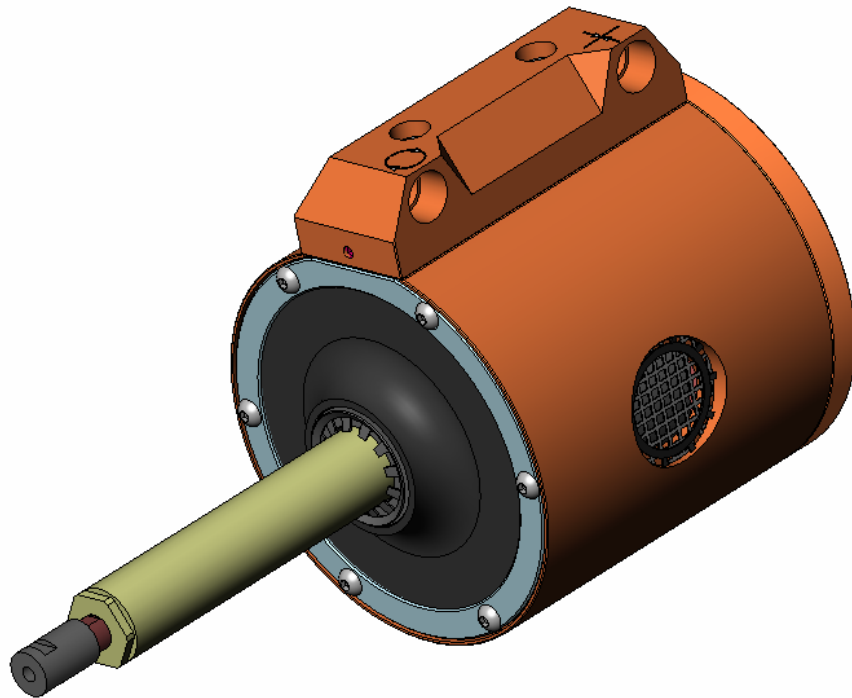




Flexdeburr™
Robotic Deburring Tool
(Model 9150-RC-151)
Installation and Operation Manual

US Patent # 6,974,286 B2 and 7,396,197 B2
UK Patent # GB2,418,631 B



9150-RC-151

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Engineered Products for Robotic Productivity

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CAUTION: This manual describes the function, application and safety considerations of this product. This manual must be read and understood before any attempt is made to install or operate this product, otherwise damage to this product or unsafe conditions may occur.

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Glossary of Terms

| <u>Term</u> | <u>Definition</u> |
|----------------------|--|
| Adapter | Device for attaching the Flexdeburr™ to robots or work surfaces. |
| Air Filter | Device for removing contamination from air supply lines. Typically refers to removal of particulates. |
| Air Turbine | Air motor that drives the spindle. |
| Bur | Any unwanted, raised protrusion on the workpiece. |
| Burr | 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. |
| 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 both the Flexdeburr assembly. |

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1. General Data

1.1 Environmental Limitations

Operation:

| | |
|------------------------|--|
| Installation position: | Mounted to machining center by various means, customer-supplied tool holders/adapters. |
| Temperature range: | 5° C–35° C 41° F–95° F |

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. Consult Section 2.5 of this manual.

Utilities: The tool requires clean, dry, filtered, non-lubricated air. The use of a coalescing filter and filter elements rated 5 micron or better is recommended. The spindle must be supplied with air at 6.2 bar (90 psi). A separate air pressure regulator is used to pneumatically control the compliance force.

2. Handling, Installation, Storage and Transportation

2.1 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 those parts that may have been damaged for a closer inspection. If necessary, notify ATI for assistance in evaluation of the product condition.

2.2 Unpacking and Handling

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

2.3 Installation

2.3.1 Mounting Adapter and Air Supply

The Flexdeburr is capable of rear (axial) or side (radial) mounting. ATI offers a blank rear interface plate kit for rear mounting and a simple foot bracket for bench mounting.

The Flexdeburr must be rigidly mounted using either of its mounting surfaces prior to use. Under no circumstances should the unit be used for manual/hand deburring. Once securely mounted, the unit should be supplied with clean, dry, non-lubricated air filtered five (5) micron or better. The use of a coalescing air filter is recommended to remove all trace moisture and oil.

Air line fittings supplying the Flexdeburr should be installed with care using a minimum of tape or liquid sealant. To prevent contaminant damage to the air motor, all air lines should be blown down to remove debris prior to connection of the Flexdeburr.



