Robotic Collision Sensor SR-48 Manual

U.S. Patent Nos. 6069415 and 6690208

Document #: 9610-60-1012

Forward

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
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 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.
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.
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.
Switch Target	A steel block mounted on top of the piston, the position of which is sensed by the Collision Sensing switch.

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 were 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 the set screw installed in the wall of the body. Doing so may result in damage to the unit or failure of the switch to operate. Refer to *Figure 5.4*.

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.

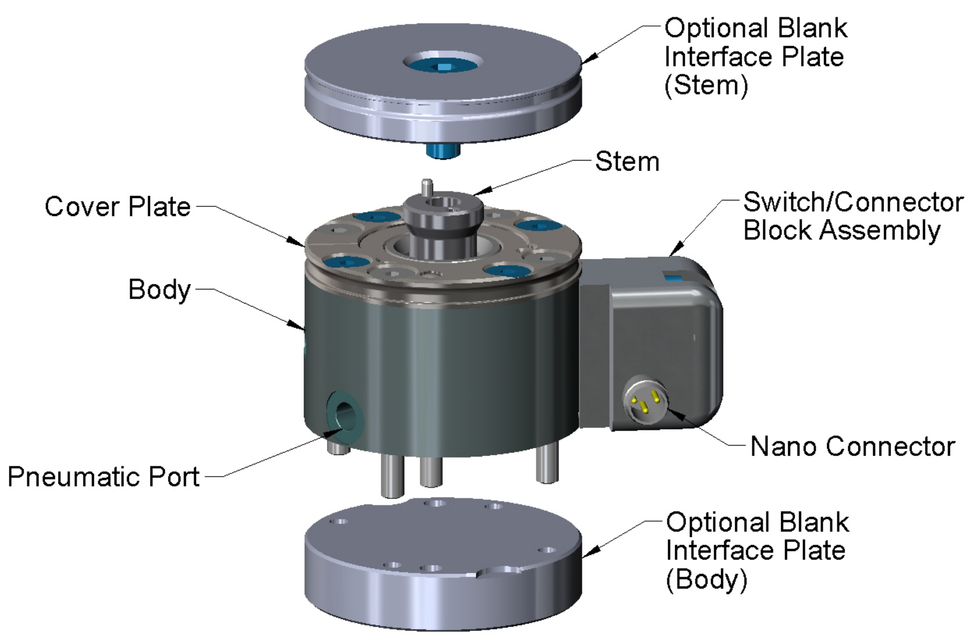
All Collision Sensor devices provide axial (compression only), torsional, and moment compliance.

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 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 M8 connector is mounted on the side of the Collision Sensor body. The user connects to the switch using the M8 connector for which a variety of cables are available. The user must also supply the Collision Sensor with dry, regulated, compressed air through a port on the side of the Collision Sensor body. The size and location of these connections are shown in the drawing provided at the end of this manual.

Figure 2.1—Collision Sensor Collision Sensor



3. Installation

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

3.1 Mechanical Installation

Refer to *Figure 2.1*

The Collision Sensor can be mounted directly to the robot or to the user tooling using the dowel pin holes and the clearance / tapped holes in the Collision Sensor body. Should this not be possible, an interface plate must be fabricated.

A second interface plate is often required for mounting to the Collision Sensor 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.

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.

Once any required machining of the interface plates is complete, mount the Collision Sensor using hardware appropriately sized for the application. Connect an appropriately sized air line and fitting to the Collision Sensor.

NOTICE: 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, refer to *Section 3.1.1—Fastener Torque Specifications.*

3.1.1 Fastener Torque Specifications

Table 3.1—Recommended Torques for ATI Supplied Fasteners

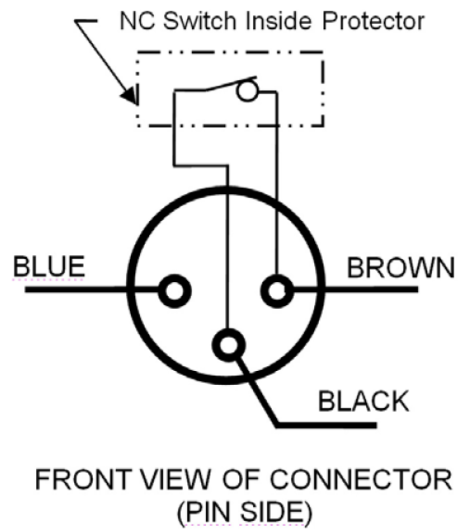
Fastener Size	Torque	Recommended Threadlocker
M3-0.5 Cap Screw	19 in-lbs (2.1 Nm)	Loctite 222 or equivalent
M4-0.7 Cap Screw	41 in-lbs (4.6 Nm)	
M5-0.8 Cap Screw	85 in-lbs (9.6 Nm)	
M6-1.0 Flat Head Cap Screw	85 in-lbs (9.6 Nm)	

