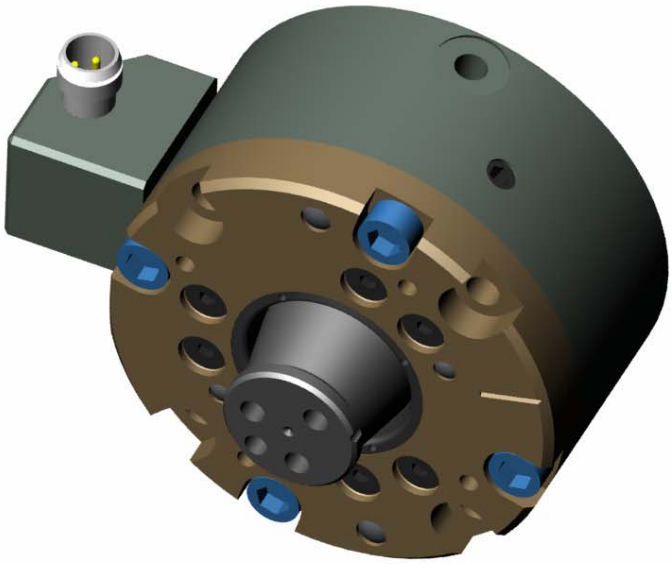
ATI INDUSTRIAL AUTOMATION
ISO 9001 Registered

Protector™

Robotic Collision Sensor
SR-61

U.S. Patent Nos. 6069415 and 6690208

Installation and Operation Manual



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

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Glossary of Terms

Term	Definition
Body	Cylindrical aluminum housing and air pressure chamber. An interface plate to the user's robot is usually attached here.
Cam	A hardened steel ring mounted inside the cover on which the hardened steel ball segments mounted to the stem are nested.
Collision	The accidental impact between the end of arm tooling and some obstruction in its path.
Collision Sensing Switch	A switch that changes state to an open circuit when a crash is detected. It is mounted in a threaded hole in the side of the body under the connector block. It is a normally open, PNP or NPN metal sensing proximity switch. It appears closed in the working (reset) position since it is sensing a steel target. The steel target moves out of range in the event of a crash.
Cover Plate	Disk-shaped aluminum cover for Protector™ Body.
Crash	The result of a disturbance that displaces the Protector™ components from their standard, working position.
Interface Plate	Optional component used to adapt the Protector™ Body or Stem to the user's robot or tooling.
Nano Connector	8mm electrical connector mounted in a block attached to the side of the Body.
Piston	The component which, together with the Body, creates a pressure chamber. Varying the pressure in this chamber varies the load required to move the piston.
Reset	The ability of the Protector™ to return to its working position when a disturbing force or displacement is removed.
Stem	Round tapered post containing tapped holes and a dowel pin hole. An interface plate to the user's tooling is usually attached here.
Switch Target	A steel block mounted on top of the Piston, the position of which is sensed by the Collision Sensing Switch.

1. Product Overview

1.1 Introduction

The Protector™ is a pneumatically-pressurized device offering protection to industrial robots and tooling in the event of accidental impacts and unanticipated loads. The Protector™ works by "breaking away" from its working geometry in the event of excessive torsional, moment, or compressive axial forces, or any combination of these. The Protector™ cannot respond to pure axial tension, which is an unlikely mode of loading. Removal of the upsetting force or moment allows the Protector™ to return to its normal working position.

As a collision occurs, internal motion of the Protector™ components cause a switch to change state to an open circuit. The switch circuit may be monitored by robotic controllers to stop operations before damage to the robot or tooling occurs. The load threshold at which the Protector™ breaks away is adjustable by controlling the air pressure supplied to the unit.

All Protector™ devices provide axial (compression only), torsional, and moment compliance.

1.2 Safety Considerations

The Protector™ is not designed for, nor should it be used in, situations involving the safety of humans or animals. The Protector™ is designed as a safety device to protect industrial components and machinery from damage resulting from collisions and impacts. In all situations the user is responsible for insuring that applicable safety practices are followed as outlined by the manufacturer of the equipment on which the Protector™ is used.

The routing of electrical and pneumatic lines must minimize the possibility of stress, pullout, kinking, rupture, etc. Failure of some critical electrical and/or pneumatic lines to function properly may result in injury to personnel and equipment.

CAUTION: The customer should lock out and discharge all energy to the work cell prior to working on any Protector™ system.

2. Description

The Protector™ consists of a piston housing (body) closed with a cover plate assembly. A stem assembly protrudes through the cover plate assembly. The cover plate assembly incorporates a cam to accurately and repeatably position the stem assembly. The stem assembly is forced into position against the cam by a piston. The piston is supported by user supplied compressed air and an optional assist spring. The stem provides a mounting surface for customized interface plates. Tapped and through holes on the back surface of the body allow direct bolting of the body to the robot. All load-bearing components and those with wear surfaces are made of hard-coat anodized aluminum, hardened bearing steel, or hardened tool steel.

A collision sensing switch is positioned in the side of the body. A connector block assembly containing a Nano connector is mounted on the side of the Protector™ body. The user connects to the switch using the Nano connector for which a variety of cables are available. The user must also supply the Protector™ with dry, regulated, compressed air through a port on the side of the Protector™ body. The size and location of these connections are shown in the drawing provided at the end of this manual.

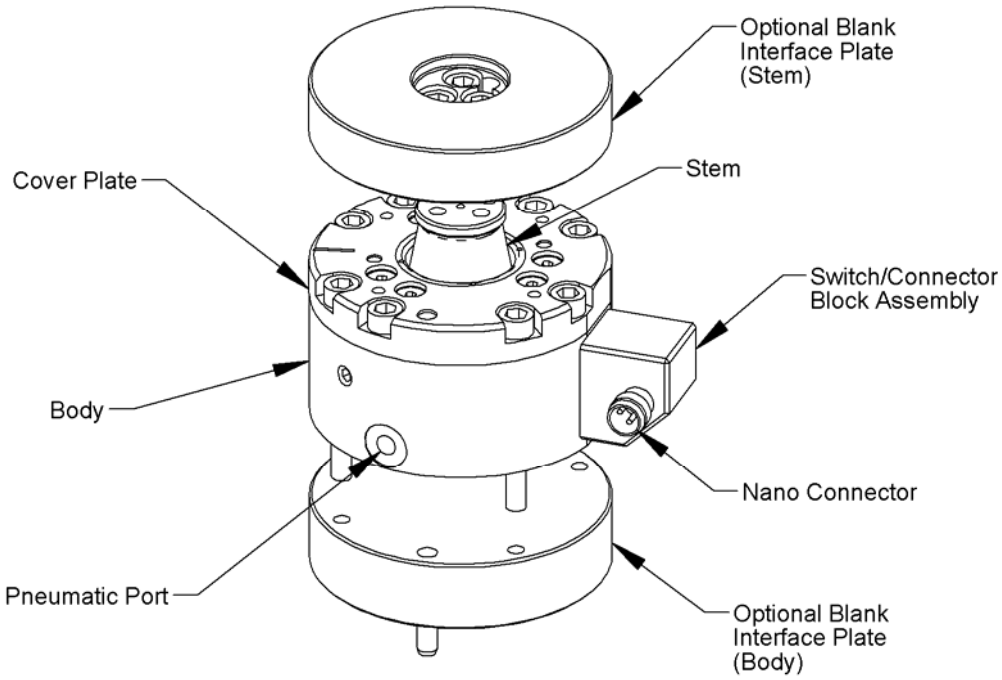


Figure 2.1—Protector™ Collision Sensor

3. Installation

3.1 Operating Requirements

The Protector™ requires clean, dry, non-lubricated air delivered from a user-supplied, **self-relieving** regulator. The Protector™ is certified for accurate, repeatable operation when supplied with air at 20–90 psi (1.4–6.2 bar) of pressure operated in an environment with an ambient temperature range of 40–120°F (5–50°C). For connection to the user's controls, the Protector™ is equipped with a collision sensing switch. When the Protector™ is in the collision mode or the electrical cable to the switch is disconnected an open circuit is generated.