CAUTION: The Flexdeburr must be supplied with clean, dry, non-lubricated air filtered five micron or better. The use of a coalescing filter is recommended. Water and oil damage of the air motor or damage associated with the debris in the air lines is not covered under warranty.

2.3.2 Pneumatics

Connect the Flexdebur as shown in Figure 2.3.

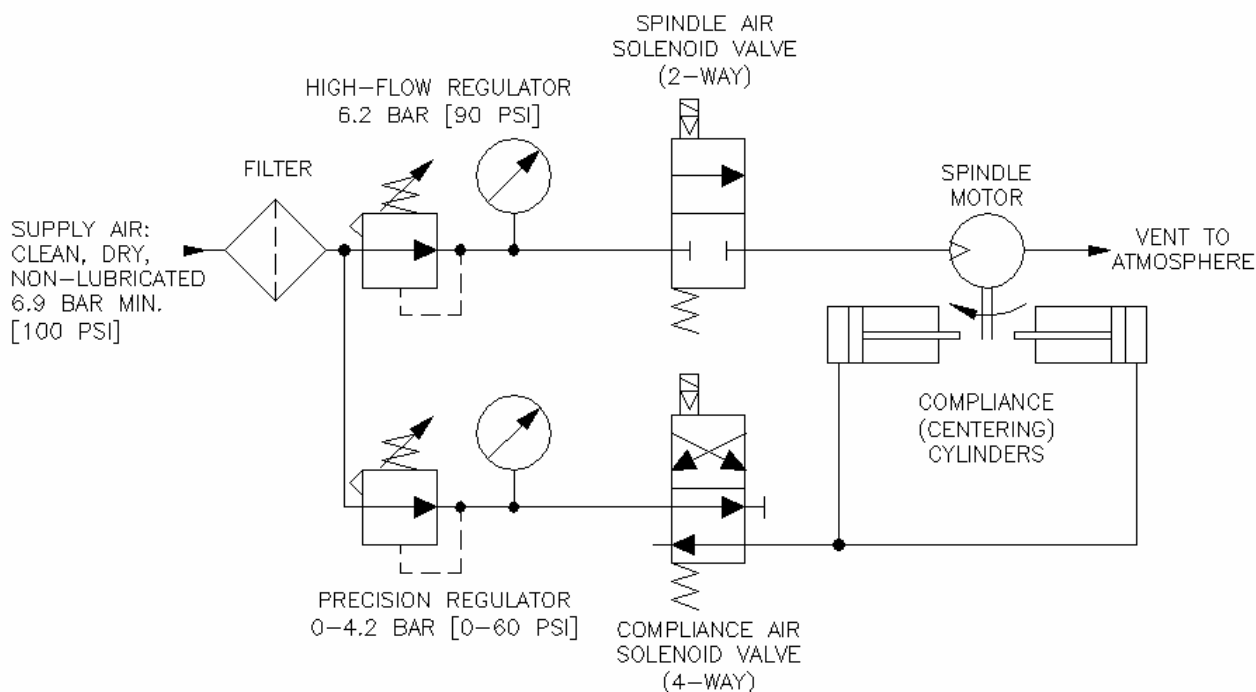


Figure 2.3—Pneumatic Connections

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

A high-flow air pressure control regulator is required to supply the spindle motor at 6.2 bar (90 psi). A second, precision, 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 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 Technical Specifications, Section 3.2). 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 Flexdebur. ATI recommends that the user install a high-flow pneumatic pressure regulator and a high-flow valve to properly supply a stable air supply of 6.2 bar (90 psi) to the spindle motor. (ATI Part #9150-FFR-90 or equivalent, see Section 3.2 for the maximum flow requirements). While the Flexdebur motor can be operated below 6.2 bar, it will not develop full power or speed. Very little airflow is required for the compliance mechanism.

The air supply solenoid valve must be controlled through robot or controller.



| Function | Connection Type | Pressure |
|---|--|--------------------------------------|
| Motor Inlet  | 1/8-NPT Port | 6.2 bar [90 psi] |
| Compliance (Radial) Force  | 1/8-NPT Port | 1.4–4.2 bar (Maximum) [20–60 psi] |
| Exhaust | Vented to Atmosphere through the Housing | Not Applicable |

Table 2.1—Pneumatic Connections

The Flexdeburr should be plumbed using flexible tubing when possible. The inside diameter of this tubing should be as large as practical for the customer's installation to minimize pressure drop to the spindle motor.

