ATI Multi-Axis, Radially-Compliant Robotic Deburring Tool

(Model 9150-RD-390-NL)

Product Manual

Document #: 9610-50-1022

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 the product, otherwise damage to the product or unsafe conditions may occur.

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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 workpiece.
Bur	Cutting tool used to remove burs from the workpiece. 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 supply air 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 workpiece.
Conventional Milling	Method of cutting where the direction of tool motion is opposite that of tool rotation.
Deburr	To remove the burrs from a piece of machined work.
Elastomeric Coupling	Plastic/Rubber cross-shaped piece used to join a pair of axially separated shaft couplers to transmit power and accommodate offset and alignment of rotating components.
End-Effector	Tool used by the robot to perform a particular function.
RD	The ATI series of products that has radial compliance and can limit articulation to a single axis for increased rigidity that is parallel to the direction of cutter motion.
Regulator	Device used to set and control the supplied air pressure to lower acceptable levels.
Shaft Coupler	A fork shaped device threaded onto a rotating spindle or rotating component. A pair of couplers are joined by an elastomeric coupling to transmit power.
Solenoid Valve	Electrically controlled device for switching air supplies on and off.
Spindle	The rotating portion of the deburring tool assembly.
Vane-Type	A positive displacement air motor design utilizing partitions (vanes) to separate expansion regions inside a housing.

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 Deburring tool 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 stress/strain, kinking, rupture, etc. Failure of critical pneumatic lines to function properly may result in equipment damage.

1.3 Safety Precautions

CAUTION: Do not use burs rated for less than the speed of the RD deburring tool being used. Using these too may cause injury or damage equipment. Always use burs rated for at least the speed of the RD 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: Do not perform maintenance or repair on the Deburring tool 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 in a tool stand and air remaining on. Place the tool safely in the tool stand and turn off the air before performing maintenance or repair on the Deburring tool product.

2. Product Overview

The multi-axis Radially-Compliant (RD) deburring toolis a robust, high-speed and lightweight vane-type air motor deburring unit for deburring materials such as aluminum, plastic, and steel with a robot. The RD 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 RD deburring tool's pneumatically controlled, articulated design allows the cutting bit 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 RD-390-NL has an optional feature to limit articulation to a single axis to provide increased rigidity that is parallel to the direction of cutter motion. The rigid parallel support is capable of producing greater control of surface finish and reduced tool chatter. However, to maintain the proper orientation of the cutting tool and the part profile requires more skill and effort in robot programming.

Compliance is supported by air pressure that is applied to the shaft of the unit and is used to perform consistent deburring on irregular part patterns. The RD deburring tool utilizes standard industrial tungsten-carbide bits that allow for adaptation to changing assembly lines and part requirements.

The RD-390-NL provides a side mounting with (2) dowel pin locations and threaded holes. Custom adapter plates for side mounting are available from ATI. Refer to *Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf* for more information.

The RD-390-NL is equipped with a 1/4 NPT to a G 1/4 (BSPP) adapter to supply the motor air and 5/32" push-to-connect fittings to supply the compliance air.

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

Figure 2.1—RD-390-NL Deburring Tool

2.1 Tool Collet Systems

All deburring tool 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 air motor design does not allow the installation of quick-change or drawbar collet systems.

The standard tool holding system for RD series of products is an economical, industry standard DA200 collet design. This design is suitable for most applications where industry standard shank diameter cutting tools are used and runout tolerances of up to 0.001" (0.025 mm) are acceptable. The DA200 collet system is used worldwide on hand-held air tools which allows users to procure different collet sizes from local industrial supply firms.

Deburring Tool Part Number Structure

For the following part number, 9150-RD-XXX-NL:

- "RD" designates a multi-axis a tool of radial compliance.
- "xxx" designates the motor power in Watts.
- "NL" designates the option of lube free air motor operation.

2.2 Technical Description

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

2.2.1 Environmental Limitations

2.2.1.1 Operation

Table 2.1—Operation

Installation Position	Mounted to robot by means of the side mounting pattern.
	Mounted to a table or stand by means of the bench adapter. The robot is carrying the work piece to the deburring tool.
Temperature Range	5 °C – 35 °C 41 °F – 95 °F
Utilities	The tool requires the following: • Clean, dry, filtered air. The vane-type air motor can be operated without lubrication; however, longer motor life is possible with the addition of a small amount of air tool oil to the motor air supply. • A coalescing filter and filter elements that are rated 5 micron or better. • Air supply to the spindle must be 6.2 Bar (90 PSI) to develop the full rated power. • The radial compliance (centering) air must be supplied at 1.0–4.1 Bar (15–60 PSI) from a regulated source.

2.2.1.2 Storage

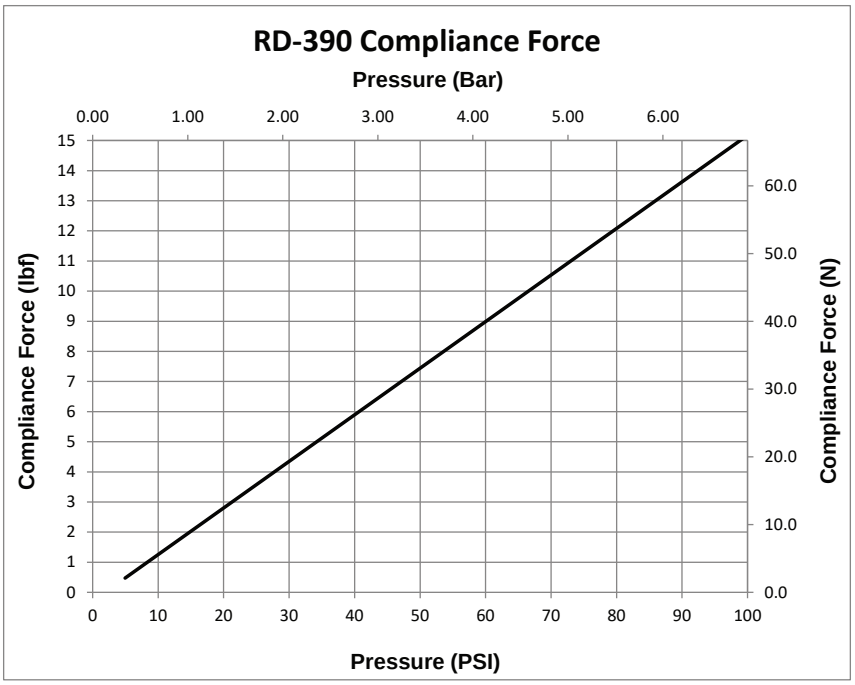
Table 2.2—Storage	
Temperature Range	0 °C – 45 °C 32 °F – 113 °F
Conditions	The tool should be stored in its crate and in a dry place. When not in use, keep the unit in its crate if possible. Consult *Section 3.4—Storage and Preventive Maintenance During Storage* of this manual.

2.2.2 Compliance Unit Performance

The following graph illustrates 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 the 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.

Figure 2.2—RD-390 Compliance Force Curves (measured at the spindle tip)



2.2.3 Air Motor Performance

The following graphs illustrate the motor torque and power performance. The air motor operating speed changes according to the applied load, until the motor develops the power that is required to perform the specific task. The idle speed of the motor is at maximum, when no load is applied. Without an applied load, the motor decreases to a slower operating speed at which the motor develops maximum torque. If the torque that is required to perform a specific task exceeds the maximum available operating speed, the motor stalls. Therefore, multiple, light, passes are preferred over slow, heavy cuts.