Proper sizing of the Protector™ is imperative for the safe and reliable operation of the unit. Contact ATI for assistance in selecting the proper unit.

Equivalent spring assist options of 5 psi (P05), 10 psi (P10), and 15 psi (P15) are available.

CAUTION: The level of the desired or required air pressure will vary according to the weight, loading, and motion of the user's tooling. Exercise caution while increasing the air pressure supplied to the Protector™. When the pneumatically-supplied force is sufficient to re-seat the Protector™ the tooling will move to its working position.

CAUTION: The user is responsible for connecting the collision sensor to their controls and providing an "electrical load" in series with the collision sensing switch The switch is rated for instrument level signals of 100mA (max.) at 10–30 VDC.

3.2 Mechanical

The Protector™ is commonly mounted with its body toward the robot and its stem toward the user tooling, however, this is strictly up to the user. The Protector™ can be mounted directly to the robot or to the user tooling using the dowel pin holes and the clearance / tapped holes in the Protector™ body. Should this not be possible, an interface plate must be fabricated.

A second interface plate is often required for mounting to the Protector™ stem. Such interface plates may be ordered from ATI as blank plates or machined as necessary for specific applications. Another option is for the user to fabricate their own interface plates.

CAUTION: The surface to which the Protector™ body is mounted must be flat and smooth, and provide support for the entire surface of the body.

Once any required machining of the interface plates is complete, mount the Protector™ using hardware appropriately sized for the application. Connect an appropriately sized air line and fitting to the Protector™. **Do not supply air pressure at this time**.

All mounting hardware should be tightened. The use of an industrial thread-locking compound is recommended for all fasteners.

3.2.1 Fastener Torque Specifications

M3-0.5 Cap Screw	19 in-lbs
M4-0.7 Cap Screw	41 in-lbs
M5-0.8 Cap Screw	85 in-lbs.

Table 3.1—Recommended torques for ATI supplied fasteners

> **CAUTION:** Before connecting or uncoupling the air supply to the Protector™ insure that the air supply is turned off and that all trapped air has been vented.

3.3 Electrical

The Protector™ is connected to the user's control wiring as a normally-open PNP or NPN proximity switch. The following sketch details the connections between the internal switch and the pins in the Connector Block Assembly. Optional mating cables, available from ATI (see Table 3.4), utilize the brown-black-blue color code indicated.

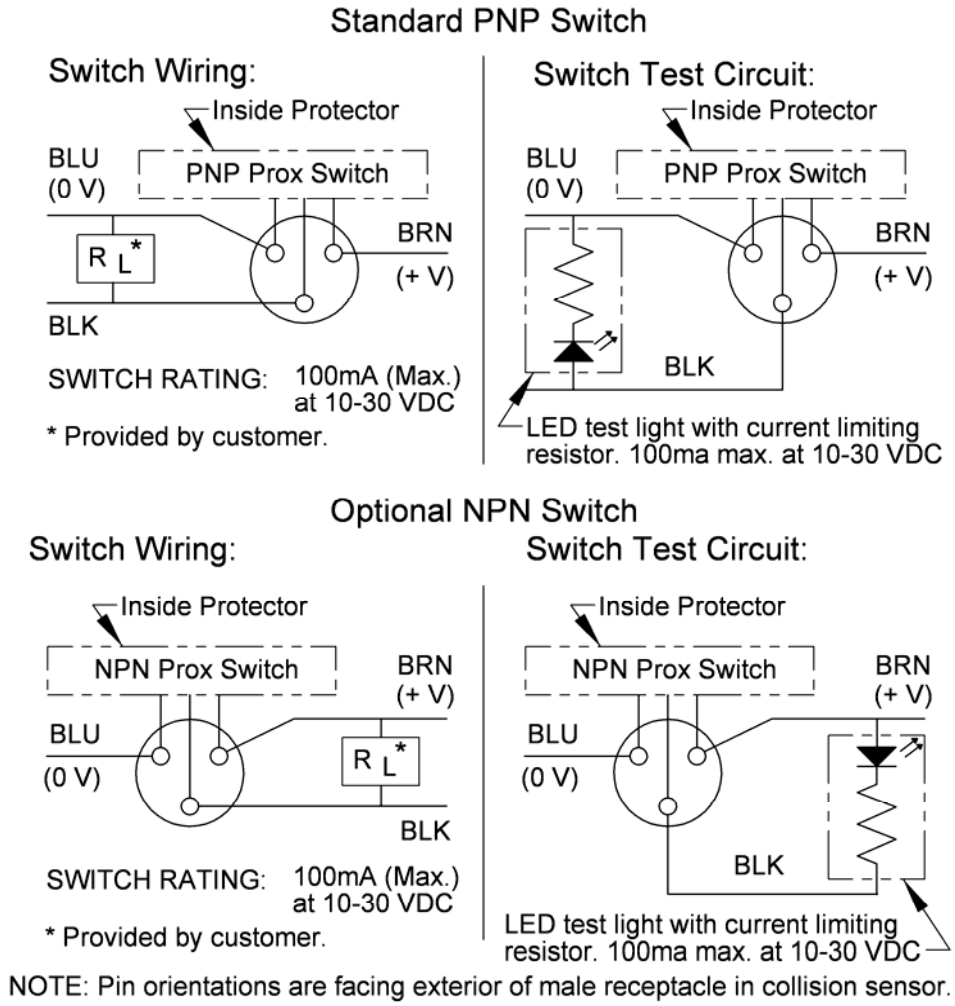


Figure 3.2—Switch Wiring

> ⚠ **CAUTION:** The user is responsible for connecting the collision sensor to their controls and providing an "electrical load" in series with the collision sensing switch. The switch is rated for instrument level signals of 100mA (max.) at 10–30 VDC.

Once the Protector™ has been installed and connected as described in the preceding paragraphs proper electrical operation of the unit may be confirmed.

Supply the Protector™ with approximately 15 psi (1 bar) and insure that the unit is electrically connected to the user's control circuit or to a test box per Figure 3.2. The switch should appear closed.

Manually push the Protector™ to simulate a collision while observing the switch output. When the collision occurs the switch will open and the test light will turn off.

Release the Protector™ and it will return to its working position. The test light will illuminate

3.3.1 Switch Adjustment

Note: The switch is factory adjusted to open after the stem has traveled .020" in the axial direction. Adjustments should only be made if replacing the switch.