The turbine air motor is extremely quiet and vents dry air to the environment through the screen-covered ports on the side of the housing. No mufflers are required. Information on the sound intensity is provided in Section 3.2. 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 3.2).

The compliance force air supply pressure regulator should be adjusted between 1.4–4.2 bar (20–60 psi). When testing for the proper contact force start with a very low pressure and increase slowly until the desired cut is achieved.

2.4 Transportation and Protection during Transportation

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

2.5 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 and place the Flexdeburr inside the crate.

3. Technical Description

3.1 Product Description

Attached at the end of this document you will find the Flexdeburr product description.

3.2 Technical Specifications

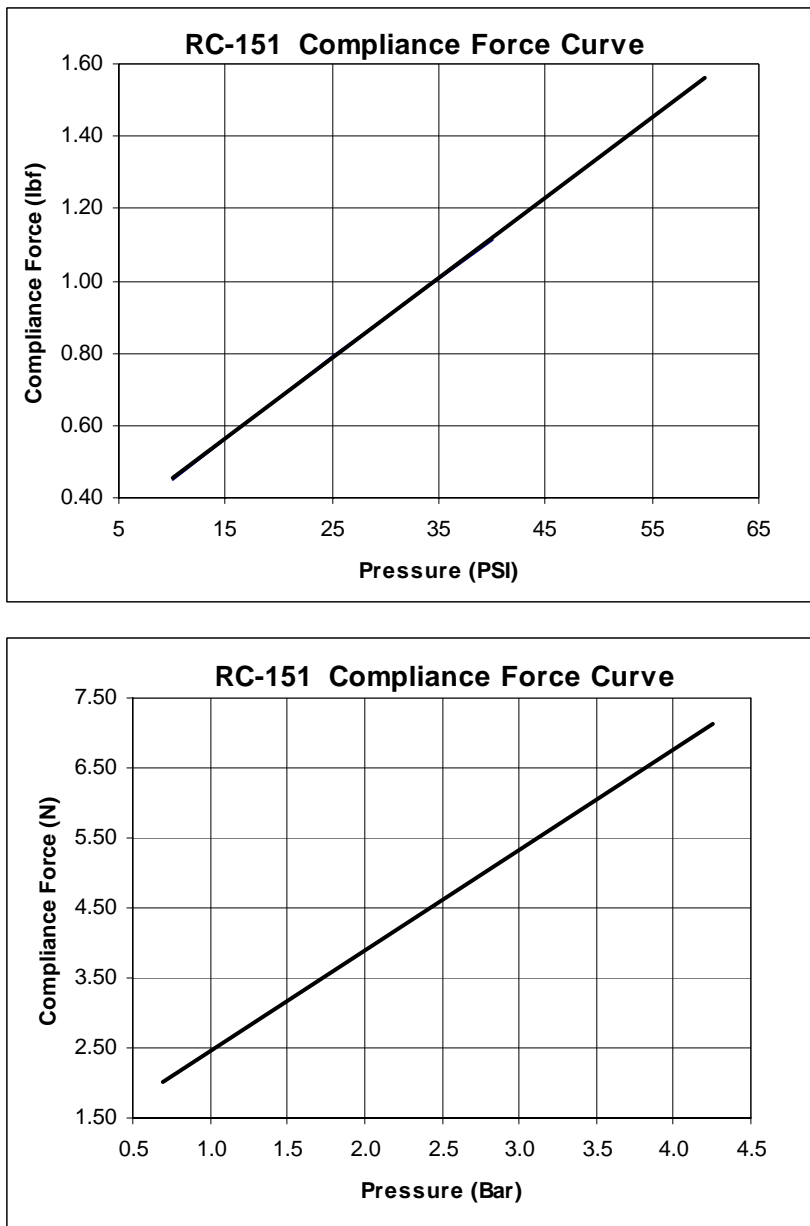
Main specifications for the Flexdeburr:

