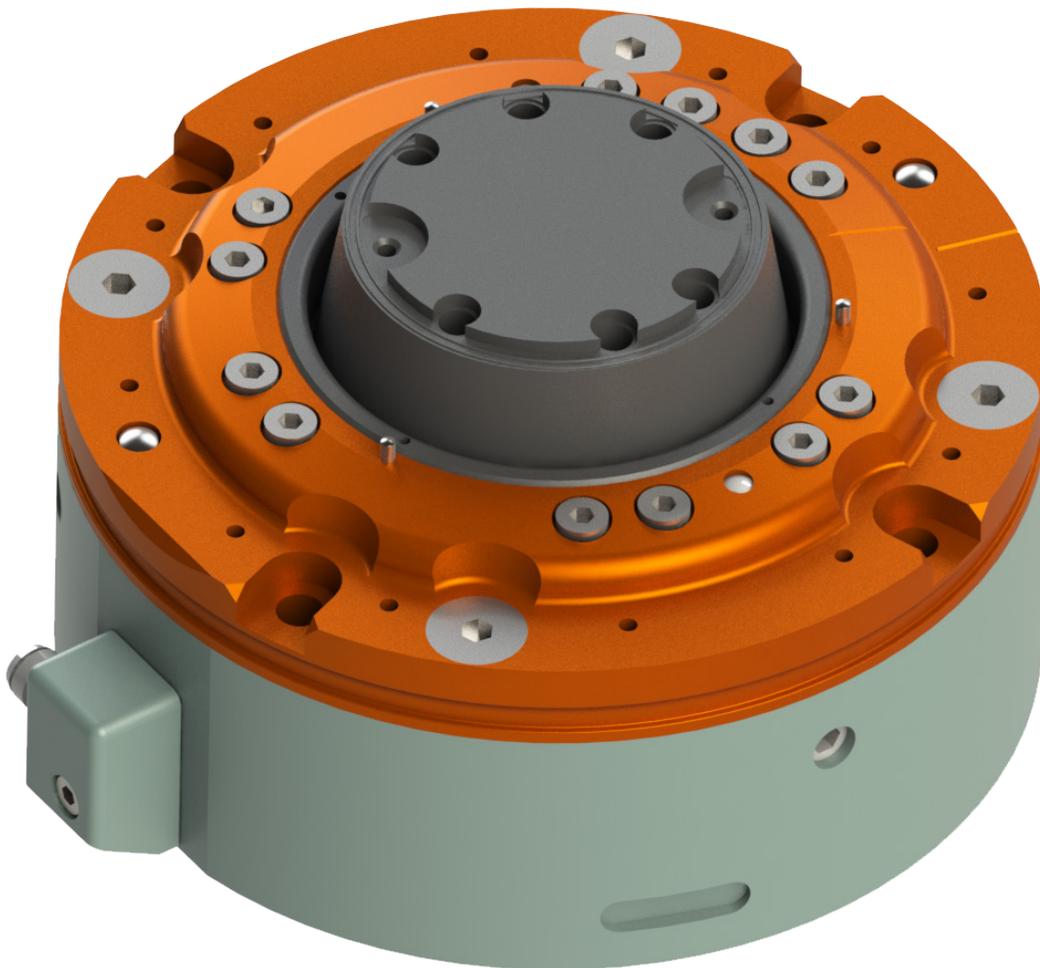




**Robotic Collision Sensor
SR-81, SR-101, SR-131, SR-176, SR-221
Manual**

U.S. Patent Nos. 6069415 and 6690208



Document #: 9610-60-1004

Foreword

Please contact ATI Industrial Automation with any questions concerning your particular model.



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. Failure to read and understand the information in this manual may result in damage to equipment or injury to personnel.

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Glossary

Term	Definition
8 mm Connector	8 mm electrical connector mounted in block attached to the side of the body.
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 Sensing Switch	A mechanical switch that changes state to an open circuit when a crash is detected. It is mounted in the center of the body.
Collision	The accidental impact between the end of arm tooling and some obstruction in its path.
Cover Plate	Disk-shaped aluminum cover for Collision Sensor body.
Cover Plate	Disk-shaped aluminum cover for Collision Sensor body.
Crash	The result of a disturbance that displaces the Collision Sensor components from their standard, working position.
Interface Plate	Optional component used to adapt the Collision Sensor body or stem to the user's robot or tooling.
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 Collision Sensor 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.

1. Safety

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

1.1 Explanation of Notifications

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



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



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



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

NOTICE: Notification of specific information or instructions about maintenance, operation, installation, or setup of the product that if not followed could result in damage to equipment. The notification can emphasize specific grease types, good operating practices, or maintenance tips.

1.2 General Safety Guidelines

The Collision Sensor is not designed for, nor should it be used in, situations involving the safety of humans or animals. The Collision Sensor 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 Collision Sensor is used.

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



CAUTION: The customer should lock out and discharge all energy to the work cell prior to working on any Collision Sensor system. Failure to do so may result in damage to equipment or injury to personnel.

1.3 Safety Precautions



WARNING: Do not perform maintenance or repair on the Collision Sensor with air pressure applied, current supplied to the sensor, or the robot not in a safe condition. Injury or equipment damage can occur if this is not observed. Always ensure that air pressure has been vented from the unit, that electrical current is not supplied to the Collision Sensor's signal circuit, and that the robot is in a safe, locked-out condition consistent with local and national safety standards before performing maintenance or repair on the Collision Sensor.



WARNING: The Collision Sensor is only to be used for intended applications and applications approved by the manufacturer. Using the Collision Sensor in applications other than intended will result in damage to Collision Sensor or end-of-arm tooling and could cause injury to personnel.



CAUTION: Do not adjust or remove either of the (3) 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 5.1](#).

2. Product Overview

The Collision Sensor is a pneumatically-pressurized device offering protection to industrial robots and tooling in the event of accidental impacts and unanticipated loads. The Collision Sensor 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 Collision Sensor cannot respond to pure axial tension, which is an unlikely mode of loading. Removal of the upsetting force or moment allows the Collision Sensor to return to its normal working position.

As a collision occurs, internal motion of the Collision Sensor 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 Collision Sensor breaks away is adjustable by controlling the air pressure supplied to the unit.

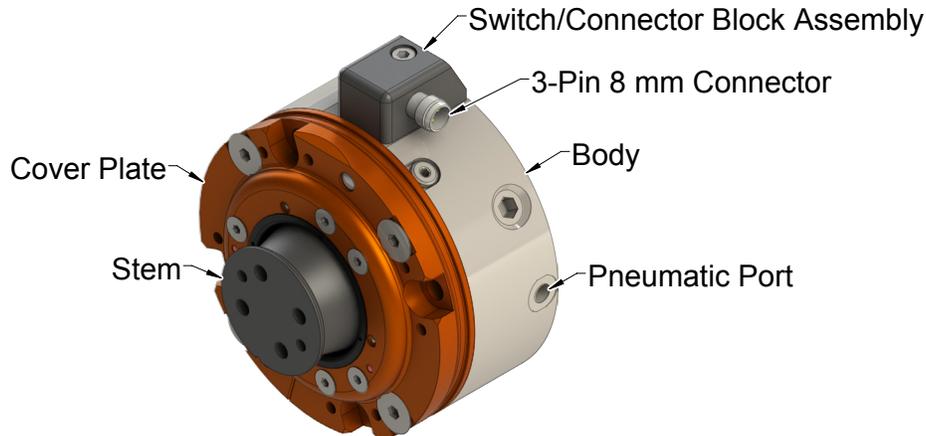
All Collision Sensor devices provide axial (compression only), torsional, and moment compliance.

2.1 Product Description

The Collision Sensor 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 mounting of the Collision Sensor. 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 inside the body. A connector block assembly containing a 8 mm connector is mounted on the side of the Collision Sensor body. The user connects to the switch using the connector for which a variety of cables are available, refer to [Section 8.1—Cable Replacement](#). The user must supply the Collision Sensor with dry, regulated, compressed air through a port on the side of the Collision Sensor body.

Figure 2.1—Collision Sensor



3. Installation

The Collision Sensor is typically mounted with its body toward the robot and its stem toward the user tooling, however this is up to the user.

The Collision Sensor can be mounted to the robot using an interface plate. A second interface plate may be required for mounting the Collision Sensor stem to the tooling. Blank and custom interface plates are available from ATI. Users may fabricate their own interface plates.

NOTICE: The surface to which the Collision Sensor body is mounted must be flat and smooth and provide support for the entire surface of the body.

NOTICE: Do not supply air pressure at this time.

Dowel pins are required at all interfaces to minimize movement between components. Interface plates, supplied by ATI, come with dowel pins and mounting bolts for attachment to the Collision Sensor. The dowel pins are press fit into the interface plates and slip fit into the Collision Sensor. They are not typically installed prior to shipment. Refer to drawing 9230-60-1150 in [Section 9—Drawings](#) for the proper depths to press these dowel pins into the interface plates.

