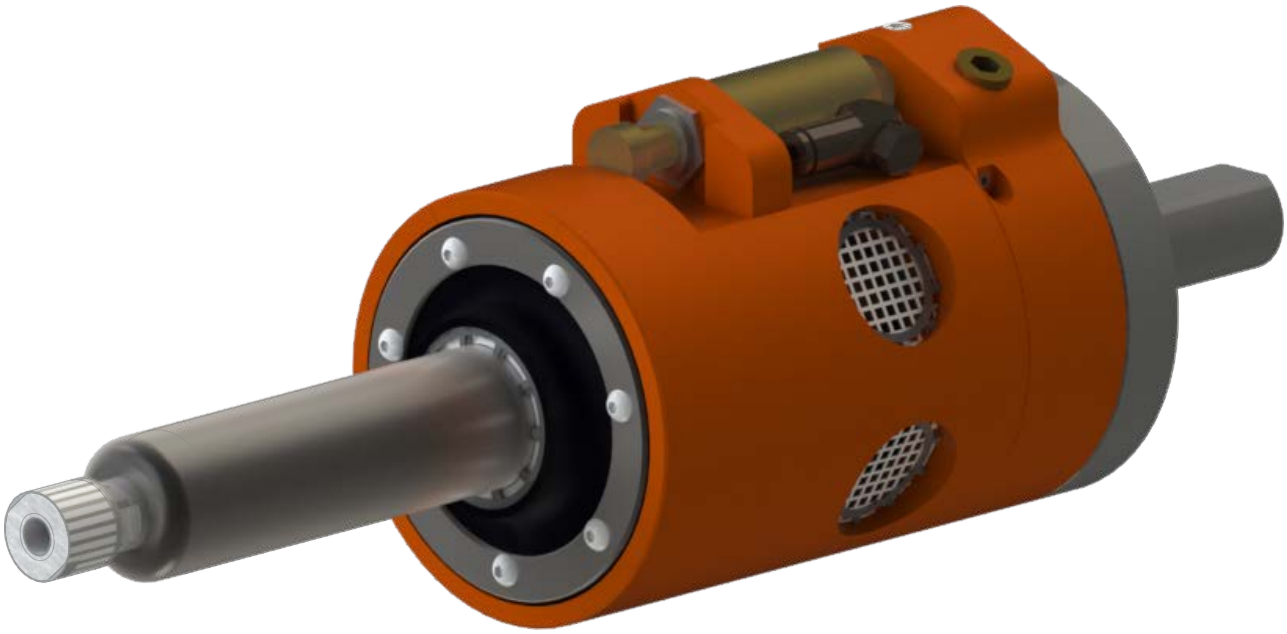
ATI Radially-Compliant Robotic Deburring Tools CNC-Flexdeburr™

(Model 9150-RC-340-CNC)

Product Manual

US Patent # 6,974,286 B2 and 7,137,763 B2

UK Patent # GB2,417,006 B



Document #: 9610-50-1010

Engineered Products for Robotic Productivity

Pinnacle Park • 1031 Goodworth Drive • Apex, NC 27539 USA • Tel: 919.772.0115 • Fax: 919.772.8259 • www.ati-ia.com

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.

How to reach us:

Sale, Service and Information about ATI products:

ATI Industrial Automation
1031 Goodworth Drive
Apex, NC 27539 USA
www.ati-ia.com
Tel: +1.919.772.0115
Fax: 919.772.8259

Application Engineering
Tel: +1.919.772.0115
Fax: 919.772.8259
E-mail: *ATI-MRapplications@novanta.com*

24/7 Support: +1 855 ATI-IA 00 (+1 855-284-4200)

Table of Contents

Glossary

Term	Definition
Adapter Plate	Device for attaching the flexdeburr to robots or work surfaces.
Air Filter	Device for removing contamination from air supply lines.
Burr	Any unwanted, raised protrusion on the work piece.
Bur	Cutting tool used to remove burrs 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 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 work piece.
Conventional Milling	Method of cutting where the direction of tool motion is opposite that of tool rotation.
Regulator	Device used to set and control the supplied air pressure to lower acceptable levels.
Solenoid Valve	Electrically controlled device for switching air supplies on and off.
Spindle	The rotating portion of the flexdeburr assembly.
Turbine Motor	Component of flexdeburr that drives the spindle.
-E	Euro models.

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. Product specific notifications are imbedded within the sections of this manual (where they apply).

1.1 Explanation of Notifications

These notifications are used in all of ATI manuals and are not specific to this product. The user should 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 flexdeburr 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

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.

CAUTION: Do not perform maintenance or repair on the Flexdeburr product unless the tool is safely supported or docked in the tool stand and air has been turned off. Injury or equipment damage can occur with tool not docked and air on. Dock 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 operation 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 the flexdeburr, is a robust, high-speed, lightweight turbine-motor driven unit for deburring materials such as aluminum, plastic, or steel with a robot or CNC machine. The flexdeburr is especially suited for the removal of parting lines and flash from parts. However, its flexible design allows it to be used in a wide variety of applications.

The flexdeburr'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 tool also requires no oil, allowing clean exhaust air to be vented directly into the work environment.

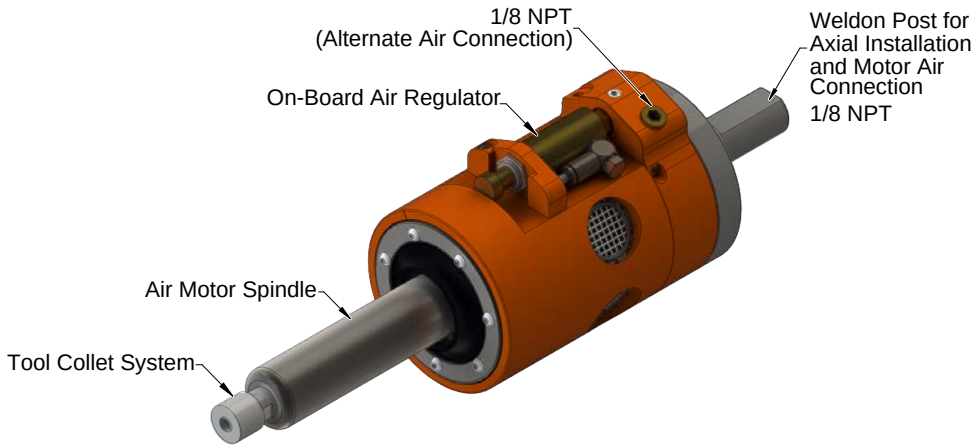
Compliance is supported by air pressure applied to the attached on-board air regulator and is used to perform consistent deburring on irregular part patterns. The motor's internal governor maintains high spindle speeds for optimum surface finish. The flexdeburr also utilizes standard industrial tungsten-carbide bits for the burs, allowing for adaptation to changing assembly lines and part requirements.

The RC-340-CNC series is installed via axial mounting. The axial mounting utilizes a hollow shank, the weldon post, through which the motor's air can be supplied. A customer supplied adapter can be installed to the weldon post. Refer to *Section 9—Drawings* for more information.

The RC-340-CNC series is equipped with a 1/8 NPT port located on the weldon post to supply the motor and compliance air (1/8 NPT for -E models). Alternatively, the weldon post can be plugged and a hose can be connected to the 1/8 NPT radial port on the top of the housing (see *Figure 2.1*). Both ports have the same air supply requirements (see *Section 2.2.1.1—Operation*).

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

Figure 2.1—RC-340-CNC Series Deburring Tool



2.1 Tool Collet Systems

A collet system secures the bur to the tool. Various collet sizes are available to accommodate different applications. The RC-340-CNC uses a 1/4'' collet (6 mm for -E models).

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. Note that the turbine motor design does not allow the installation of quick-change or drawbar collet systems.

The standard tool holding system for flexdeburr products is an economical, proprietary, single-angle collet design that utilizes multiple gripping fingers. This 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. Special sizes are available upon request but require custom machining.

2.2 Technical Description

A general description of the flexdeburr is provided in *Section 2—Product Overview*. The following is a technical overview of the product.

2.2.1 Environmental Limitations

2.2.1.1 Operation

Table 2.1—Operation	
Installation position	Mounted to machining center by means of a straight Weldon shank and customer-supplied tool holder/ adapter. Refer to *Section 3.5—Axial Mounting Installation*.
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. • Air supplied to the spindle motor at 6.2 bar (90 psi). An on-board regulator reduces this pressure to control the compliance force. This force is monitored during setup using an external pressure gauge.

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 charts in *Figure 2.2* and *Figure 2.3* illustrate the variation of compliance force with applied air pressure. 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 the 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 will attempt 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 2.2—RC-340-CNC Series Radial Compliance Force Curves (Measured at the Spindle Tip)

