ATI INDUSTRIAL AUTOMATION
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Compensator
9116 Series 000, 100, 200, and 400

Installation and Operation Manual

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

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Glossary of Terms

Term	Definition
Top Plate	Plate that interfaces Compensator to robot or assembly machine.
Bottom Plate	Plate that interfaces customer tooling to Compensator.
Overload Pin	Component that limits amount of compliance to prevent damage to compensator when overloaded.
Shear Pad	Component that provides compliance in the lateral, cocking, axial, and torsional directions.
Lock-up	Pneumatically-powered locking mechanism that locks compensator rigid for accelerated movements to reduce wear on shear pads.
Lock-up Screw	Locking mechanism component that is pulled into bottom plate by the lock-up to help securely lock unit.
Lock-up Screw Bushing	Wear bushing for lock-up screw.
Lock Sensing	Proximity sensor mounted in sensor fitting detects when compensator is locked.
Sensor Ready	Compensator with sensor fitting. Customer supplies proximity sensor for lock sensing.
Insertion Contact Point	Point at which part being inserted contacts its mating part. At this point a contact force is created.
Center-of-Compliance (C-of-C)	The point in space at which a contact force will cause a translation with no rotation and a torque will cause a rotation with no translation.
RCC	Remote Center-of-Compliance or **R**emote **C**ompliance **C**enter (same as C-of-C).

1. Safety

1.1 General

Prior to purchase and installation, the customer should verify that the Compensator selected is rated for the maximum loads expected during operation (refer to *Section 10—Specifications* in this manual or contact ATI for assistance).

The customer is responsible for understanding the function of the Compensator and implementing the proper hardware and/or software to operate the Compensator safely.

All pneumatic fittings and tubing must be capable of withstanding the repetitive motions of the application without failing. The routing of electrical and pneumatic lines must minimize the possibility of stress pullout, kinking, rupture, etc.

All electrical power and pneumatics should be disconnected during servicing.

1.2 Explanation of Warnings

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

Danger indicates that a situation could result in potentially serious injury or damage to equipment.

Caution indicates that a situation could result in damage to the product and/or the other system components.

1.3 Precautions

DANGER: During operation, the area inside the Compensator must be kept clear.

DANGER: Power and air should always be removed prior to maintenance or repair.

CAUTION: The Compensator is only to be used for intended applications and applications approved by the manufacturer.

2. Product Overview

2.1 Introduction

The Compensator is a compliance device that enhances the flexibility and reliability of a robot or assembly machine. Compensators are used in automated assembly applications to provide compliance for misalignment during assembly. The sizes covered in this manual include 9116 Series 000, 100, 200, and 400.

The Compensator is designed to provide compliance in the lateral, cocking, axial, and torsional directions (see Figure 2.1). A key feature to the Compensator is the projected (remote) compliance center. The Center-of-Compliance (C-of-C) is the point in space at which a contact force will cause a translation with no rotation and a torque will cause a rotation with no translation. When the Center-of-Compliance is near the insertion contact point, the insertion part axis will align with the location axis during assembly. The Compensator consists of a single device with all components contained within the unit's outside diameter. The Compensator is available in various sizes and configurations (see *Section 10—Specifications*).