Figure 2.3—RD-390 Motor Torque Curves

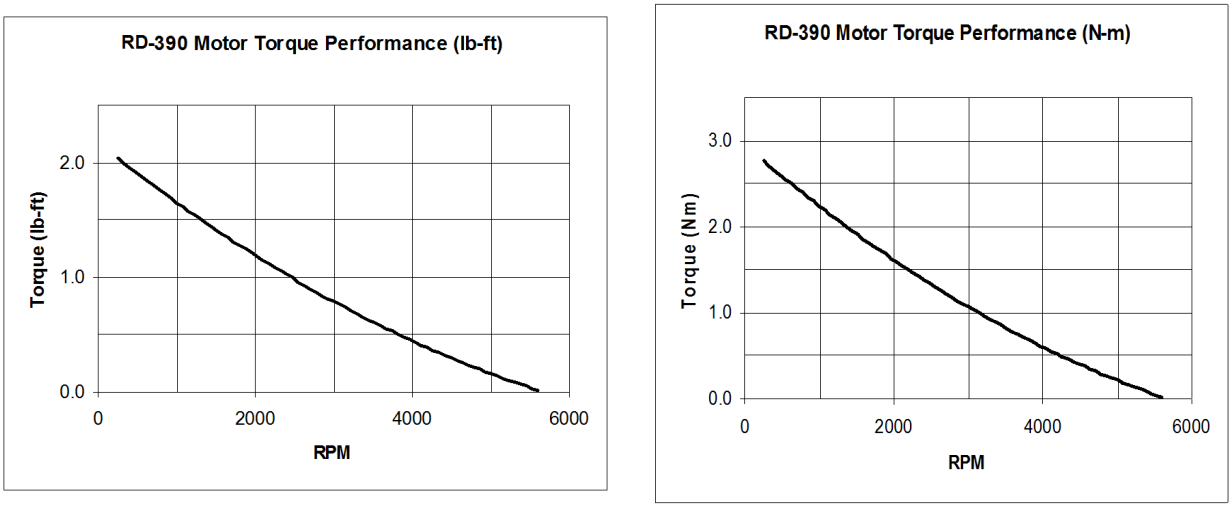
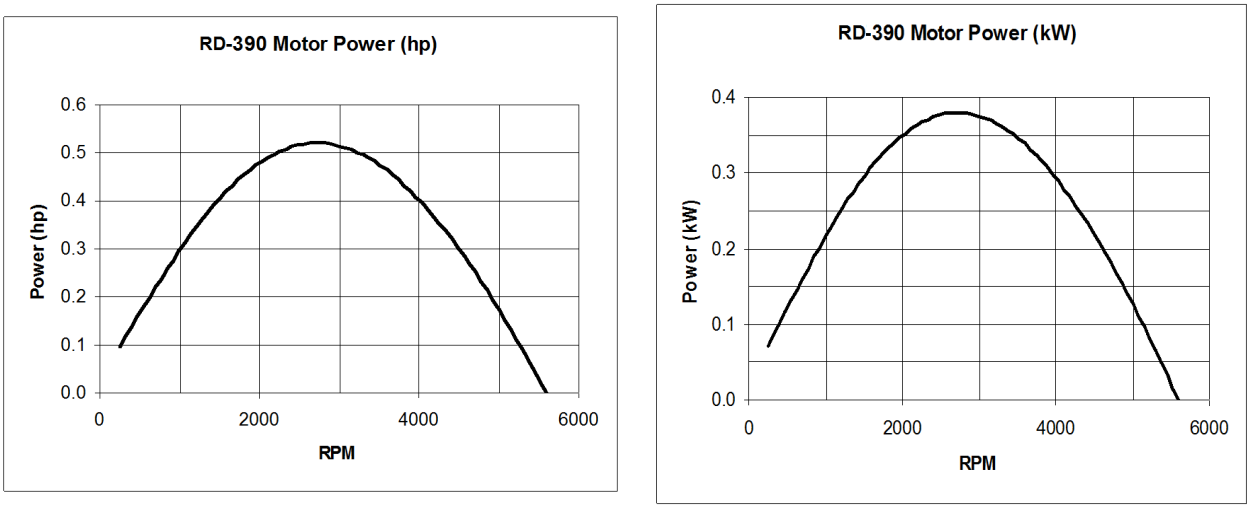


Figure 2.4—RD-390 Motor Power Curves



3. Installation

The deburring tool is delivered fully assembled. Optional equipment such as mounting adapter plates, burr tools, additional collets will be separate.

3.1 Protection During Transportation

The deburring tool is packaged in a crate that secures and protects the tool 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 is 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 the evaluation of the product condition.

3.3 Unpacking and Handling

The deburring tool should always be placed inside the accompanying crate, while transporting, 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 always be stored in its crate, when not in use. The deburring tool should be stored in a dry place.

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

3.5 Side Mounting Installation

CAUTION: The length of the fasteners should not interfer with the compliant motion of the air motor spindle. Refer to *Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf* for the maximum fastener length. Do not use fasteners that exceed the maximum length; otherwise, damage will occur.

CAUTION: Lock washers are recommended on all mounting fasteners. Liquid thread lockers should not be used for the mounting fasteners as this may damage or remove thread inserts during disassembly.

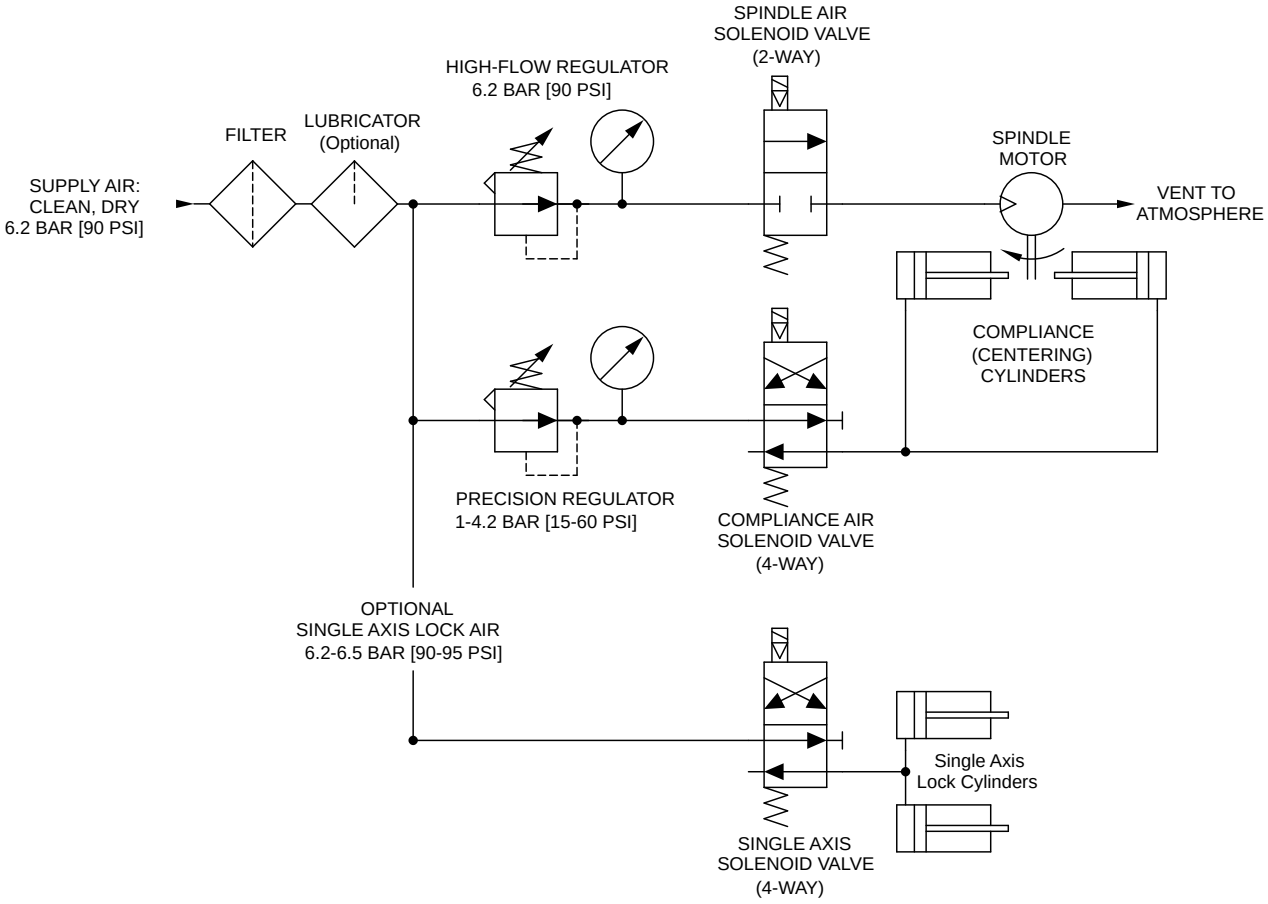
The side mounting pattern of the RD deburring tool consists of (2) dowel pin holes and (4) threaded holes Refer to the following figure and *Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf*. An optional bench mount adapter plate allows the deburring tool to attach to a bench or other work surface. The bench mount adapter may also be used with intermediate plates to attach the deburring tool to a robot flange or to an ATI tool changer. If the RD deburring tool is permanently mounted to a work surface, the robot carries the part to be deburred to the deburring tool.