1. De-energize all electrical and pneumatic power supplied to the Protector™. Drain all stored air and electric power in compliance with standard (OSHA) safety practices and standards.
2. Disconnect the air lines and signal wires connected to the Protector™.
3. Remove the user-installed mounting hardware from the Protector™ and remove the unit. Take the unit to a test bench equipped with a clean working surface and compressed air.
4. Insure that the Protector™ returns to its Reset or Working position with the stem fully extended and the alignment mark on the stem in line with the alignment mark on the cover plate. (Temporarily supply approx. 15 psi (1 bar) to the unit unless equipped with a preload spring.)
5. Loosen and remove the screw holding the connector block in place (see Figure 5.1).
6. Taking care not to break the wires, pull the connector block away from the body. Loosen the locknut on the proximity switch.
7. Connect a test box per Figure 3.2.
8. Attach an interface plate to the stem of the Protector™.
9. Center the Protector™ under the press ram (see Figure 3.3).
10. Set a dial indicator in contact with the interface plate and adjust it so that the probe is vertical. Set the dial indicator height so that it can read at least .06" (1.5mm) stroke. Set the dial ring to zero.
11. Push on the press handle until the switch circuit opens and check the distance traveled on the dial indicator.
12. If the distance traveled is greater than desired turn the proximity switch counterclockwise. If the distance traveled is less turn the proximity switch clockwise.
13. Repeat steps d) and e) as necessary to obtain the desired switch setting.

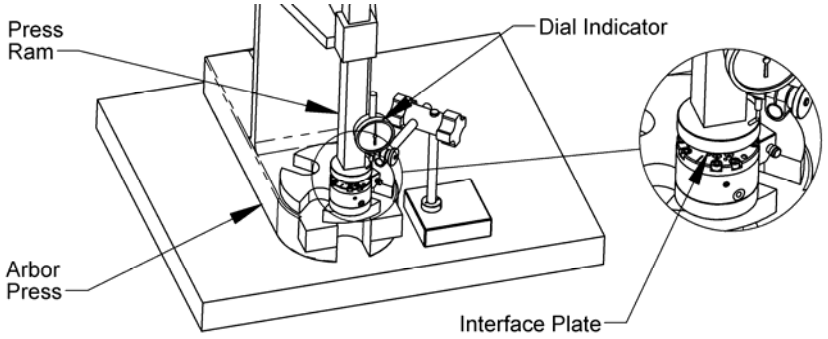


Figure 3.3—Checking Switch Height Adjustment

14. Tighten the locknut on the proximity sensor.
15. Slide the connector block over the proximity sensor carefully routing the wires into the slotted area under the proximity sensor. Line up the dowel pin with the hole in the body and the screw hole with the threaded hole in the body.
16. Apply Loctite® 222MS to the M3 mounting screw and thread it into the body. Tighten the screw securely.
17. Re-install the Protector™ using the user-installed mounting hardware.

> ⚠ **CAUTION:** Before putting the Protector™ back into operation, confirm that the switch is functioning properly. See Section 3.3.

3.3.2 Cable Replacement

If the cable attached to your Protector™ becomes broken or worn, replacement cables may be purchased as follows:

Protector Model Number: 9610-061-Pxx-**XX**-x-x-x. (x = any value).

XX	Cable Number	Description
BN	---	No cable purchased with Protector™ – choose one of the following replacement cables
BB	8590-9909999-15	High-flex cable with straight screw-on connector, 5M (16.4 ft.) long with flying leads
BC	8590-9909999-06	High-flex cable with 90° snap-on connector, 5M (16.4 ft.) long with flying leads
BD	8590-9909999-89	High-flex cable with 90° screw-on connector, 10M (32.8 ft.) long with flying leads
BE	8590-9909999-116	High-flex cable with 90° screw-on connector, 5M (16.4 ft.) long with flying leads
BT	8590-9909999-48	High-flex cable with straight snap-on connector, 5M (16.4 ft.) long with flying leads
BU	8590-9909999-07	High-flex cable with straight snap-on connector, 10M (32.8 ft.) long with flying leads

Table 3.4—Cable choices

3.4 Pneumatic

Compressed air is to be supplied to the port marked "P" in the range of 20 psi to 90 psi. This port accepts #10-32 or M4 pneumatic fittings. The pressure setting required for a particular application can be estimated using the procedure outlined in section 3.4.1. The exact pressure required must be determined through testing using the procedure outlined in section 3.4.2.

3.4.1 Calculating Estimated Pressure Setting

In order to determine the proper pressure setting for the collision sensor one must consider all static and dynamic loads to which it is subjected. These include the loads produced due to the static weight of the tooling, the inertial loads imposed by robot motion and the loads produced by the end-effector when performing its intended tasks. Once these loads are calculated the nominal pressure setting for the break-away point can be determined. The calculation proceeds as follows:

3.4.1.1 Calculate Applied Loads:

Figure 3.5 can be used to convert the forces acting on the end-effector tooling into the resulting moment, torque, and axial loads applied to the Protector. Use the diagram shown in Figure 3.5 and the formulas below to calculate the worst-case applied loads for your application. All three load cases—Axial, Torque, and Moment—should be assessed for their Static, Dynamic, and Working force components.

Note: Not all of the component forces (Static, Dynamic, and Working) are present during all phases of the robot program. As a result, the worst case conditions for Axial, Torque, and Moment loads may occur at different times in the program.

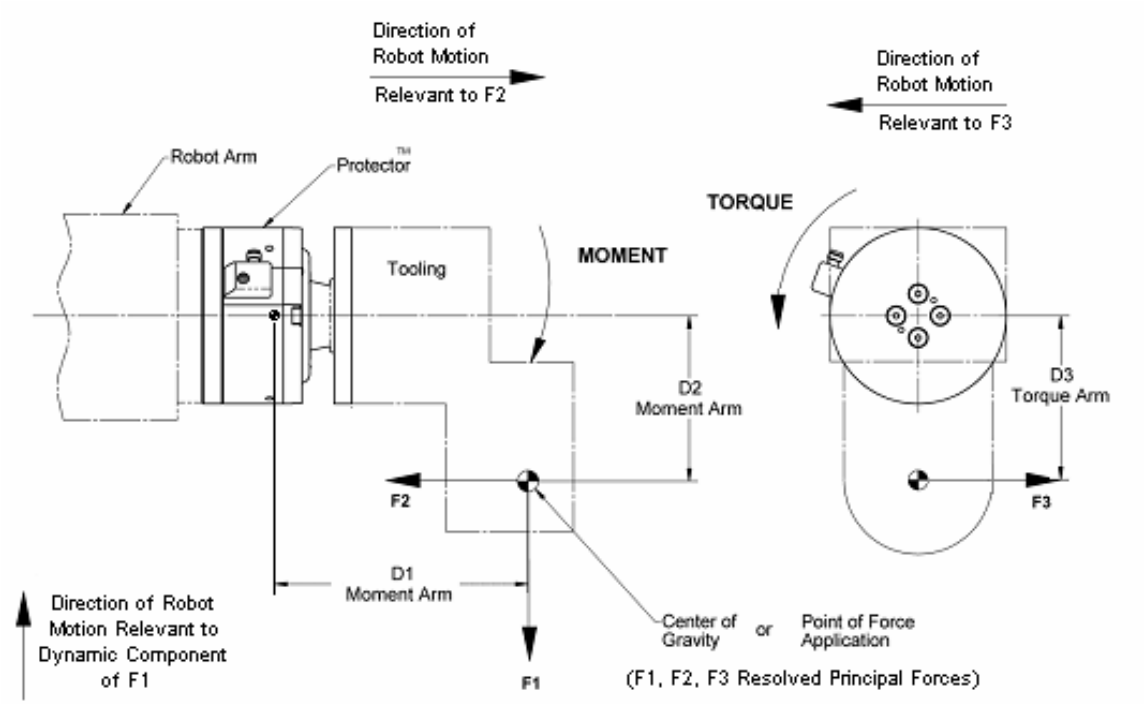


Figure 3.5—Collision Sensor Loading Diagram

Formulas:
Axial Load (F) = F2
Torque (T) = F3*D3
Moment (M) = $\sqrt{(F1*D1)^2 + (F2*D2)^2}$

Notes:

F1, F2, & F3 consist of the sum of their respective Static, Dynamic, and Working force components; and should always be positive for purposes of calculating break-away pressure settings.