3.2 Electrical Connection

The Collision Sensor is connected to the user's control wiring as a normally-closed, dry-contact 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 (refer to *Table 6.2*), utilize the brown-black-blue color code indicated.

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 10–30VDC.

Figure 3.1—Switch Wiring



3.2.1 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 3.1*. 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.

3.3 Pneumatic Connection

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 M5 pneumatic fittings. The pressure setting required for a particular application can be estimated using the procedure outlined in *Section 3.3.1—Calculating Estimated Pressure Setting* The exact pressure required must be determined through testing using the procedure outlined in *Section 3.3.2—Determining Exact Pressure Required.*

3.3.1 Calculating Estimated Pressure Setting

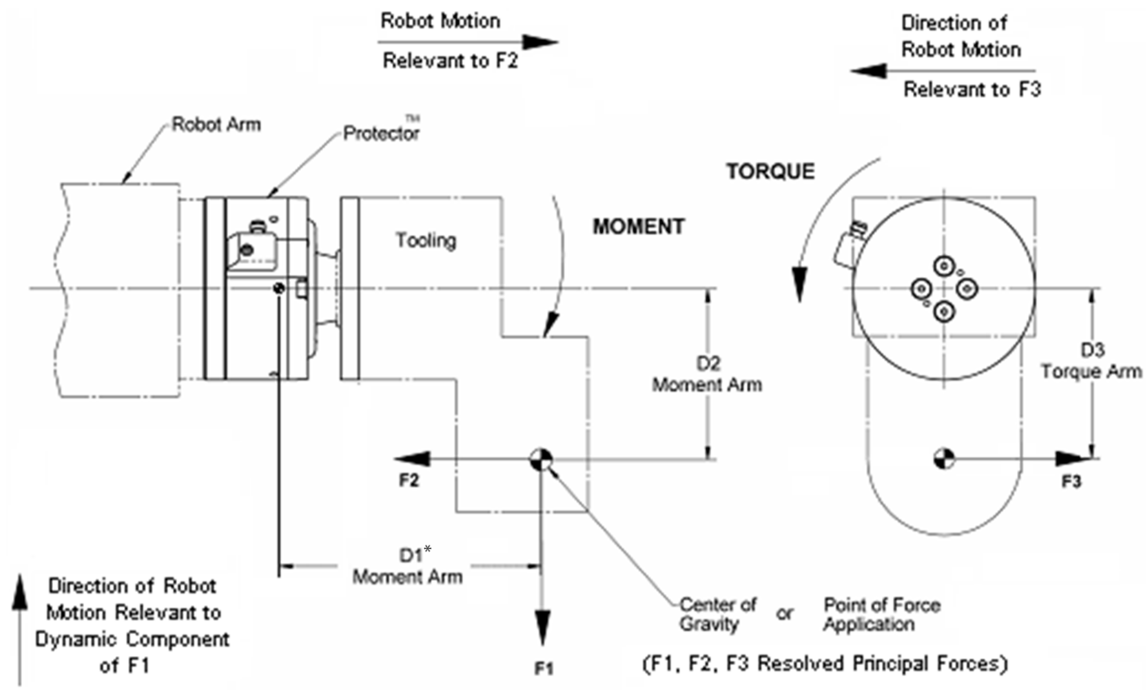
In order to determine the proper pressure setting for the collision sensor one must consider all static and dynamic loads to which it is subjected. These include the loads produced due to the static weight of the tooling, the inertial loads imposed by robot motion and the loads produced by the end-effector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

3.3.1.1 Calculate Applied Loads

Figure 3.2 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 3.2* and the formulas below to calculate the worst-case applied loads for your application. All (3) 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 3.2—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-48) and the thickness of the tooling side interface plate (.47” or 12 mm on an SR-48 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.