Figure 3.1—Side Mounting Installation

3.6 Pneumatics

Connect the RD deburring tool as shown in the following figure.

Figure 3.2—Pneumatic Connections



> **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.

To develop full power from the vane-type spindle air motor ATI recommends that the user install a high-flow pneumatic pressure regulator (ATI Part #9150-FFR-90, or equivalent) and a high-flow valve to properly supply a stable air supply of 6.2 Bar (90 PSI) to the spindle motor. See *Section 8—Specifications* for the maximum flow requirements. With a small amount of commercial air tool oil is in the motor's air supply stream, the motor will have a longer life. The air supply should be dry, filtered, with optional lubrication. Use a coalescing filter with elements rated for 5 micron or better. Because the deburring motor is a positive displacement device, lower operating speeds can be achieved by reducing the motor supply air pressure.

A second, precision, self-relieving regulator (ATI Part # 9150-P16-B-G, or equivalent) and valve supply the compliance (centering) mechanism. The compliance air pressure corresponds to the side, radially applied force on the rotary bur. Adjust the compliance air pressure and robot traverse speed to achieve the desired finish. Because very little airflow is required, a significantly smaller valve can 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 the compliance air supply. 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 that is controlled from the robot. An analog output port in the robot or logic controller will be needed.

To reduce the RD tool to compliant operation along a single axis, a third air supply at 6.2–6.5 Bar (90–95 PSI) must be provided with a control valve. Very little air flow is required to lock the tool into single axis compliance mode.

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

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 the equipment.

Table 3.1—Pneumatic Connections

Connection Function	Connection Type	Pressure Requirement
Air Motor Inlet	1/4" tapped port (1/4 NPT in the motor body and a G 1/4 (BSPP) Adapter is provided.)	6.2 bar (90 psi)
Compliance (Radial) Force Inlet	4 mm (5/32") quick-connect tube Alternate Method: remove the supplied fitting and use 1/8" pipe tap.	1.0–4.1 bar (15–60 psi) (Maximum)
Compliance Lock (Single Axis)	4 mm (5/32") Quick Connect Tube (Alternate: Remove Supplied Fitting to use 1/8" Pipe Tap)	6.2–6.5 bar (90–95 psi)
Exhaust	Vented to atmosphere through the supplied 1/4" muffler. If piping away from the operation, use ≥ 3/8" tubing.	Not Applicable

For the motor air supply, use the largest possible flexible plastic tubing or hose that has a 10 mm (3/8") minimum inside diameter. For the compliance air force and compliance lock air supply, 4 mm (5/32") outer diameter plastic tubing is sufficient. The vane-type air motor vents exhaust air to the environment through the supplied muffler. Alternatively, the muffler can be removed and the exhaust air plumbed to a remote location if necessary. For the exhaust connection, use the largest possible flexible plastic tubing or hose that has a 12 mm (1/2") minimum inside diameter.

The sound level around deburring equipment cannot be predicted by ATI, because the sound pressure from deburring operations is process and part dependent. 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 about 1 bar (15 psi) 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 and have extensive knowledge about automation applications that incorporate robots.

4.1 Safety Precautions

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

DANGER: Never use the deburring tool as a hand-held machine. If used in this way, serious injury or damage to equipment will occur.

WARNING: All personnel, who are involved in the operation of the 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 deburring tool.

WARNING: Never operate the deburring tool 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 proximity of the deburring tool.

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

CAUTION: Do not use burs that are rated for less than the speed of the 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 deburring tool that is being used.

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 or Lexan 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 deburing 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 describe the normal operating conditions for the RD deburring tools.

4.2.1 Air Quality

The air supply should be clean, dry, filtered, and lubricated. A coalescing filter that has 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 not receive the proper air pressure, the tool stalls. Any water in the system damages the housing and blades.

4.2.2 Lubrication

Lubricate the air supply with 3-5 drops of commercial air tool oil.

Vane motors for the RD deburring tool should be run with lubrication in the air supply to maximize motor life. If no lubrication is available, the motor can operate, but the life of the motor is significantly decreased.

4.2.3 Media Selection, Design, and Maintenance

Use radial brushes under 3 inches in diameter.

Do not use media that requires axial loading.

Do not use media that is rated below the RD-390 idle speed.

The RD-390 has a slower speed that allows the use of abrasive and wire wheels. Carbide tools can be used also, but the surface finish and material removed is different from RC deburring tools.

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.

In many robotic deburring applications, including steel and aluminum, no cooling or lubrication of the rotary bur is necessary. For some materials and situations, the addition of coolants or compressed air may aid the cutting process. If it is determined that liquid coolants are required, a non-oil, cutting type fluid should be used to prevent premature wear of the spindle bearing.

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 miminize 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 results in premature failing of the unit. 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 underlying material below the edge, because axial loading results on the tool and bearings. This axial loading results in premature failing of the unit.

Do not attempt to deburr to a depth of more than 30% of the diameter of the bur. Exceeding this depth causes excessive chatter and could result in the following: premature bur wear, the motor stalling, and damage to the bearings, the compliance ring, or both.

When deburring holes, interpolate the perimeter. Do not use a countersink tool because that tool results in axial loading and premature wear of 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 Deburring tool Working Environment

As described in previous sections, the RD 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 RD 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 deburring tool air motor is not loud, the cutting action associated with deburring frequently is loud. Always use hearing protection while working in the proximity 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

The overall deburring tool dimensions are shown in *Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf*. The deburring tool 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 6 mm collets, this will mean 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 (*Figure 4.1*). The diameter of the cutter should not exceed that of the dowel pin by more than the compliance of the RD 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 (*Figure 4.2*). The programming method used depends on the robot's capabilities and programmer preferences.

Figure 4.1—Dowel Teaching Tool

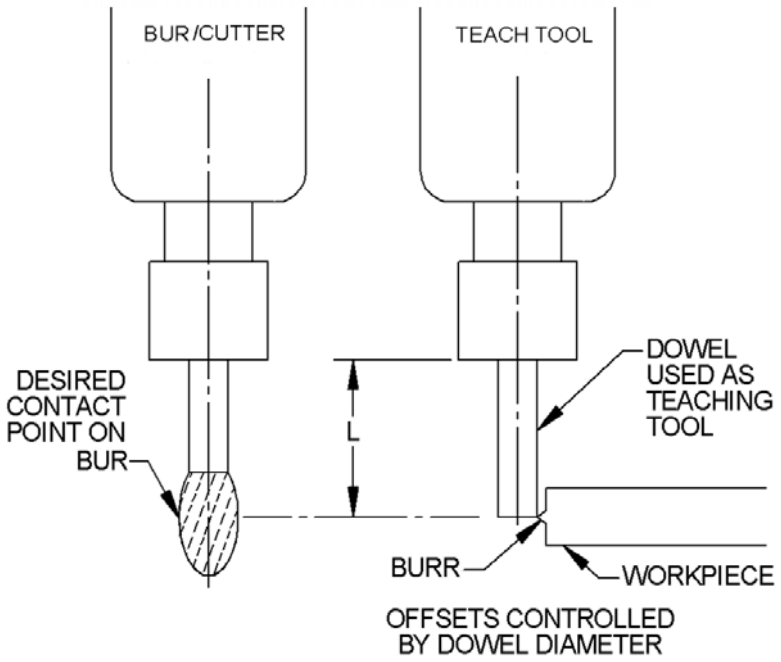
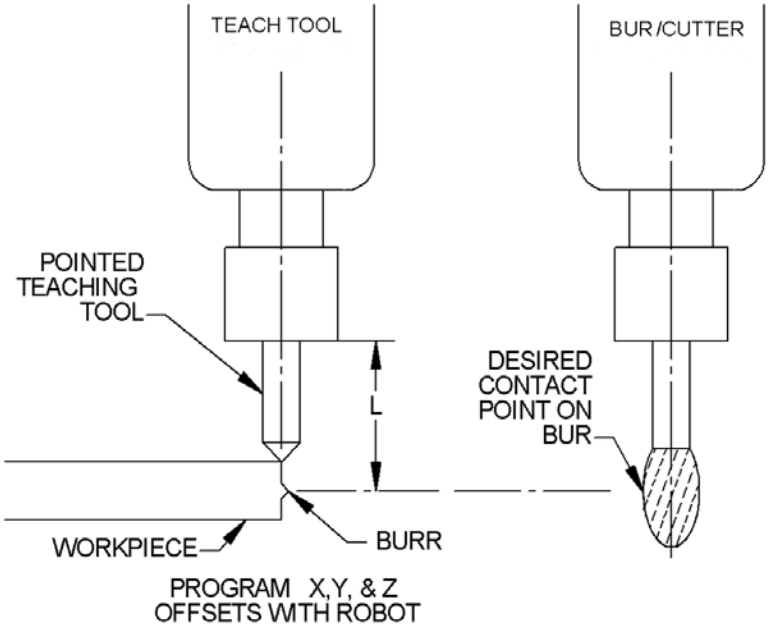