D1 should include the distance from the end of the stem to the internal pivot point on the collision sensor (.75" or 18.9mm on an SR-61) and the thickness of the tooling side interface plate (.47" or 12mm on an SR-61 with optional blank interface plate).

a. **Static Force:** The load applied by tooling weight while the robot arm is idle. This includes the weight of all parts attached to the Protector, acting at the assembly's center of gravity along the direction of gravity.
b. **Dynamic Force:** The inertial force imposed at the center of gravity of the tooling due to acceleration of the robot arm. This force acts in the direction opposite of motion. Dynamic forces are additive to static forces and must be carefully considered to ensure proper sizing of the protector.
c. **Working Force:** Forces are generated at the tool-tip under normal working conditions. If these forces and their location are known, they can be converted into loads on the Protector using the same technique.

3.4.1.2 Obtain required pressure setting

The pressure setting required can be approximated from the following formula:

$P = Pm + Pt + Pf + Pm_A + Pt_A$

Where Pm, Pt, and Pf are the pressure components related to the moment, torque, and force load components expected at the break-away. Pm_A and Pt_A are the dynamic versions of Pm and Pt. Dynamic forces from axial loading can usually be ignored since the robot is usually not accelerating in the axial direction. Pm, Pt, and Pf are calculated using the following formulas, where M, T, and F are the expected loads at the set pressure break-away:

English Units: lb-in, psi, lb	**Metric Units: N-m, Bar, N**
Pm = (M x 0.376) – 3.3	Pm = (M x 0.2294) – 0.2
Pt = (T x 0.444) – 6.3	Pt = (T x 0.2708) – 0.4
Pf = F x 0.462	Pf = F x 0.00719

Pm_A and Pt_A are calculated using the following formulas where A is the maximum acceleration in gravities (G's):

English Units: lb-in, psi, G's	**Metric Units: N-m, Bar, G's**
Pm = (M x 0.376 x A) – 3.3	Pm = (M x 0.2294 x A) – 0.2
Pt = (T x 0.444 x A) – 6.3	Pt = (T x 0.2708 x A) – 0.4

Example: For an SR-61 with a static moment load of 50 lb-in, a static torque load of 30 lb-in, no axial load, and an acceleration of 2 G's, the pressure setting is calculated as follows:

P = [(50 lb-in x 0.376) – 3.3) + (30 lb-in x 0.444) – 6.3] + [(50 lb-in x 0.376 x 2G's) – 3.3]
= 15.5 psi + 7 psi + 34.3 psi
= 56.8 psi

A nominal air pressure setting of 57 psi is required.

Notes:

1. If the calculated pressure required is above 90 psi do not install the unit. Contact ATI to determine the correctly sized collision sensor model for the application.
2. If the unit is equipped with P05 (5 psi equivalent), P10 (10 psi equivalent, or P15 (15 psi equivalent) preload spring, subtract this pressure to determine the actual pressure to be supplied.

3.4.2 Determining Exact Pressure Required:

1. Set the pressure approximately 5 psi (0.3 Bar) higher than the pressure calculated in procedure 3.1.
2. Run the robot through a fully loaded cycle.
3. Watch for crash signals.
   If the collision sensor does not generate a crash signal (open circuit) slightly reduce the pressure until a crash signal is generated and then increase the pressure slightly until the unit runs without false crash signals.
   If the collision sensor does generate a crash signal increase the pressure slightly until the unit runs without false crash signals.
   Note: If the pressure required is above 90 psi remove the unit from service and contact ATI to determine the correctly sized collision sensor model for this application.

CAUTION: Use of pressures in excess of 90 psi can result in excessive damage to the unit in the event of a crash and voids the warranty.

4. Operation

With the Protector™ mounted and connected pneumatically and electrically the unit may be placed into operation. If possible, for safety and convenience, position the Protector™ and the tooling vertically so that the load is suspended below the Protector™. Apply low-pressure air (2–15psi, 0.15–1bar) to the unit. Gradually increase the air pressure until the desired working pressure is applied.

In operation, the Protector™ should be supplied with the minimum air pressure necessary to allow continuous, un-interrupted operation of the unit. Nuisance collision detections caused by high accelerations and unanticipated loads will occur if the air pressure is too low. The magnitude of overhung loads, robot accelerations, and applied loads prevent ATI from recommending air pressure settings. Where high robot accelerations are anticipated the user may wish to supply the Protector™ with electronically variable or multiple, switchable air supplies. Alternatively, where working loads are small the Protector™ may be outfitted with auxiliary springs and supplied with high-pressure air only during robot moves. Using these techniques, the Protector™ may be supplied with higher air pressure when higher loads or accelerations are anticipated.

5. Maintenance

> **CAUTION:** Do not adjust or remove either of the two (2) set screws installed in the wall of the Body. Doing so may result in damage to the unit or failure of the switch to operate. See Figure 5.4.

5.1 General

The Protector™ is a reliable device fabricated using heavy-duty components. In normal operation the unit requires no maintenance if proper air quality and pressures are maintained. Service kits are available in the event that the Nano connector or collision sensing switch becomes damaged.

Proper collision sensing should be verified on a regular basis. This can be scheduled twice a year or as a part of any robot or work cell preventative maintenance activities.

In applications where a high number of collisions occur on a regular basis, the life of the Protector™ can be extended with periodic maintenance. Partial disassembly allows the unit to be cleaned, re-greased, and reassembled without special tools or adjustment procedures. Such maintenance work should be conducted every 5,000 or fewer collisions.

> **CAUTION:** In all instances where the Protector™ is to be examined, installed, or removed from service, insure that air pressure has been vented from the unit, that electrical current is not supplied to the Protector's™ signal circuit, and that the robot is in a safe, locked-out, condition consistent with local and national safety standards.

5.2 Replacement of Switch/Connector Block Assembly

5.2.1 Removal

1. Remove the mounting screw using a 2.5mm hex key (see Figure 5.1).
2. Pull the Connector Block away from the Protector™ being careful not to strain the wires inside.
3. Loosen the locknut on the proximity switch.
4. Screw the proximity switch out of the body.
5. Discard the entire assembly.

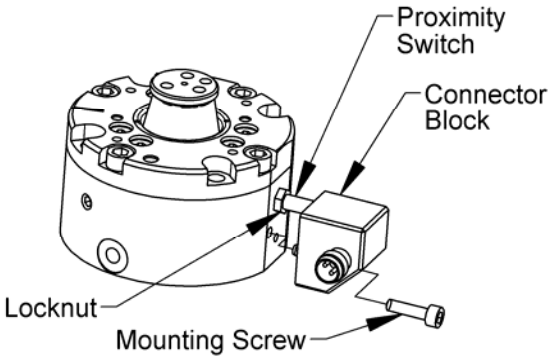


Figure 5.1—Removal of Switch/Connector Block Assembly from the Protector™

5.2.2 Replacement

1. Provide 5 to 15 psi of air to the unit at the port marked "P" (unless the unit is equipped with preload springs).

CAUTION: If the piston is not up against the dog point screws while screwing in the proximity switch, applying air to the unit could damage the proximity switch.