3.3.1.2 Obtain Required Pressure Setting

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

$$\mathbf{P = Pm + Pt + Pf + Pm_A + Pt_A}$$

Where **Pm**, **Pt**, and **Pf** are the pressure components related to the moment, torque, and force load components expected at the break-away. $\mathbf{Pm_A}$ and $\mathbf{Pt_A}$ 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 1.782) – 7.6	Pm = (M x 1.0874) – 0.5
Pt = (T x 1.519) – 2.3	Pt = (T x 0.9267) – 0.2
Pf = F x 0.926	Pf = F x 0.01435

$\mathbf{Pm_A}$ and $\mathbf{Pt_A}$ 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 1.782) – 7.6	Pm = (M x 1.0874) – 0.5
Pt = (T x 1.519) – 2.3	Pt = (T x 0.9267) – 0.2

Example: For an SR-48 with a static moment load of 10 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 = [(10 lb-in x 1.782) – 7.6] + [(5 lb-in x 1.519) – 2.3] +{[(10 lb-in x 1.782)-7.6] x 2Gs} + {[(5 lb-in x 1.519) – 2.3] x 2Gs}
= 10.2 psi + 5.3 psi + 20.4 psi + 10.6 psi
= 46.5 psi

A nominal air pressure setting of 47 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.

3.3.2 Determining Exact Pressure Required

1. Set the pressure approximately 5 psi (0.3 Bar) higher than the pressure calculated in *Section 3.3.1—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.

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 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 (2–15psi, 0.15–1bar) 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, uninterrupted 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.

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 M8 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

5.1.1 Cover Plate and Stem Disassembly

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

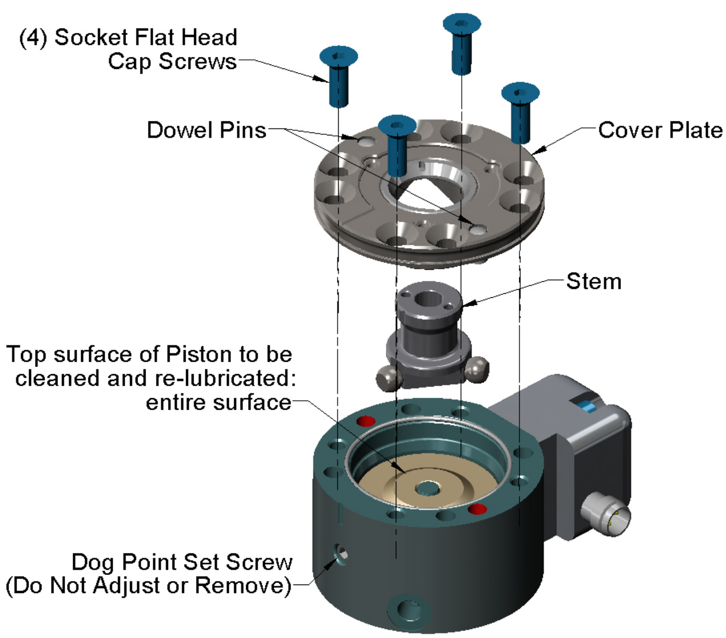
1. Remove the (4) socket head cap screws securing the cover plate assembly to the body using a 2.5 mm hex key (refer to *Figure 5.11*).

⚠ **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 5.1—Disassembly of Cover Plate



5.1.2 Cover Plate and Stem Cleaning and Lubrication

1. Clean the lubricant from the working surfaces of the cam and the clearance ring. Set the cover plate assembly aside for later re-use (refer to *Figure 5.22*).
2. 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 (refer to *Figure 5.33*).
3. Clean the lubricant from the top surface of the piston.