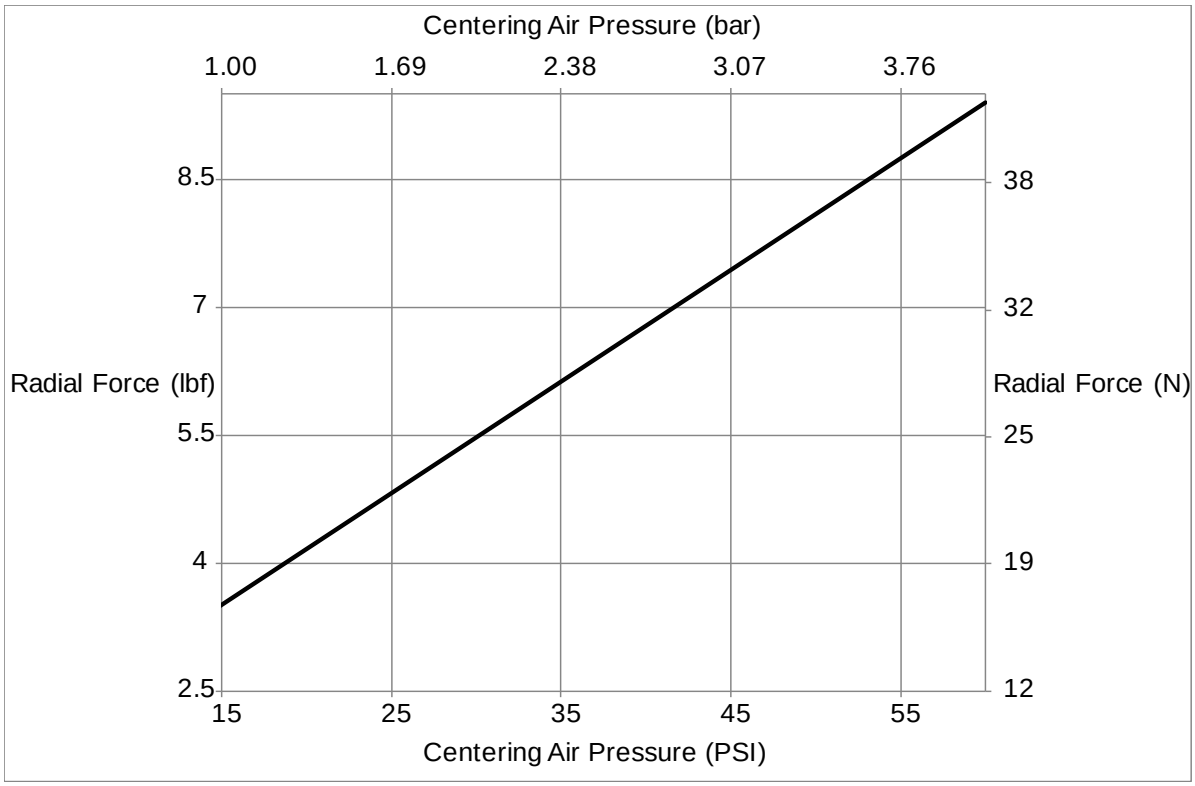
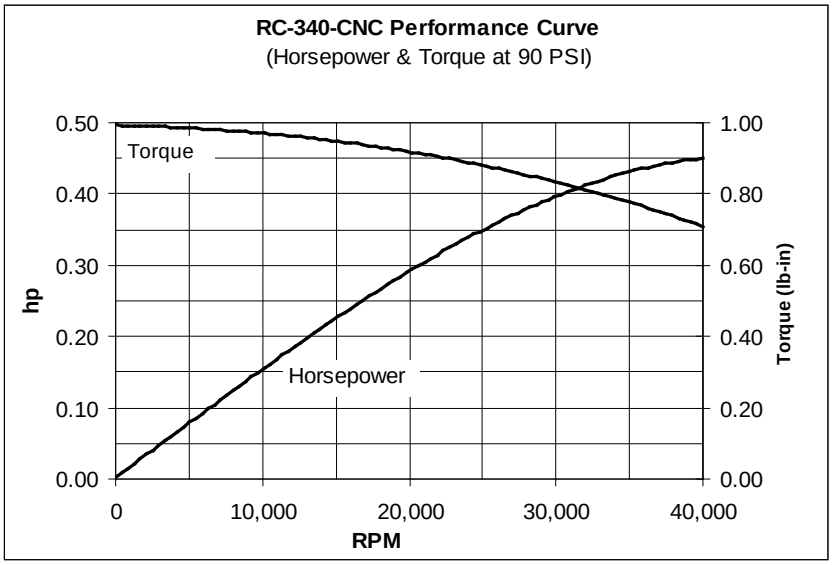
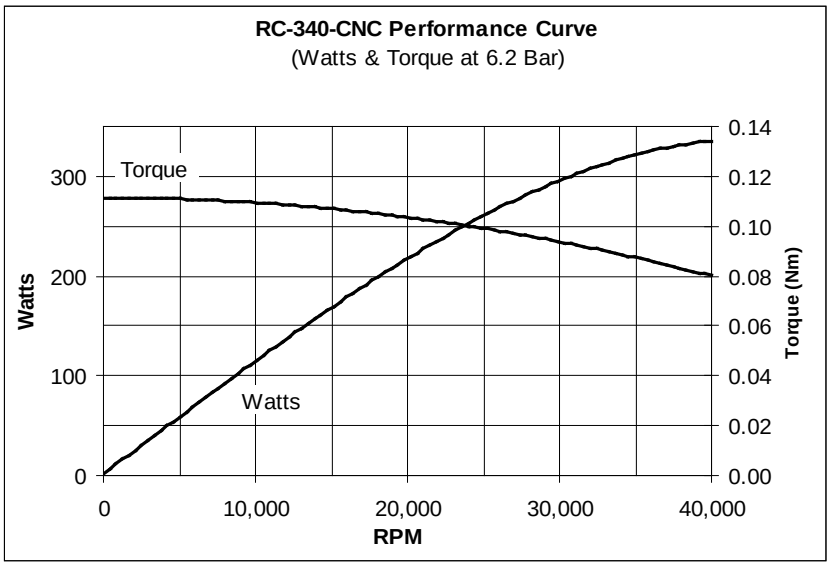


Figure 2.3—RC-340-CNC Series Compliance Force Curves (Measured at the Spindle Tip)





3. Installation

The RC-340-CNC series flexdeburr tools are delivered fully assembled. Optional equipment such as mounting adapter plates, burr tools, additional collets will be separate.

3.1 Transportation and Protection during Transportation

The RC flexdeburr tool is packaged in a crate designed to secure and protect it during transportation. Always use the crate when transporting the flexdeburr 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
- Damage to packaging

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

3.3 Unpacking and Handling

The flexdeburr should always be placed inside the accompanying box (crate) during transportation, storage 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 flexdeburr should be stored in its crate when it is not in use. The flexdeburr should also be stored in a dry place.

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

3.5 Axial Mounting Installation

The flexdeburr is normally supplied with a straight weldon shank. The weldon shank is to be mounted in a customer supplied tool holder compatible with the customer's machining center. The shank is hollow to allow the customer to supply air to the motor through the machining center spindle. The customer should perform a thorough blow-down cycle of the machining center spindle to eliminate any residual coolant or contaminates.

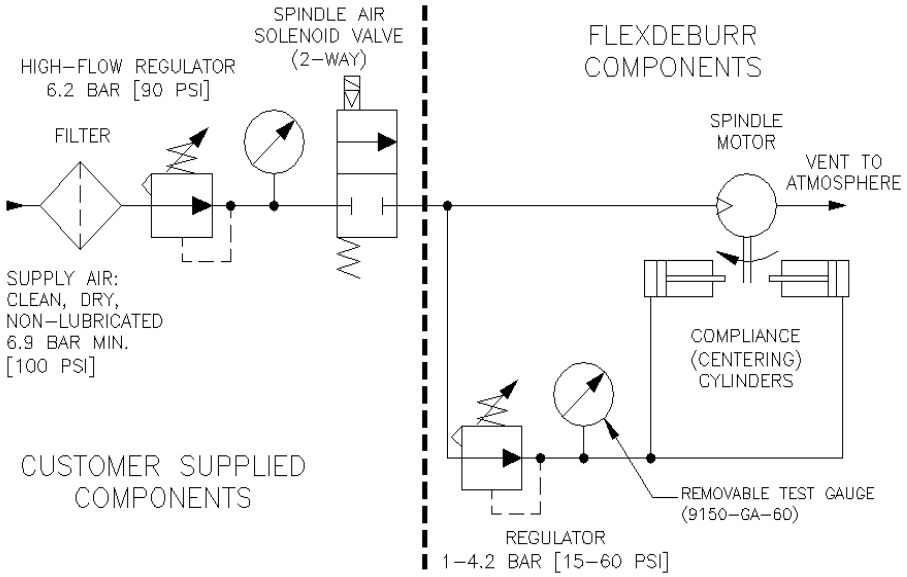
If the RC flexdeburr is permanently mounted to a work surface, the robot carries the part to be deburred to the flexdeburr. Refer to *Section 9.1—RC-340-CNC Series Geometry, Mounting, and Parts* for more information.

3.6 Pneumatics

Connect the flexdeburr as shown in *Figure 3.1*.

WARNING: The air supply line must be purged of any coolant or liquid before attaching the flexdeburr tool to the CNC machine. Having any liquid in the air supply line while operating the flexdeburr tool may result in irreparable damage to the flexdeburr tool.

Figure 3.1—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 possibilities of pullout and over-stressing or kinking the lines. Failure to properly attend to pneumatic line routing may cause critical pneumatic lines to malfunction, resulting 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. Only one air connection is required; the air can be supplied by the weldon shaft or the 1/8 NPT alternate air connection on the rear housing assembly (see *Figure 2.1*). A high-flow air pressure control regulator and high-flow valve are required to supply air to the turbine motor at 6.2 bar (90 psi). An on-board, self-relieving regulator will supply 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 incorrect components are used.

Conventional, customer-supplied, pneumatic components are used to control the air supply to the flexdeburr. ATI recommends that the user install a high-flow pneumatic pressure regulator (ATI part number 9005-50-6160 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 turbine motor. The flexdeburr will not operate properly if the supplied air is below 6.2 bar (90 psi).

The on-board, self-relieving regulator is used to supply the compliance (centering) mechanism. Adjustment of the compliance force requires the use of the removable pressure gauge (ATI part number: 9150-GA-60). For further details, refer to *Section 4.4—Adjusting Compliance Air*.

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 by location 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.

The air supply solenoid valve must be controlled through the machining center. 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	1/8 NPT Port in Weldon Shank (Alternate connection: remove supplied plug to use 1/8 NPT Port) (1/8 NPT Port for -E models)	6.2 bar [90 psi]
Compliance (Radial) Force Inlet	Internally plumbed to take air from the spindle air supply	1-4.2 bar (Maximum) [15-60 psi]
Exhaust	Vented to Atmosphere through the Housing	Not Applicable

Flexible plastic tubing should 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.

Flexible tubing of 3/8” diameter is recommended if the customer chooses to use the external radial air-supply connection. The installed plug can be removed to expose the tapped 1/8-NPT supply port. The customer is responsible for supplying the 1/8-NPT plug to close the port in the weldon shank.

The turbine motor is extremely quiet and vents dry air to the environment through the screen-covered ports on the side of the housing. Mufflers are not required. Information on the sound intensity is provided in *Section 8—Specifications*. To reduce the sound from the cutting operation, 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 1-4.2 bar (15–60 psi) range. When testing for the proper contact force, begin at an extremely low pressure and increase the compliance pressure 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 flexdeburr. The system integrator should be familiar with automation-incorporating robots and the task of deburring.

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 describe 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 not receive proper air pressure, the tool stalls. Any water in the system damages the housing and blades.

4.2.2 No Lubrication

Lubrication of any kind is strictly prohibited.

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 at least the RC idle speed.

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 operating speed of the deburring tool. Operating the brush above its maximum rated speed can be unsafe due to unbalanced loading. Additionally, even balanced brushes can result in an excessive load on the motor and reduced motor life.

Do not use a tool that results in axial loading on the RC tool.

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 Adjusting Compliance Air

The RC-340-CNC flexdeburr is equipped with a side-mounted air pressure regulator for adjusting the compliance force on the cutter. This regulator draws its air supply from the 6.2 bar (90 psi) air driving the spindle. Therefore, the compliance force can only be adjusted when the spindle is rotating.