| | |
|--|---|
| Motor | Air motor, turbine type |
| Idle Speed | 65,000 RPM |
| Power | RC-151: 150 W (0.20 hp) at 65,000 RPM |
| Weight total (w/o adapter) | 1.1 kg (2.4 lbs) |
| Compensation | ± 5 mm max. radial, ± 2.5 mm recommended (± 0.2 in. max. radial, ± 0.10 in. recommended) |
| Compliance force (Measured at the Collet) | 3.1–6.7 N, @ supply pressure of 1.4–4.14 bar (0.7–1.5 lbs, @ supply pressure of 20–60 psi) |
| Burr surface speed | Dependent on cutter geometry |
| Spindle Air pressure | 6.2 bar (90 psi) maximum |
| Air consumption (idle) | approx. 1.42 l/s (3 CFM) |
| Air consumption (stall) | approx. 3.78 l/s (8 CFM) |
| Sound pressure level | Less than 67 dB(A) (not mounted and w/o cutter) |
| Collet Size | 1/8" Standard (3mm optional) |
| Rotary burrs | Commercial units, customer supplied |
| Special tools (supplied) | Open end spanners 6.4mm (1/4") and 7mm (9/32"). |

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. The deburring tool may also excite resonant frequencies on equipment to which it is mounted creating higher sound pressure levels than the unit by itself.

Each Flexdeburr receives a thorough test procedure before it is shipped.

The following charts show measured forces relative to applied compliance (centering) air pressure. Measurements may vary from one product to another, and should only be treated as nominal.



**Figure 3.1—Flexdeburrr-151 Radial Compliance Force Curves
(Measured at the Spindle Tip)**

The actual force characteristics will vary slightly from installation to installation due to mounting orientation and condition of the unit.

The air turbine 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.

4. Operation

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

4.1 General Precautions

It is important that all personnel involved in operation of the Flexdeburrr have a thorough understanding of the operating procedures. Failure to follow these or neglecting safety precautions can create hazardous situations, which may, in the worst case, injure personnel or damage the deburring installation and the Flexdeburrr.

The Flexdeburrr must only be used for automated deburring applications. The Flexdeburrr is a deburring tool only.



DANGER: Never use the Flexdeburrr for purposes other than automated deburring. Never use the Flexdeburrr as a hand-held machine.

Countersinking and other axial metal-forming processes should not be performed by the Flexdeburrr. It may be dangerous to operate the Flexdeburrr for these purposes. If a failure occurs due to forces caused by improper use, hazardous situations for both personnel and equipment could be created. The Flexdeburrr is intended to perform deburring only.

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

Reduce the feed rate when the workpiece and the Flexdeburrr are making initial contact. Making the contact movement between the Flexdeburrr and the workpiece too fast may in some situations result in a collision. Collisions may create hazardous situations for both personnel and equipment.

When performing maintenance, always remember to tighten nuts and bolts. When replacing burrs, always attach the burrs correctly. Please consult Section 5.1.



DANGER: Never use the Flexdeburrr in a manner to produce axial loads. Never use the Flexdeburrr for countersinking or drilling.

4.2 Flexdeburrr Working Environment

As described in previous sections, the Flexdeburrr should only be used in an automated 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 Flexdeburrr maintenance, make sure the Flexdeburrr and equipment are stopped before entering the cell. When installing and testing, never be present in the cell when the Flexdeburrr is running.

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

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

4.3 Burr / Cutter Considerations

For instructions on how to replace the burr, please consult Section 5.1.

In many robotic deburring applications, including steel and aluminum, no cooling or lubrication of the rotary burr is necessary. For some materials and situations, the addition of coolants or compressed air may aid the cutting process. Coolant must be prevented from entering the deburring unit through its exhaust screens.

Burr selection is discussed in Sections 4.5 and 7.2.

4.4 Tool Center Point (TCP) Position and Programming

Figure 6.1 shows the Flexdeburr dimensions. The Flexdeburr provides radial compliance and performs best when the cuts taken are not excessively deep. The Flexdeburr spindle must never be running while programming a machining center. During teaching the compliance air must be on and supplied near 1.4 bar (20psi).

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 1/8" collets this will mean a 1/8" diameter pin of suitable length. The dowel pin should extend sufficiently from the collet to reach the surface on the burr where cutting is desired. (See Figure 4.1) The diameter of the cutter should not exceed that of the dowel pin by more than the compliance range of the Flexdeburr.

Another programming method is to teach the path using the centerline of the burr as a guide, following the edge of the part, and then manually or automatically adding offsets to the robot path to achieve the final correct burr path. (See Figure 4.2) The programming method used will depend on the machining center's capabilities and programmer preferences.