Figure 5.2—Cleaning and Re-lubricating the Cover Plate Assembly

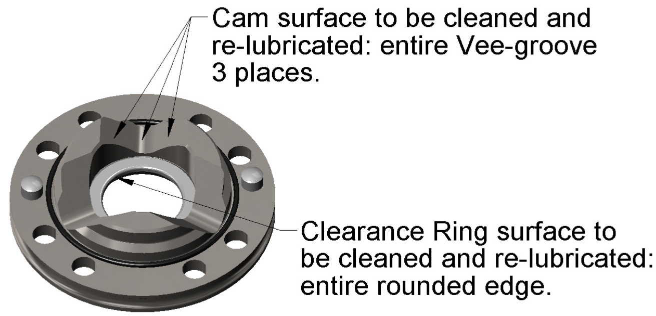
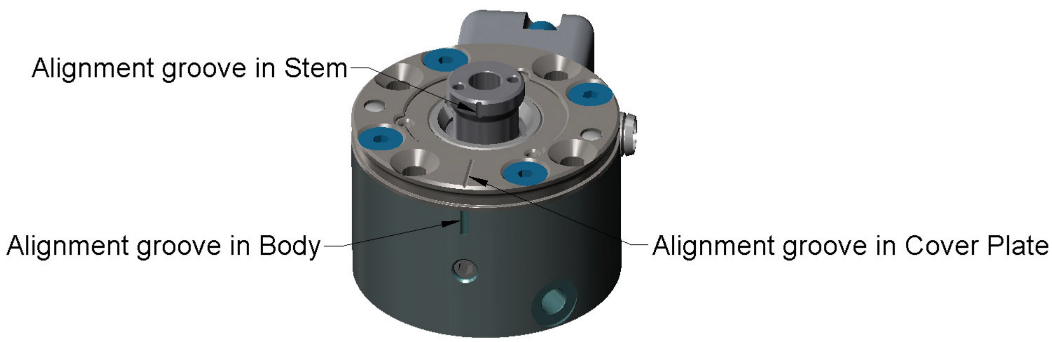


Figure 5.3—Cleaning and Re-lubricating the Stem

5.1.3 Cover Plate and Stem 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 (refer to *Figure 5.4*).
2. 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 (refer to *Figure 5.33*).
3. 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 (refer to *Figure 5.22*).
4. With the stem assembly upright, set the cover plate assembly onto it. Make certain that the alignment grooves are lined up (refer to *Figure 5.45*).
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 (refer to *Figure 5.45*).
6. Press the cover plate down onto the body.
7. Apply Loctite® 222MS to the (4) socket head cap screws and thread them into the body. Tighten the screws to 25 in-lbs (2.8 Nm).

Figure 5.4—Cover Plate and Stem Alignment



6. Troubleshooting

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 when the unloaded unit is in its working condition, contact ATI.

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 3.3.1—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.
	O-ring or u-cup seals worn	Check to refer to if there is air pressure loss due to air escaping past O-ring or u-cup seals. Air leak may be detectable from air leaking past stem. If air is leaking replace seals, refer to *Section 6.3—Seal Replacement.*
	Improper cover and stem alignment from maintenance or repair	Check to refer to 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 5.1.1—Cover Plate and Stem Disassembly* and *Section 5.1.3—Cover Plate and Stem Re-assembly* to correct stem alignment.
	Internal component damage	Check to refer to 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 misaligned 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 6.1—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 3.1* on the M8 connector to confirm that the switch is closed when the Collision Sensor is in the working position. If the switch is not closed replace, contact ATI.
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 6.4—Weld Splatter Shield Replacement.*

6.1 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).

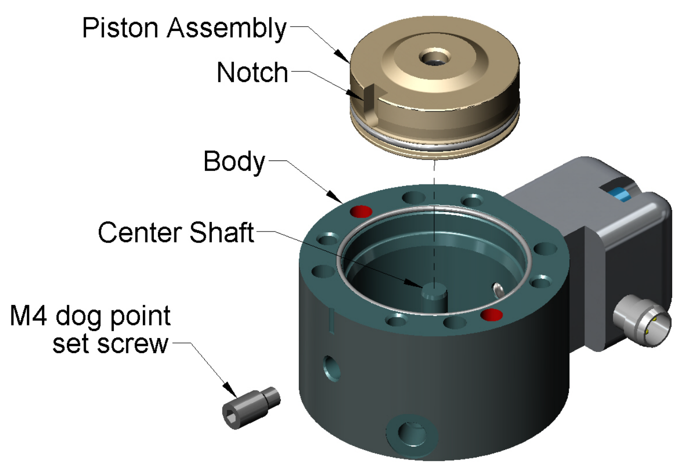
Table 6.2—Cable Choices		
XX	**Cable Number**	**Description**
BN	---	No cable purchased with Collision Sensor – choose one of the following replacement cables
BB	8590-9909999-15	High-flex cable with straight screw-on connector, 5M (16.4 ft.) long with flying leads
BC	8590-9909999-06	High-flex cable with 90º snap-on connector, 5M (16.4 ft.) long with flying leads
BD	8590-9909999-89	High-flex cable with 90º screw-on connector, 10M (32.8 ft.) long with flying leads
BE	8590-9909999-116	High-flex cable with 90º 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

6.2 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-48 may be field converted to add an assist spring or to contain a different range spring.