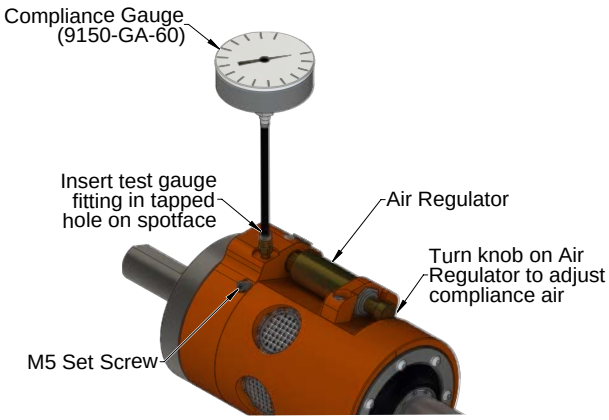
CAUTION: The flexdeburr spindle will be rotating when adjusting compliance force. Be aware of rotating components and use extreme caution when adjusting the compliance force.

Adjustment of the compliance force requires the use of the removable pressure gauge (ATI part number: 9150-GA-60). With the removable pressure gauge, perform the following:

Tools required: *2.5 mm hex key, pressure gauge (9150-GA-60)*

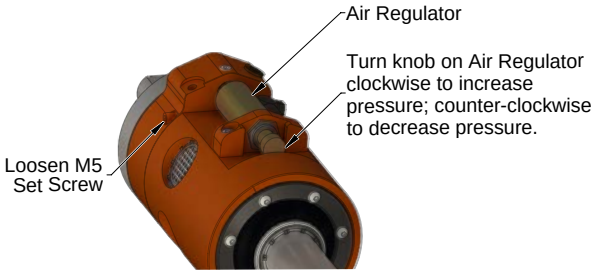
1. With the spindle off, thread the fitting of the test gauge into the tapped hole on the spotface at the top of the flexdeburr (refer to *Figure 4.1*).
2. Supply the spindle with 6.2 bar (90 psi) air and allow it to come up to speed.
3. Use a 2.5 mm hex key to loosen (but do not remove) the M5 set screw in the flexdeburr rear housing.
4. Observe the pressure gauge reading and adjust the regulator by turning its knob until the desired pressure is displayed.
5. Tighten the M5 set screw using the 2.5 mm hex key and remove the test gauge.

Figure 4.1—Adjust Air Compliance



Alternatively, if no gauge is available or if only minor adjustments are desired based on test deburring of sample parts, loosen the M5 set screw (see step *3* in *Section 4.4—Adjusting Compliance Air*) and turn the knob of the regulator in by turning it clockwise (when viewed from spindle end) to increase the pressure, or counterclockwise to reduce it. Tighten the M5 set screw when adjustment procedure is complete.

Figure 4.2—Adjusting Regulator Knob



While ATI can offer some guidance on compliance forces, the value used will be a function of the material being deburred, the cutter selected, the feed rate, and other variables.

Optimum performance will be achieved when the flexdeburr is mounted and its spindle operated vertically.

4.5 Tool Center Point (TCP) Position and Programming

Figure 4.3 shows the flexdeburr tool dimensions. The flexdeburr provides radial compliance and performs best when the cuts taken are not excessively deep. The flexdeburr's spindle must never be running while programming the robot. During teaching, the compliance air must be on and supplied above a minimum of 1 bar (15 psi).

Suggested programming methods include the following: for the first method, in place of a cutting tool, a dowel pin of suitable diameter is installed to the flexdeburr to simulate the cutter shank diameter when teaching the robot path. For example, for 1/4'' collets, a 1/4'' diameter dowel pin of adequate length will be inserted in the tool's collet. After teaching, the diameter of the cutter installed should not exceed that of the dowel pin used in teaching by more than the compliance of the flexdeburr tool. The dowel pin should extend a sufficient distance from the collet to reach the surface on the burr where cutting is desired (see *Figure 4.3*).

The second programming method is to teach the path using the center line of the bur as a guide. Follow the edge of the part, then manually or automatically add offsets to the robot path points to achieve the final correct burr path (see *Figure 4.4*).

The programming method used will depend on the robot's capabilities and programmer preferences.

Figure 4.3—Flexdeburr Dowel Teaching Tool

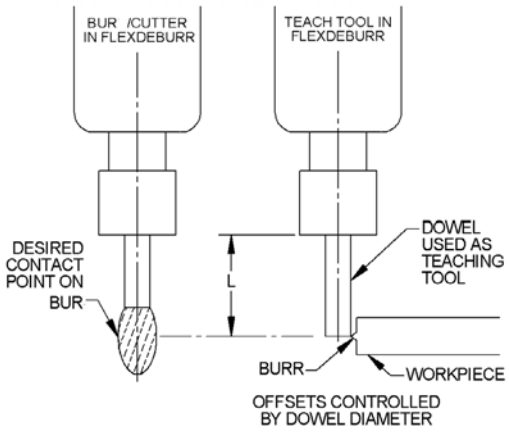
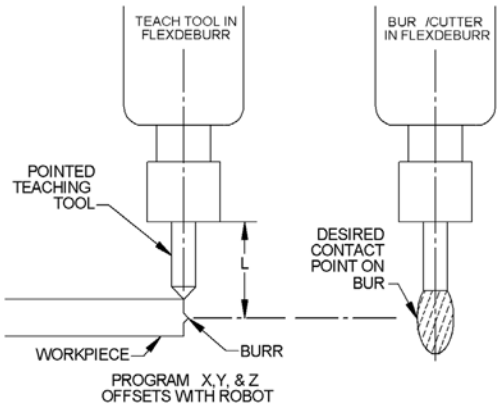


Figure 4.4—Flexdeburr Pointed Teaching Tool



Inside corners present a complex situation for compliant deburring tools. The cutter must not be allowed to simultaneously contact both perpendicular surfaces of an inside corner. Should this occur, the resulting force imbalance in two planes will cause severe tool chatter. The customer is advised to create a tool path that will prevent the cutter from simultaneously contacting two perpendicular surfaces. For example, a tapered cutter may reach further into an inside corner if the tool is oriented at an incline and the corner is contacted by the extreme 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. No attempt should be made to deburr an inside radius less than 1.5 times the diameter of the cutter in use (Rmin = 1.5 x Cutter diameter). Failing to follow these guidelines may cause excessive cutter contact, resulting in tool chatter.

The speed at which the flexdeburr tool is utilized should always correspond with the speed at which the robot was programmed. Note that when the robot path speed is increased, the robot may deviate from the programmed path. When running the robot program the first time, turn the radial compliance air supply down to approximately 1 bar (15 psi). Observe the tool's path when the robot program is run to verify that the bur is deflected but also contacts the work surface at operational robot path speed. Once this is confirmed, the compliance force of the bur can be adjusted (as described in *Section 4.4—Adjusting Compliance Air*) in order to achieve a correct depth of cut.

4.6 Cutter Operation and Bur Selection

The RC flexdeburr tool will perform best in 'climb milling,' when the cutter's traverse and rotational directions are the same. In the case of the RC deburring tools, the cutter rotation is clockwise when viewed from the spindle end. 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 work piece and the chip becomes narrower as the cut is completed.

In ‘conventional milling’, the cutter travels in a direction opposite to the cutter’s rotation. While this may aid in cutter stability for some operations, the cutting edge of the tool is subjected to higher friction and cutting forces. Thus in this mode, tool wear is accelerated and surface finish quality may be reduced. Additionally, extra care must be taken around corners as 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 cutting tool is highly dependent upon the depth of cut, as well as the part’s material and geometry. Not all selection possibilities are presented in this document. See *Section 4.6.1—Bur Selection* for a short list of burs and suitable applications. Note that a specific family of burs is available for working with die cast alloys, aluminum, and plastics. These cutters have fewer teeth and increased relief to minimize chip loading.

Plastics present a 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, the chip will melt and weld to the cutter or work piece. This can quickly load a cutter and produce unwanted results. In general, to minimize chip re-welding, the traverse or feed rate of the deburring tool will be higher for plastics. This results in larger cuts, which more effectively remove heat from the cutter-tool interface.

4.6.1 Bur Selection

Standard length commercial burs are used with flexdeburr products. The length of these tools is typically around 2” for 1/4” shank diameter burs (for -E models: 50 mm for a 6 mm diameter). Avoid the longer shank burs available from industrial suppliers that appear in catalogs described as “long” or “extended” shank burs. Using long or extended shank burs in the flexdeburr will 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. Failure due to the use of long shank tools is not covered under warranty.

ATI can provide guidance in bur selection; however, only experimentation will yield the desired results. *Table 4.1* is presented to assist in burr selection. The table is not comprehensive but includes common bur types and recommended applications.

Table 4.1—Bur Selection

	Materials/Application	Features/Benefits:
	**9150-RC-B-24033 - Diamond Cut, 1/4” Burr Diameter, 5/8” Burr Length, 1/4” Shank**	
	• For hardened and tough materials, super alloys, 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” Burr Diameter, 3/4” Burr Length, 1/4” Shank**	
	• For steels of high tensile strength die steels, cast steel, built up welds, tough materials, and welds • For beveling • Rough finishing of castings • For chamfering • For deburring	• Without chip breaker, for scratch-free surfaces

Table 4.1—Bur Selection		
	Materials/Application	**Features/Benefits:**
	**9150-RC-B-24063 - Diamond Cut, 3/8” Burr Diameter, 3/4” Burr 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” Burr 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, even while cutting sticky metals. • Smooth operation due to the peeling effect of the teeth.
	**9150-RC-B-24645 - Aluminum Cut, 3/8” Burr Diameter, 5/8” Burr Length, 1/4” Shank**	
	• For greasy aluminum alloys, soft non-ferrous metals and thermoplastics. • For use on cast aluminum. • For deburring.	• 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.
	**3710-50-1492 - Bur for Composites, 1/4” Burr Diameter, 3/4” Burr 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” Burr Dia., 3/4” Burr 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 flexdeburr tool is designed to provide reliable service for long periods of operation. The assembly includes some user serviceable parts. 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, the air supply (before the solenoid valves) should be disconnected. Drain any trapped air pressure in the lines. The air supply should 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 *Section 9—Drawings*.