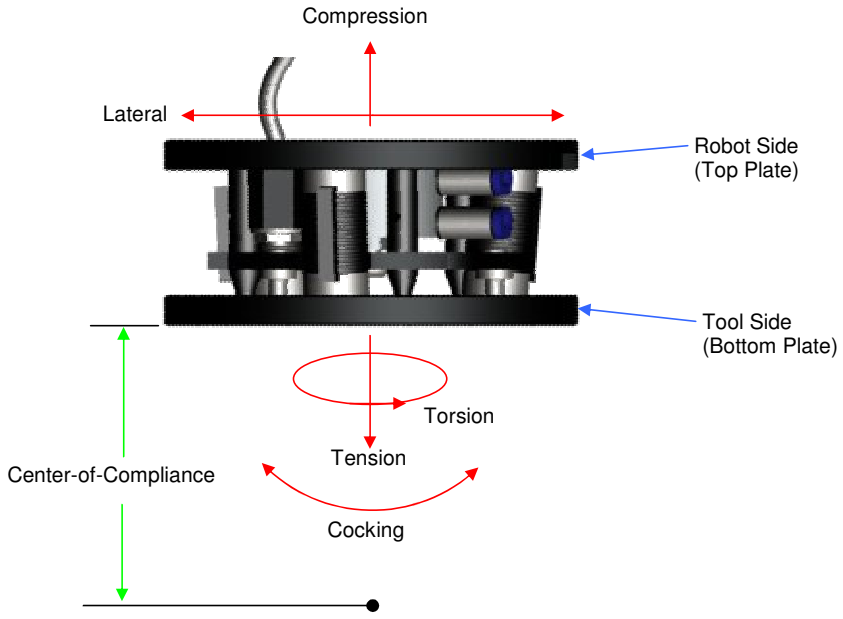

Figure 2.1—Product Description

3. Description

3.1 9116 Series 000, 100, 200, and 400 Compensator Assemblies

The base 9116 Series Compensator assembly includes anodized aluminum top and bottom plates, hardened steel overload pins, and shear pads. The 000 and 100 use 3 shear pads. The 200 uses either 3 or 6 shear pads. The 400 uses either 6 or 12 shear pads. Units with lock-up include air cylinder(s), bearing plate, lock-up screws, and lock-up screw bushings. Units with lock sensing also require a sensor fitting and cabled proximity sensor (see Figure 3.1).

Lock-up and lock sensing is optional. Lock-up is available on all sizes; lock sensing is only available on 100, 200, and 400 sizes.

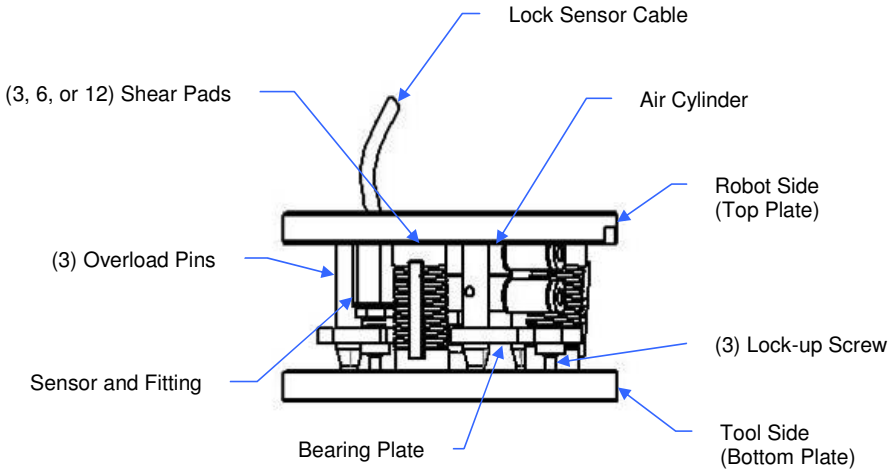

Figure 3.1—9116 Series Compensator Assembly (Lock-up Screw Bushing Not Shown)

4. Application

4.1 Intended Use

The Compensator is intended to be used in "peg-in-hole" type operations in the vertical orientation. The peg-in-hole example is an application involving the insertion of one part into another. There are a variety of peg-in-hole type applications that include: dowel pin insertion, mold alignment, washer insertion, bearings into housings, and shafts into bearings. If the Compensator is used in the horizontal orientation, over time the shear pads will develop sag. Rubber and most rubber-like materials have memorization characteristics. Over time the rubber material memorizes the repeated position and will return to this position. When this occurs, the shear pads have developed sag. Use of the Lock-up option is recommended to prevent shear pad sag.

4.2 Compensator Selection

1.) Compare possible assembly misalignment with Compensator allowable misalignment:
Follow the two steps below (see Figure 4.3).

Step 1: Perform a tolerance study of your worst case assembly misalignment.

a.) Tolerance to which your assembly machine can position part A.
b.) Tolerance to which your feeder can position part B.
c.) Repeatability of tooling handling part A.
d.) Locational tolerance of part B's feature (i.e.; hole)
e.) Repeatability of Compensator is +/- 0.002" in the vertical position.