1. Remove cover plate assembly and stem assembly per *Section 5.1.1—Cover Plate and Stem Disassembly*
2. Remove the M4 dog point set screw using a 2.5 mm hex key (refer to *Figure 5.45*) (If unit is equipped with an assist spring, temporarily place the stem assembly on top of the piston and push down while removing the set screws.)
3. Remove the stem assembly, piston assembly and assist spring (if present).
4. Place the new assist spring into the counter bore in the body.
5. 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 (refer to *Figure 6.11*).
6. Temporarily place the stem assembly on top of the piston assembly.
7. Apply Loctite 222MS to the M4 dog point set screw.
8. 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.)
9. Screw the M4 dog point set screw clockwise until it touches the piston and then counterclockwise one turn.
10. Remove the stem assembly.
11. Replace the cover plate assembly and stem assembly per *Section 5.1.3—Cover Plate and Stem Re-assembly*.

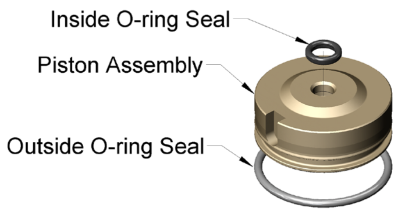
Figure 6.1—Piston Orientation



6.3 Seal Replacement

1. Disassemble cover assembly and stem assembly per *Section 5.1.1—Cover Plate and Stem Disassembly*.
2. Remove the M4 dog point set screw using a 2.5 mm hex key (refer to *Figure 5.45*) (If unit is equipped with an assist spring, temporarily place the stem assembly on top of the piston and push down while removing the set screw.)
3. Remove the stem assembly, piston assembly and assist spring (if present).
4. Remove and discard O-ring from groove on outside of piston.
5. Remove and discard u-cup from groove in center bore of piston.

Figure 6.2—U-cup Orientation

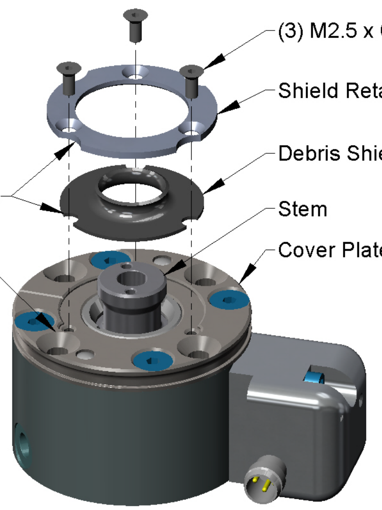


6. Apply Magnalube-G (Teflon/Petroleum base grease) to the new O-ring and u-cup.
7. Apply Magnalube-G to the body bore and post.
8. Assemble the new O-ring to the outer piston groove.
9. Assemble the new u-cup in the groove in the center bore of the piston making certain that the grooved end faces the plain round end of the piston (refer to *Figure 6.22*).
10. If equipped place the assist spring into the counter bore in the body.
11. 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 (refer to *Figure 6.11*).
12. Temporarily place the stem assembly on top of the piston assembly.
13. Apply Loctite 222MS to the M4 dog point set screw.
14. 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.)
15. Screw the M4 dog point set screw clockwise until it touches the piston and then counterclockwise one turn.
16. Remove the stem assembly.
17. Re-assemble stem assembly and cover assembly per *Section 5.1.3—Cover Plate and Stem Re-assembly*.

6.4 Weld Splatter Shield Replacement

1. Remove (2) M2.5 x 6 flat head socket cap screw and shield retainer (refer to *Figure 6.34*).
2. Remove weld shield seal and discard.
3. Install new EPDM seal by stretching the center hole over the stem.
4. 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.
5. Place the shield retainer on top of the weld shield. Line up the screw holes and clearance slots.
6. Apply Loctite 222MS to threads of (3) M2.5 x 6 socket flat head cap screw and install through shield retainer and weld shield into cover plate. Tighten until weld shield is slightly compressed.