5.1 Pneumatics

The condition of the air lines to the deburring tools should be routinely checked and replaced as required. The air to the flexdeburr must be filtered, dry, and non-lubricated. 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

Lubrication systems are not to be used. The flexdeburr turbine motor must be supplied with clean, dry, filtered air. Oil in the air stream will cause the turbine motor to fail. Failure of the motor due to oil in the air stream is not covered under the warranty. See *Section 3.6—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 failure of the turbine motor. Failure due to using lubricated air 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 Bur Inspection

The bur will wear depending on cut depth, feed rate, and the material being deburred. Inspect the bur regularly for wear. Refer to *Section 6—Troubleshooting and Service Procedures* for symptoms of a worn bur.

5.4 Spindle Motion Inspection

The pivot bearing allows articulation of the motor assembly. The pivot bearing in the air cap is subject to wear and should be replaced when excessive spindle motion is observed. Refer to *Section 6.2.3—Pivot Bearing Replacement*.

6. Troubleshooting and Service Procedures

The RC 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 should return the unit to ATI for service. *Section 6.2—Service Procedures* is provided to assist the user when they choose to service the unit in the field.

For all service, the air supply (before the solenoid valves) should be disconnected. Drain any trapped air pressure in the lines. The air supply should be "locked out" to prevent accidental operation of the turbine motor spindle. During maintenance operations, 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 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 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 6.2.4—Ring Cylinder Assembly Replacement*.
	Pivot bearings and/or pivot pins are worn	Replace pivot bearing. Refer to *Section 6.2.3—Pivot Bearing Replacement*.
	Defective Regulator	Replace regulator.
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*
	Turbine motor bearings are worn	Inspect spindle shaft, if shaft feels loose or has play, replace the turbine motor. Refer to *Section 6.2.2—Turbine Motor Replacement.*
Bur 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 4.6.1—Bur Selection*.
	Bur is worn	Inspect bur if worn, replace. Refer to *Section 6.2.1—Bur and Collet Replacement*.
	Turbine motor bearings are worn	Inspect spindle shaft. If spindle shaft feels loose or has play, replace the turbine motor. Refer to *Section 6.2.2—Turbine Motor Replacement.*
Secondary burrs 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 4.6.1—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 turbine motor spindle shaft. If spindle feels loose or has play, replace the turbine motor. Refer to *Section 6.2.2—Turbine Motor Replacement.*

Table 6.1—Troubleshooting		
Symptom	**Cause**	**Resolution**
Chip packing of burr	Too heavy a cut	Decrease width of cut; make multiple passes.
	Not enough chip clearance	Use a bur with fewer flutes.
Bur stalls	Not enough or no drive air	Check drive air regulator has 6.2 bar (90 psi) of air, and inspect for leaks.
	Bur is not secure in collet	Properly tighten burr in collet. Refer to *Section 6.2.1—Bur and Collet Replacement.*.
	Too much side load	Decrease width of cut/make multiple passes
	Turbine motor needs replacement	Replace turbine motor. Refer to *Section 6.2.2—Turbine Motor Replacement*.
Sticking turbine motor spindle	Turbine motor bearings are worn	Replace 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

The bur will wear with normal operation. If improper feeds and speeds are used, the cutter may become “loaded” with material. In both instances, the cutter will need to be replaced. During initial production, the bur and the work piece should be examined often in order to determine at what interval the bur should be replaced. Replacing the collet will not be required when the bur is replaced but may be necessary when a different sized tool is required.

The following procedure detail replacing the cutter and or collet:

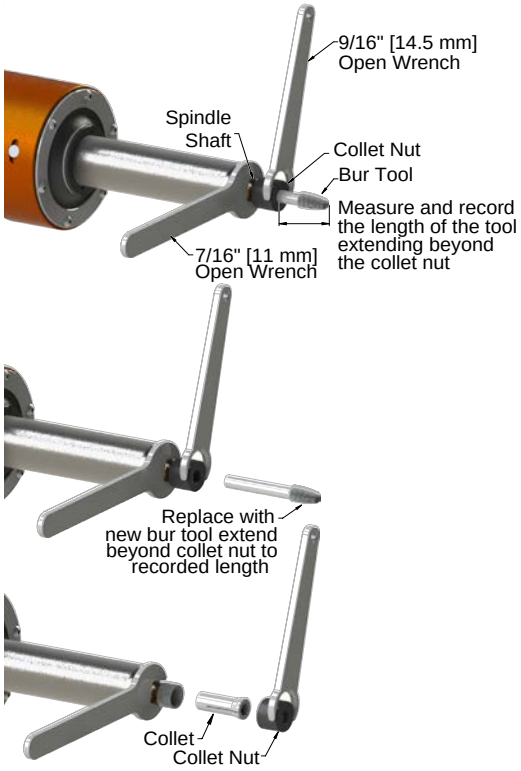
Parts required: *Refer to Section 7—Serviceable Parts*

Tools required: *7/16” (11 mm) and 9/16” (14.5 mm) open-end wrench, (optional) bur setting tool accessory (Part Number: 9150-RC-T-4230)*

1. Remove and/or lock out the turbine motor air supply for safety (De-energize all energized circuits such as air and power).
2. If applicable, disconnect the air hoses from the turbine motor and compliance air fittings.
3. Remove the flexdeburr from the robot or work location.
4. Using compressed air and a clean, lint-free rag, remove debris and grease from the outer surfaces of the flexdeburr.

5. If the cutter 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 tool exposure length. Refer to the Supplemental Documentation for Deburring Tools - Bur Setting Fixture Instructions Document # 9640-50-1005.
6. Use the 7/16” (11 mm) open-end wrench to hold the spindle just behind the collet nut.
7. Use the 9/16” (14.5 mm) collet wrench to turn the collet locknut counterclockwise (when viewed from the cutter tip) to loosen the collet.

Figure 6.1—Bur and Collet Replacement



CAUTION: During operation of the deburring tool, the bur reaches high temperatures. Failure to allow the bur to cool or to wear proper personal protection equipment could result in serious injury to the user. Be aware that during operation, the bur becomes very hot. When removing the bur, take necessary safety precautions to avoid injury.

8. To remove a worn cutter, pull the cutter out of the loosened collet.
9. 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.
10. If an identical new cutter is replacing a worn one, measure and adjust the length of its exposed portion according to the measurement taken in Step *5*.
11. Use the 7/16” (11 mm) open-end wrench to hold the spindle just behind the collet nut.
12. Use the 9/16” (14.5 mm) collet wrench to turn the collet locknut clockwise (when viewed from the cutter tip) to tighten the collet.
13. If applicable, install the deburring tool to the robot or work location.
14. If applicable, replace hose connections to the compliance and spindle supply air fitting.
15. When the above procedure is complete, all circuits (i.e. air, power, etc.) may be placed into normal operation.

6.2.2 Turbine Motor Replacement

If the turbine motor is operated using oil-laden or contaminated 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. 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 procedure:

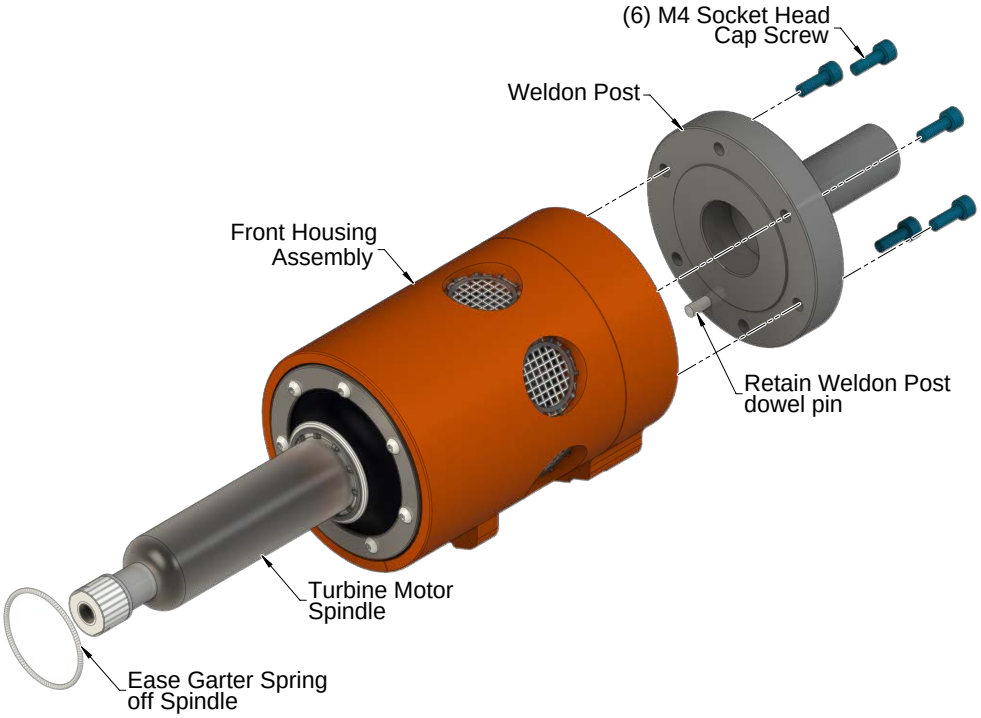
Parts required: *Refer to Section 7—Serviceable Parts*

Tools required: *5/32" socket wrench, diagonal cutters, 2.5 mm, 3 mm hex keys, and 5 mm long hex key*

Supplies required: *Clean lint free rag, Magnalube, Loctite 222, non-hardening pipe dope*

1. Remove and/or lock out the turbine motor air supply for safety (De-energize all energized circuits such as air and power).
2. If applicable, disconnect the air hoses from the turbine motor and compliance air fittings.
3. Remove the flexdeburr from the robot or work location.
4. Using compressed air and a clean, lint-free rag, remove debris and grease from the outer surfaces of the flexdeburr.
5. Remove the cutting bur; refer to *Section 6.2.1—Bur and Collet Replacement* steps *5* through *8*.
6. Ease the garter spring off the front boot.
7. Remove the (6) M4 socket head cap screws securing the weldon post to the front housing assembly using a 3 mm hex key.
8. Remove the weldon post. Retain the dowel pin inserted in the weldon post for reuse.