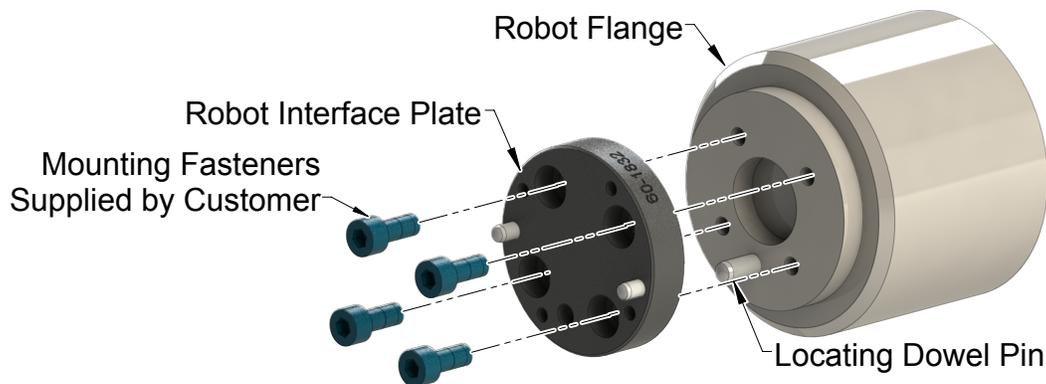
Table 3.1—Recommended Torques for ATI Supplied Fasteners		
Fastener Size	Torque	Recommended Thread Locker
M5-0.8 Cap Screw	45–60 in-lbs.	Loctite 222 or equivalent
M6-1.0 Cap Screw	80–105 in-lbs.	
M8-1.25 Cap Screw	190 – 250 in-lbs.	
M10-1.50 Cap Screw	390 – 520 in-lbs.	
M12-1.75 Cap Screw	55 – 75 ft-lbs.	

Tools required: Variety of Allen wrenches (hex keys)

Supplies required: Loctite 222

1. Attach the robot interface plate to the robot flange, locate using the dowel pin. It is recommended to use thread locking compound on all mounting fasteners. Refer to [Table 3.1](#) for torque.

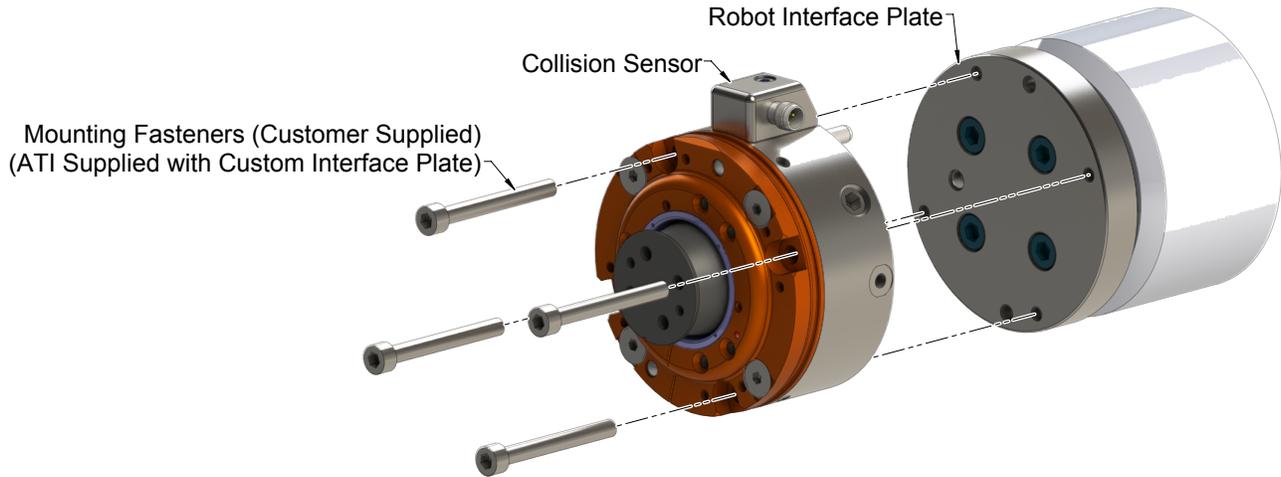
Figure 3.1—Install Robot Interface Plate



NOTICE: The robot interface plate can be purchased from ATI or manufactured, refer to [Section 9—Drawings](#). The use of a robot interface plate supplied by ATI is strongly recommended.

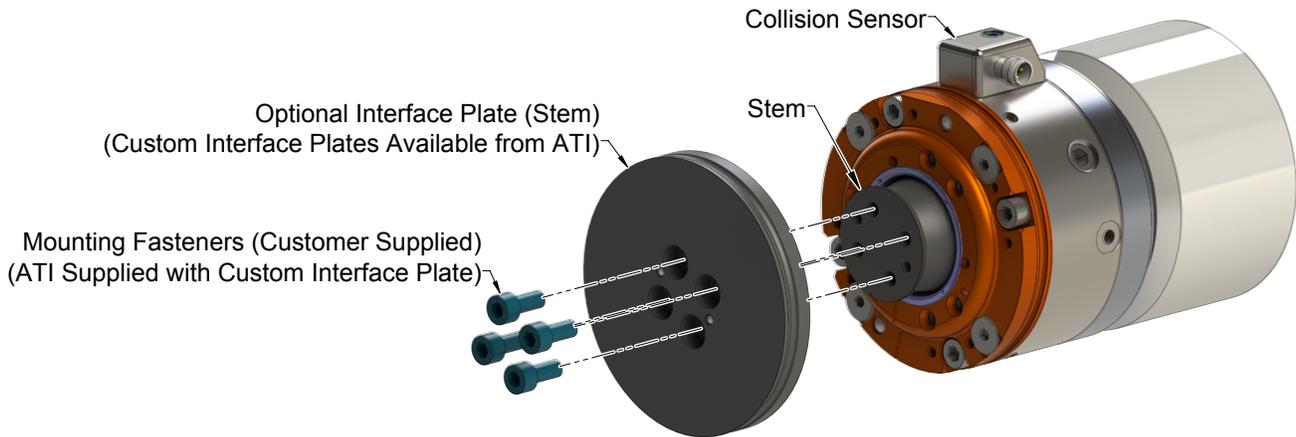
2. Attach, locate using the dowel pin, the Collision Sensor to the robot interface plate using the (4) mounting fasteners. All mounting hardware should be tightened. The use of thread locking compound is recommended for all fasteners. Refer to [Table 3.1](#) for torque.

Figure 3.2—Install the Collision Sensor to the Robot Interface Plate



3. Attach, locate using the dowel pin, the tooling or tooling interface plate to the Collision Sensor using the (4) mounting fasteners. All mounting hardware should be tightened. The use of thread locking compound is recommended for all fasteners. Refer to [Table 3.1](#) for torque.

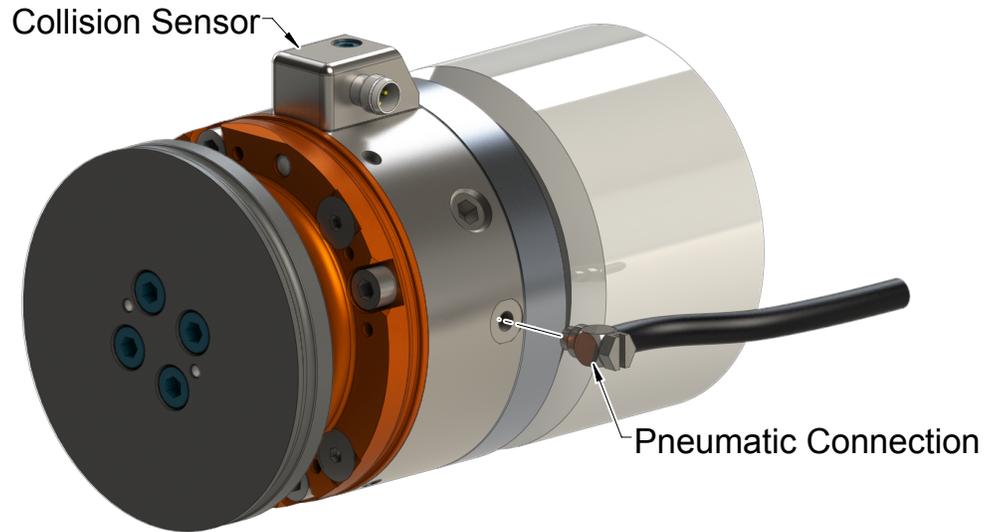
Figure 3.3—Install the Tooling Interface Plate to the Collision Sensor Stem



4. Connect the pneumatic supply hose to the Collision Sensor and apply 10-20 psi to raise the stem. Note:
This step is not required for Collision Sensors that are spring loaded.

NOTICE: SR-81 and SR-101 models are equipped with a #10-32 or M5 x 0.8 air port connection. SR-131, SR-176, and SR-221 models are equipped with a 1/8" NPT air port connection

Figure 3.4—Install the Pneumatic Supply Hose to the Collision Sensor



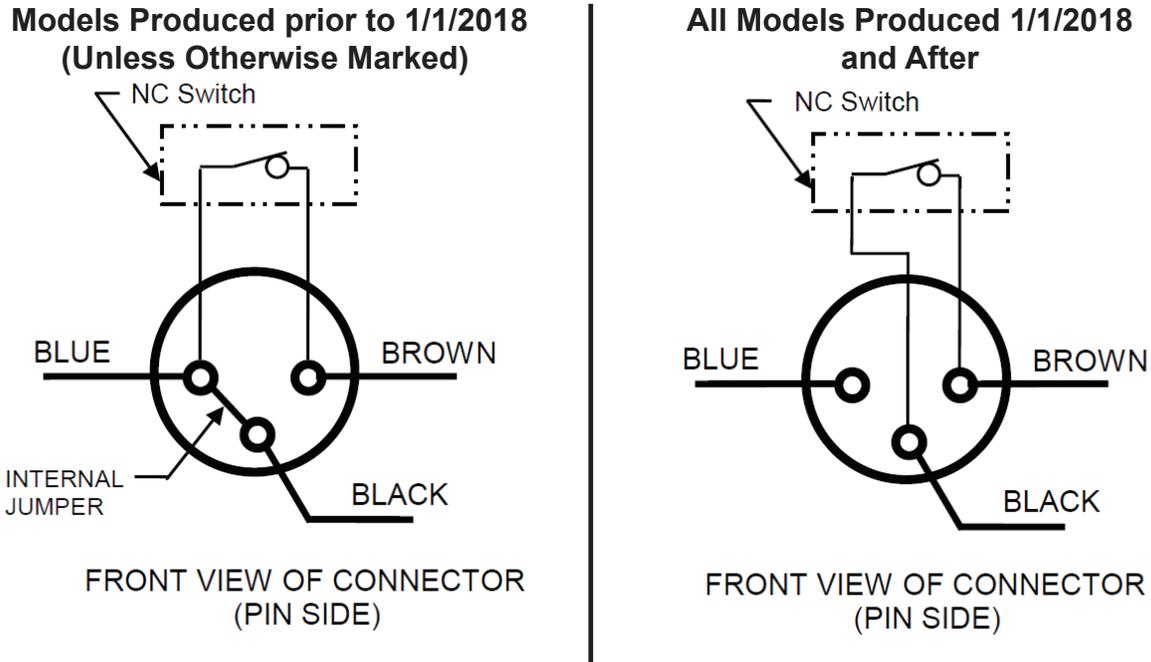
3.1 Electrical Connection



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 125 mA (max.) at 28 V (max.) AC or DC.