Figure 4.2—Pointed Teaching Tool



Inside 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 inside corner. The resulting force imbalance in two planes causes 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 inside 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 inside radii, a similar situation may arise. Do not attempt to deburr an inside 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 3.6—Pneumatics*, in order to achieve a correct depth of cut.

4.5 Cutter Operation and Bur Selection

The RD deburring tool will perform best in “climb milling”, which is when the cutter directions of traverse and cutter rotation are the same. In the case of the RD deburring tools, the cutter rotation is clockwise when viewed from above. Climb milling would therefore involve clockwise motion around the part being deburred. In climb milling, the heaviest cut is made as the tool enters the workpiece and the chip becomes narrower as the cut is completed. In “conventional milling”, the cutter travels in a direction opposite of cutter rotation. This may aid in cutter 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 generally is reduced. When “conventional milling”, take extra care around corners. A corner poses a potential hazard where the cutting force can deflect the bur and cause the bur to break as the robot continues along its path.

The selection of a cutting tool 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 burrs and suitable applications. It is worth mentioning here that a specific family of burrs is available for working with die cast alloys, aluminum, and plastics. These cutters 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 cutter is dull or the feeds and speeds are not correct for the material removed, chip will melt and weld to the cutter or the work piece. This can quickly load a cutter and produce unacceptable results. In general, the traverse or feed rate of the deburring tool is higher for plastics to minimize melting and welding. A faster feed rate creates larger cuts that more effectively remove heat from the cutter-tool interface.

4.5.1 Bur Selection

Standard length commercial burs are used with deburring tool products. The length of these tools is typically around 2 inches for 1/4” shank diameter burrs (50 mm for 6 mm diameter). Avoid longer shank burs that are available from industrial suppliers and appear in their catalogs with descriptions such as "long" or "exteneded" shank. Using extended or long shank burrs in the deburring tool will place higher loads and vibrations on the motor bearings and result 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 deburring tool. Long shank tools can lead to premature failure of the air motor and is not covered under warranty. Use a standard length commercial bur with the deburring tool.

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

This following table is not comprehensive, but includes many common burr types and burrs 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" Burr Diameter, 5/8" Bur Length, 1/4" Shank**	
	• For greasy aluminum alloys, soft non-ferrous metals and thermoplastics. • For deburring. • For use on cast aluminum.	• Easy chip flow through positive rake angle, rounded base of tooth, convex tooth back. • No loading of the flutes, not even 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-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 deburring. • For use on cast aluminum.	• Easy chip flow-through positive rake angle, rounded base of tooth, convex tooth back. • No loading of the flutes, not even while cutting sticky metals. • Smooth operation due to the peeling effect of the teeth.
	**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 Dia., 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.

4.6 Single Axis Compliance Operation

The RD deburring tool offers the ability to convert the tool from full radial compliance to single axis compliance. This functionality increases stiffness in the direction of cutter travel to allow smoother cuts without chatter. Single-axis mode is implemented using the following procedure.

1. Remove the tool from all cutting operations (the cutting media must not be touching any surface).
2. Increase the compliance air pressure to 60 PSI (4.1 Bar) (this will center the spindle in the housing).
3. Supply and maintain compliance lock air at 90-95 PSI (6.2-6.6 Bar) (this will extend the internal lock pistons to secure the compliance unit).
4. Return the compliance air pressure to the value necessary to produce the desired surface finish.
5. To return the unit to full radial compliance, repeat the preceding steps and remove the lock air pressure supplied that is in step *3*.

5. Maintenance

The RD deburring tool is designed to provide reliable service for long periods of operation. While simple in design, there are few user-serviceable parts in the assembly. The user is encouraged to return the unit to ATI for service. *Section 6—Troubleshooting and Service Procedures* is provided to assist the user when they choose to service the unit in the field.

For all service, it is recommended that the air supply (before the solenoid valves) 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. During maintenance operations, refer to *Section 6—Troubleshooting and Service Procedures* for maintenance instructions. Service and repair parts are identified in *Section 7—Serviceable Parts* and *Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf*.

The RD deburring tool is of modular construction. The subassemblies shown in *Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf* may be purchased and installed quickly to return a unit to operation.

5.1 Pneumatics

The air lines to the deburring tools should routinely be checked for their general condition and replaced as required. The air to the deburring tool must be filtered and dry. The air filters should be checked 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

The deburring tool air motor must be supplied with clean, dry, filtered air. Oil in the air stream is optional. See *Section 3.6—Pneumatics* for details on air supply and quality

CAUTION: It is recommended that the customer use a coalescing filter and filter elements rated 5 micron or better.

5.3 Bur Inspection

The bur will wear depending on cut depth, feed rate, and the material that is being deburred. Inspect the bur regularly for wear and refer to *Section 6—Troubleshooting and Service Procedures* for symptoms of a worn bur. If necessary, replace the bur. Refer to *Section 6.2.1—Bur and Collet Replacement*.

5.4 Spindle Boot Inspection

The spindle boot prevents debris from entering the housing and protects internal components. Inspect the boot regularly for damage. Refer to *Section 6—Troubleshooting and Service Procedures* for symptoms of a worn bur. If necessary, replace the bur. Refer to *Section 6.2.6—Boot Replacement*.

6. Troubleshooting and Service Procedures

The deburring tool is designed to provide reliable service for long periods of operation. While simple in design, there are few user-serviceable parts in the assembly. The user is encouraged to return the unit to ATI for service. *Section 6.1—Troubleshooting* is provided to assist the user when they choose to service the unit in the field.

For all service, it is recommended that the air supply, which is before the solenoid valves in the process, 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 motor spindle. During maintenance operations, refer to *Section 6.2—Service Procedures* for instructions. Service and repair parts are identified in *Section 7—Serviceable Parts* and *Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf*.

6.1 Troubleshooting

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

Table 6.1—Troubleshooting

Symptom	Cause	Resolution
Bur wear.	Hard work material.	Use better grade burr material add coating (TiAlN).
	Too heavy a cut.	Decrease the width of cut. Make multiple passes.
	Feed rate is too slow.	Increase the feed rate.
Bur breakage.	Too heavy a cut.	Decrease the width of cut. Make multiple passes.
	Deflection at corner.	Climb mill. Do not begin the path at sharp corner.
	Impacting the part.	Decrease feed rate at contact. Enter part at an angle.
Unequal compliance.	The regulator is defective.	Replace the regulator.
	Worn ring cylinder.	Replace the ring cylinder. Refer to *Section 6.2.5—Ring Cylinder Assembly 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 6.2.1—Bur and Collet Replacement.*
	The spindle bearings are worn.	Inspect the spindle shaft. If the spindle shaft feels loose or has play, replace. Refer to *Section 6.2.4—Spindle Assembly 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 that is designed for work material.
	The bur is worn.	Inspect bur. If worn, replace. Refer to *Section 6.2.1—Bur and Collet Replacement.*
	The spindle bearings are worn.	Inspect the spindle shaft. If the shaft feels loose or has play, replace. Refer to *Section 6.2.4—Spindle Assembly Replacement.*
Secondary burrs are created on the work piece after cut.	Incorrect feed rate.	Reduce the feed rate.
	Too heavy a cut.	Decrease width of cut. Make multiple passes.
	Improper bur selection.	Choose bur that is designed for work material.
	Bur is worn.	Inspect bur. If worn, replace. Refer to *Section 6.2.1—Bur and Collet Replacement.*
	The spindle bearings are worn.	Inspect the spindle shaft. If the shaft feels loose or has play, replace. Refer to *Section 6.2.4—Spindle Assembly Replacement.*
Chip packing of bur.	Too heavy a cut.	Decrease the width of cut. Make multiple passes.
	Not enough chip clearance	Use a bur with less flutes.