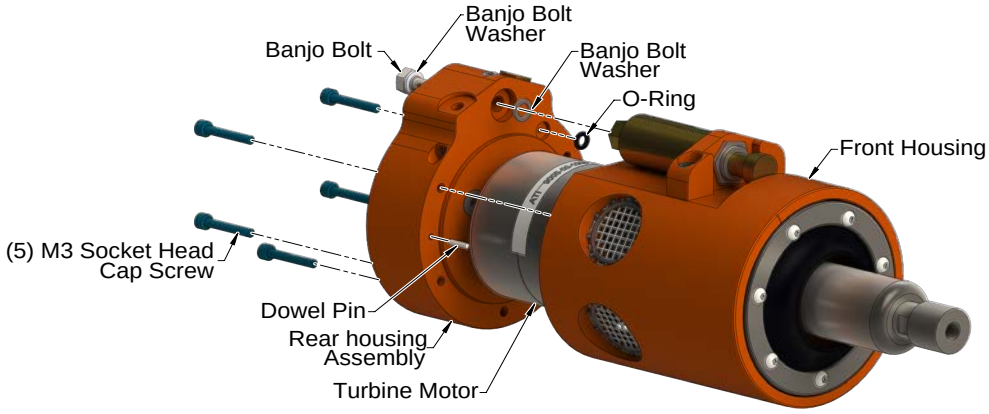
Figure 6.2—Weldon Post Removal



9. Using a 2.5 mm hex key, remove the (5) M3 socket head cap screws securing the rear housing assembly to the front housing.

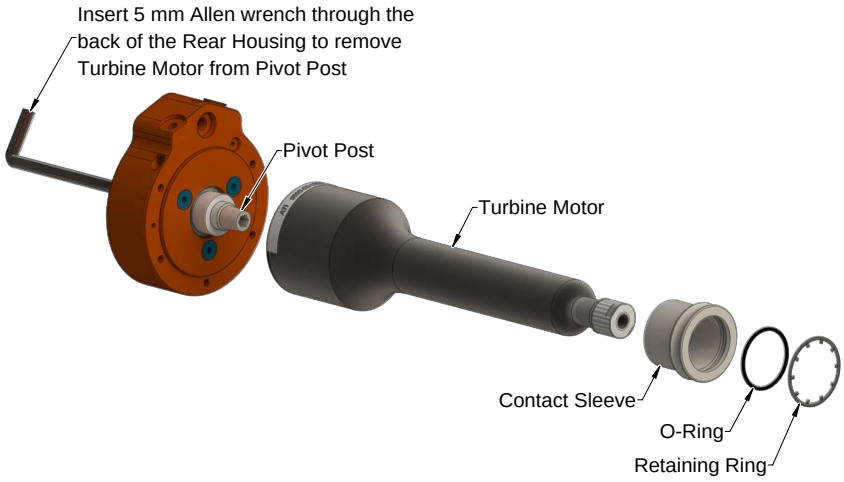
10. Using a 5/32’’ socket wrench, loosen the banjo bolt securing the regulator to the rear housing assembly. Remove the banjo bolt and the (2) washers installed on the bolt (see *Figure 6.3* below for washer location). Retain both washers for reuse; replace washers if worn.
11. Slide the turbine motor and rear housing assembly out of the front housing assembly.
12. Note the location of the small O-ring and small dowel pin installed between rear and front housing assemblies. Retain all parts for reuse; replace any worn parts.

Figure 6.3—Air Turbine Assembly Removal



13. Insert a 5 mm long hex key in the center of the rear housing to reach the hex of the pivot post that attaches the turbine motor to the rear housing.
14. Hold the motor securely and turn the wrench counterclockwise to separate the motor from the rear housing.
15. If installing a new air motor, use diagonal cutters to clip apart the retaining ring within the contact sleeve (Do not remove this retaining ring and contact sleeve if the existing motor will be reused).
16. Slide the contact sleeve off the air motor body.
17. Remove the O-ring within the contact sleeve. Replace the O-ring if worn.

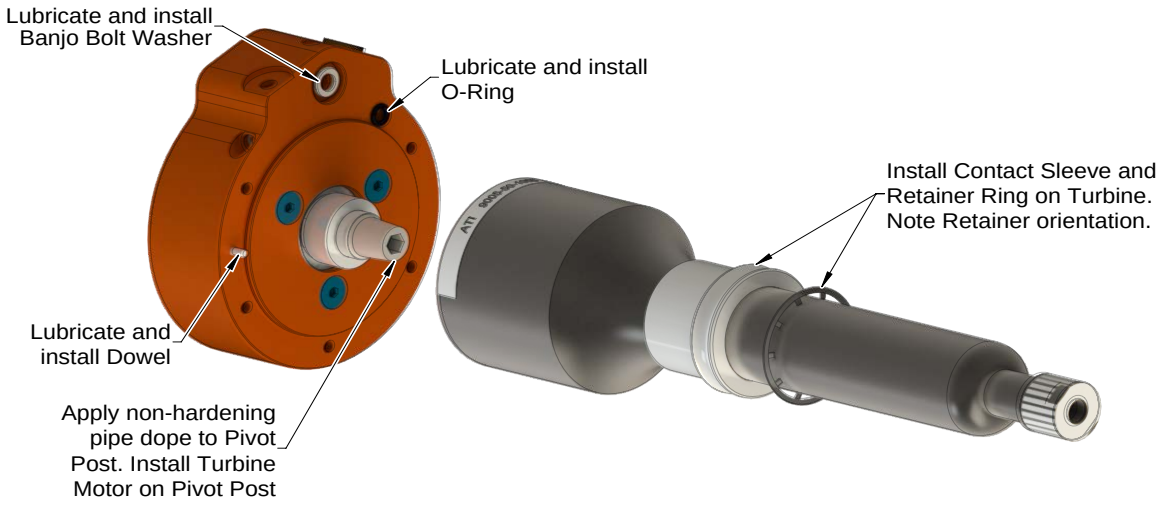
Figure 6.4—Turbine Motor Removal from Rear Housing Assembly



18. Reassembly: lightly grease the contact sleeve O-ring and install it in the contact sleeve. Ensure the O-ring is fully seated in the sleeve groove.
19. Slide the contact sleeve down the body of the new turbine motor spindle. Slide the retainer ring down the spindle. Note the orientation of the retainer ring; the ring teeth should point towards the spindle tip.

20. Apply non-hardening pipe dope to the threads of the pivot post.
21. Apply Magnalube to the small O-ring and dowel pin and install both in the appropriate positions (noted in step *12*) of the rear housing assembly.
22. Apply Magnalube to one banjo bolt washer and install the washer in the bore at the top of the rear housing assembly.
23. Install the turbine motor on the rear housing assembly's pivot post.
24. Using the 5 mm long hex key, tighten the pivot post hex to the turbine motor through the back end of the rear housing assembly. Tighten the pivot post to 100 in-lbs (11.3 Nm).

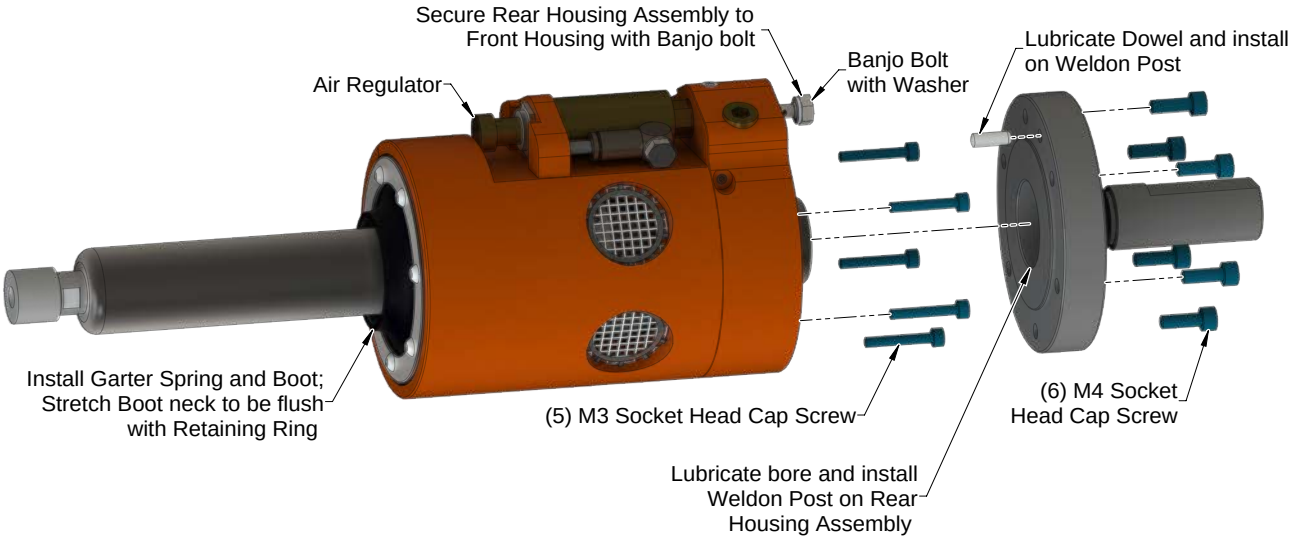
Figure 6.5—Turbine Motor Reinstallation on Rear Housing



25. Install the rear housing assembly with the turbine motor attached to the front housing.
26. Thread washer on banjo bolt and install the banjo bolt to the end of the rear housing assembly to secure the air regulator to the rear housing assembly (see *Figure 6.6*). Use the 5/32'' socket wrench to tighten the banjo bolt to 100 in-oz (0.7 Nm).
27. Apply Loctite 222 to the (5) M3 socket head cap screws. Secure the rear housing assembly to the front housing with the screws. Torque the screws to 12 in-lbs (1.4 Nm) using a 2.5 mm hex key.
28. Stretch the boot to ensure the boot neck is flush with the turbine motor's retaining ring.
29. Slide the garter spring over the turbine motor spindle. Install garter spring in groove on boot neck.
30. Lubricate the dowel that fits into the weldon post and install it in the post's dowel hole.

31. Lubricate the inner bore of the weldon post and install the post on the rear housing assembly using the dowel pin to properly align the weldon post to the rear housing.
32. Apply Loctite 222 to the (6) M4 socket head cap screws and use the screws to secure the weldon post to the rear housing assembly. Tighten the screws to 25 in-lb (2.8 Nm) using a 3 mm hex key.
33. Reinstall the cutting bur. Refer to *Section 6.2.1—Bur and Collet Replacement* and execute steps *9* to *12*.
34. When the above procedures are complete, resume operation.

Figure 6.6—Complete Flexdeburr Reassembly



6.2.3 Pivot Bearing Replacement

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. Refer to *Section 6.2.5—Air Regulator Replacement*. When a spare unit can be placed into service or downtime is not a concern, a new pivot bearing can be installed in an existing rear housing assembly. Refer to *Section 6.2.2—Turbine Motor Replacement*.