CAUTION:

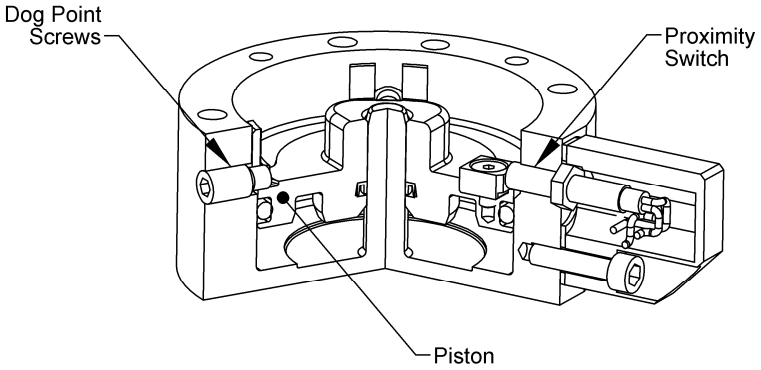


Figure 5.2—Piston location during proximity switch installation

2. Screw the new proximity switch clockwise into the hole on the side of the body until it bottoms.
3. Rotate the connector block along with the proximity switch to prevent damage to the wires.

CAUTION: Turning the proximity switch without turning the connector block more than 180^{o} could result in damage to the proximity switch wires.

4. Screw the proximity switch out 1 turn (counterclockwise).
5. Perform switch adjustment per section 3.3.1.
6. Press the Connector Block Assembly firmly against the body of the Protector™ while tightening the screw. When tightened securely, the Connector Block Assembly should rest parallel to its mounting surface.

5.3 Periodic Lubrication Instructions

5.3.1 Disassembly

Note: Cleaning may be accomplished with a clean, dry rag. For more thorough cleaning, use isopropyl alcohol.

1. Remove the four (4) socket head cap screws securing the Cover Plate assembly to the Body using an M3 hex key (see Figure 5.3).

CAUTION: Do not attempt to pry or wedge the Cover Plate assembly and Body apart. Doing so can damage the mating surfaces and may render the parts unusable.

2. Remove the Cover Plate assembly by carefully pulling it straight up and off of the Body. This may be difficult due to the close fit of the dowel pins used to align the parts. It may be necessary to hold the unit up by the Cover Plate and lightly tap on the Stem with a rubber or plastic mallet. Note: The dowel pins are pressed into the Cover Plate and are a slip fit into the Body.

> ⚠ **CAUTION:** The Cover Plate assemblies and Stem assemblies are factory assembled as matched parts. Do not allow either of these assemblies to be mixed with those from other units.

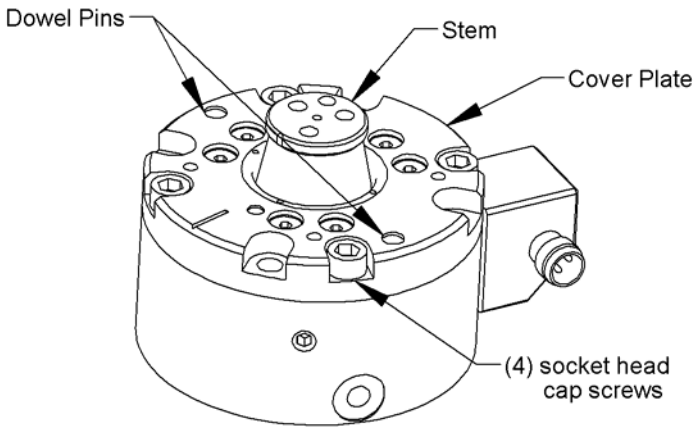


Figure 5.3—Disassembly of Cover Plate

3. Clean the lubricant from the working surfaces of the Cam and the Clearance Ring. Set the Cover Plate assembly aside for later re-use (see Figure 5.4).
4. Remove the Stem assembly and clean the lubricant from the working surfaces of the ball segments and the Stem. Set the Stem assembly aside for later re-use (see Figure 5.5).
5. Clean the lubricant from the top surface of the Piston (see Figure 5.6).