The Collision Sensor is connected to the user’s control wiring as a normally-closed mechanical 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 8.1](#)), utilize the brown-black-blue color code indicated.

Figure 3.5—Switch Wiring



3.1.1 Test Switch Functionality

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

Supply the Collision Sensor with approximately 15 psi (1 bar) and ensure that the unit is electrically connected to the user’s control circuit or to a test box per [Figure 3.5](#). The switch should appear closed.

Manually push the Collision Sensor 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 Collision Sensor and it will return to its working position. The test light will illuminate.

3.2 Pneumatic Connection

Compressed air is to be supplied to the port marked “P” in the range of 20-90 psi (1.4–6.2 bar). This port accepts #10-32 or M5 pneumatic fittings. The pressure setting required for a particular application can be estimated using the procedure outlined in [Section 3.2.2—Calculating Estimated Pressure Setting](#) The exact pressure required must be determined through testing using the procedure outlined in [Section 3.2.3—Determining Exact Pressure Required](#).

3.2.1 Operating Requirements



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 125 mA (max.) at 28 V (max.) AC or DC.



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 Collision Sensor. When the pneumatically-supplied force is sufficient to re-seat the Collision Sensor the tooling will move to its working position.

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

Proper sizing of the Collision Sensor 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. The 15 psi (P15) spring is not available for the SR-131 Collision Sensor.

3.2.2 Calculating Estimated Pressure Setting

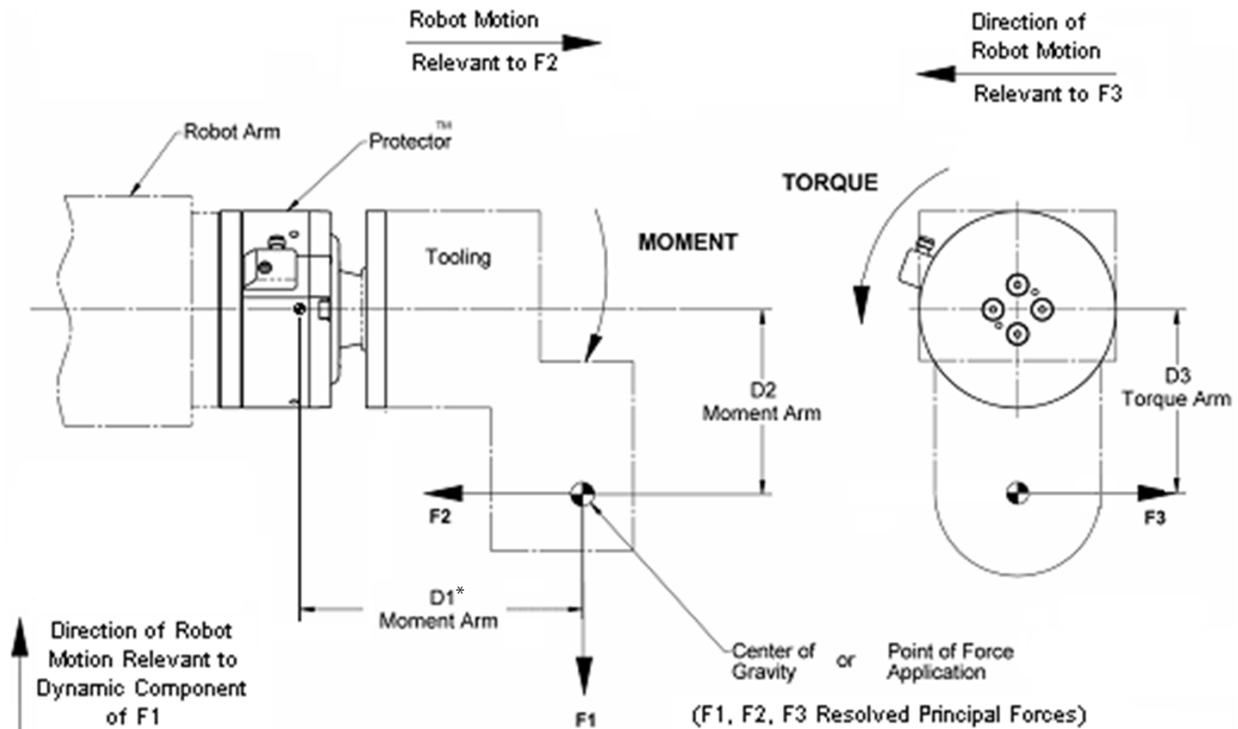
In order to determine the proper pressure setting for the collision sensor one must consider all static and dynamic loads to which it is subjected. These include the loads produced due to the static weight of the tooling, the inertial loads imposed by robot motion and the loads produced by the end-effector 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:

3.2.2.1 Calculate Applied Loads

[Figure 3.6](#) can be used to convert the forces acting on the end-effector tooling into the resulting moment, torque, and axial loads applied to the Collision Sensor. Use the diagram shown in [Figure 3.6](#) 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.

NOTICE: 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 3.6—Collision Sensor Loading Diagram



Formulas:

Axial Load (F) = F2

Torque (T) = F3*D3

Moment (M) = $\sqrt{(F1*D1)^2 + (F2*D2)^2}$

*D1 - Information needed to calculate found within 9230 drawing on ATI website.

NOTICE:

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 18.9 mm on an SR-61) and the thickness of the tooling side interface plate (.47" or 12 mm 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 Collision Sensor, 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 Collision Sensor.

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 Collision Sensor using the same technique.

3.2.2.2 Obtain Required Pressure Setting

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

$$P = P_m + P_t + P_f + P_{mA} + P_{tA}$$

Where **P_m**, **P_t**, and **P_f** are the pressure components related to the moment, torque, and force load components expected at the break-away. **P_{mA}** and **P_{tA}** are the dynamic versions of **P_m** and **P_t**. Dynamic forces from axial loading can usually be ignored since the robot is usually not accelerating in the axial direction. **P_m**, **P_t**, and **P_f** 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

$$P_m = (M \times 0.376) - 3.3$$

$$P_t = (T \times 0.444) - 6.3$$

$$P_f = F \times 0.462$$

Metric Units: N-m, Bar, N

$$P_m = (M \times 0.2294) - 0.2$$

$$P_t = (T \times 0.2708) - 0.4$$

$$P_f = F \times 0.00719$$

P_{mA} and **P_{tA}** are calculated using the following formulas where **A** is the maximum acceleration in gravities (**G**'s):

English Units: lb-in, psi, G's

$$P_m = (M \times 0.376 \times A) - 3.3$$

$$P_t = (T \times 0.444 \times A) - 6.3$$

Metric Units: N-m, Bar, G's

$$P_m = (M \times 0.2294 \times A) - 0.2$$

$$P_t = (T \times 0.2708 \times A) - 0.4$$

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:

$$\begin{aligned} P &= [(50 \text{ lb-in} \times 0.376) - 3.3] + [(30 \text{ lb-in} \times 0.444) - 6.3] + [(50 \text{ lb-in} \times 0.376 \times 2\text{G's}) - 3.3] \\ &= 15.5 \text{ psi} + 7 \text{ psi} + 34.3 \text{ psi} \\ &= 56.8 \text{ psi} \end{aligned}$$

A nominal air pressure setting of 57 psi is required.

NOTICE: 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.

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.

3.2.3 Determining Exact Pressure Required



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.

1. Set the pressure approximately 5 psi (0.3 Bar) higher than the pressure calculated in [Section 3.2.2—Calculating Estimated Pressure Setting](#).
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.

NOTICE: 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.

4. Operation

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

In operation, the Collision Sensor 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 Collision Sensor with electronically variable or multiple, switchable air supplies. Alternatively, where working loads are small the Collision Sensor may be outfitted with auxiliary springs and supplied with high-pressure air only during robot moves. Using these techniques, the Collision Sensor may be supplied with higher air pressure when higher loads or accelerations are anticipated.