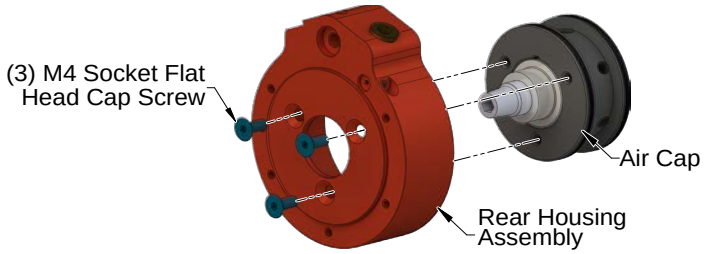
Parts required: *Refer to Section 7—Serviceable Parts*

Tools required: *2.5 mm and 3/16" hex key*

Supplies required: *Magnalube, Loctite 222, Loctite 569, clean, lint-free rag*

1. Remove and/or lock out the turbine motor air supply for safety (De-energize all energized circuits such as air and power).
2. If applicable, disconnect the air hoses from the turbine motor and compliance air fittings.
3. Remove the flexdeburr from the robot or work location.
4. Using compressed air and a clean, lint-free rag, remove debris and grease from the outer surfaces of the flexdeburr, as well as the rear and front housing assemblies.
5. Remove the turbine motor assembly from the housing as described in *Section 6.2.2—Turbine Motor Replacement,* steps *6* to *14*.
6. Use a 2.5 mm hex key to remove the (3) M4 socket flat head cap screws securing the air cap to the rear housing assembly.
7. Remove the air cap assembly from the rear housing assembly.

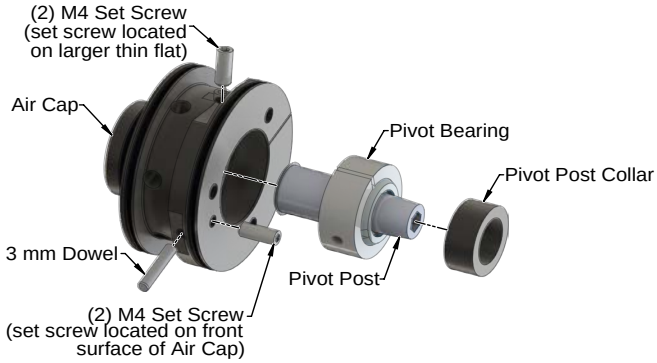
Figure 6.7—Air Cap Removal from Rear Housing Assembly



8. Using a 2.5 mm hex key, remove the (2) M4 set screws; one from the larger thin flat on top of the air cap, the other from the front surface (refer to *Figure 6.8*). Remove the (1) 3 mm dowel from the smaller flat on the air cap.

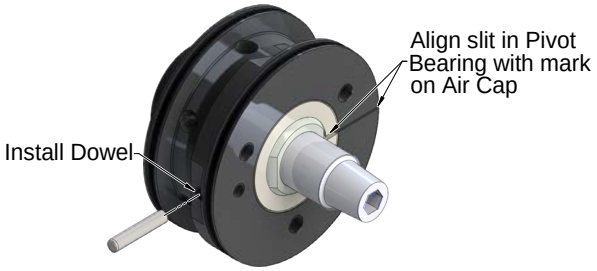
9. Remove the pivot post collar from the pivot post.
10. Grasp the pivot post and remove the post with the pivot bearing attached from the air cap.
11. Push the pivot post out from the pivot bearing; discard old pivot bearing.

Figure 6.8—Disassemble Pivot Post Assembly



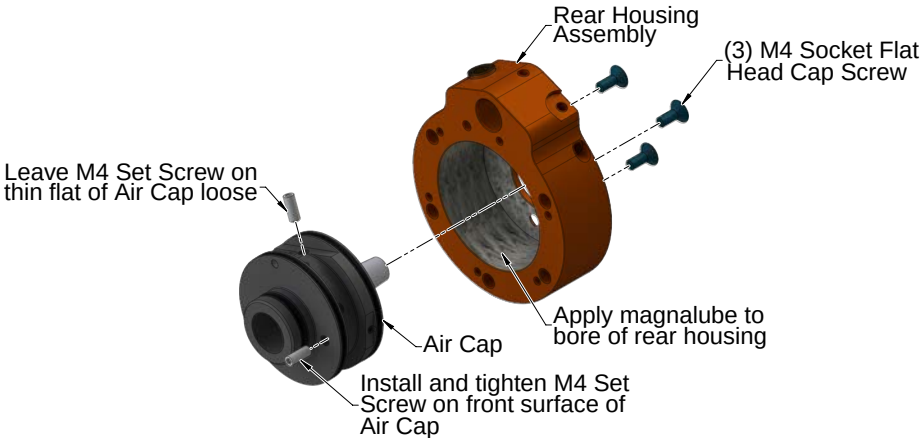
12. Reassembly: slide the pivot post into the new pivot bearing.
13. Install pivot post with the pivot bearing attached in the air cap. Align pivot bearing slit with mark on the air cap.
14. Install 3 mm dowel in air cap. Push dowel all the way into the air cap, such that it enters the groove of the pivot bearing.

Figure 6.9—Pivot Bearing Alignment in Air Cap.



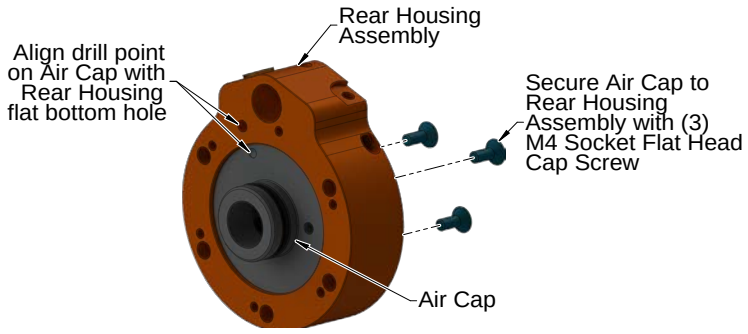
15. Apply Loctite 222 to the (2) M4 set screws and install both in the air cap. Use a 2.5 mm hex key to tighten the set screw on the front surface of the air cap to 12 in-lb (1.4 Nm). Leave the second set screw on the large, thin flat loose.
16. Apply Magnalube to the bore of the rear housing assembly and install the air cap assembly in the bore.

Figure 6.10—Reinstall M4 Set Screws in air cap, Install Air Cap in Rear Housing bore



17. Ensure the drill point hole in air cap and flat bottom hole in rear housing assembly are aligned.
18. Secure the air cap to the rear housing assembly using the (3) M4 socket flat head cap screws. Using a 2.5 mm hex key, tighten to 14 in-lb (1.6 Nm).

Figure 6.11—Air cap alignment in Rear Housing Assembly.

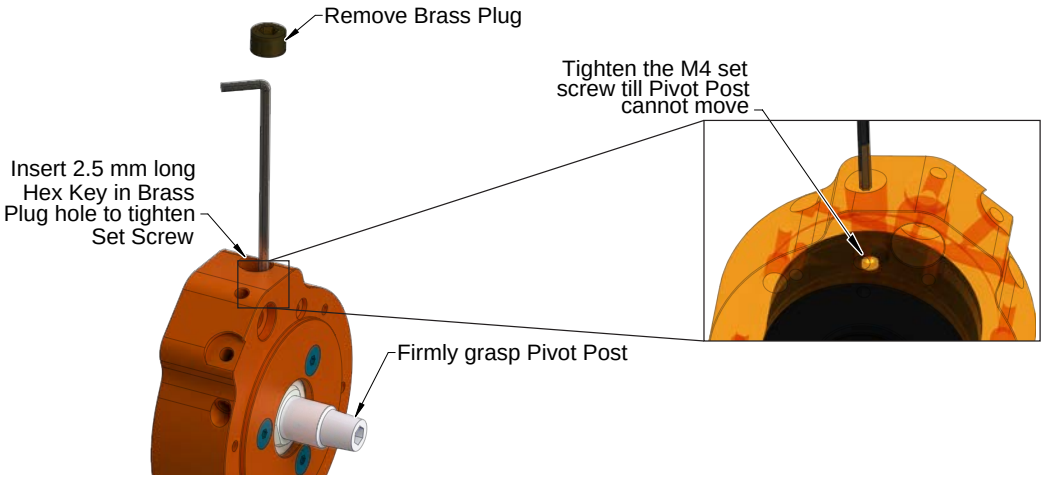


19. Secure pivot bearing in air cap:
    a. Ensure the slit in the pivot bearing and air cap are aligned (see *Figure 6.9* for alignment)
    b. Using a 3/16’’ hex key, remove the brass plug from the top of the rear housing assembly.

c. Lower a 2.5 mm long hex key through the brass plug hole and into the set screw on the air cap's large, thin flat (for set screw location, refer to *Figure 6.8*).

d. Tighten the M4 set screw until the pivot post cannot move.

Figure 6.12—Tighten Pivot Bearing Set Screw



e. Slightly loosen the set screw by backing it out 1/6 of a turn, or 1 flat of a hex key

f. Install pivot post collar on pivot post.

g. Apply Loctite 569 to brass plug and install plug in rear housing assembly. Using a 3/16" hex key, tighten the plug until contact, then tighten an additional 1/4 rotation.