Assembly misalignment (worst case) = a) + b) + c) + d) + e)

Step 2: Find your total clearance.

a.) Chamfer size on part A (a lead in is required on at least one part).
b.) Chamfer size on part B.
c.) Worst case part clearance, Y subtract X.

Total Clearance = a) + b) +c)

- The Compensator is needed when your assembly misalignment is greater than your part clearance.
- Your total clearance must be greater than your assembly misalignment or two parallel surfaces will contact. If your total clearance is less than your assembly misalignment, then increase the chamfer size on part A and/or part B.
- Select a Compensator with allowable misalignment greater than your assembly misalignment (see *Section 10—Specifications*).

When the insertion axis is not vertical, the initial offset of the Compensator due to the weight of tooling and part must be taken into consideration as there is some lateral and cocking deflection of the flexing shear pads. This reduces the allowable misalignment in the downward direction, while increasing it in the upward direction.

2.) Calculate the optimum Center-of-Compliance (C-of-C)
Calculate the total distance, L, from the tool side (bottom) plate of the Compensator to the initial contact point of the part being inserted (see Figure 4.1). Take into account any interface plates. Select the model with a C-of-C within 30% of the distance L. It is better to have a C-of-C below the insertion point than above. If the fit between the peg and hole is loose, a model with a C-of-C within 60% of distance L is allowable.

3.) Determine the required load capacity:
Observe the following guidelines:

- The tension load capacity for a vertical application is the weight of the tool and part.
- Use HCL-13A shear pad for high-impact loads.

- Use lock-up device to reduce high inertia loads due to acceleration.
- A high compression load capacity will be needed for tight tolerance applications (i.e.; press fit).
- When needed, use six (6) shear pads on the 200 and twelve (12) on the 400 to double the load capacity. See *Section 10—Specifications* for model lateral and cocking load specifications.

4.) Minimize insertion force:
Calculate your maximum insertion force by multiplying your assembly misalignment by the lateral stiffness. See *Section 10—Specifications* for lateral stiffness.

- Make sure your assembly device can overcome the insertion force.
- Minimize Compensator stiffness when handling lightweight or delicate parts.
- Longer, heavier parts can usually tolerate a greater insertion force.

The 100 and 200 use three types of shear pads. The HCL-12A is the softest shear pad, while the HCL-11A is nearly as soft, but with a longer C-of-C. The HCL-13A is the stiffest shear pad with a C-of-C similar to the HCL-12A.

The 000 uses two types of shear pads, HCL-01A2 and HCL-02A. The HCL-01A2 is the softest shear pad. The HCL-02A is stiffer axially and laterally.

Find the lowest stiffness model that is within the applications load capacity and near the optimum C-of-C.

The 400 uses one type of shear pad, HCL-13A.

5.) Environment
The shear pads performance can be affected by the environment, such as temperature and oil. See *Section 10—Specifications* for shear pad specifications.

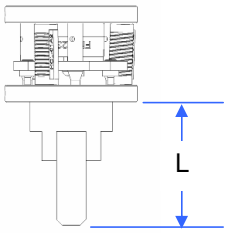

Figure 4.1—Calculating the Optimum Center-of-Compliance (C-of-C)

4.3 Contact Force

Excessive contact force is the main problem in many assembly applications. Excessive contact force causes galling, jamming, and broken parts. During a typical assembly process, there are three main contact forces: single-point, sliding, and two-point (see Figure 4.2). The key to reducing single-point or sliding contact force is using a compliance device with a low lateral stiffness. Two-point contact force is reduced with a low cocking stiffness.

4.4 Repeatability

The Compensator has a positional repeatability of +/-.026mm (.001") when in the locked position. When unit is unlocked, shear pads have a positional repeatability of +/- .051mm (.002").