5. Maintenance

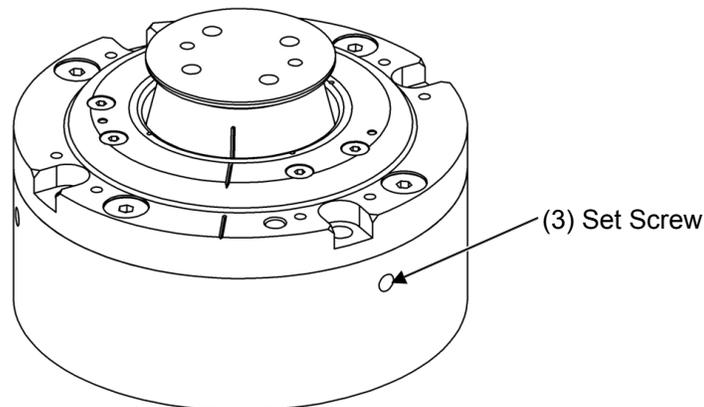


WARNING: Do not perform maintenance or repair on the Collision Sensor with air pressure applied, current supplied to the sensor, or the robot in an unsafe condition. Injury or equipment damage can occur if this is not observed. Always ensure that air pressure has been vented from the unit, that electrical current is not supplied to the Collision Sensor's signal circuit, and that the robot is in a safe, locked-out condition consistent with local and national safety standards before performing maintenance or repair on the Collision Sensor.



CAUTION: Do not adjust or remove any of the three (3) set screws installed in the wall of the Body. Doing so may result in personal injury and/or damage to the unit. See Figure 5.1 below.

Figure 5.1—Set Screws



The Collision Sensor 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 8 mm 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 preventive maintenance activities.

In applications where a high number of collisions occur on a regular basis, the life of the Collision Sensor 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.

5.1 Periodic Lubrication Instructions

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

Tools required: 3 mm Allen wrench (hex key)

Supplies required: Clean rag, Loctite 222, CRC Extreme Pressure Moly C.V. Joint Grease



CAUTION: Collision Sensors equipped with the spring assist option contain a significant amount of stored energy and present an increased level of hazard if not handled properly. Do not attempt to disassemble or repair these units beyond all procedures described in this manual. All additional repair work requires the use of special tools and procedures necessary to prevent personal injury and/or damage to the unit.



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.

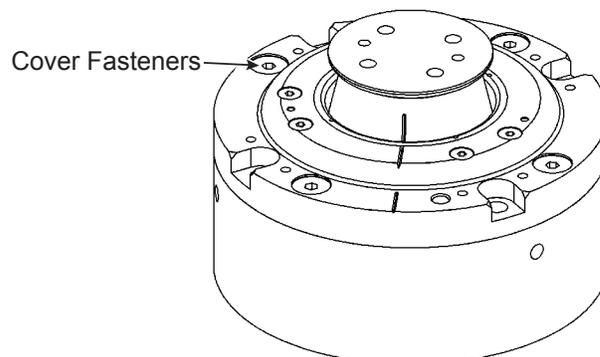


CAUTION: The cover plate assemblies and stem assemblies are factory-assembled as matched parts. Do not allow either of these assemblies to be mixed with those from other units.

Table 5.1—Recommended torques for ATI supplied fasteners				
Model	Fastener Size	Torque	Allen Wrench (Hex Key)	Thread Locker
SR-081 and SR-101	M5x20 mm Socket Flat Head Cap Screw	55 in-lbs.	3 mm	Loctite 222 or equivalent
SR-131	M6x25 mm Socket Flat Head Cap Screw	70 in-lbs.	4 mm	Loctite 242 or equivalent
SR-176	M8x40 mm Socket Flat Head Cap Screw	175 in-lbs.	5 mm	
SR-221	M10-1.5x30 mm Socket Head Cap Screw	420 in-lbs.	8 mm	

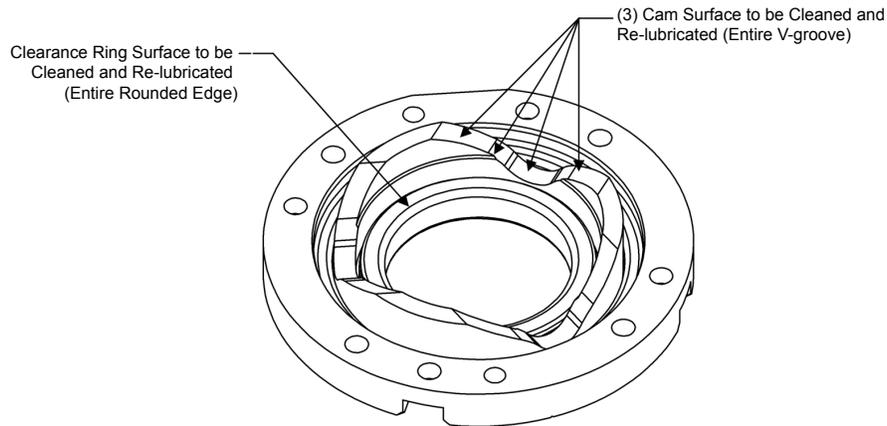
1. Remove the Collision Sensor from the interface plate or mounting location.
2. Remove the cover fasteners (refer to [Table 5.1](#)) securing the cover plate assembly to the body using the proper Allen wrench.
3. Remove the cover plate assembly by carefully pulling it straight up and off of the body. 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.

Figure 5.2—Disassembly of Cover Plate



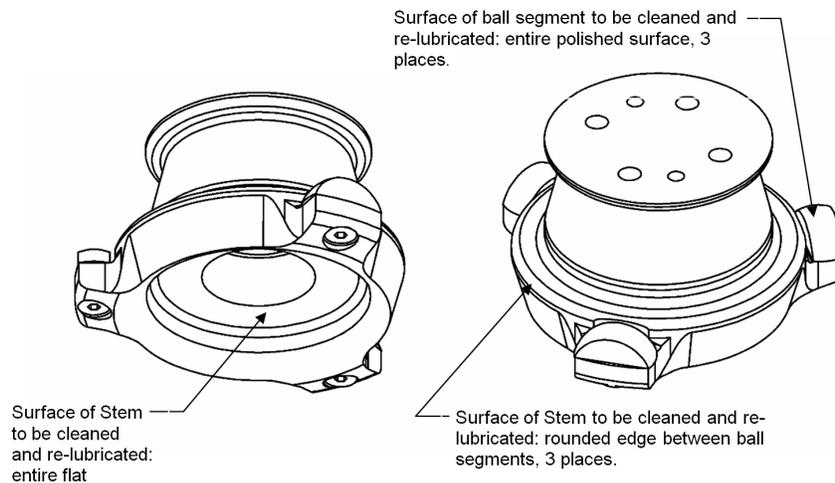
4. Clean the lubricant from the working surfaces of the cam and the clearance ring. Set the cover plate assembly aside for later re-use (see [Figure 5.3](#)).

Figure 5.3—Cleaning and Re-lubricating the Cover Plate Assembly



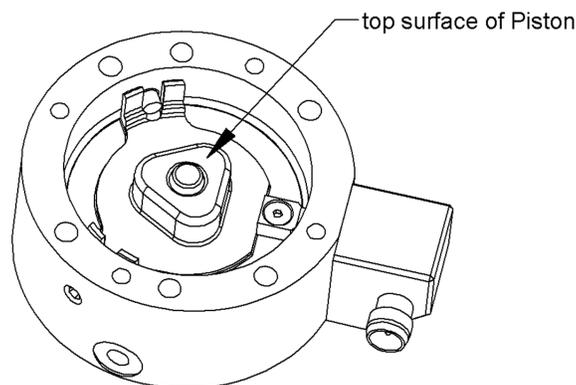
5. Remove the stem assembly and clean the lubricant from the working surfaces of the ball segments and the stem.

Figure 5.4—Cleaning and Re-lubricating the Stem



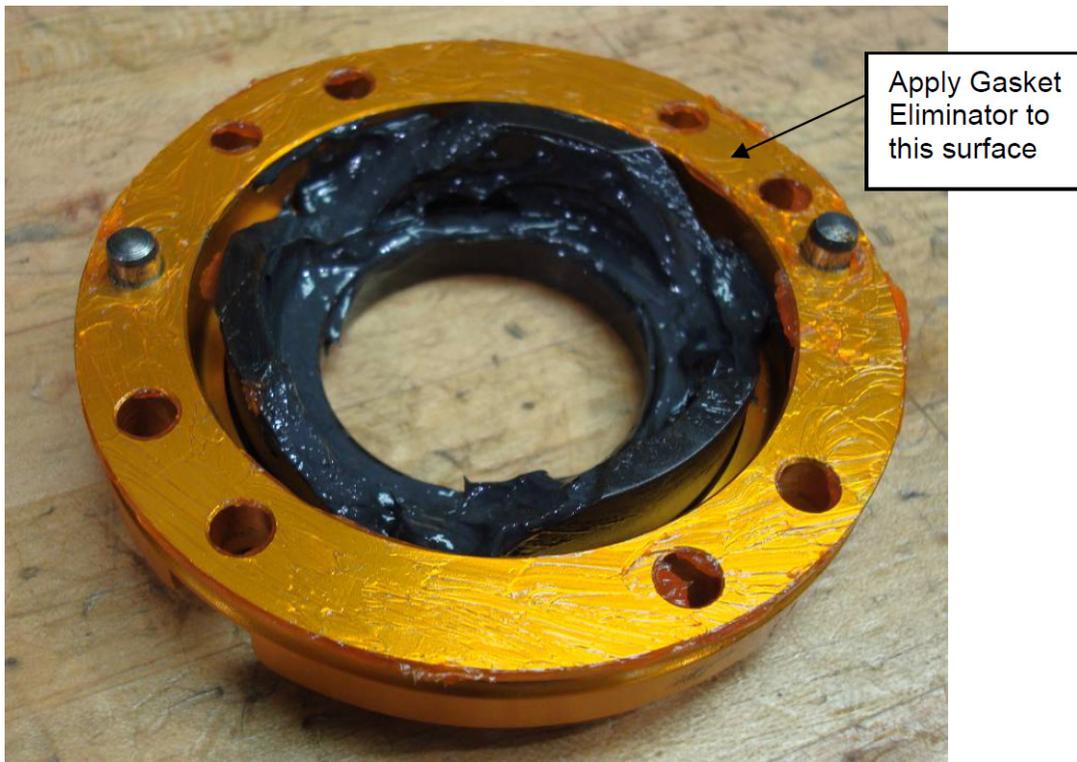
6. Clean the lubricant from the top surface of the piston.