20. Reinstall the rear housing assembly and turbine air motor assembly according to the procedure outlined in *Section 6.2.2—Turbine Motor Replacement* steps *18* to *32.*

21. When the above procedures are complete, resume operation.

6.2.4 Ring Cylinder Assembly Replacement

The compliant motion of the turbine motor spindle is accomplished using a circular array of pistons (ring cylinder) at the front of the housing. After extended operation, this component may need to be replaced to insure free motion of the pistons. The unit may be replaced as an assembly, but its subcomponents are not user serviceable. The ring cylinder is available as a complete assembly with new O-ring seals. To replace the ring cylinder assembly, execute the following procedure:

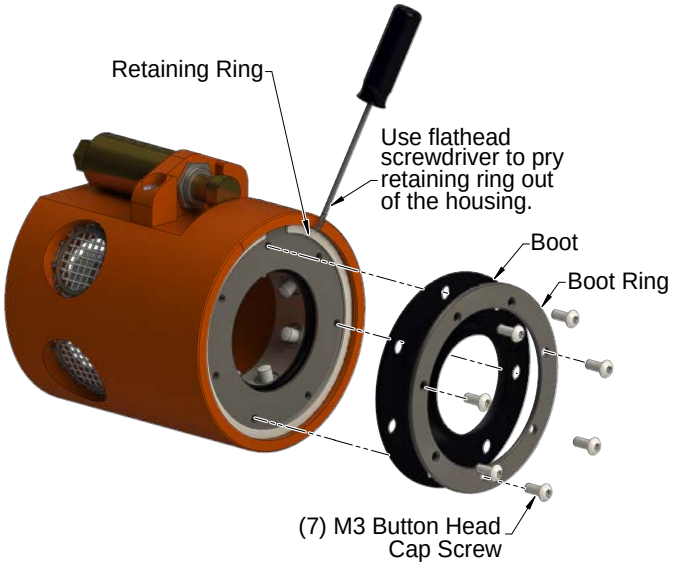
Parts required: *Refer to Section 7—Serviceable Parts*

Tools required: *2 mm hex key, small flat blade screwdriver, non-metallic drift or arbor press, flat plate*

Supplies required: *Clean rag, Magnalube*

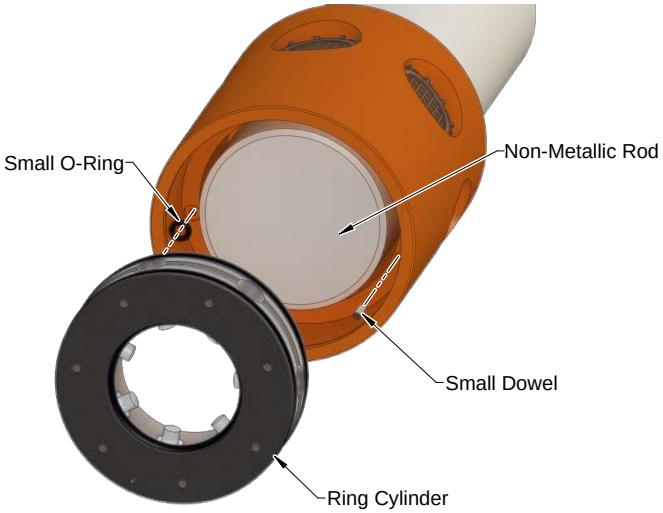
1. Remove and/or lock out the turbine motor air supply for safety (De-energize all energized circuits such as air and power).
2. If applicable, disconnect the air hoses from the turbine motor and compliance air fittings.
3. Remove the flexdeburr from the robot or work location.
4. Using compressed air and a clean, lint-free rag, remove debris and grease from the outer surfaces of the flexdeburr.
5. Remove the turbine motor assembly. Refer to *Section 6.2.2—Turbine Motor Replacement* steps *6* through *14*.
6. Using a 2 mm hex key, remove the (7) M3 button head cap screws securing the boot ring to the front housing.
7. Remove the boot and boot ring from the front housing.
8. Use a small flat blade screwdriver to pry the ring cylinder retaining ring free. Remove the retaining ring.

Figure 6.13—Boot, Boot Ring, and Ring Cylinder Removal.



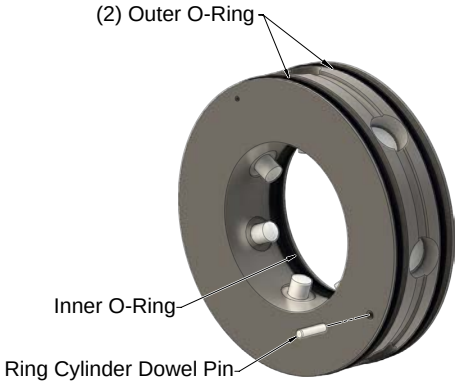
9. From inside the housing, use a non-metallic drift to press the ring cylinder out of the housing. Retain the small O-ring and dowel pin located on the front housing bore for reuse; replace both if worn.

Figure 6.14—Remove Ring Cylinder with a Non-Metallic Drift (Plastic or Wooden Rod)



10. Reassembly: If old unit is being reinstalled, lubricate new O-rings and install the two larger O-rings to the outside and the smaller O-ring to the inner edge of the new ring cylinder (refer to *Figure 6.15)*.
11. Apply Magnalube to the small O-ring and install the O-ring in the front housing. See *Figure 6.14* for O-ring location.
12. Apply Magnalube to the dowel and install dowel in the ring cylinder body.

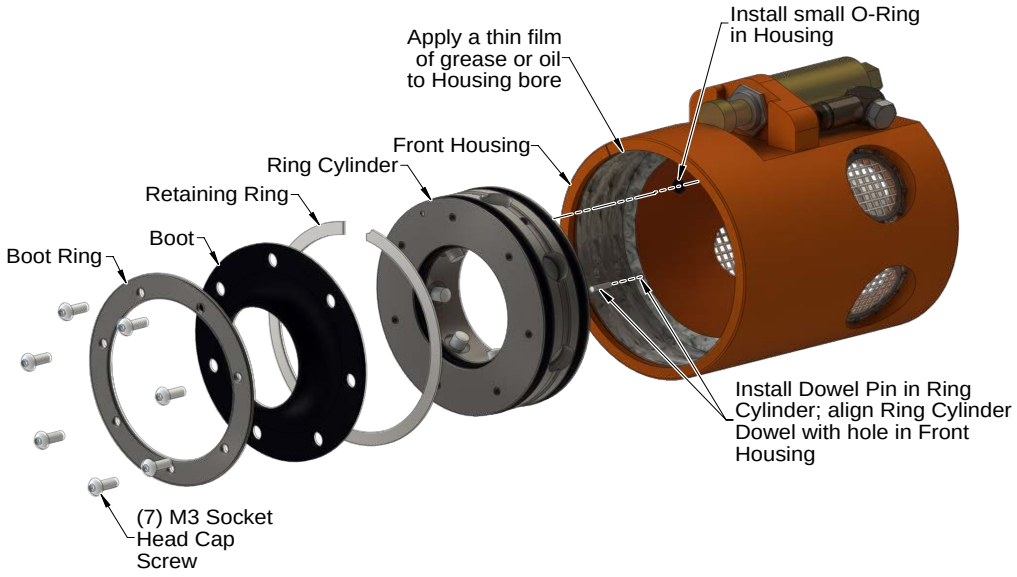
Figure 6.15—Install Ring Cylinder O-Rings and Dowel



13. Apply a thin film of grease or oil to the housing bore where the ring cylinder sits (refer to *Figure 6.16*).

14. Install the ring cylinder in the front housing. Ensure small O-ring in the front housing remains in place. Align the ring cylinder dowel with the dowel hole on the inner ledge of the front housing.
15. Use hand pressure and a flat plate to press the ring cylinder into the housing, past the retaining ring groove.
16. Install the retaining ring in the front housing.
17. Install the boot and boot ring on the housing. Use the (7) M3 button head cap screws to secure the boot and boot ring to the front housing with a 2 mm hex key.
18. Reinstall the turbine air motor assembly according to the procedure outlined in *Section 6.2.2—Turbine Motor Replacement* steps *23* to *32*.
19. When the above procedures are complete, resume operation.

Figure 6.16—Ring Cylinder Reassembly.



6.2.5 Air Regulator Replacement

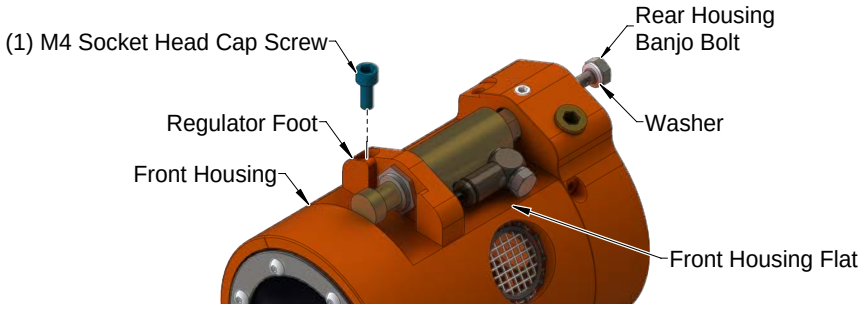
Parts required: *Refer to Section 7—Serviceable Parts*

Tools required: *3 mm hex key, 5/32" socket wrench*

Supplies required: *Magnalube, Loctite 222, and clean lint-free rag*

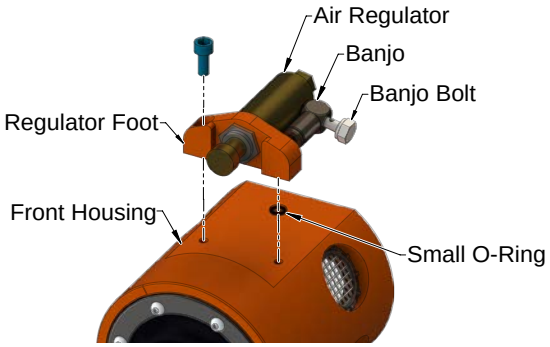
1. Remove and/or lock out the turbine motor air supply for safety (de-energize all energized circuits such as air and power).
2. If applicable, disconnect the air hoses from the turbine motor and compliance air fittings.
3. Remove the flexdeburr from the robot or work location.
4. Using compressed air and a clean, lint-free rag, remove debris and grease from the outer surfaces of the flexdeburr.
5. Refer to *Section 6.2.2—Turbine Motor Replacement* and execute steps *6* to *14* to remove the air turbine motor.
6. Using a 5/32" socket wrench, remove the banjo bolt from the back of the rear housing assembly. Ensure the washer located around the banjo bolt comes out of the rear housing assembly. Retain the washer and bolt for reuse.
7. Using a 3 mm hex key, remove the (1) M4 socket head cap screw that secures the regulator foot to the front housing flat.

Figure 6.17—Remove Rear Housing Assembly Banjo Bolt



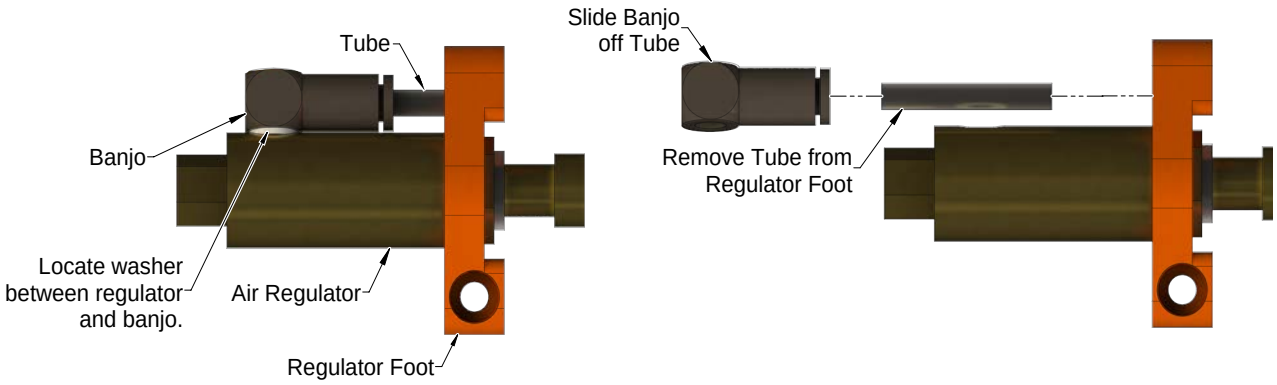
8. Remove the regulator foot from the front housing flat. Note the location of the small O-ring between the regulator foot and front housing flat (see *Figure 6.18*). Retain O-ring for reuse; replace if worn.
9. Using a 5/32" socket wrench, remove the banjo bolt and washer that secure the banjo to the air regulator from the side of the regulator. Retain both the bolt and washer for reuse; replace the old washer if worn.