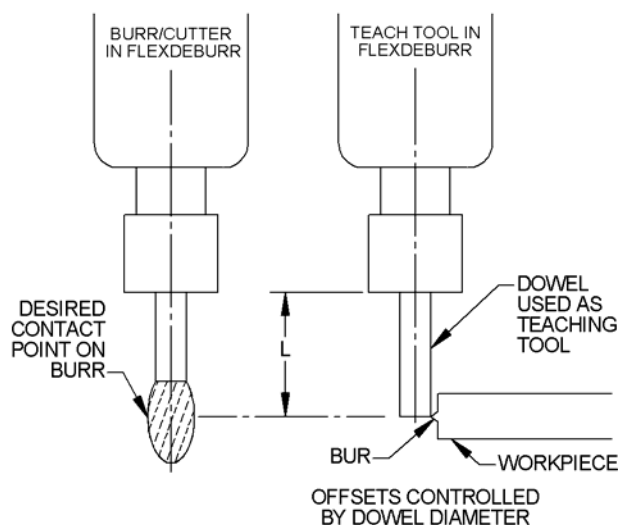


Figure 4.1—Flexdeburr Dowel Teaching Tool

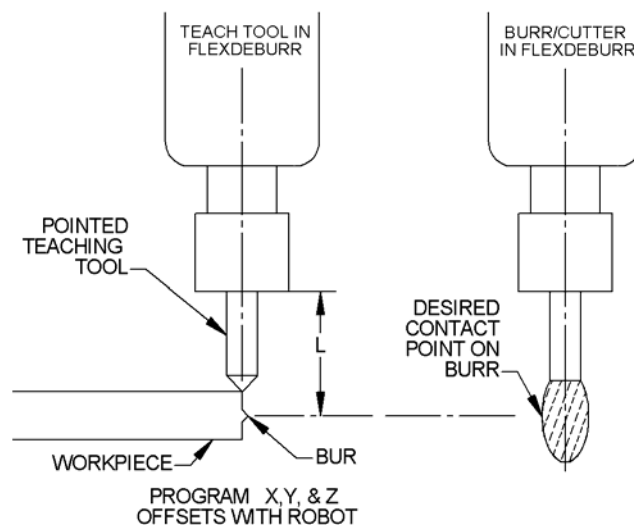


Figure 4.2—Flexdeburr Pointed Teaching Tool

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. Unlike a machining center, the spindle of the deburring tool is inherently and intentionally non-rigid. The resulting force imbalance when the cutting tool contacts two planes can cause severe tool chatter. The customer is advised to create a tool path, which will prevent the cutter from simultaneously contacting two perpendicular surfaces.

When deburring inside radii, a similar situation may arise. The customer is advised that no attempt should be made to deburr an inside radius less than 1.5 times the diameter of the desired cutter. ($R_{min} = 1.5 \times \text{Cutter diameter}$). 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 program the first time, observe the path with the radial compliance air supply turned down to approximately 1.4 bar (20 psi). Verify that at operational speed the burr is deflected but contacts the work surface. Once the path has been confirmed, the compliance force of the burr should be adjusted as described in Section 2.3.2 in order to achieve a correct depth of cut.

4.5 Cutter Operation and Burr Selection

The Flexdeburr will perform best in “climb milling.” This refers to a cutter whose directions of traverse and cutter rotation are the same. In the case of the Flexdeburr, the cutter rotation is clockwise when viewed from above. Climb milling would therefore involve clockwise motion around the outside of a 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 will generally be reduced. When “conventional milling,” extra care must be taken around corners. This poses a potential hazard where the cutting force can deflect the burr and cause the burr to break as the machine 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 7 of this document 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, the 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 will be higher for plastics to minimize this behavior. This results in larger cuts which more effectively remove heat from the cutter-tool interface.

4.6 Safety Precautions

- Never use or start the Flexdeburr without first reading and understanding the operating procedures described in this manual.
- Make sure that the Flexdeburr is mounted as described in this document.
- Never use the Flexdeburr for any purposes or in any ways not explicitly described in this document.
- Make sure that the pneumatic control equipment is connected as described.
- Only original spare parts supplied by ATI must be used.
- Install a barrier to prohibit people from approaching the Flexdeburr while in operation.
- Never be present near the Flexdeburr while it is started or running. If it is necessary to approach the Flexdeburr while in motion, stand behind appropriate Plexiglas windows.
- Be aware of rotating parts.
- Burrs must be rated for at least 65,000 RPM
- Use eye-protection.
- Be aware of high sound levels during cutting. Always use hearing protection while working in the neighborhood of the Flexdeburr.

5. Maintenance Instructions

5.1 Routine Operational Maintenance

The Flexdeburr 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. The following information 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 Figure 6.1.

