Applied
5	9	3500-1158008-21	M3 x 8mm SBHCS, SS
6	2	3500-1964006-11	Set Screw, M5x6, Cup Point, Alloy
7	1	3540-0102008-11	2mm x 8mm Dowel Alloy Steel
8	1	3610-1600901-11	Wave Spring, 1/2" OD, .09" Tall, 2.5#, Steel
9	1	3690-8200001-11	RET.,INT. 1.25" 5005-125
10	1	3700-50-4004	DISK, RUBBER, FLEXDEBURR 660
11	2	3700-50-4206	Pin, Pivot, 20.25mm
12	1	3700-50-4207	Disk Boot, Front Pivot RC/RS-660/1000
13	1	3700-50-4208	Retainer Ring, Disk Boot, Front Pivot, RS-660/RC-1000
14	1	9005-50-1035	Ring Cylinder Assembly, Front Pivot, RS-660/RC-1000
15	1	9005-50-1042	Motor Assembly, RS-660

ITEM NO.	PART NUMBER	DESCRIPTION
A	9005-50-1041	Front Housing Assembly, RC/RS-660, Orange
	9005-50-1043	Front Housing Assembly, RC/RS-660, Black
B	3700-50-4201	Rear Housing, RC/RS-660, Orange
	3700-50-4216	Rear Housing, RC/RS-660, Black
C	9005-50-1030	Fitting, Spindle Supply, 1/2"
	9005-50-1040	Fitting, Spindle Supply, 12mm
D	9150-RC-C-87694477	ER-11 COLLET, 6mm-1/4"
	9150-RC-C-22768	ER-11 COLLET, 6mm
E	9150-RC-T-11058	ER-11 Collet Wrench
	9150-RC-T-12475	7/16" Collet Wrench

NOTES: UNLESS OTHERWISE SPECIFIED.

DO NOT SCALE DRAWING. ALL DIMENSIONS ARE IN MILLIMETERS.

3rd ANGLE PROJECTION

DRAWN BY: D.Lawson-6/16/14
CHECKED BY: D.Swanson-6/16/14
PROJECT # 140217-1 SHEET 3 OF 3

TITLE
RS-660 Single-Axis, Radially-Compliant, Deburring Tool
Customer Drawing

SCALE 1:2 | SIZE B | DRAWING NUMBER 9630-50-RS-660-ER SERIES | REVISION 02

1031 Goodworth Drive, Apex, NC 27539, USA
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ISO 9001 Registered Company

Rev.	Description	Initiator	Date
-	See Sheet 1	-	-

10. Terms and Conditions of Sale

The following Terms and Conditions are a supplement to and include a portion of ATI's Standard Terms and Conditions, which are on file at ATI and available upon request.

ATI warrants the compliant tool product will be free from defects in design, materials, and workmanship for a period of one (1) year from the date of shipment and only when used in compliance with the manufacturer's specified normal operating conditions. This warranty does not extend to tool components subject to wear and tear under normal usage; including but not limited to those components that require replacement at standard service intervals. The warranty period for repairs made under a RMA shall be for the duration of the original warranty, or ninety (90) days from the date of repaired product shipment, whichever is longer. This warranty is void if the unit is not used in accordance with guidelines that are presented in this document. ATI will have no liability under this warranty unless: (a) ATI is given written notice of the claimed defect and a description thereof within thirty (30) days after Purchaser discovers the defect and in any event not later than the last day of the warranty period; and (b) the defective item is received by ATI not later ten (10) days after the last day of the warranty period. ATI's entire liability and Purchaser's sole remedy under this warranty is limited to repair or replacement, at ATI's election, of the defective part or item or, at ATI's election, refund of the price paid for the item. The foregoing warranty does not apply to any defect or failure resulting from improper installation, operation, maintenance or repair by anyone other than ATI.

ATI will in no event be liable for incidental, consequential or special damages of any kind, even if ATI has been advised of the possibility of such damages. ATI's aggregate liability will in no event exceed the amount paid by purchaser for the item which is the subject of claim or dispute. ATI will have no liability of any kind for failure of any equipment or other items not supplied by ATI.

No action against ATI, regardless of form, arising out of or in any way connected with products or services supplied hereunder may be brought more than one (1) year after the cause of action occurred.

No representation or agreement varying or extending the warranty and limitation of remedy provisions contained herein is authorized by ATI, and may not be relied upon as having been authorized by ATI, unless in writing and signed by an executive officer of ATI.

Unless otherwise agreed in writing by ATI, all designs, drawings, data, inventions, software and other technology made or developed by ATI in the course of providing products and services hereunder, and all rights therein under any patent, copyright or other law protecting intellectual property, shall be and remain ATI's property. The sale of products or services hereunder does not convey any express or implied license under any patent, copyright or other intellectual property right owned or controlled by ATI, whether relating to the products sold or any other matter, except for the license expressly granted below.

In the course of supplying products and services hereunder, ATI may provide or disclose to Purchaser confidential and proprietary information of ATI relating to the design, operation or other aspects of ATI's products. As between ATI and Purchaser, ownership of such information, including without limitation any computer software provided to Purchaser by ATI, shall remain in ATI and such information is licensed to Purchaser only for Purchaser's use in operating the products supplied by ATI hereunder in Purchaser's internal business operations.

Without ATI's prior written permission, Purchaser will not use such information for any other purpose or provide or otherwise make such information available to any third party. Purchaser agrees to take all reasonable precautions to prevent any unauthorized use or disclosure of such information.

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10.1 Motor Life and Service Interval Statement

The air motors that are used in ATI deburring/finishing tools are subject to wear and have a finite life. Motors that fail, during the warranty period, will be repaired or replaced by ATI as lon as there is no evidence of abuse or neglect and that the normal operating practices outlined in this manual have been observed.

Components such as motor vanes, bearings, any gear reduction components, and collet nuts/chucks are considered consumable and are not covered by warranty. The customer should expect to service or replace these items at designated service intervals. For any part that is not detailed in this manual, contact ATI for Part Numbers and pricing.

Premature bearing failure can occur from exposing the deburring tool to coolants and water or impacts from collisions. Other failure modes that are outlined in the manual and relate to improper machining practices and deburring media selection.

10.1.1 Turbine Motor Products (Flexdeburr (RC) models)

Turbine motors are not serviceable at this time. The expected life of a turbine motor in normal operation is entirely application dependent based on a multitude of factors To maximize the life of turbine motor products, the customer should follow closely the normal operation guide in the product manual. The supplied air must be totally lube free and filtered to remove particulates and moisture. Exposing the turbine motors to oil in the air supply results in premature failure. Premature bearing failure can occur from exposing the deburring tool to coolants and water or impacts from collisions. Other failure modes are outlined in the manual and relate to improper machining practices and deburring media selection.