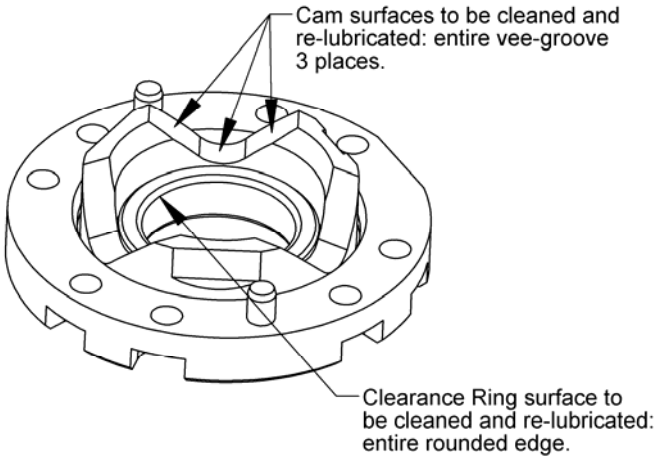


Figure 5.4—Cleaning and Re-lubricating the Cover Plate Assembly

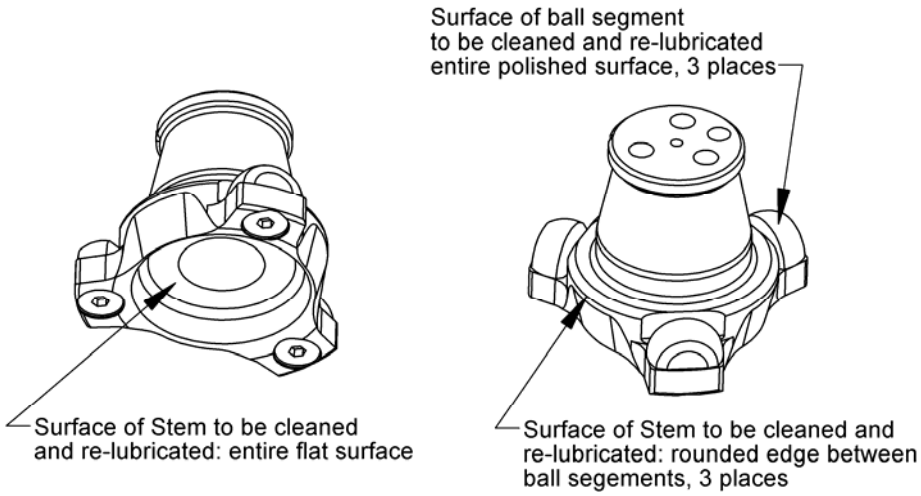


Figure 5.5—Cleaning and Re-lubricating the Stem

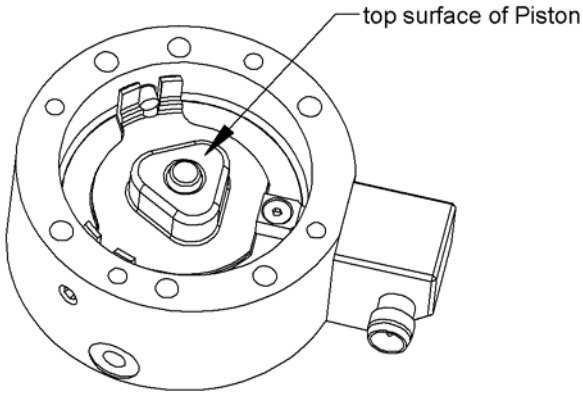


Figure 5.6—Cleaning and Re-lubricating Top Surface of Piston

5.3.2 Re-assembly

1. Apply a generous coating of CRC Extreme Pressure Moly C.V. Joint Grease (Moly Grease) to the top surface of the Piston (see Figure 5.6).
2. Apply a generous coat of Moly Grease to each of the three (3) ball segments on the Stem Assembly and to the rounded edge of the shoulders between the ball segments. Apply a layer of Moly Grease to the flat underneath surface of the Stem (see Figure 5.5).
3. Apply a generous coat of Moly Grease to each of the three (3) v-grooves in the Cam and to the rounded edge of the Clearance Ring (see Figure 5.4).
4. With the Stem assembly upright, set the Cover Plate assembly onto it. Make certain that the alignment grooves are lined up (see Figure 5.7).
5. Place the Stem and Cover Plate together onto the Body. Make certain that the alignment grooves in the Plate and the Stem are still lined up (see Figure 5.7).
6. Press the Cover Plate down onto the Body.
7. Apply Loctite® 222MS to the four (4) socket head cap screws and thread them into the Body. Tighten the screws securely.

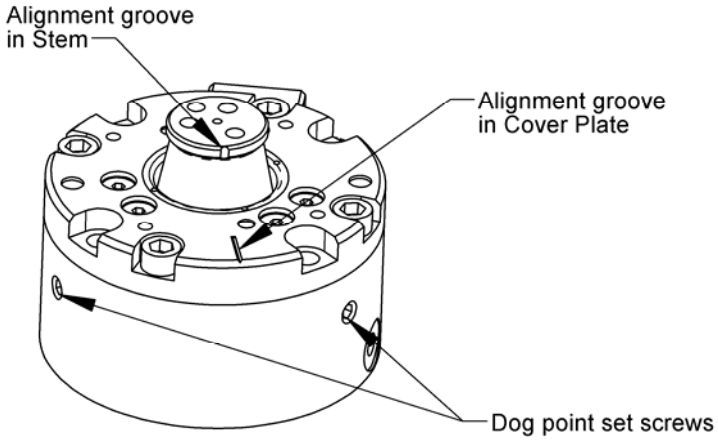


Figure 5.7—Cover Plate and Stem Alignment

5.4 Spring Conversion

The collision sensor may be equipped with an assist spring which provides a force equivalent to 5 psi (P05), 10 psi (P10) or 15 psi (P15) of applied pressure. An SR-61 may be field converted to add an assist spring or to contain a different range spring.

5.4.1 Disassembly

1. Remove Cover Plate assembly and Stem assembly per section 5.3.1.
2. Remove the two (2) M4 dog point setscrews using an M2.5 hex key (see Figure 5.7). (If unit is equipped with an assist spring, temporarily place the Stem assembly on top of the Piston and push down while removing the setscrews.)
3. Remove the Stem assembly, Piston assembly and assist spring (if present).

5.4.2 Re-assembly

1. Place the new assist spring into the counter bore in the body.
2. Place the Piston assembly in the Body, orienting the notches in the ribs on the piston with the screw holes in the body and the Switch Target with the Proximity Switch (see Figure 5.8).
3. Temporarily place the Stem assembly on top of the Piston assembly.
4. Apply Loctite® 222MS to the two (2) M4 dog point setscrews.
5. Push the Piston assembly down until its main surface is below the step in the body bore and hold in place. (An arbor press may be used for this purpose.)
6. Screw the two (2) M4 dog point setscrews clockwise until they touch the piston and then counterclockwise one turn.
7. Remove the Stem assembly.
8. Replace the Cover Plate assembly and Stem assembly per section 5.3.2.

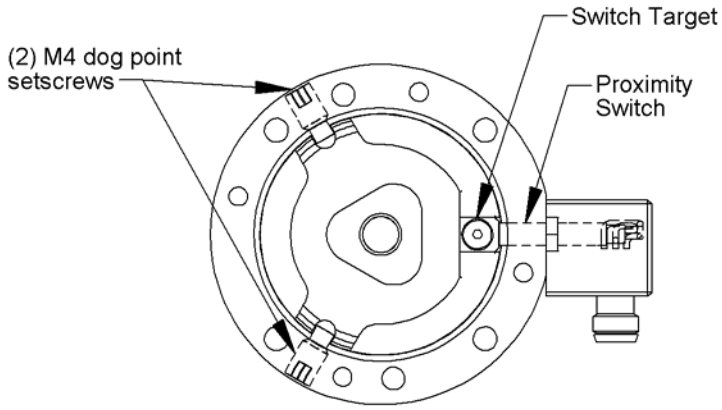


Figure 5.8—Piston Orientation

5.5 Seal Replacement

5.5.1 Disassembly

1. Disassemble Cover assembly and Stem Assembly per section 5.3.1.
2. Disassemble Piston per section 5.4.1.
3. Remove and discard o-ring from groove on outside of Piston.
4. Remove and discard u-cup from groove in center bore of Piston.

5.5.2 Re-assembly

1. Apply Magnalube-G (Teflon/Petroleum base grease) to the new o-ring and u-cup.
2. Apply Magnalube-G to the body bore and post.
3. Assemble the new o-ring to the outer piston groove.
4. Assemble the new u-cup in the groove in the center bore of the piston making certain that the grooved end faces the plain round end of the piston (see Figure 5.9).
4. Re-assemble Piston per section 5.4.2.
5. Re-assemble Stem Assembly and Cover Assembly per section 5.3.2.

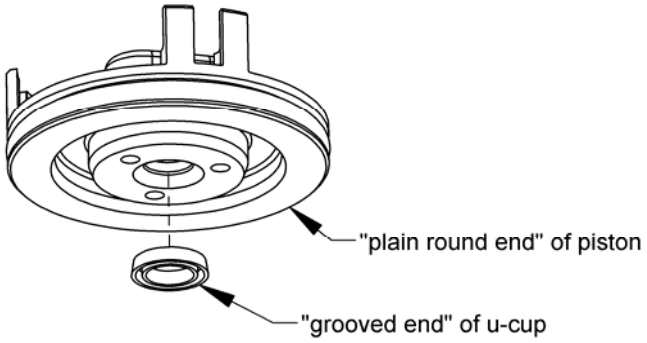


Figure 5.9—U-cup Orientation

5.6 IP65 Boot Replacement

5.6.1 Disassembly

1. Remove four (4) M3 x 6 SFHCS and Shield Retainer (see figure 5.10).
2. Remove Boot and discard.
3. Use a clean cloth soaked in isopropyl alcohol to remove gasket sealer from the Stem and Cover Plate.

5.6.2 Re-assembly

1. Apply Permatex® Grade 2 gasket sealer to top of Stem below flange and to center band of Cover Plate (see Figure 5.10).
2. Install new Boot by stretching the center hole over the Stem. Line up the screw holes and clearance slots with those in the Cover Plate.
2. Place the Boot Retainer on top of the Boot. Line up the screw holes and clearance slots.
4. Apply Loctite® 222MS to threads of (4) M3 x 6 SFHCS and install through Boot Retainer and Boot into Cover Plate. Tighten until Boot is slightly compressed.