5.2 Burr Replacement

In normal operation, the burr will become worn. 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 burr and the workpiece should be examined often in order to determine at what interval the burr should be replaced.

The following steps detail replacing the cutter:

1. If the cutter is to be replaced with an identical type, measure and record the length of the tool extending beyond the collet nut.
2. Use the 1/4" (6.4mm) open-end wrench to hold the spindle shaft where it exits the air motor housing.
3. Use the 9/32" (7mm) open-end wrench to turn the collet locknut counter-clockwise when viewed from the cutter tip.

4. Remove and replace the cutter. 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 1.
5. Tighten the collet by reversing the steps above and restore the air supply.

5.3 Air Motor Replacement

If the air motor is operated using oil laden air, it will fail and require replacement. Failure of the motor due to oil in the spindle air is not covered under warranty. The motor may also require replacement after an extended operating life. There are no user-serviceable parts in the air motor. Flexdeburrr units with defective motors should be returned to ATI during the warranty period.

The air motor is replaced as a subassembly. Should the customer wish to replace the motor subassembly after the warranty period, the following steps must be performed:

1. Remove the garter spring from the front boot.
2. Remove the button head screws and retainer securing the boot to the front of the unit.
3. Remove the boot.
4. On the air supply block, remove the small set screw visible below/near the spindle air supply port.
5. Remove the two socket head screws securing the air supply block to the side of the unit.
6. Remove the air supply block. Retain all seals and fasteners for reuse.
7. Remove the fitting exposed when the air block is removed by turning it counterclockwise.
8. Move the air motor spindle sideways in the housing toward where the fitting was removed in the previous step and pull the motor assembly from the unit.
9. Loosen the three small set screws from the air supply ring around the back of the motor.
10. Pull the ring to the rear off the motor.
11. Remove the two pieces of tubing from the gimbal ring.
12. Locate the two small set screws in the gimbal ring and remove them.
13. Use needle-nose pliers to remove the pins that were secured by the set screws removed in the previous step.
14. Pull the motor assembly out of the gimbal ring being careful not to loose the wave spring.
15. Reassembly is the reversal of these steps noting the following important steps:
 - Coat the wave spring with light grease and place it on the shoulder inside the outer gimbal ring prior to sliding the motor assembly in place. The grease will hold the spring in position during this step. (Reverse the disassembly steps above concerning pins and set screws).
 - Lubricate the o-rings in the air supply ring.
 - Lubricate the OD of the two pieces of tubing that go between the outer gimbal ring and the air ring prior to their installation, then fit them to the gimbal ring.
 - Locate and align the axial scribe marks on the gimbal ring and the air supply ring.
 - Slide the air supply ring down the motor body. Stop when there is a gap of 0.449" (11.4mm) between the air ring and the gimbal ring measured at the pivot pins in the gimbal ring then tighten the three set screws securing the air ring to the motor body.

5.4 Pivot Bearing Replacement

The articulation of the air motor spindle is accomplished using a gimbal suspension. After prolonged heavy use, the bearings in this suspension may require replacement. There are two bearings in the outer gimbal ring and two bearings in the black anodized ring on the motor subassembly. Should the bearings require replacement refer to the steps below:

1. Remove the air motor as described above.
2. Remove the gimbal ring from the motor assembly as described above.
3. The bearings of each ring are now accessible. To remove the bearings, use a suitable pair of pliers to grab the outer race and pull the bearing out of the ring. (The bearings are only lightly retained.) Alternatively, a hooked piece of wire can be inserted in the bearing bore to pull the bearings out.
4. Reassembly is the reversal of these steps with the following points:
 - Apply a tiny amount of non-hardening gasket sealant (Permatex #2 or equivalent) to the outer race of the new bearings to secure them during the reassembly process. Only the smallest amount is required.
 - If the large bearings on the outer gimbal ring are replaced, note that the bearing WITHOUT an extended inner race goes in the bore with the cup seal in the bottom of the hole.
 - Follow the applicable steps covered under Air Motor Replacement to complete reassembly.