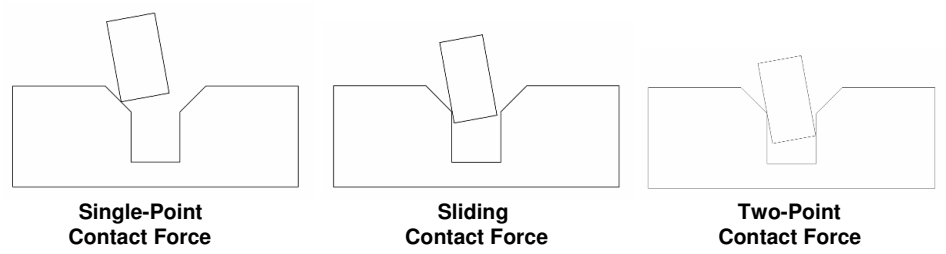

Figure 4.2—Contact Forces

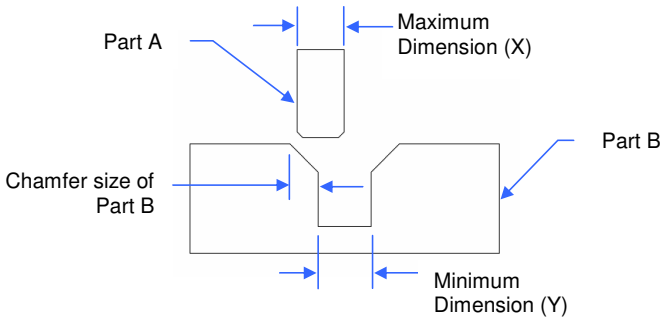

Figure 4.3—Assembly Inaccuracy

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5. Installation

5.1 Robot Side Interface

The 000, 100, 200, and 400 have two options for interfacing to a robot or assembly machine. Units can be mounted by using the tapped holes on the robot side (top) plate or by bolting through robot side (top) plate to robot or assembly machine. All sizes have (2) dowel holes for location. Robot or assembly machine interface must accommodate sensor cable if unit is equipped with lock sensing. For size and location of mounting features and lock sensor cable exit, see *Section 11—Drawings*. Mounting hardware not provided.

5.2 Tool Side Interface

The tool side (bottom) plate uses the same two methods for mounting tooling to unit as the robot side (top) plate. This plate also has (2) dowel holes for location. See *Section 11—Drawings* for size and location of mounting features.

5.3 Units with Lock-up and Lock Sensing (optional)

Units equipped with lock-up require an air supply to operate lock-up. Air supply should be clean, dry, and non-lubricated. Air supply is connected to Compensator by 5/32” or 4mm O.D. flexible, pneumatic tubing. See Figure 6.1 for air fitting identification.

Units equipped with lock sensing use a M5 x 0.5 x 25mm long threaded barrel proximity sensor. For power requirements and additional specifications, see *Section 10—Specifications*. Customers that order units sensor-ready should use the same type proximity sensor as specified. Sensor gap should be set at 1.02mm (.040”) on 100 and 200 with unit locked. Sensor gap should be set at 0.5mm (0.020”) on 400 with unit locked (see Figure 7.1).

CAUTION: The routing of electrical and pneumatic lines must minimize the possibility of stress pullout, kinking, etc. Failure of electrical or pneumatic lines to operate the unit properly may result in damage to equipment.

6. Operation

6.1 Compliance

The Compensator's compliance is limited by three overload pins. When the unit has reached maximum compliance, the overload pins support the load to prevent damage to shear pads. See Figure 2.1 for compliant directions.

6.2 Lock-up (optional)

Units equipped with lock-up are recommended to use an air supply from 60 to 120 psi (4.1 to 8.3 bar). In severe locking conditions, air supply can be adjusted to a maximum of 120 psi (8.3 bar). See *Section 10—Specifications* for air cylinder force factors. Lock-up is operated by applying air to the desired fitting (lock or unlock). Opposite fitting must be exhausted for cylinder to operate correctly. Unit is recommended to be locked in the vertical position. This creates a normal locking condition. Severe locking condition occurs when the unit is locked in the horizontal position under load. Load is being lifted by lock-up mechanism (see Figures 6.1 and 6.2). Please note that severe locking conditions will create above normal wear on lock-up screw bushings. For recommended lubrication periods for normal and severe locking conditions, see *Section 7—Maintenance*. Using a flow control valve to reduce acceleration of the lock-up screw into the tool side (bottom) plate will help reduce wear on lock-up screw bushings.

CAUTION: Unit must be in the unlocked position for full compliance.