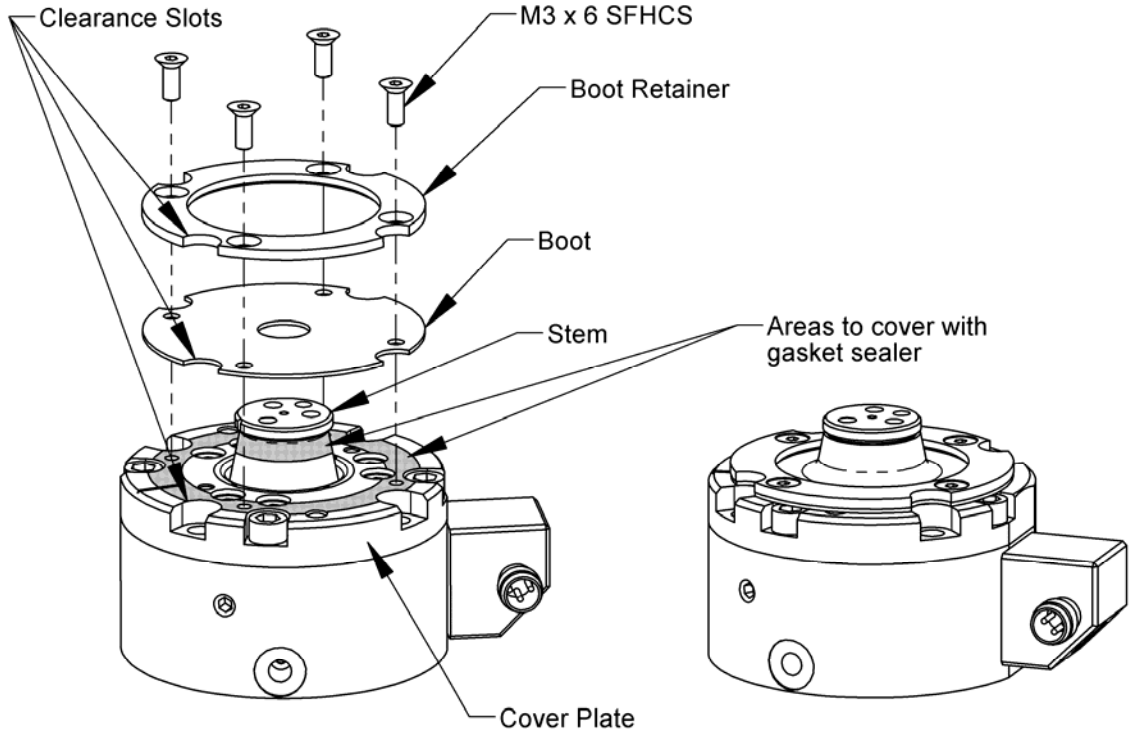


Figure 5.10—IP65 Boot Replacement

5.7 Weld Splatter Shield Replacement

5.7.1 Disassembly

1. Remove four (4) M3 x 6 SFHCS and Shield Retainer (see Figure 5.11).
2. Remove Weld Shield and EPDM Seal and discard.

5.7.2 Re-assembly

1. Install new EPDM Seal by stretching the center hole over the Stem.

2. Place the new Weld Shield on top of the Cover Plate and partially covering the EPDM Seal. Line up the screw holes and clearance slots.
3. Place the Shield Retainer on top of the Weld Shield. Line up the screw holes and clearance slots.
4. Apply Loctite® 222MS to threads of (4) M3 x 6 SFHCS and install through Shield Retainer and Weld Shield into Cover Plate. Tighten until Weld Shield is slightly compressed.

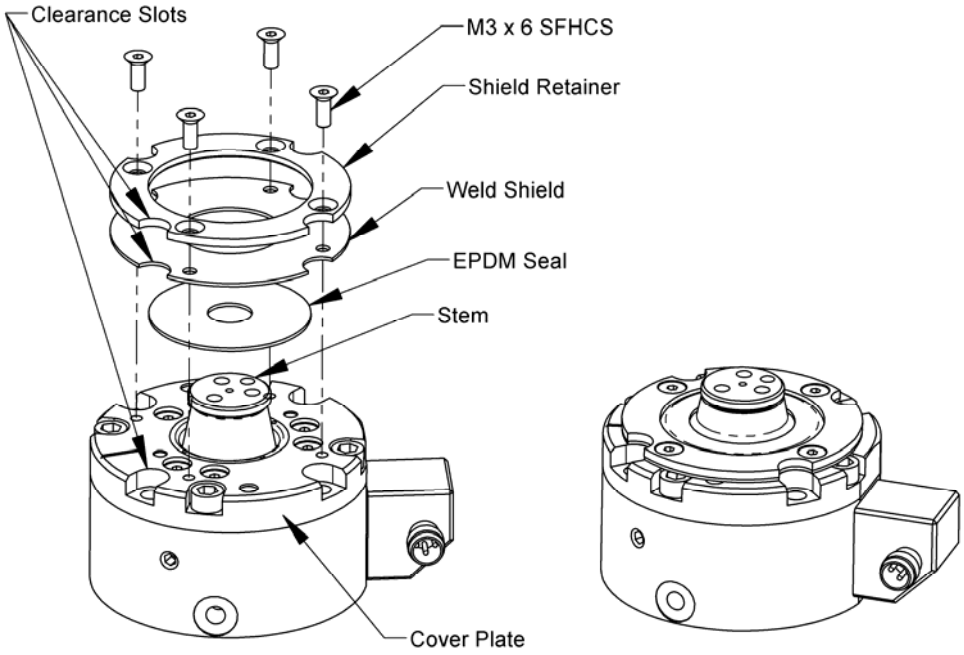


Figure 5.11—Weld Splatter Shield Replacement

6. Troubleshooting

The Protector™ will offer exceptional performance in normal operation. However, the Protector™ is not a compliance device and frequent collisions should be avoided to maximize performance and life. The Protector™ is designed to automatically return to its working position once the disturbing force is removed. Should this fail to happen the following examinations should be performed to verify proper operation of the unit.

Check the supply air pressure. Insure that the supply air pressure is sufficient to support the loads placed upon the unit. If the supply pressure is too low the Protector™ will experience excessive nuisance collision sensings and fail to reset.

Once proper air supply pressure has been verified, check the **self-relieving** function of the pressure regulator. Do so by deflecting the tooling while listening for the regulator to exhaust air in response to compression of the air trapped within the Protector™. If the regulator does not properly relieve the air pressure, it may need to be cleaned or replaced.

Check the control wiring. Disconnect the cable from the Protector™ and use a test box connected per Figure 3.2 on the Nano connector to confirm that the switch is closed when the Protector™ is in the working position. (The scribe lines on the Protector™ cover plate and stem must be aligned and the mounting surfaces of the body and stem must be parallel. Remove tooling or increase air pressure if necessary to allow the unit to move to its working position.) If the switch does not close, adjustment or replacement may

be necessary. See section 3.3.1 for adjustment procedure. If the switch is closed under this condition examine the system for control wiring and logic problems.