5.5 Ring Cylinder Assembly Replacement

The compliance and articulation of the air motor spindle is accomplished using a circular array of pistons (ring cylinder) at the rear of the Flexdeburrr housing. After extended operation, this component may need replacing to insure free motion of the pistons. The unit may be replaced as an assembly, but its subcomponents are not user-serviceable. To replace the ring cylinder assembly, perform the following steps:

1. Remove the air motor as described previously.
2. Remove the rear housing.
3. Invert the unit and press the ring cylinder outwards to the rear. Use a non-metallic drift to prevent damage. (It may be necessary to use a small arbor press and support plate to remove the ring cylinder if the unit has been in service for a prolonged time).
4. Replacing the ring cylinder assembly is the reversal of these steps with the following points:
 - Apply a thin film of grease or oil to the housing bore where the ring cylinder seats prior to installation.
 - Fit new o-rings to the outside of the ring cylinder assembly if the old unit is being reinstalled.
 - Use hand pressure and a flat plate to press the ring cylinder into the housing and past the retaining ring groove.
 - Complete the re-assembly steps as outlined under Air Motor Replacement.

5.6 Pneumatics

The air tubing/lines to the Flexdeburrr should routinely be checked for their general condition and replaced as required. The air to the Flexdeburrr 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.

5.7 Lubrication

Lubrication systems are not to be used. The Flexdeburr air motor must be supplied with clean, dry, filtered air. Oil in the air stream will cause the air motor to fail prematurely. Failure of the motor due to oil in the air stream is not covered under the warranty.



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

6. Recommended Spare Parts

For repair and spare parts please contact ATI. Figure 6.1 is an exploded drawing showing all the components of the Flexdeburr. Suggested user replaceable, optional and spare parts are listed in the tables below. All other repairs must be performed by ATI.

The following optional parts are available for the Flexdeburr:

| Part Number | Description |
|-----------------|-------------------------------------|
| 9150-RC-C-12141 | 1/8" Collet |
| 9150-RC-C-12142 | 3mm Collet |
| 9150-RC-C-12149 | Collet Nut |
| 9150-FFR-90 | High-Flow Filter/Regulator Assembly |
| 9150-GA-60 | Compliance Air Gauge |

ATI recommends stocking the following spare parts:

| Part Number | Description |
|-----------------|--|
| 3700-50-5014 | Flexdeburr Boot |
| 9150-RC-T-12173 | 1/4"-9/32" (6.35-7.1mm) Double Ended Open End Wrench |