Figure 5.5—Cleaning and Re-lubricating Top Surface of Piston



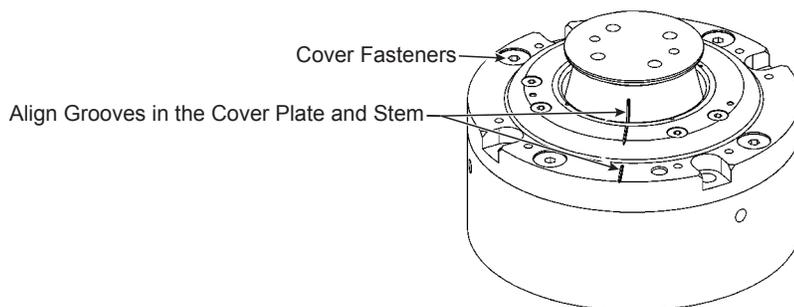
7. Apply a generous coating of CRC Extreme Pressure Moly C.V. Joint Grease (moly grease) to the top surface of the piston (see [Figure 5.5](#)).
8. Apply a generous coat of moly grease to each of the (3) ball segments on the stem assembly and to the rounded edge of the shoulders between the ball segments. Apply a layer of moly grease to the flat underneath surface of the stem (see [Figure 5.4](#)).
9. Apply a generous coat of moly grease to each of the (3) v-grooves in the cam and to the rounded edge of the clearance ring (see [Figure 5.3](#)).
10. For the SR-131, SR-176, and SR-221: Apply Magnalube to the cover seal and assemble to the groove in the cover plate.
11. 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](#)).
12. 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](#)).
13. If the Collision Sensor is being exposed to moisture, apply Loctite 548 Gasket Eliminator to the underside of the cover.

Figure 5.6—Apply Gasket Eliminator



14. Apply thread locker to the cover fasteners (refer to [Table 5.1](#)) and thread them into the body.
15. Process for tightening the cover fasteners.
 - a. Align the dowels with the dowel holes.
 - b. Press down on the cover plate.
 - c. Install (2) opposing fasteners.
 - d. Use the (2) opposing fasteners to evenly pull the cover plate down until the cover contacts the body. (This is to prevent binding against the dowels.)
 - e. Install the remaining cover fasteners.
 - f. Tighten all the cover fasteners to torque. Refer to [Table 5.1](#).

Figure 5.7—Cover Plate and Stem Alignment



6. Troubleshooting and Service Procedures



WARNING: Do not perform maintenance or repair on the Collision Sensor with air pressure applied, current supplied to the sensor, or the robot in an unsafe condition. Injury or equipment damage can occur if this is not observed. Always ensure that air pressure has been vented from the unit, that electrical current is not supplied to the Collision Sensor's signal circuit, and that the robot is in a safe, locked-out condition consistent with local and national safety standards before performing maintenance or repair on the Collision Sensor.



CAUTION: Collision Sensors equipped with the spring assist option contain a significant amount of stored energy and present an increased level of hazard if not handled properly. Do not attempt to disassemble or repair these units beyond all procedures described in this manual. All additional repair work requires the use of special tools and procedures necessary to prevent personal injury and/or damage to the unit.

NOTICE:

The Collision Sensor will offer exceptional performance in normal operation. However, the Collision Sensor is not a compliance device and frequent collisions should be avoided to maximize performance and life. The Collision Sensor 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.

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

The following section provides troubleshooting information to help diagnose conditions with the Collision Sensor and service procedures to help resolve these conditions.

6.1 Troubleshooting

Refer to the following table for troubleshooting information.

Table 6.1—Troubleshooting		
Symptom	Cause	Resolution
Unit fails to return to its working position.	Mechanical obstruction preventing the Collision Sensor from free motion.	Ensure that there are no obstructions either on or around the tooling or the stem of the Collision Sensor. Pay particular attention to cables and tubing that may become trapped or snagged.
	Air supply insufficient or nonexistent.	Check the supply air pressure. Ensure that the supply air pressure is sufficient to support the loads placed upon the unit. Refer to Section 3.2.2—Calculating Estimated Pressure Setting for more information . If the supply pressure is too low the Collision Sensor will experience excessive nuisance collision sensing and fail to reset.
	Improper cover and stem alignment from maintenance or repair.	Check to see if the scribe lines on the Collision Sensor cover plate and stem are aligned or at a 120° off of alignment. If aligned or slightly misaligned refer to Internal component damage. If 120° out of alignment refer to Section 5.1—Periodic Lubrication Instructions to correct stem alignment.
	Internal component damage.	Check to see if the scribe lines on the Collision Sensor cover plate and stem are aligned and the mounting surfaces of the body and stem must be parallel. If slightly missaligned or mounting surface is not parallel contact ATI.
Open circuit with unit reset.	Control wiring damaged.	Disconnect the cable from the Collision Sensor and check the continuity of the cable. If damaged replace cable, refer to Section 8.1—Cable Replacement . If not damaged examine the system for logic problems.
	Switch is not functioning.	Disconnect the cable from the Collision Sensor and use a test box connected per Figure 3.5 on the 8 mm connector to confirm that the switch is closed when the Collision Sensor is in the working position. If the switch is not closed replace, refer to Section 6.2.1—Replacement of Connector Block Assembly .
Excessive force required to deflect stem.	Regulator set at too high a pressure.	Lower Pressure Setting.
	Regulator is not self-relieving.	Replace regulator with self-relieving regulator.
Optional Equipment		
Optional boot or EPDM seal leaking.	Boot damaged.	Inspect the boot for tears or damage replace if damaged. Refer to Section 6.3—Flexible Boot Replacement .

6.2 Service Procedures

The following service procedures provide instructions for inspection, adjustment, test or replacement of components.

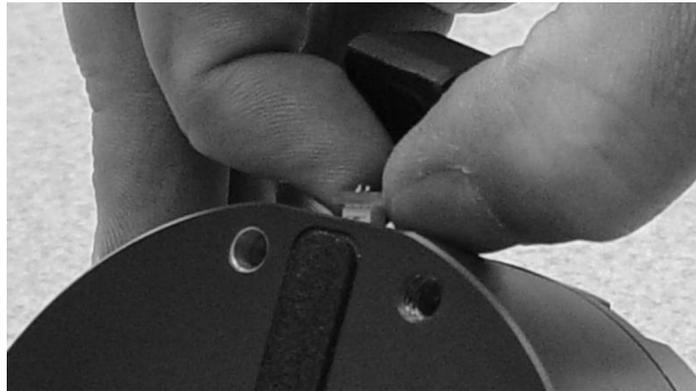
6.2.1 Replacement of Connector Block Assembly

Parts required: Refer to [Section 9—Drawings](#)

Tools required:

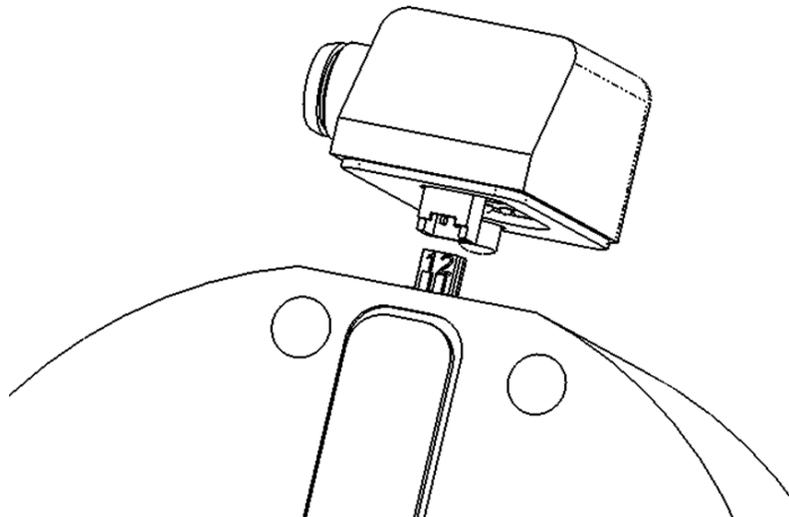
1. Remove the mounting screw using a 2.5 mm Allen wrench.
2. Pull the connector block assembly away from the Collision Sensor just enough to ensure that the gasket is free from the body. Be careful not to strain the wires inside (older versions only).
3. If the connector board pulls away from the connector block perform step 4 otherwise perform step 5.
4. Pivot the connector block up and away from the Collision Sensor and firmly grasp the circuit board on either side of the PCB header (see [Figure 5.1](#)). Pull the circuit board away from the Collision Sensor, bringing the connector block along with it. This will unplug the PCB header from its mate in the body of the Collision Sensor.

Figure 6.1—Removal of Connector Block Assembly from the Collision Sensor (Older versions)



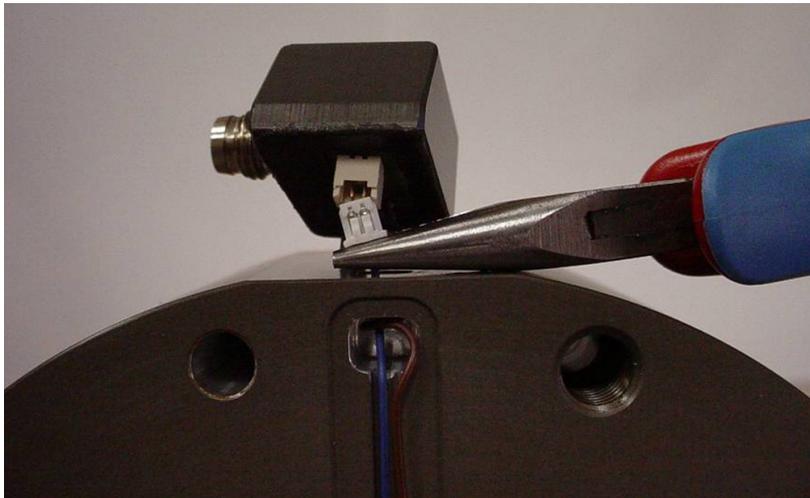
5. Unplug the PCB header from its mate in the body of the Collision Sensor. (See [Figure 6.2](#)) (Newer versions have the connector boards attached to the connector block.)