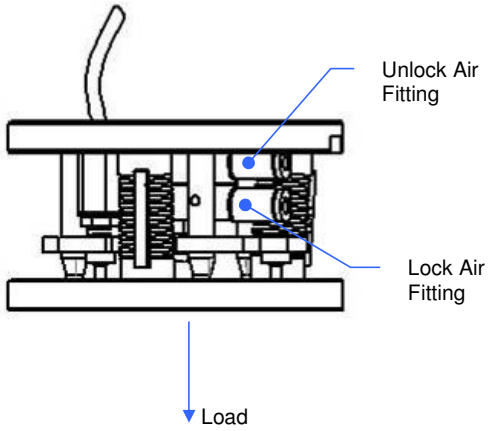


Figure 6.1—Vertical Lock Position / Normal

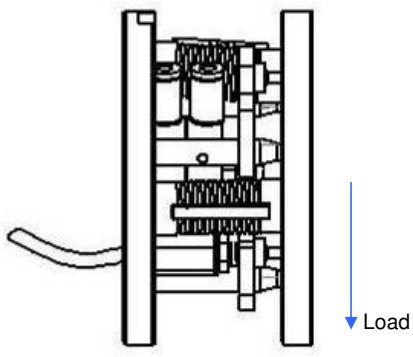


Figure 6.2—Horizontal Lock Position / Severe

6.3 Lock Sensing (optional)

Lock sensing is achieved by monitoring the position of the lock-up screw on the 100 and 200. The bearing plate position is monitored on the 400 to achieve lock sensing. When air pressure is applied to the air cylinder to lock unit, the lock-up screw is pulled into the tool side (bottom) plate. The lock-up screw or bearing plate enters the sensing range of the proximity sensor sending a lock signal (see Figure 7.1).

DANGER: Stay clear of compensator when lock-up is being cycled. Injury could result from moving parts.

7. Maintenance

7.1 Lock-up (optional)

The lock-up mechanism should be inspected periodically to ensure that it is operating freely and is free of debris. Overload pins should be lubricated with a light machine oil at their point of contact with bearing plate every 25,000 cycles under severe locking conditions and 50,000 cycles under normal locking conditions. Lock-up screws and bushings should be inspected for lubricant every 100,000 cycles under severe locking conditions and 250,000 cycles under normal locking conditions. If lubricant is required, use Anti-Seize (MIL-A-907E). Lubricant should be applied under head of lock-up screw between lock-up screw bushing and lock-up screw (see Figure 7.1). Routine inspection of pneumatic and electrical lines is recommended to avoid possible failure.

7.2 Lock Sensing (optional)

The lock sensor should be inspected at lubrication periods. Ensure that sensing face of sensor and sensor target (bottom of lock-up screw or bearing plate) is clean, and jam nut and sensor fitting are tight (see Figure 7.1).

7.3 Assembly Instructions for Spare Parts

See *Section 9—Recommended Spare Parts* and *Section 11—Drawings,* for assembly drawings and instructions.