Figure 6.3—Weld Splatter Shield Replacement



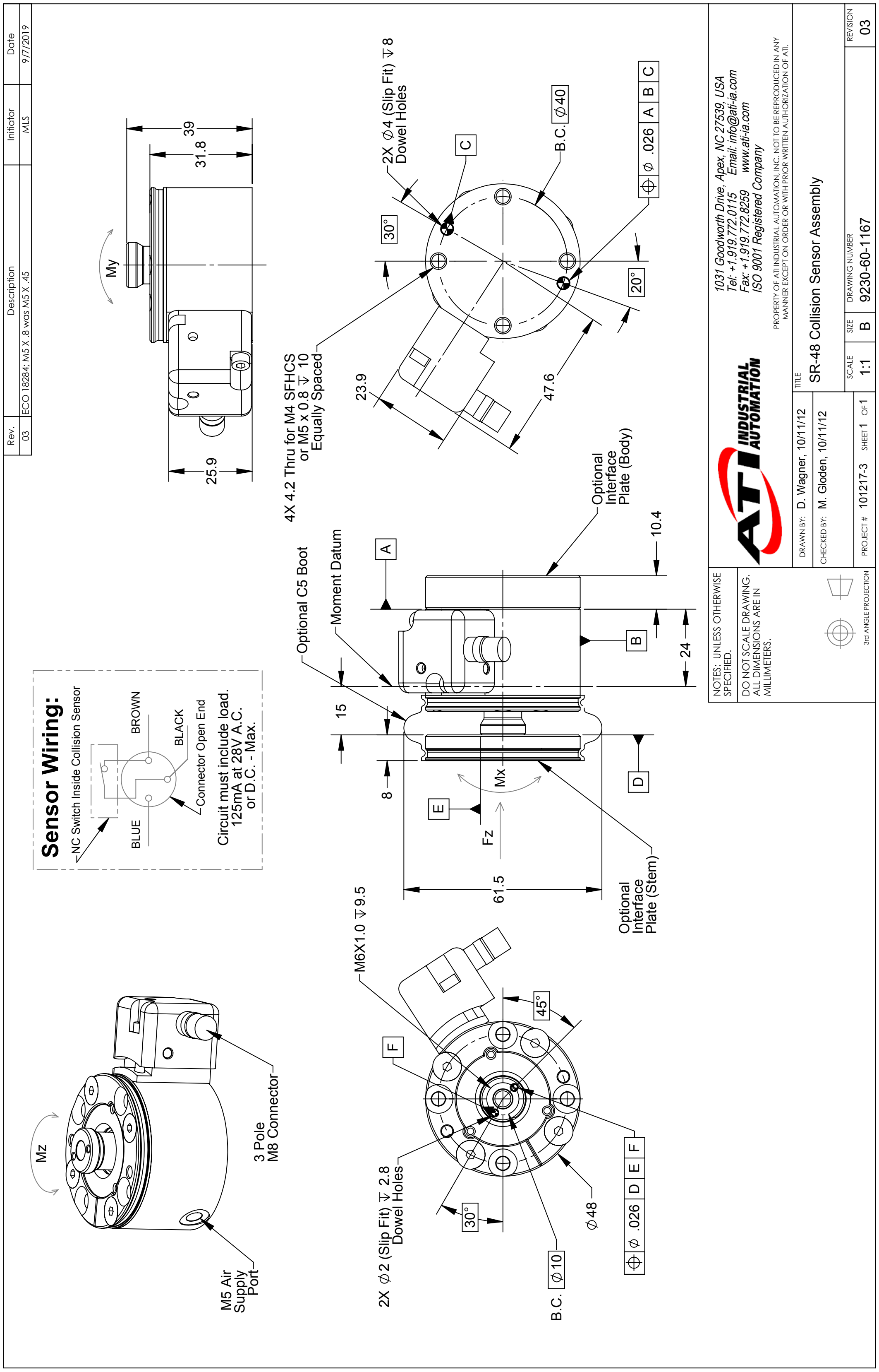
7. Specifications

Figure 7.1—Specifications

Displacement	**Angular**	+/- 13° max.
	Torsional	+/- 20° max.
	Axial	0.20 in (5.1 mm) max.
Load Limit	**Moment**	53 in-lbs (6 Nm)
	Axial	100 lb (440 N)
	Torsional	61 in-lbs (6.9 Nm)
Weight		0.55 lb (0.25 Kg)
Operating	**Pressure**	25-90 psi (1.7-6.2bar)
	Temp.	40-120ºF (5-50ºC)
Connector Type Switch Rating		3-pin M8 connector 100mA 10-30VDC
Sensitivity		.025 in (.64 mm) axial
Spring Assist Option		5, 10,15 psi equivalents available