Figure 6.2—Removal of Connector Block Assembly from the Collision Sensor (Newer versions)



6. Hold the micro header socket protruding from the body with needle nose pliers while plugging it into the PCB header of the connector block assembly (see [Figure 6.3](#)). Position the connector block assembly so that the dowel pin in the connector block assembly is aligned with its mating hole in the body.
7. Carefully push the connector block assembly into position. Check to see that the connector parts have properly mated by letting the connector block assembly fall away from the Collision Sensor body.
8. Reposition the connector block assembly for final attachment and check that the 3 wire loops are not pinched between the connector block assembly and the body of the Collision Sensor. (Newer versions do not contain wire loops.)
9. Slide the plastic flat washer onto the mounting screw and apply a drop of Loctite 222 to the end of the threads.
10. Install the mounting screw and plastic flat washer.
11. Press the connector block assembly firmly against the body of the Collision Sensor while tightening the screw. When tightened securely, the connector block assembly should rest parallel to its mounting surface.
12. Confirm the integrity of the circuit between the 3-pole 8 mm connector and the internal switch by following the instructions in [Section 3.1—Electrical Connection](#).

Figure 6.3—Connector Block Assembly Replacement

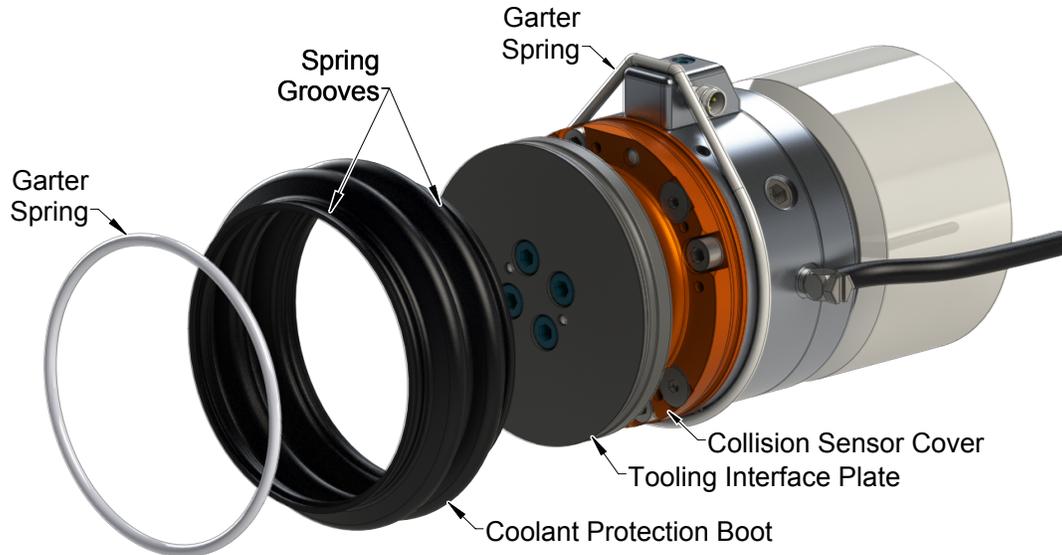


6.3 Flexible Boot Replacement

Parts required: Refer to [Section 9—Drawings](#)

1. Remove the two garter springs retaining the flexible boot to the Collision Sensor body and the interface plate.(see [Figure 6.4](#)).
2. Remove the flexible boot and discard.
3. Install the new flexible boot by stretching over the Collision Sensor body and the Interface plate.
4. Secure the flexible boot using the two garter springs, make sure the garter springs fit tightly in the groove in the Collision Sensor body and the interface plate.

Figure 6.4—Flexible Boot Replacement



7. Specifications

Figure 7.1—SR-81 Specifications		
Displacement	Angular	+/- 13° max.
	Torsional	+/- 25° max.
	Axial	0.34 in. (8.6 mm) max.
Load Limit	Moment	521 in-lbs. (59 N-m)
	Axial	385 lb. (1713 N)
	Torsional	540 in-lbs. (61 N-m)
Weight		1.28 lb. (0.58 Kg)
Operating	Pressure	20-90 psi (1.4-6.2 bar)
	Temp.	40-120°F (5-50°C)
Connector Type Switch Rating		3-pin 8 mm connector 125 mA 28 VAC/VDC
Sensitivity		0.025 in. (0.64 mm) axial
Spring Assist Option		5, 10,15 psi equivalents available

Figure 7.2—SR-101 Specifications		
Displacement	Angular	+/- 12° max.
	Torsional	+/- 25° max.
	Axial	0.40 in. (10.2 mm) max.
Load Limit	Moment	1060 in-lbs. (120 N-m)
	Axial	600 lb. (2670 N)
	Torsional	1145 in-lbs. (130 N-m)
Weight		2.6 lb. (1.2 Kg)
Operating	Pressure	20-90 psi (1.4-6.2 bar)
	Temp.	40-120°F (5-50°C)
Connector Type Switch Rating		3-pin 8 mm connector 125 mA 28 VAC/VDC
Sensitivity		0.025 in. (0.64 mm) axial
Spring Assist Option		5, 10,15 psi equivalents available

Figure 7.3—SR-131 Specifications		
Displacement	Angular	+/- 10° max.
	Torsional	+/- 20° max.
	Axial	0.46 in. (11.7 mm) max.
Load Limit	Moment	2520 in-lbs. (285 N-m)
	Axial	1060 lb. (4715 N)
	Torsional	2555 in-lbs. (290 N-m)
Weight		5.0 lb. (2.3 Kg)
Operating	Pressure	20-90 psi (1.4-6.2 bar)
	Temp.	40-120°F (5-50°C)
Connector Type Switch Rating		3-pin 8 mm connector 125 mA 28 VAC/VDC
Sensitivity		0.025 in. (0.64 mm) axial
Spring Assist Option		5, 10 psi equivalents available

Figure 7.4—SR-176 Specifications		
Displacement	Angular	+/- 10° max.
	Torsional	+/- 20° max.
	Axial	0.63 in. (16.0 mm) max.
Load Limit	Moment	7130 in-lbs. (806 N-m)
	Axial	2000 lb. (8900 N)
	Torsional	7530 in-lbs. (851 N-m)
Weight		12.0 lb. (5.4 Kg)
Operating	Pressure	20-90 psi (1.4-6.2 bar)
	Temp.	40-120°F (5-50°C)
Connector Type Switch Rating		3-pin 8 mm connector 125 mA 28 VAC/VDC
Sensitivity		0.025 in. (0.64 mm) axial
Spring Assist Option		5, 10,15 psi equivalents available

Figure 7.5—SR-221 Specifications		
Displacement	Angular	+/- 8° max.
	Torsional	+/- 20° max.
	Axial	0.63 in. (16.0 mm) max.
Load Limit	Moment	17,390 in-lbs. (1965 N-m)
	Axial	3100 lb. (13,800 N)
	Torsional	13,250 in-lbs. (1497 N-m)
Weight		25.1 lb. (11.4 Kg)
Operating	Pressure	20-90 psi (1.4-6.2 bar)
	Temp.	40-120°F (5-50°C)
Connector Type Switch Rating		3-pin 8 mm connector 125 mA 28 VAC/VDC
Sensitivity		0.025 in. (0.64 mm) axial
Spring Assist Option		5, 10,15 psi equivalents available

8. Serviceable Parts

Refer to [Section 9—Drawings](#)

8.1 Cable Replacement

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

Collision Sensor Model Number: 9610-061-Pxx-XX-x-x-x. (x = any value) (XX = Cable Designation)

Table 8.1—Cable choices		
XX	Cable Number	Description
BN	---	No cable purchased with Collision Sensor – choose one of the following replacement cables
BB	8590-9909999-15	High-flex cable with straight screw-on connector, 5 M (16.4 ft.) long with flying leads
BC	8590-9909999-06	High-flex cable with 90° snap-on connector, 5 M (16.4 ft.) long with flying leads
BD	8590-9909999-89	High-flex cable with 90° screw-on connector, 10 M (32.8 ft.) long with flying leads
BE	8590-9909999-116	High-flex cable with 90° screw-on connector, 5 M (16.4 ft.) long with flying leads
BT	8590-9909999-48	High-flex cable with straight snap-on connector, 5 M (16.4 ft.) long with flying leads
BU	8590-9909999-07	High-flex cable with straight snap-on connector, 10 M (32.8 ft.) long with flying leads

9. Drawings

9.1 SR-81

ITEM NO.	QTY.	PART NO.	DESCRIPTION	Rev.	Description	Initiator	Date
1	4	3500-1264020-15	M5 x 20mm SFHCS	03	ECO 10274: Replaced 9160-CON2 with 9160-CON2. Removed ** Units with grey covers use 9160-CON-2. Note: Removed 3810-60-1758 tool & see to tooling tab. Removed Revision Block from Sheet 2.	TBC	12/19/2017
2	1	9160-STEMCOVKIT-2-081*	Cover Plate Sub-assembly				
3	1	(Includes Item 1)					
4	1	9160-SWITCHKIT-081	Stem Sub-assembly				
5	1	(Includes Item 10)					
6	1		Actuation Pin Housing				
7	1		Actuation Spring				
8	1		Actuation Pin				
9	1		Switch Carrier Spring				
10	1	3500-1956005-12A	Switch Assembly				
11	1	3700-60-1745	M2.5 x 5MM Flat Point Set Screw, N.D. Microspheres				
		3700-60-1758	Wire Channel Gasket				
		9160-CON2	Molded Wire Channel Gasket (Use with C1, C4 and C5 Boots)				
			Connector Block Assembly				

* For units with grey covers add "S" to end of part number.