Figure 6.1—User-Serviceable Parts

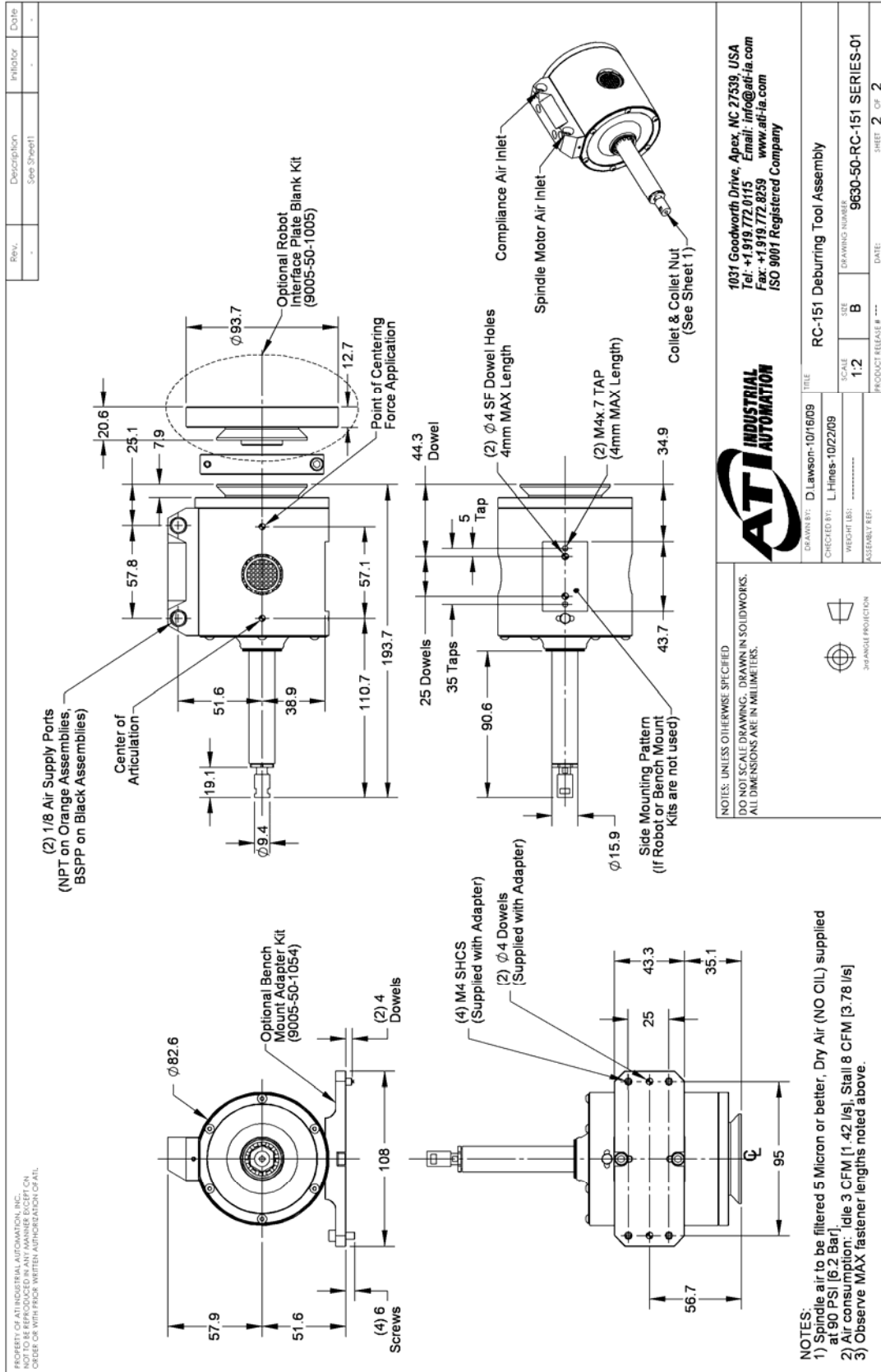


Figure 6.2—Product Dimensions and Mounting

7. Troubleshooting and Burr Selection

7.1 Troubleshooting Matrix



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

| Problem | Cause | Solution |
|---------------------------|------------------------------|--|
| 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 |
| 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 | Pivot worn | Replace gimbal bearings Section 5.3 |
| | Worn ring cylinder | Replace ring cylinder Section 5.4 |
| | Defective regulator | Replace regulator |
| Poor finish | Feed rate is too fast | Reduce feed rate |
| | Burr is worn | Replace or regrind burr |
| Chattering | 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 Burr selection | Choose burr designed for work material |
| Secondary Burrs | Incorrect feed rate | Reduce feed rate |
| | Too heavy a cut | Decrease width of cut/make multiple passes |
| | Improper Burr selection | Choose burr designed for work material |
| Chip Packing | Too heavy a cut | Decrease width of cut/make multiple passes |
| | Not enough chip clearance | Use a burr with less flutes |
| Burr stalls | Not enough or no drive air | Check drive air regulator for 90 psi [6.2 bar] and for leaks |
| | Burr is not secure in collet | Properly tighten burr in collet |
| | Too much side load | Decrease width of cut/make multiple passes |
| | Air motor needs replacing | Replace air motor Section 5.2 |
| Sticking spindle | Spindle bearings are worn | Replace air motor Section 5.2 |

7.2 Burr Selection Table

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

This list is not comprehensive, but includes several common burr types and burrs recommended for particular applications.

| | | |
|--|---|--|
|  | <p>9150-RC-B-17203</p> <p>Materials/Application:</p> | <p>Double Cut, Straight, 1/8" Burr Diameter, 9/16" Burr Length, 1/8" Shank</p> <ul style="list-style-type: none"> • 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 |
|  | <p>9150-RC-B-18053</p> <p>Materials/Application:</p> | <p>Double Cut, 14° Cone, 1/8" Burr Diameter, 7/16" Burr Length, 1/8" Shank</p> <ul style="list-style-type: none"> • For hardened and tough materials, super alloys, and stainless steel, alloyed cast steel and fiber reinforced plastics • Edge and surface working |
| | <p>Features/Benefits:</p> | <ul style="list-style-type: none"> • Higher cutting capacity than standard cuts • Smoother finish for surface treatments |
| | <p>Features/Benefits:</p> | <ul style="list-style-type: none"> • Higher cutting capacity than standard cuts • Smoother finish for surface treatments |

8. Terms and Conditions

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 to Purchaser that robotic deburring products purchased hereunder will be free from defects in material and workmanship under normal use for a period of one (1) year from the date of shipment. This warranty does not cover components subject to wear and tear under normal usage or those requiring periodic replacement. This warranty is void if the unit is not used in accordance with guidelines 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.

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9. Attachments