8. Drawings

8.1 SR-48 Collision Sensor Assembly Drawing

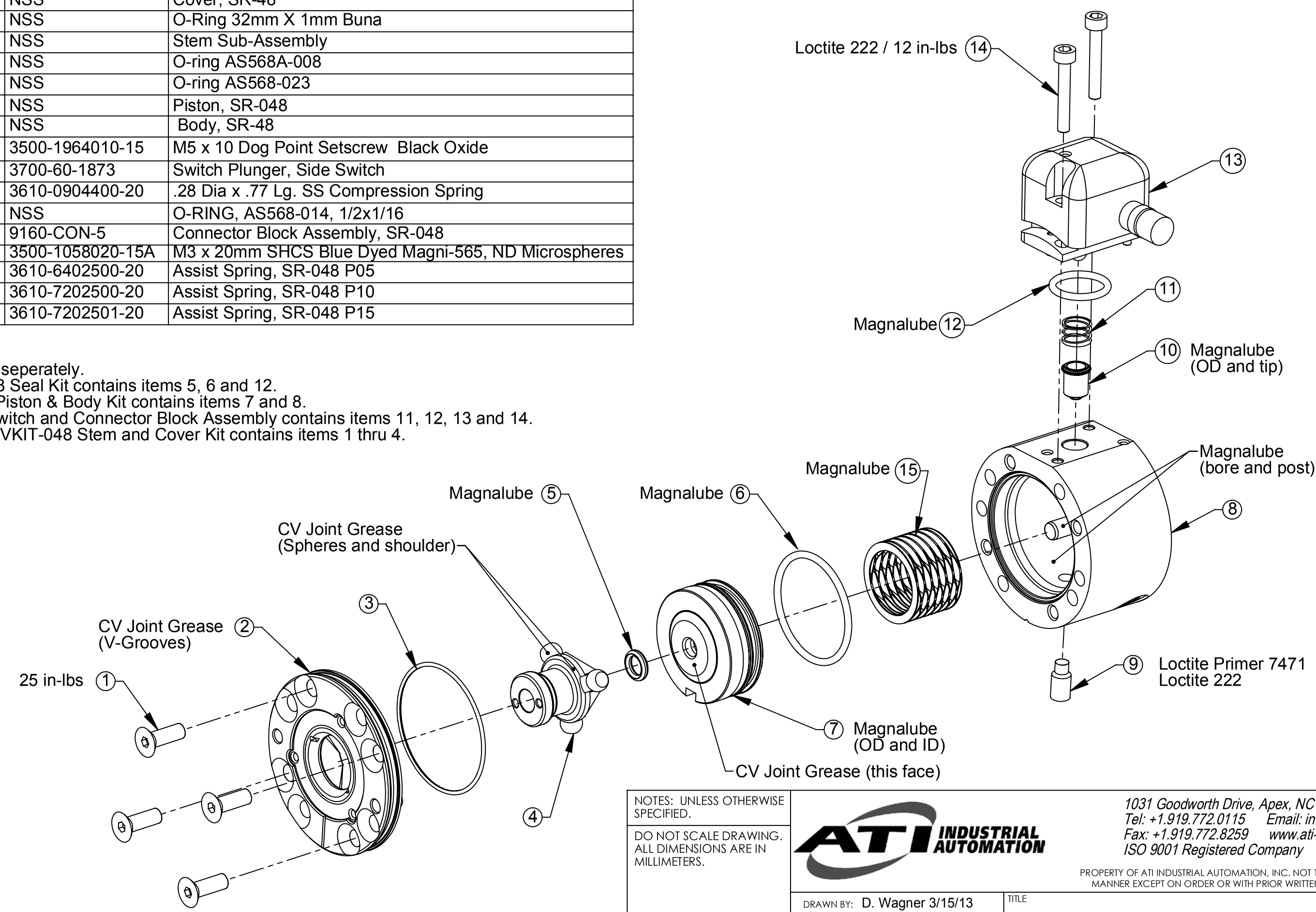


8.2 SR-48 Collision Sensor Assembly Replacement Parts

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	4	3500-1262012-15A	M4 x 12mm SFHCS, Blue Dyed Magni-565 w/Microspheres
2	1	NSS	Cover, SR-48
3	1	NSS	O-Ring 32mm X 1mm Buna
4	1	NSS	Stem Sub-Assembly
5	1	NSS	O-ring AS568A-008
6	1	NSS	O-ring AS568-023
7	1	NSS	Piston, SR-048
8	1	NSS	Body, SR-48
9	1	3500-1964010-15	M5 x 10 Dog Point Setscrew Black Oxide
10	1	3700-60-1873	Switch Plunger, Side Switch
11	1	3610-0904400-20	.28 Dia x .77 Lg. SS Compression Spring
12	1	NSS	O-RING, AS568-014, 1/2x1/16
13	1	9160-CON-5	Connector Block Assembly, SR-048
14	2	3500-1058020-15A	M3 x 20mm SHCS Blue Dyed Magni-565, ND Microspheres
15	1	3610-6402500-20	Assist Spring, SR-048 P05
15	1	3610-7202500-20	Assist Spring, SR-048 P10
15	1	3610-7202501-20	Assist Spring, SR-048 P15

1. NSS - Not sold seperately.
2. 9160-SEAL-048 Seal Kit contains items 5, 6 and 12.
3. 9005-60-1038 Piston & Body Kit contains items 7 and 8.
4. 9160-CON-5 Switch and Connector Block Assembly contains items 11, 12, 13 and 14.
5. 9160-STEMCOVKIT-048 Stem and Cover Kit contains items 1 thru 4.

Rev.	Description	Initiator	Date