Table 6.1—Troubleshooting		
Symptom	**Cause**	**Resolution**
The bur stalls.	Not enough or no drive air.	Verify the drive air regulator is operating at 90 PSI (6.2 Bar), and check for leaks.
	The bur is not secure in the collet.	Properly tighten bur in the collet.
	Too much side load.	Decrease the width of cut. Make multiple passes.
	Air motor must be replaced.	Replace the air motor. Refer to *Section 6.2.3—Air Motor Replacement.*
The motor spindle is sticking.	The spindle bearings are worn.	Inspect spindle shaft, if shaft feels loose or has play, replace. Refer to *Section 6.2.4—Spindle Assembly Replacement.*
	Motor bearings are worn.	Replace the air motor. Refer to *Section 6.2.3—Air 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.

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 to the user. Be aware that during operation, the bur becomes very hot, and removing the bur, take necessary safety precautions to avoid injury.

6.2.1 Bur and Collet Replacement

In normal operation the bur becomes worn. If improper feeds and speeds are used, the bur may become “loaded” with material. In both instances, replace the bur. During initial production, the bur and the workpiece should be examined often in order to determine at what interval the bur should be replaced. When replacing the same size bur, it's not necessary to replace the collet. When replacing the old bur with a different bur size, the collet must be replaced.

Refer to the following steps for replacing the bur and collet.

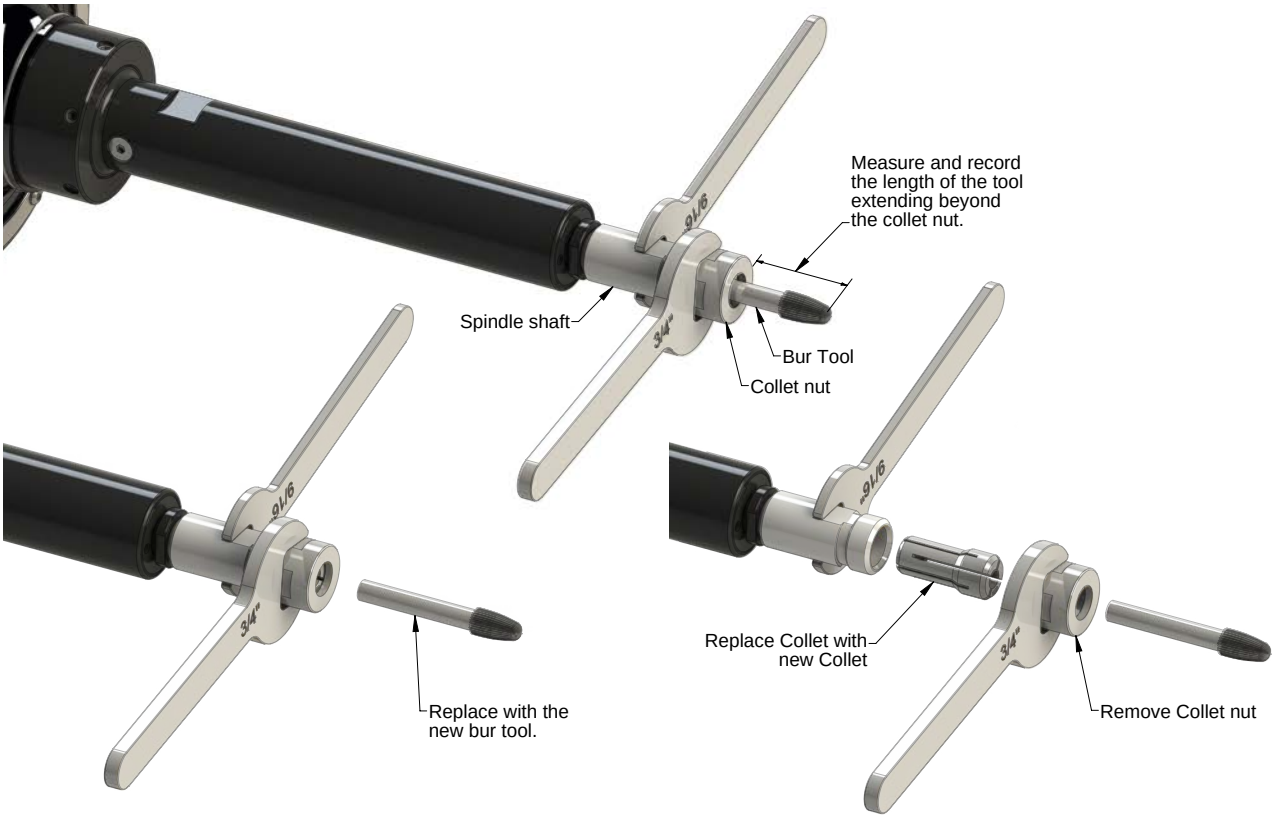
Refer to *Figure 6.1*.

Tools required: *9/16" open-end wrench, 3/4" open-end wrench*

1. Remove and/or lock-out the spindle motor air supply for safety. De-energize all energized circuits such as air and power.
2. If the bur is to be replaced with one of an identical type, measure and record the tool length extending beyond the collet lock nut. Alternatively, the optional ATI 9150-RC-T-4230 bur setting tool accessory can be used to duplicate the tool exposure length.
3. Use the 9/16" open-end wrench to hold the body of the collet holder just behind the collet nut.
4. Use the 3/4" open-end wrench to turn the collet locknut counterclockwise (when viewed from the bur tip) to loosen the collet.
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 refit the nut leaving it loose.
7. If an identical new bur is replacing a worn one, measure and adjust the length of its exposed portion according to the measurement taken in step *2*.
8. Use the 9/16" open-end wrench to hold the body of the collet holder just behind the collet nut.
9. Use the 3/4" open-end wrench to turn the collet locknut clockwise (when viewed from the bur tip) to tighten the collet.
10. When the replacement procedure is complete, return to normal operation.

Figure 6.1—Bur and Collet Replacement



6.2.2 Collet Holder Replacement

In harsh operating environments, the collet holder may become damaged, or the customer may wish to change to a different type of tool holder. The collet components, which are supplied with the deburring tool, are threaded onto the spindle assembly and can be replaced.

Refer to the following steps for replacing collet components.

Refer to *Figure 6.2*.

Tools required: *2.5 mm hex key, 3 mm (1/8") pin, 9/16" open-end wrench, torque wrench*

Supplies required: *Loctite 222*

1. Remove and/or lock-out the spindle motor air supply for safety.
2. Remove the bur, collet, and collet lock nut. Refer to *Section 6.2.1—Bur and Collet Replacement.*
3. Lock the spindle to prevent rotation.
   a. Using a 2.5 mm hex key, remove the M4 socket flat head screw from the side of the spindle housing assembly.
   b. Turn the collet assembly by hand until a 3 mm (1/8”) pin can be inserted into the hole where the screw was removed and through the spindle shaft.
4. Use the 9/16" open-end wrench to loosen the collet holder by turning counterclockwise and remove it from the shaft.

Figure 6.2—Collet Holder Replacement

5. Install the new collet holder.
   a. Thread the collet holder onto the shaft.
   b. Use the 9/16" open-end wrench to tighten the collet holder to 52 in-lbs (5.876 Nm).