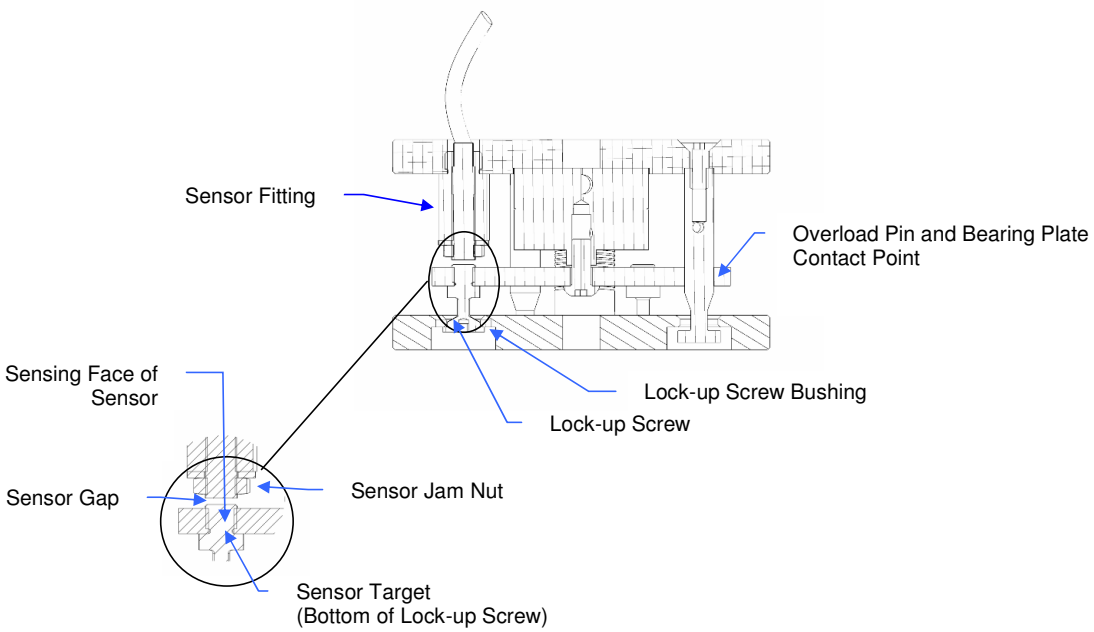


Figure 7.1—Section View

8. Troubleshooting

Symptom	Possible Cause / Correction
Unit will not lock or unlock	Check air supply. Pneumatic cylinder rod should be compressed during locked condition. Cylinder rod should be fully extended during unlock condition. Verify that when air is supplied to one port, the opposite port is being exhausted. Verify that air lines are connected to correct air fittings. Verify locking mechanism is operating freely and is lubricated properly.
Lock sensor not operating properly	Ensure sensing face of sensor and sensor target are clean. Verify sensor is wired correctly to power source. Verify that sensor gap is set at correct distance and jam nut and sensor fitting are tight.
Unit is not compliant	Verify unit is unlocked.
Air leak at unit	Verify pneumatic tubing is fully inserted into air fittings.

9. Recommended Spare Parts

Assembly	Part Number	Description
9116 Series 000	3700-15-1056	Overload Pins
	3500-1262010-11	Overload Pin Fasteners – M4x10mm SFHCS
	3700-15-2019	Lock-up Screws
	3405-1220004-01	Air Fittings
	3415-0020002-01	Air Cylinder
	3500-1058018-11	Air Cylinder Fasteners – M3x18mm SHCS
	3700-15-2024	Bearing Plate
	3500-9962010-11	Bearing Plate Fastener – M4x10mm Button Head Screw
	*3710-15-1008	Shear Pads HCL-01A2
	*3710-15-1005	Shear Pads HCL-02A
	3500-0356008-12	Shear Pad Fasteners – M2.5x0.45x8mm Slotted FHS
9116 Series 100	*8590-9909999-49	Proximity (Lock) Sensor – PNP
	*8590-9909999-53	Proximity (Lock) Sensor – NPN
	3700-15-2015	Sensor Fitting
	3700-15-1026	Overload Pins
	3500-1262010-11	Overload Pin Fasteners – M4x10mm SFHCS
	3700-15-2019	Lock-up Screws
	3405-1220004-01	Air Fittings
	3415-0020002-01	Air Cylinder
	3500-1058020-15A	Air Cylinder Fasteners – M3x20mm SHCS
	3700-15-2020	Bearing Plate
	3500-9962010-11	Bearing Plate Fastener – M4x10mm Button Head Screw
	*3710-15-1001	Shear Pads HCL-11A
	*3710-15-1002	Shear Pads HCL-12A
	*3700-15-1003	Shear Pads HCL-13A
	3500-1057005-11	Shear Pad Fasteners – M3x5mm SHCS
9116 Series 200	*8590-9909999-49	Proximity (Lock) Sensor – PNP
	*8590-9909999-53	Proximity (Lock) Sensor – NPN
	3700-15-2015	Sensor Fitting
	3700-15-1036	Overload Pins
	3500-1262010-11	Overload Pin Fasteners – M4x10mm SFHCS
	3700-15-2010	Lock-up Screws
	3405-1220004-01	Air Fittings
	3415-0020001-01	Air Cylinder
	3500-1058020-15A	Air Cylinder Fasteners – M3x20mm SHCS
	3700-15-2014	Bearing Plate
	3500-9964010-11	Bearing Plate Fastener – M5x10mm Button Head Screw
	*3710-15-1001	Shear Pads HCL-11A
	*3710-15-1002	Shear Pads HCL-12A
	*3710-15-1003	Shear Pads HCL-13A
	3500-1057005-11	Shear Pad Fasteners – M3x5mm SHCS
9116 Series 400	3700-15-1072	Overload Pins
	3500-1263016-11	Overload Pin Fasteners – M5x16mm SFHCS Vibra-Tite
	3700-15-2034	Lock-up Screws
	3405-1220004-01	Air Cylinder Fittings
	3405-1230002-01	Lock / Unlock Air Fittings
	3415-0020001-01	Air Cylinder
	3415-0021019-01	(4) Port Air Cylinder
	3500-1058018-11	Air Cylinder Fasteners – M3x18mm SHCS Vibra-Tite
	3700-15-2036	Air Fitting Block
	3500-1064010-11	Bearing Plate Fasteners – M5x10mm SHCS Vibra-Tite
	3710-15-1003	Shear Pads HCL-13A
	3500-1057005-11	Shear Pad Fasteners – M3x5mm SHCS Vibra-Tite
	3500-1258010-11	Air Fitting Block Fasteners – M3x10mm SFHCS Vibra-Tite
	3500-1262016-11	Air Fitting Retaining Screw – M4x16mm SFHCS Vibra-Tite
	3700-15-2015	Sensor Fitting
	*8590-9909999-49	Proximity (Lock) Sensor – PNP
	*8590-9909999-53	Proximity (Lock) Sensor – NPN