01	Initial Drawing	DAW	3/15/2013
02	ECO-11161; Added C5 boot kit to sheet 2	DAW	7/8/2013



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

3rd ANGLE PROJECTION

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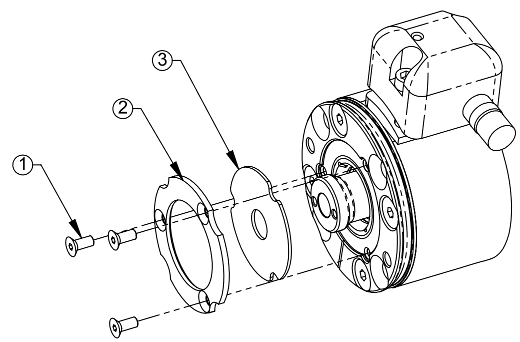
DRAWN BY: D. Wagner 3/15/13
CHECKED BY: DKL 4/3/13
PROJECT # 101217-3 SHEET 1 OF 2
TITLE: SR-48 Collision Sensor Assembly Replacement Parts
SCALE 1:1 | SIZE B | DRAWING NUMBER 9230-60-1168 | REVISION 02

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	3	NSS	M2.5 x 6mm SFHCS Black Oxide, ND Microspheres
2	1	NSS	Shield Retainer, SR-048
3	1	NSS	Debris Shield, SR-048
4	2	NSS	Garter Spring
5	1	NSS	C5 Boot

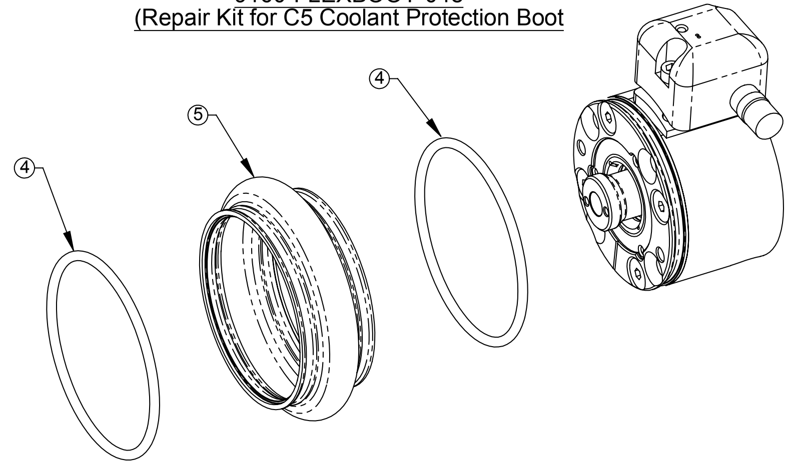
NSS - Not sold seperately.

Rev.	Description	Initiator	Date
-	See Sheet1	-	-

9160-SHIELD-048
(Repair Kit for C2 Weld Splatter Shield



9160-FLEXBOOT-048
(Repair Kit for C5 Coolant Protection Boot



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PROJECT # 101217-3 SHEET 2 OF 2

TITLE: SR-48 Collision Sensor Assembly Replacement Parts

SCALE	SIZE	DRAWING NUMBER	REVISION
1:1	B	9230-60-1168	02

9. Terms and Conditions of Sale

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

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