6. Unlock the spindle to restore rotation.
   a. Remove the 3 mm anti-rotation pin.
   b. Reinstall the M4 socket flat head cap screw.
      i. Apply Loctite 222 to the threads.
      ii. Using a 2.5 mm hex key, refit the socket flat head screw to the side of the spindle assembly.
      iii. Tighten to 6 in-lbs (0.678 Nm).
7. Install the collet, collet lock nut, and bur. Refer to *Section 6.2.1—Bur and Collet Replacement.*
8. After the procedure is complete, return to normal operation.

6.2.3 Air Motor Replacement

The air motor requires replacement after an extended operating life or following a severe collision. There are no user serviceable parts in the air motor. Deburring tools with defective motors should be returned to ATI during the warranty period. Motors are sold as complete 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 6.3*.

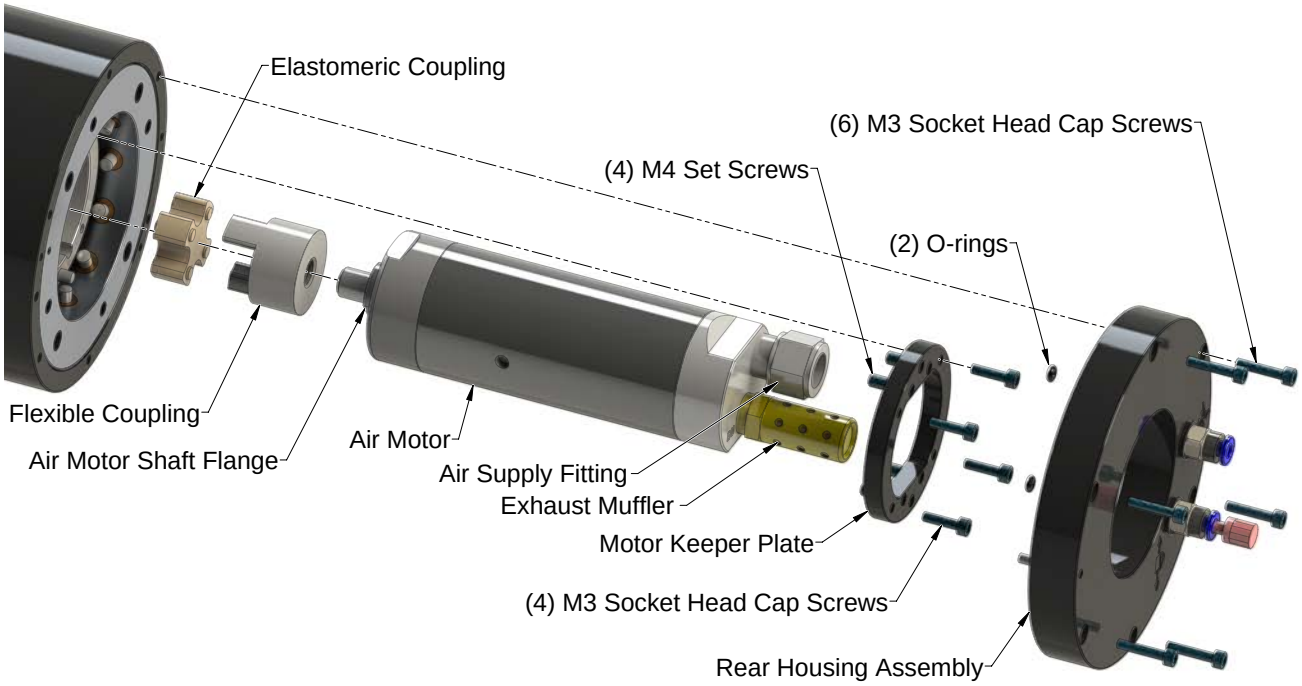
Parts required: *Refer to Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf.*

Tools required: *2 mm and 2.5 mm hex key, long pliers or tweezers, 15 mm open-end wrench, torque wrench*

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

1. Remove and/or lock-out the spindle motor air supply (De-energize all energized circuits such as air and power).
2. Remove the deburring tool from the robot or work location.
3. Disconnect hoses from the fittings on the rear of the deburring tool.
4. Remove and retain the air supply fitting and exhaust muffler from the rear of the motor.
5. Clean the debris from the deburring tool using compressed air and a clean rag to wipe any grease from the outer surfaces.
6. Remove the rear housing assembly from the main housing.
   a. Using a 2.5 mm hex key, remove the (6) M3 Socket Head Cap Screws that secure the rear housing assembly to the main housing.
   b. Retain the (2) small o-rings for re-use during reassembly.
7. Loosen the motor keeper plate.
   a. Using a 2.5 mm hex key, remove the (4) M3 Socket Head Cap Screws that secure the motor keeper plate to the rear of the motor housing.
   b. Using a 2 mm hex key, tighten the (4) M4 set screws in the motor keeper plate to push the plate off the rear of the motor housing.
   c. Withdraw the motor keeper plate.
8. Remove the motor keeper plate and the air motor from the motor housing.
9. If the elastomeric shaft coupling was not extracted with the motor, use long pliers or tweezers to remove it from the motor housing.

Figure 6.3—Air Motor Replacement



10. Remove and retain the flexible coupling from the air motor.
    a. Using a 15 mm open-end wrench, hold the flange on the motor shaft and unscrew the shaft coupler from the front of the motor (counterclockwise when looking at the end of the shaft coupler).

11. Install the flexible coupling on the new motor.
    a. Use a 15 mm open-end wrench to hold the flange on the motor shaft and thread the flexible coupling to the front of the motor (clockwise when looking at the end of the flexible coupling).

    b. Tighten to 52 in-lbs (5.876 Nm).

12. Fit a new elastomeric shaft coupling to the flexible coupling on the motor.

13. Install the air motor in the motor housing.
    a. Rotate the motor slowly into the housing so that the new elastomeric coupling engages the flexible coupling on the spindle assembly.

14. Install the motor keeper plate.
    a. Use a 2 mm hex key to loosen the (4) M4 set screws on the motor keeper plate then fit the retainer plate to the rear of the motor housing.

    b. If needed apply Loctite 222 to the set screws.

    c. Using a 2.5 mm hex key, secure the motor keeper plate to the air motor using the (4) M3 socket head cap screws.

    d. Torque the (4) M3 Socket Head Cap Screws to 12 in-lbs (1.356 Nm).

    e. Torque the (4) M4 set screws to 12 in-lbs (1.356 Nm).

15. Install the rear housing assembly to the motor housing.
    a. Verify the (2) small o-rings are located on the rear housing assembly; apply magnalube if required.
    b. Fit the rear housing assembly to the motor housing.
    c. Using a 2.5 mm hex key, secure the rear housing assembly with the (6) M3 socket head cap screws.
    d. Torque the (6) M3 socket head cap screws to 12 in-lbs (1.356 Nm).
16. Install the exhaust muffler in the rear of the air motor.
    a. Apply Loctire 569 to the threads of the exhaust muffler.
    b. Thread the muffler into the port that is labeled "EXH".
    c. Tighten the muffler finger tight plus half a turn.
17. Install the air supply fitting in the rear of the air motor.
    a. Apply Loctire 569 to the threads of fitting.
    b. Thread the fitting into the port that is adjacent to the exhaust muffler.
    c. Tighten the fitting finger tight plus half a turn.
18. Re-connect the hoses to the fittings on the rear of the deburring tool.
19. Install the deburring tool to the robot or work location.
20. When the procedure is complete, return to normal operations.

6.2.4 Spindle Assembly Replacement

Because the spindle is a complicated assembly that includes multiple ball bearings and related components, replace the assembly as a unit. To replace the spindle assembly perform the following steps.