Notes:

1. See sheet 2 for optional boots and shields.
2. Apply the specified grade of Loctite / tighten fasteners to the specified torque.
3. Special linked Tool required.

222MS / 64 in-ozs

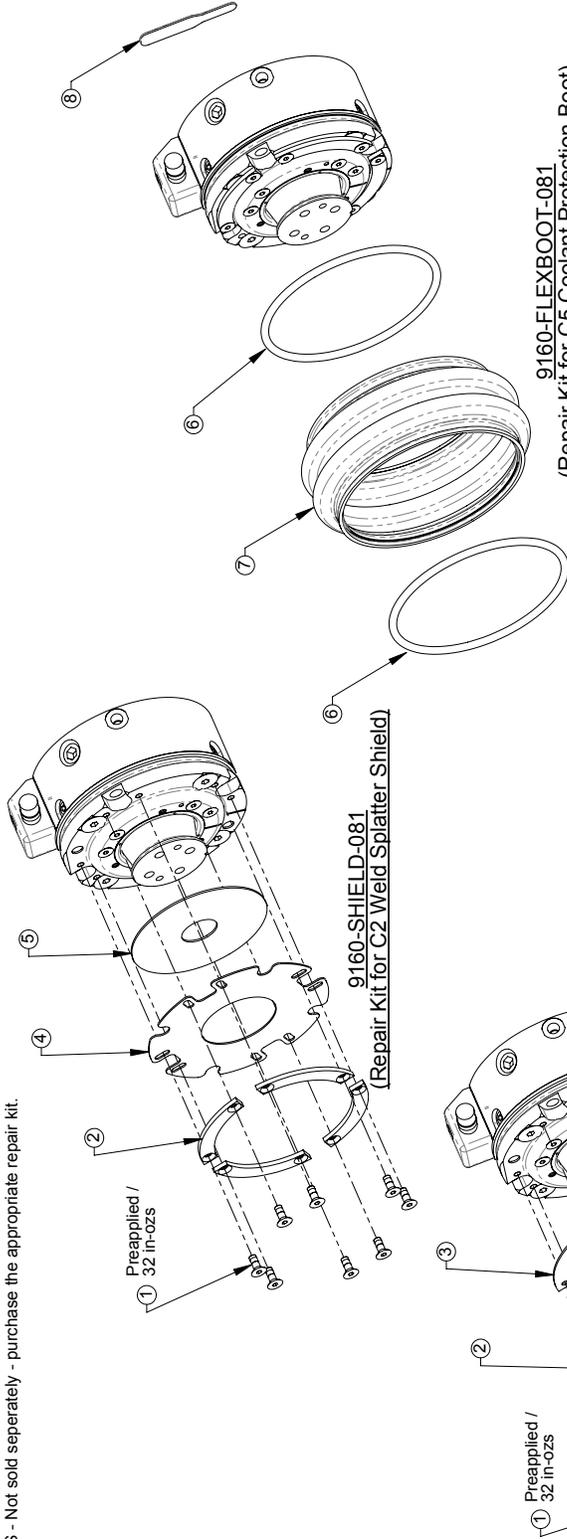
Pre-applied Thread Locker / 6 in-lbs
See note 3.

222MS / 55 in-lbs

222MS / 64 in-ozs

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	8	NSS	M3 x 8 SFHCS, Metric Blue, Microspheres Epoxy
2	4	NSS	Boot Retainer
3	1	3700-60-1099	Boot
4	1	NSS	Weld Splatter Shield
5	1	NSS	EDPD Rubber Seal
6	2	NSS	Garter Spring
7	1	3700-60-1548	Flexible Boot
8	1	3700-60-1758	Molded Wire Channel Gasket

NSS - Not sold separately - purchase the appropriate repair kit.



NOTES: UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS.



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DRAWN BY: D. Wagner 6/4/08	TITLE: SR-81 Collision Sensor Assembly
CHECKED BY: W.B. 6/16/08	SCALE: 5:8
PROJECT #: 070517-2	SHEET 2 of 2
DRAWING NUMBER: 9230-60-1136	REVISION: 03

9.2 SR-101

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	4	3500-1264020-15	M5 x 20mm SFHCS
2	1	9160-STEMCOVKIT-2-101*	Cover Plate Sub-assembly
3	1	(Includes Item 1)	Stem Sub-assembly
4	1	9160-SWITCHKIT-101	Actuation Pin Housing
5	1	(Includes Item 10)	Actuation Spring
6	1		Actuation Pin
7	1		Switch Carrier Spring
8	1		Switch Assembly
9	1	3500-1956008-12A	M3 X 8 SHSS- Black Oxide, N.D. Microspheres
10	1	3700-60-1113	Wire Channel Gasket
11	1	3700-60-1607	Molded Wire Channel Gasket (Use with C1, C4 and C5 Boots)
	1	9160-CON-2	Connector Block Assembly

* For units with grey covers add ".S" to end of part number.

Notes:

1. See sheet 2 for optional boots and shields.
2. Apply the specified grade of Loctite / tighten fasteners to the specified torque.
3. Special linked Tool required.

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AT INDUSTRIAL AUTOMATION

DRAWN BY: D. Wagner, 7/16/08
 CHECKED BY: W. Bernocal, 7/16/08
 TITLE: SR-101 Collision Sensor Assembly
 PROJECT #: 070517-2 SHEET 1 OF 2
 DRAWING NUMBER: 9230-60-1139
 SCALE: 3:4
 SIZE: B
 REVISION: 05

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30° ANGLE PROJECTION

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	8	NSS	M3 x 8 SFHCS, Metric Blue, Microspheres Epoxy
2	4	NSS	Boot Retainer
3	1	3700-60-1263	Boot
4	1	NSS	Weld Splatter Shield
5	1	NSS	EDPD Rubber Seal
6	2	NSS	Garter Spring
7	1	3700-60-1558	Flexible Boot
8	1	3700-60-1607	Molded Wire Channel Gasket

NSS - Not sold separately - purchase the appropriate repair kit.

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DRAWN BY: D. Wagner, 7/16/08
 CHECKED BY: W. Berrocal 7/16/08

TITLE: SR-101 Collision Sensor Assembly

PROJECT #: 070517-2 SHEET 2 OF 2
 SCALE: 1:2
 DRAWING NUMBER: 9230-60-1139
 REVISION: 05

9.3 SR-131

ITEM NO.	QTY.	PART NO.	DESCRIPTION	Rev.	Description	Initiator	Date
1	4	3500-1265025-15	M6 x 25mm SFHCS	04	ECO 10276: Replaced 9160-CON-1 with 9160-CON-2. Removed **Units with grey covers use 9160-CON-2. note. Removed revision block from Sheet 2.	TBC	11/27/2017
2	1	9160-STEMCOVKIT-131*	Cover Plate Sub-assembly				
3	1	(Includes Items 1 & 4)	Stem Sub-assembly				
4	1	3410-0001202-01	Cover O-ring				
5	2	3500-1058020-15A	M3 x 20 SHCS, Metric Blue, ND Microspheres				
6	1	3700-60-1698	Spring Plate				
7	1	3510-1902601-20	Actuation Spring				
8	2	3700-60-1702	5mm x 12mm Standoff				
9	1	3700-60-1699	Actuation Plate				
10	2	9160-SWITCHKIT-131	M2.5 x 6mm SFHCS, Black Oxide				
11	1	(Includes Item 16)	Spring Stop				
12	1		Switch Carrier Spring				
13	1		Switch Assembly				
14	1	3490-0001009-01	1/8" Pipe Plug, Air Supply Port				
15	1	3490-0001021-01	Rc 1/8" Pipe Plug, Air Supply Port				
16	1	3500-1958008-12A	M3 x 8 SHSS, Black Oxide, N.D. Microspheres				
17	1	3700-60-1308	Wire Channel Gasket				
			Molded Wire Channel Gasket (Use with C1, C3 and C5 Boots)				
			Connector Block Assembly				

* For units with grey covers add "-S" to end of part number.

Notes:

- See sheet 2 for optional boots and shields.
- Apply the specified grade of Loctite / tighten fasteners to the specified torque.