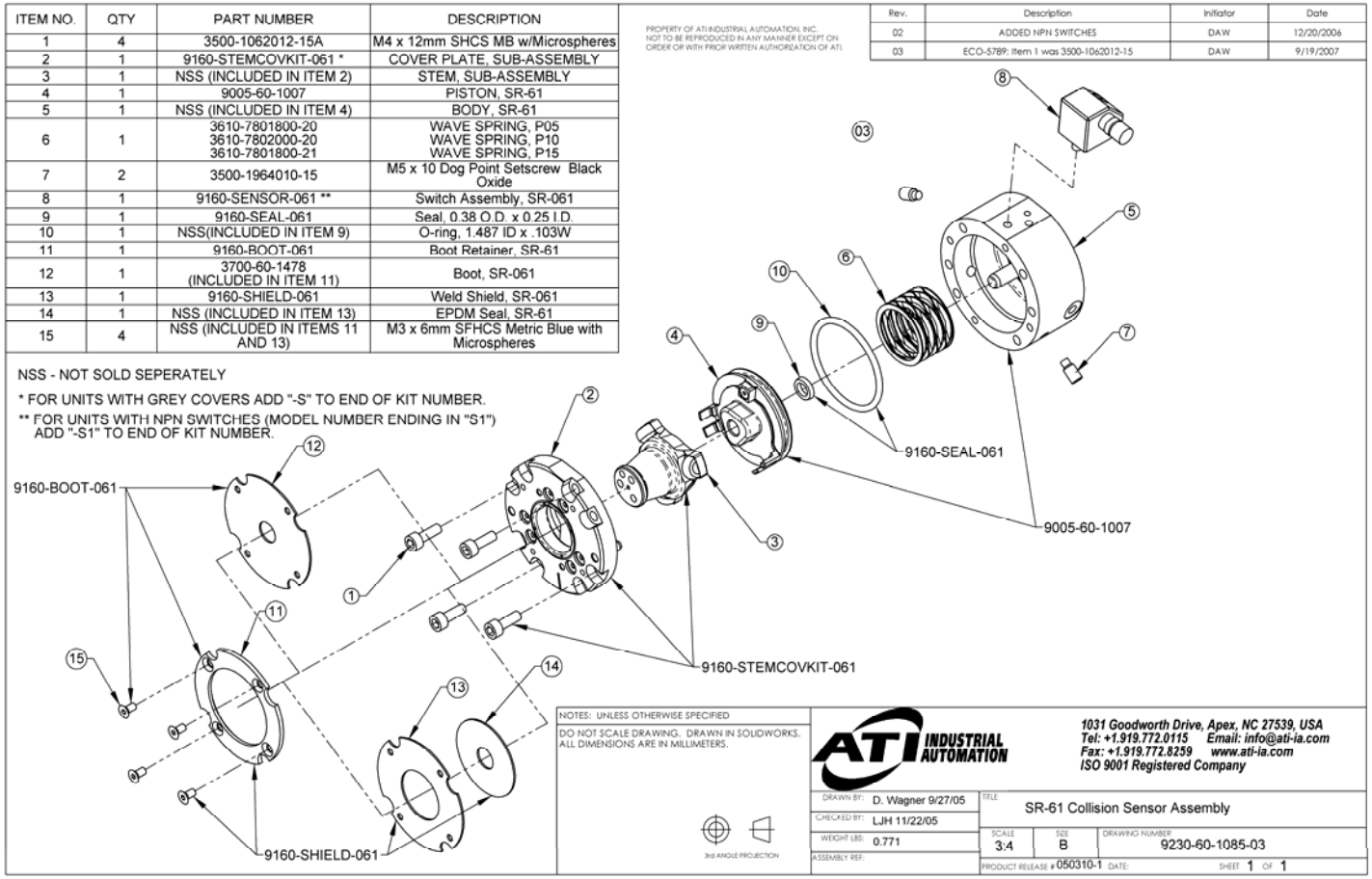
Check for mechanical obstructions. The Protector™ will not be free to rotate back to its working position if obstructions prevent its free motion. Insure that there are no obstructions either on or around the tooling or the stem of the Protector™. Pay particular attention to cables and tubing that may become trapped or snagged.

If the Protector™ still fails to reset or if the switch fails to close after adjustment when the unloaded unit is in its working condition, contact ATI.

7. 7. Specifications and Drawings

7.1 SR-61

Specifications											
Displacement			Load Limit			Weight	Operating		Connector Type Switch Rating	Sensitivity	Spring Assist Option
Angular	Torsional	Axial	Moment	Axial	Torsional		Pressure	Temp.			
+/- 11° max.	+/- 20° max.	0.22 in. (5.6mm) max.	248 in-lbs. (28 N-m)	195 lb. (867 N)	216 in-lbs. (24 N-m)	0.70 lb. (0.58 Kg)	(25-90 psi) (1.7-6.2bar)	40-120°F (5-50°C)	3-pole "Nano" connector 100 mA 10-30 VDC	.02 in. (.5mm) axial	5, 10,15 psi equivalents available



ITEM NO.	QTY	PART NUMBER	DESCRIPTION
1	4	3500-1062012-15A	M4 x 12mm SHCS MB w/Microspheres
2	1	9160-STEMCOVKIT-061 *	COVER PLATE, SUB-ASSEMBLY
3	1	NSS (INCLUDED IN ITEM 2)	STEM, SUB-ASSEMBLY
4	1	9005-60-1007	PISTON, SR-61
5	1	NSS (INCLUDED IN ITEM 4)	BODY, SR-61
6	1	3610-7801800-20 3610-7802000-20 3610-7801800-21	WAVE SPRING, P05 WAVE SPRING, P10 WAVE SPRING, P15
7	2	3500-1964010-15	M5 x 10 Dog Point Setscrew Black Oxide
8	1	9160-SENSOR-061 **	Switch Assembly, SR-061
9	1	9160-SEAL-061	Seal, 0.38 O.D. x 0.25 I.D.
10	1	NSS(INCLUDED IN ITEM 9)	O-ring, 1.487 ID x .103W
11	1	9160-BOOT-061	Boot Retainer, SR-61
12	1	3700-60-1478 (INCLUDED IN ITEM 11)	Boot, SR-061
13	1	9160-SHIELD-061	Weld Shield, SR-061
14	1	NSS (INCLUDED IN ITEM 13)	EPDM Seal, SR-61
15	4	NSS (INCLUDED IN ITEMS 11 AND 13)	M3 x 6mm SFHCS Metric Blue with Microspheres

Rev.	Description	Initiator	Date
02	ADDED NPN SWITCHES	DAW	12/20/2006
03	ECO-5789: Item 1 was 3500-1062012-15	DAW	9/19/2007

NSS - NOT SOLD SEPERATELY

* FOR UNITS WITH GREY COVERS ADD "-S" TO END OF KIT NUMBER.

** FOR UNITS WITH NPN SWITCHES (MODEL NUMBER ENDING IN "S1") ADD "-S1" TO END OF KIT NUMBER.

NOTES: UNLESS OTHERWISE SPECIFIED

DO NOT SCALE DRAWING. DRAWN IN SOLIDWORKS. ALL DIMENSIONS ARE IN MILLIMETERS.

3rd ANGLE PROJECTION

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ISO 9001 Registered Company

DRAWN BY: D. Wagner 9/27/05
CHECKED BY: LJH 11/22/05
WEIGHT LBS: 0.771
ASSEMBLY REF:

TITLE: SR-61 Collision Sensor Assembly
SCALE: 3:4 SIZE: B DRAWING NUMBER: 9230-60-1085-03
PRODUCT RELEASE # 050310-1 DATE: SHEET 1 OF 1

8. 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 to Purchaser that Protector™ products purchased hereunder will be free from defects in material and workmanship under normal use for a period of one (1) years from the date of shipment. This warranty does not cover components subject to wear and tear under normal usage or those requiring periodic replacement. 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.

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

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