Refer to *Figure 6.4.*

Parts required: *Refer to Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf.*

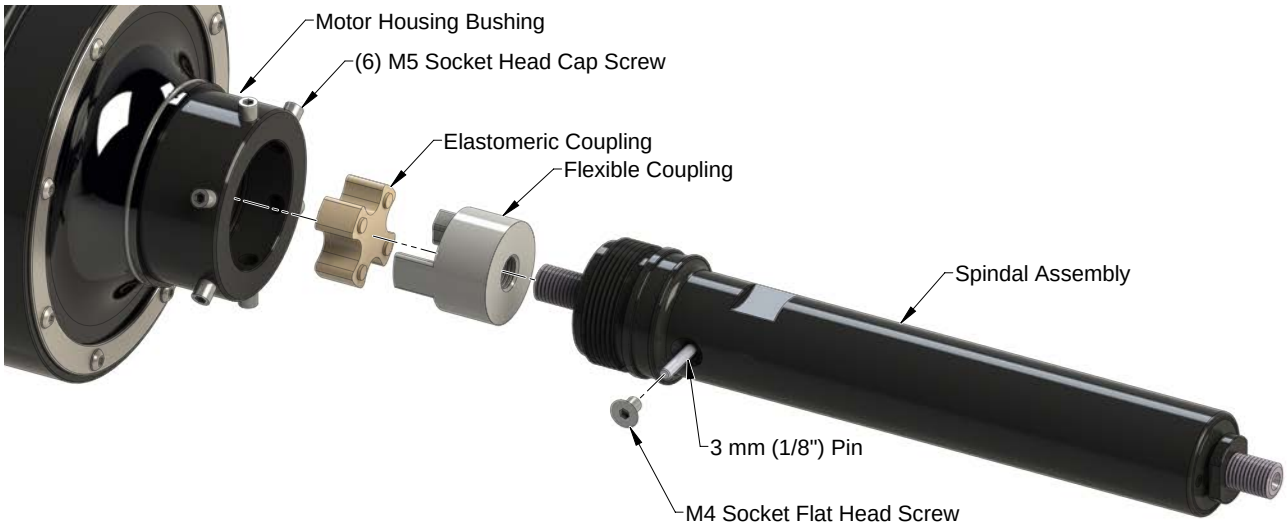
Tools required: *2.5 mm hex key, 24 mm (15/16") open-end wrench, long pliers or tweezers, 3 mm (1/8") pin, torque wrench*

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

1. Remove and/or lock-out the spindle motor air supply (De-energize all energized circuits such as air and power).
2. Remove the deburring tool from the robot or work location.
3. Clean the debris from the deburring tool using compressed air and a clean rag to wipe any grease from the outer surfaces.
4. Remove the spindle assembly from the motor housing.
    a. Using a 2.5 mm hex key, loosen the (6) M5 set screws in the bushing of the spindle assembly.
    b. Use a 24 mm (15/16”) open-end wrench to unscrew the spindle (counterclockwise) from the front of the deburring tool.
    c. Use long pliers or tweezers to remove the elastomeric coupling from inside the deburring tool if it did not come out when the spindle was extracted.

5. Lock the spindle to prevent rotation.
   a. Using a 2.5 mm hex key, remove the M4 socket flat head screw from the side of the spindle housing.
   b. Turn the spindle assembly by hand until a 3 mm (1/8”) pin can be inserted into the hole where the screw was removed and through the spindle shaft.
6. Use the appropriate wrenches to remove the shaft coupling from the spindle assembly.
7. Remove the bur, collet, and collet holder. Refer to *Section 6.2.1—Bur and Collet Replacement* steps *2* through *6* and *Section 6.2.2—Collet Holder Replacement* step *4*.

Figure 6.4—Spindle Assembly Replacement



8. Lock the spindle of the new spindle assembly to prevent rotation.
   a. Using a 2.5 mm hex key, remove the M4 socket flat head screw from the side of the new spindle housing.
   b. Turn the spindle shaft by hand until a 3 mm (1/8”) pin can be inserted into the hole where the screw was removed and through the spindle shaft.
9. Install the bur, collet, and collet holder on the new spindle assembly. Refer to *Section 6.2.2—Collet Holder Replacement* step *5* and *Section 6.2.1—Bur and Collet Replacement* steps *7* through *9*.
10. Unlock the spindle of the new spindle assembly to restore rotation.
    a. Remove the 3 mm (1/8") pin.
    b. Using a 2.5 mm hex key, insert the M4 socket flat head screw into the spindle assembly.
    c. Tighten to 6 in-lbs (0.678 Nm).
11. Fit a new elastomeric coupling to the flexible coupler on the end of the spindle assembly.

12. Install the new spindle assembly into the motor housing.
    a. Turn the spindle shaft slowly while threading the new spindle into the deburring tool so the new elastomeric coupling engages the flexible coupler on the motor assembly.
    b. Use the 24 mm (15/16”) wrench to tighten the spindle to the deburring tool.
    c. Secure the spindle assembly to the bushing of the motor housing.
        i. Apply loctite 222 to the (6) M5 set screws.
        ii. Tighten the (6) M5 set screws to 12 in-lbs (1.356 Nm).
13. Install the deburring tool to the robot or work location.
14. When the procedure is complete, return to normal operations.

6.2.5 Ring Cylinder Assembly Replacement

The compliant motion of the air motor spindle is accomplished using an array of pistons (ring cylinder) installed inside the rear of the deburring tool. After extended operation, this component may need replacing to ensure free motion of the pistons. The unit is replaced as an assembly. The ring cylinder subcomponents are not user serviceable. To replace the ring cylinder assembly, perform the following steps.

Refer to *Figure 6.5.*

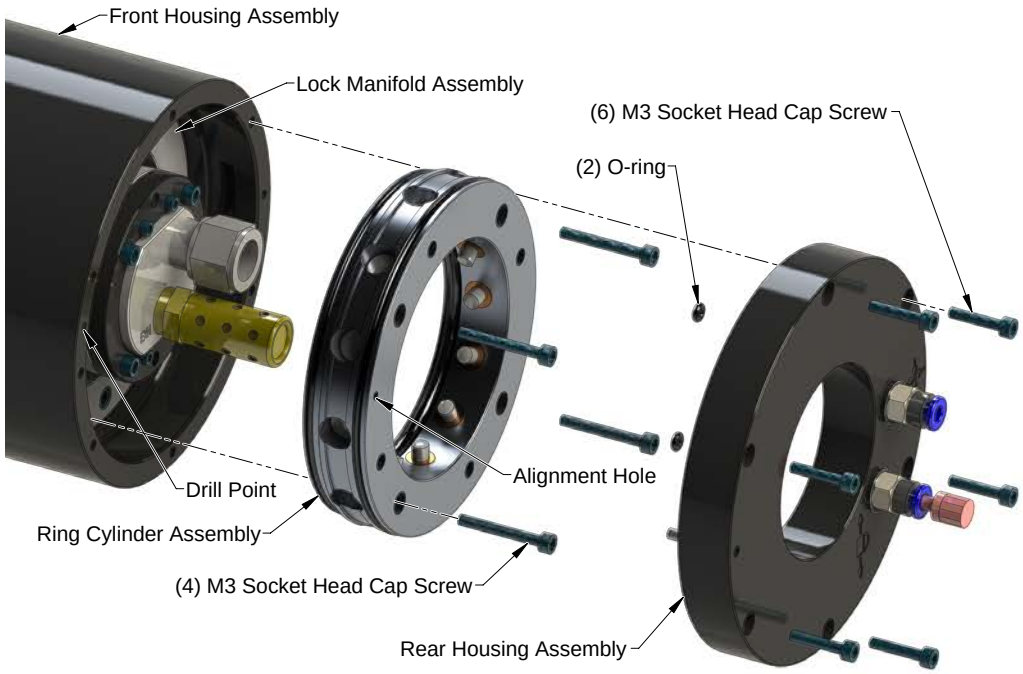
Parts required: *Refer to Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf.*

Tools required: *2.5 mm hex key, 24 mm (15/16") open-end wrench, long pliers or tweezers, 3 mm (1/8") pin, torque wrench*

Supplies required: *Clean rag, Loctite 222, light grease NLGI-2, Magnalube*

1. Remove and/or lock-out the spindle motor air supply (De-energize all energized circuits such as air and power).
2. Remove the deburring tool from the robot or work location.
3. Disconnect hoses from the fittings on the rear of the deburring tool.
4. Remove the rear housing assembly.
    a. Using a 2.5 mm hex key, remove the (6) M3 socket head cap screws that secure the rear housing assembly to the main housing.
    b. Retain the (2) O-rings for reinstallation.
5. Remove the ring cylinder assembly.
    a. Using a 2.5 mm hex key, remove the (4) M3 socket head cap screws that secure the ring cylinder to the lock manifold.
    b. Move those (4) M3 socket head cap screws, which were removed in previous step, to the tapped holes in the ring cylinder and tighten them slowly. The screws will push the ring cylinder assembly away from the motor so it can be removed.