222MS / 64 in-ozs

222MS / 12 in-lbs

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DRAWN BY: D. Wagner 4/25/2008
 CHECKED BY: W.B. 5/8/2008

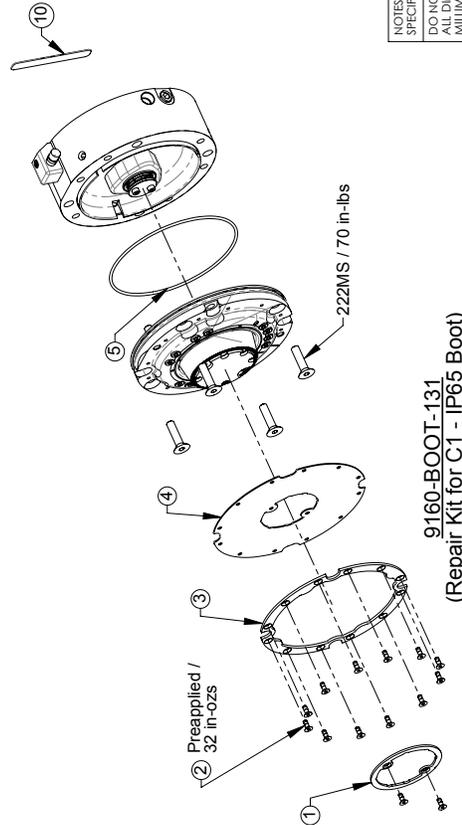
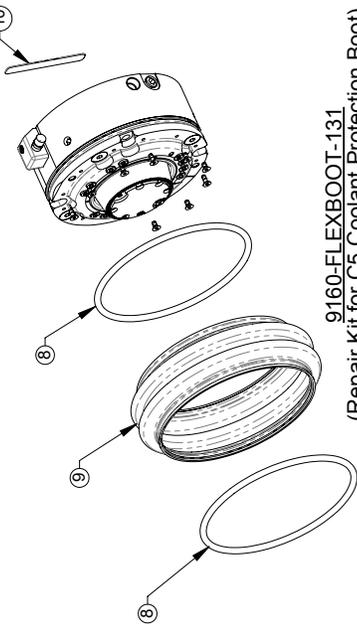
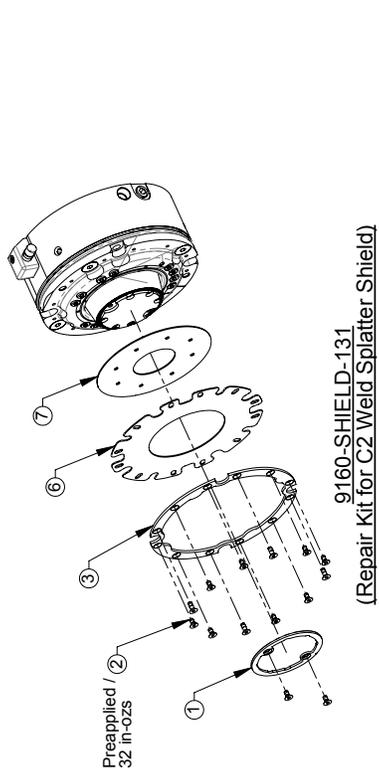
SR-131 Collision Sensor Assembly

SCALE: 1:2
 SIZE: B
 DRAWING NUMBER: 9230-60-1132

PROJECT #: 070517-2 SHEET 1 OF 2
 REVISION: 04

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	NSS	Upper Boot Retainer
2	14	NSS	M3 x 8 SFHCS, Black Oxide, Microspheres Epoxy
3	1	NSS	Lower Boot Retainer
4	1	3700-60-1307	Boot
5	1	3410-0001202-01	O-Ring, 105mm ID x 2mm
6	1	NSS	Weld Splatter Shield
7	1	NSS	EDPD Rubber Seal
8	2	NSS	Garter Spring
9	1	3700-60-1563	Flexible Boot
10	1	3700-60-1663	Molded Wire Channel Gasket

NSS - Not sold separately - purchase the appropriate repair kit.



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DRAWN BY: D. Wagner 4/25/2008
 CHECKED BY: W.B. 5/8/2008

PROJECT #: 070517-2 SHEET 2 of 2

SCALE: 1:3
 DRAWING NUMBER: B
 PROJECT NUMBER: 9230-60-1132

REVISION: 04

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	NSS	Upper Boot Retainer
2	14	NSS	M3 x 8 SFHCS, Black Oxide, Microspheres Epoxy
3	1	NSS	Lower Boot Retainer
4	1	3700-60-1288	Boot
5	1	3410-0001206-01	5.595 ID X .070 W O-RING
6	1	NSS	Weld Splatter Shield
7	1	NSS	EDPD Rubber Seal
8	2	NSS	Garter Spring
9	1	3700-60-1581	Flexible Boot
10	1	3700-60-1664	Molded Wire Channel Gasket

NSS - Not sold separately - purchase the appropriate repair kit.

9160-FLEXBOOT-176
(Repair Kit for C5 Coolant Protection Boot)

9160-SHIELD-176
(Repair Kit for C2 Weld Splatter Shield)

9.5 SR-221

Rev.	Description	Indicator	Date
04	Eco 14278; 9160-Con-2 was 9160-Con-1	LJH	11/27/17

ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	4	3500-1070030-15A	M10 x 30mm SHCS MB w/Microspheres
2	1	9160-STEMCOVKIT-221*	Cover Plate Sub-assembly
3	1	(Includes Items 1 & 4)	Stem Sub-assembly
4	1	3470-0001145-01	Cover O-ring
5	4	3500-1062030-15A	M4 x 30mm SHCS MB w/Microspheres
6	1	3700-60-1676	Spring Plate
7	1	3610-230400-20	Actuation Spring
8	4	3700-60-1681	8mm x 18mm Standoff
9	1	3700-60-1677	Actuation Plate
10	2	9160-SWITCHKIT-221	M2.5 x 6mm SFHCS, Black Oxide
11	1	(Includes Item 16)	Spring Stop
12	1		Switch Carrier Spring
13	1		Switch Assembly
14	1	3490-0001009-01	1/8" Pipe Plug, Air Supply Port
15	1	3490-0001021-01	Rc 1/8" Pipe Plug, Air Supply Port
16	1	3500-1956008-12A	M3 x 8 SHSS, Black Oxide, N.D. Microspheres
17	1	3700-60-1348	Wire Channel Gasket
	1	3700-60-1685	Molded Wire Channel Gasket (Use with C1, C3 and C5 Boots)
	1	9160-CON-2	Connector Block Assembly

* For units with grey covers add "-S" to end of part number.

Notes:

- See sheet 2 for optional boots and shields.
- Apply the specified grade of Loctite / tighten fasteners to the specified torque.
- Screw in until touching bottom of groove in piston and then back out 1/2 turn.

<p>NOTES: UNLESS OTHERWISE SPECIFIED, DO NOT SCALE DRAWING. ALL DIMENSIONS ARE IN MILLIMETERS.</p>	<p>1031 Goodworth Drive, Apex, NC 27539, USA Tel: 919.772.0115 Email: info@ati-ia.com Fax: +1 919.772.8259 ISO 9001 Registered Company</p> <p>PROPERTY OF AT INDUSTRIAL AUTOMATION, INC. NOT TO BE REPRODUCED IN ANY MANNER EXCEPT ON ORDER OR WITH PRIOR WRITTEN APPROVAL FROM AT-IA.</p>	<p>ATI INDUSTRIAL AUTOMATION</p> <p>TITLE: SR-221 Collision Sensor Assembly</p> <p>DRAWN BY: D. Wagner, 4/14/08 CHECKED BY: WB, 4/16/08</p> <p>SCALE: 1:3 SIZE: B DRAWING NUMBER: 9230-60-1127</p> <p>SHEET 1 OF 2 PROJECT #: 070517-2</p> <p>3RD ANGLE PROJECTION</p>
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ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	4	NSS	M3 x 8 SFHCS, Black Oxide, Microspheres Epoxy
2	1	NSS	Upper Boot Retainer
3	12	NSS	M4 x 8 SFHCS, Zinc
4	1	NSS	Lower Boot Retainer
5	1	3700-60-1356	Boot
6	1	3410-0001145-01	O-Ring AS568-168
7	1	3700-60-1665	Molded Wire Channel Gasket
8	2	NSS	Garfer Spring
9	1	3700-60-1585	Flexible Boot

NSS - Not sold separately - included in the appropriate repair kit.

9160-BOOT-221
 Repair Kit for C1-IP65 Boot

9160-FLEXBOOT-221
 (Repair Kit for C5 Coolant Protection Boot)

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NOTES: UNLESS OTHERWISE SPECIFIED, DO NOT SCALE DRAWING. ALL DIMENSIONS ARE IN MILLIMETERS.

DRAWN BY: D. Wagner, 4/14/08
 CHECKED BY: WB, 4/16/08
 PROJECT #: 070517-2 SHEET 2 OF 2

TITLE: SR-221 Collision Sensor Assembly
 DRAWING NUMBER: 9230-60-1127
 SCALE: 1:5
 SIZE: B
 REVISION: 04

9.6 Collision Sensor Interface Plate Dowel Pin Insertion

PROPERTY OF ATI INDUSTRIAL AUTOMATION INC.
 NOT TO BE REPRODUCED IN ANY MANNER EXCEPT ON
 ORDER OR WITH PRIOR WRITTEN AUTHORIZATION OF ATI.

Depths to Press ATI Supplied Dowel Pins

Rev.	Description	Initiator	Date
01	Initial Version	DAW	3/13/2009

Body Side Interface Plate
(9160-XXX-IPB-XXXX)

Stem Side Interface Plate
(9160-XXX-IPS-XXXX)

Collision Sensor Model	"X"
SR-081	5 - 6
SR-101	5 - 6
SR-131	6.5 - 7.5
SR-176	8.5 - 9.5
SR-221	12 - 13

Notes:

1) "XXX" represents any valid model. "XXXX" represents any valid interface plate number.

NOTES: UNLESS OTHERWISE SPECIFIED
 DO NOT SCALE DRAWING. DRAWING IN SOLIDWORKS.
 ALL DIMENSIONS ARE IN MILLIMETERS.

3RD ANGLE PROJECTION

ATI INDUSTRIAL AUTOMATION

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Collision Sensor Interface Plate Dowel Pin Insertion

SCALE: 1:1 SIZE: B DRAWING NUMBER: 9230-60-1150-01

DATE: PRODUCT RELEASE #:

SHEET 1 OF 1

10. Terms and Conditions of Sale

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

ATI warrants to Purchaser that Collision Sensor 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. 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. 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.