Figure 6.18—Remove Air Regulator Assembly from Front Housing



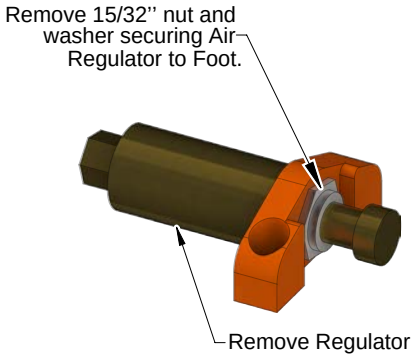
10. Slide the banjo off the air tube. Remove the washer between the banjo and air regulator. Replace washer if worn.
11. Remove the tube from the regulator foot.

Figure 6.19—Disassemble Air Regulator Assembly



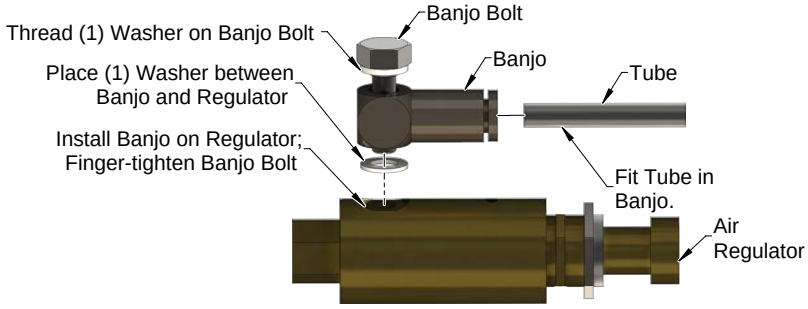
12. Remove the 15/32'' nut and washer to remove the air regulator from the regulator foot. Discard the old regulator.

Figure 6.20—Rear Housing Assembly Replacement



13. Reassembly: apply grease to one banjo bolt washer and thread washer on banjo bolt.
14. Place second banjo bolt washer on the outer surface of the new air regulator and position banjo against washer, ensuring the washer fits between the banjo and air regulator.
15. Install banjo bolt in banjo and regulator; finger-tighten the banjo bolt.
16. Position tube in banjo.

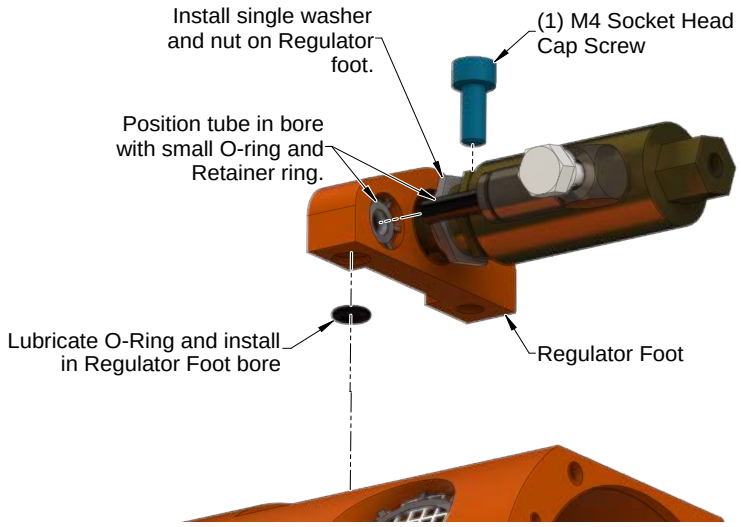
Figure 6.21—Install Banjo Bolt and Banjo to Regulator



17. Install new air regulator assembly in regulator foot:
    a. Position the tube within the bore containing the O-ring and retainer ring.
    b. If installed, remove the 15/32'' lockwasher and nut from the new air regulator.
    c. Position air regulator in the regulator foot
    d. Install the lockwasher and nut in front of regulator foot, as pictured in *Figure 6.20*.

18. Apply Magnalube to the regulator foot's small O-ring.
19. Position small O-ring in the bore directly under where the tube is installed on the regulator foot.
20. Install regulator foot assembly on the front housing. Apply Loctite 222 to the (1) M4 socket head cap screw.
21. Install the (1) M4 socket head cap screw in regulator foot and tighten to 25 in-lb (2.8 Nm) using a 3 mm hex key.

Figure 6.22—Rear Housing Assembly Replacement

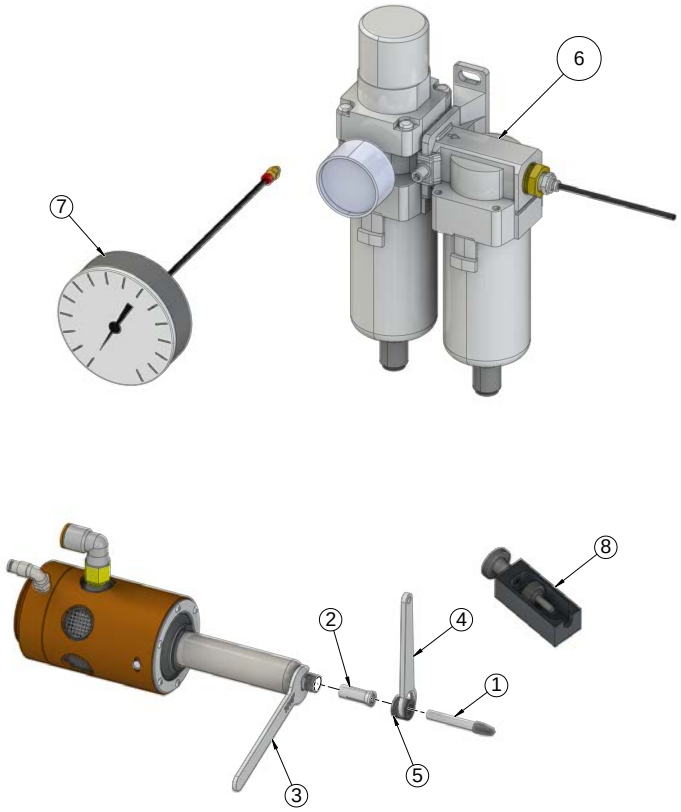


22. Refer to *Section 6.2.2—Turbine Motor Replacement* and execute steps *21* to *32*. Ensure the end of the air regulator not connected to the regulator foot enters the shallow bore on the rear housing assembly.
23. When the above procedures are complete, resume operation.

7. Serviceable Parts

For repair and spare parts please contact ATI. Refer to *Section 9.1—RC-340-CNC Series Geometry, Mounting, and Parts* 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



NOTICE: Individual parts may differ slightly in appearance from what is shown in the figure above.

Table 7.1—Available Accessories, Tools, and Optional Replacement Parts

Item No.	Part Number	Description
1	9150-RC-B-XXXXX	Refer to *Table 4.1* for bur part numbers and descriptions
2	9150-RC-C-12442	Ø 3 mm Collet
	9150-RC-C-12443	Ø 1/8” Collet
	9150-RC-C-12444	Ø 3/16’’ Collet
	9150-RC-C-12445	Ø 6 mm Collet
	9150-RC-C-12446	Ø 1/4” Collet (Standard on Inch Models)
3	9150-RC-T-12475	7/16” [11 mm] Open End Wrench
4	9150-RC-T-12479	9/16” [14.5 mm] Open End Wrench
5	3700-50-3081	Collet Nut, RC-300/340 Motor (.450 Lg. x .318 Hole)
	3700-50-3082	Collet Nut, RC-300/340 Motor (.450 Lg. x .254 Hole)
6	9005-50-6160	High-Flow Filter/Regulator Assembly
7	9150-GA-60	Compliance Air Gauge
8	9150-RC-T-4230	Bur Setting Fixture, RC/RS Tools

8. Specifications

Table 8.1—RC-340-CNC Series Specifications	
Parameter	**Rating**
	RC-340-CNC Series
Motor Type	Turbine
Motor part number	3490-0001026-01
Motor Series	525JSL
Idle Speed (RPM)	40,000 (44,000 Max.)
Power	340 W (0.45 hp) @ 40,000 RPM
Weight (without Adapter)	4.21 lbs (1.91 kg)
Compensation (Radial)	+/-7.5 mm max., +/-3 mm recommended (+/-0.3 in. max., +/-0.12 in. recommended)
Compliance Force (Measured at Collet)	2.86 lbf-9.4 lbf (12.7 N- 42 N) @ 1.0-4.1 bar (15–60 psi)
Bur Surface Speed	Dependent on Cutter Geometry and Motor Speed
Turbine Motor Air Pressure	6.2 Bar (90 PSI) (All Models)
Air Consumption (Idle)	2.83 l/s (6 CFM)
Air Consumption (Stall)	10.2 l/s (21.5 CFM)
Air Connection (Spindle)	1/4 NPT / 1/8 NPT alternate connection (including -E Models)
Air Connection (Compliance)	Internally plumbed from spindle
Sound Pressure Level[1]	78 dBa
Collet Size, Standard[2]	1/4" standard (All Modules) [1/8'', 3/16'', 3 mm, 6 mm optional]
Rotary Burs [3]	Commercial Units Rated 40,000 RPM or Higher
Special Tools	Open End Wrenches (1 Pair Supplied) 7/16” (11 mm) 9/16” (14.5 mm)

Notes:

1. 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.
2. Optional Sizes Available, See *Section 7—Serviceable Parts*
3. ATI Can Supply Burs, See *Section 4.6.1—Bur Selection*.

9. Drawings

9.1 RC-340-CNC Series Geometry, Mounting, and Parts

The drawing is available on the ATI website: *https://www.ati-ia.com/app_content/Documents/9630-50-RC-340-CNC.auto.pdf*.

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.

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

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 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 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.