Figure 6.5—Ring Cylinder Replacement



6. Install the new ring cylinder assembly.
   a. Use light grease (NLGI-2) to lubricate the bores in the entrance to the front housing assembly and the O-rings in the new ring cylinder assembly.
   b. Locate the alignment mark hole on the ring cylinder and align it with the drill point on the rear of the main housing.
   c. Insert the ring cylinder slowly by hand while maintaining the orientation of the alignment marks.
   d. Using a 2.5 mm hex key, secure the new ring cylinder assembly to the front housing assembly with the (4) M3 socket head cap screws. Tighten them to 12 in-lbs (1.356 Nm).
7. Install the rear housing assembly.
   a. Ensure that the (2) small o-rings are located on the rear housing assembly; apply magnalube if required.
   b. Fit the rear housing assembly to the front housing assembly.
   c. Using a 2.5 mm hex key, secure the rear housing assembly to the front housing assembly with the (6) M3 socket head cap screws. Tighten to 12 in-lbs (1.356 Nm).
8. Re-connect the hoses to the fittings on the rear of the deburring tool.
9. Install the deburring tool to the robot or work location.
10. When the procedure is complete, return to normal operations.

6.2.6 Boot Replacement

The boot prevents debris from entering the housing and protects internal components. If the boot is damaged, replace. Refer to *Figure 6.5.*

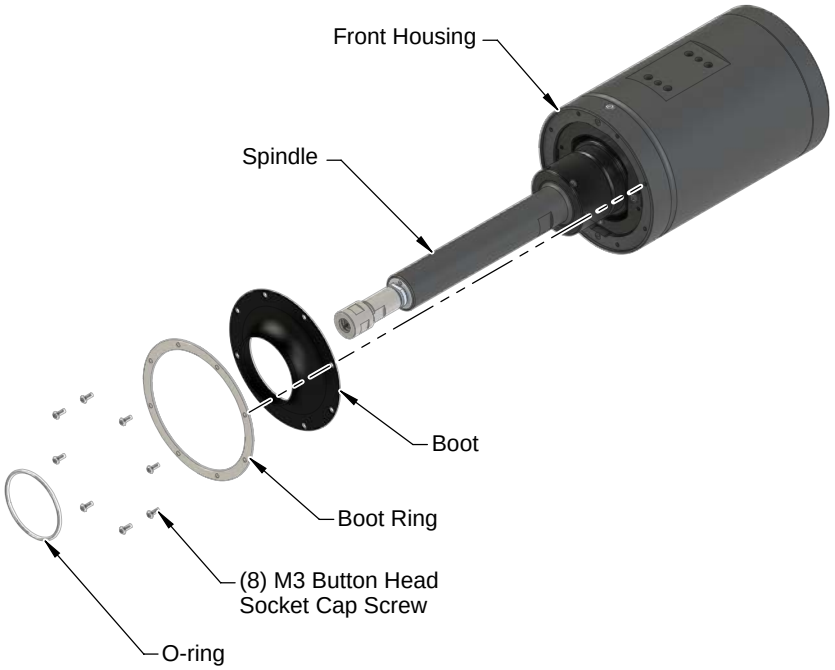
Parts required: *Refer to Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf.*

Tools required: *2 mm hex key, torque wrench*

Supplies required: *Clean rag, Loctite 222*

1. Remove and/or lock-out the spindle motor air supply (De-energize all energized circuits such as air and power).
2. Remove the deburring tool from the robot or work location.
3. Disconnect hoses from the fittings on the rear of the deburring tool.
4. Clean debris from the deburring tool using compressed air and a clean rag to wipe any grease from the outer surfaces.
5. Ease the O-ring off the spindle.
6. Using a 2 mm hex key, remove the (8) M3 button head socket head cap screws that secure the boot ring to the housing.
7. Remove the boot ring and boot.
8. Align the spindle boot and ring with the holes in the housing and slide the boot onto the spindle. Align the edge of the boot to the edge of the contact surface.
9. Apply Loctite 222 to the threads of the (8) M3 button head socket cap screws.
10. Using a 2 mm hex key, install the (8) M3 button head socket cap screw that secure the boot to the housing.
11. Stretch the O-ring over the boot.
12. Re-connect air hoses to the fittings.
13. Install the deburring tool to the robot or work location.
14. If the procedure is complete, return to normal operation.

Figure 6.6—Spindle Boot Replacement



7. Serviceable Parts

The serviceable parts for the 9150-RD-390-NL and 9150-RD-390-NL-E are shown in *Https://www.ati-ia.com/app_content/Documents/9630-50-RD-390%20Series.auto.pdf.*

7.1 Accessories

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-ACT-T-841056IN	ACT-390 10ga, 9/16" open-end wrench
3	1	9150-ACT-T-841075IN	ACT-390 10ga, 3/4" open-end wrench
4	1	9150-ACT-T-841015 mm	ACT-390 15 mm open-end wrench
5	1	9150-FFR-90	High-Flow Filter/Regulator Assembly
6	1	9150-P16-B-G	Precision Regulator
7	1	9150-RC-T-4230	Bur Setting Fixture

8. Specifications

Parameter	Rating
Motor	Pneumatic, Vane-Type
Idle Speed (RPM)	5,600
Working Speed (RPM)	2,600 (Approximate)
Torque (Max. Power)	1.4 Nm (1 lb-ft)
Torque (Starting/Stall)	2.7 Nm (2 lb-ft)
Power	390 Watts (0.52 hp) @ 2,600 RPM
Weight (without Adapters	5.62 kg (12.4 lb)
Compensation (Radial)	+/- 5.5 mm Max., +/- 3 mm Recommended
Compliance Force (Measured at Collet)	8-45 N (2.2-10.5 lb) @ 1.0-4.0 Bar (10–60 PSI)
Burr Surface Speed	Dependent on Cutter Geometry and Motor Speed
Spindle Air Pressure	6.2–6.5 Bar (90–95 PSI) (6.9 Bar (100 PSI) max)
Air Consumption (Max.)	Approximately 9 l/s (19 CFM)
Collet Size, Standard[1]	1/4” (6 mm & 8 mm Supplied on Euro Models)
Abrasive Media	Customer-Supplied
Rotary Burrs [2]	Commercial Units Rated 40,000 RPM or Higher
Special Tools	Open End Wrenches (1 Each Supplied) 14.5 mm (9/16”), 19 mm (3/4”), 15 mm (19/32”)

Notes:

1. Optional sizes are available. Refer to *Section 7—Serviceable Parts*.
2. ATI can supply burrs. Refer to *Section 4.5.1—Bur Selection*.

9. 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 that are 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 the 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 no later then 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.

Purchaser will not be liable hereunder with respect to disclosure or use of information which: (a) is in the public domain when received from ATI; (b) is thereafter published or otherwise enters the public domain through no fault of Purchaser; (c) is in Purchaser's possession prior to receipt from ATI; (d) is lawfully obtained by Purchaser from a third party entitled to disclose it; or (f) is required to be disclosed by judicial order or other governmental authority, provided that, with respect to such required disclosures, Purchaser gives ATI prior notice thereof and uses all legally available means to maintain the confidentiality of such information.

9.1 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 long 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 this is not detailed in this manual, contact ATI for part numbers and pricing.

Premature bearing failure can occur from exposing the deburring tool to coolandts 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.

9.1.1 Vane Motor Products

Vane type motors have a finite life and require regular service. At that time the customer should expect to replace the motor vanes and bearings. Any gear reduction components should also be inspected and replaced as necessary. Vane type motors perform best and longest with lubricated air. They can be run without lubricated air, but this service interval will be reached in half the time. The same components will require attention with particular emphasis on replacing the motor vanes. The expected life of a properly lubricated vane motor in normal operation is entirely application dependent based on a multitude of factors. To maximize the life of a vane type motor products the customer should follow closely the normal operation guide in the product manual. The supplied air must be lubricated, and filtered to remove particulates and moisture. 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.

CAUTION: Operating the device without lubrication will reduce the service interval by up to 50%.