* Note: Part number required depends on unit.

10. Specifications

Metric Units

Size	Overall Size (mm)		Weight w/ (3) Shear Pads (N)		Allowable Misalignment (Standard)		
	D	H	Standard	w/ Lock-up & Sensor	Lateral (mm)	Cocking (rad)	Torsion (rad)
000*	56.9	41.4	1.3	1.8	1.7	0.017	0.079
100	80.0	45.0	2.2	3.1	2.2	0.019	0.087
200	99.1	45.0	3.6	4.9	2.2	0.019	0.070
400^	160.0	50.8	12.3	16.1	2.2	0.006	0.044

*Note: Lock sensing currently not available. ^Note: Weight shown is with (12) shear pads.

Standard Units

Size	Overall Size (in)		Weight w/ (3) Shear Pads (lbs)		Allowable Misalignment (Standard)		
	D	H	Standard	w/ Lock-up & Sensor	Lateral (in)	Cocking (degree)	Torsion (degree)
000*	2.24	1.63	0.3	0.4	0.065	1.0	4.5
100	3.15	1.77	0.5	0.7	0.085	1.1	5.0
200	3.90	1.77	0.8	1.1	0.085	1.1	4.0
400^	6.3	2	2.76	3.62	0.085	0.3	2.5

Metric Units

Model Number	C of C (mm)	Maximum Load Capacities				Stiffness	
		Vertical (N)*	Horizontal (N)*	Compression (N)	Cocking (N-m)	Lateral (N/mm)	Cocking (N-m/rad)
9116-001-A	23	22.2	6.7	355.9	3.4	5.8	180.4
9116-111-B	122	44.5	8.9	1290.9	5.1	11.4	372.2
9116-112-B	69	44.5	8.9	533.8	5.1	7.2	180.4
9116-113-B	61	80.1	26.7	1290.0	7.9	26.2	631.5
9116-211-A	140	53.4	8.9	1334.5	6.8	11.4	473.7
9116-211-B	155	53.4	8.9	1334.5	7.3	11.4	552.6
9116-211-C	148	106.9	17.8	2713.4	14.1	22.7	1026.3
9116-212-A	82	62.3	8.9	622.8	6.8	7.2	225.6
9116-212-B	92	62.3	8.9	711.7	7.3	7.2	270.7
9116-212-C	87	124.6	17.8	1334.5	14.1	14.3	496.2
9116-213-A	74	97.9	26.7	1334.5	8.5	26.2	789.4
9116-213-B	82	97.9	26.7	1378.9	9.0	26.2	947.3
9116-213-C	79	195.7	53.4	2713.4	17.5	52.4	1736.8
9116-413-C	229	195.7	26.7	2713.4	39.7	69.9	9022.1
9116-413-D	229	391.4	53.4	5426.8	79.4	139.8	18044.2

Standard Units

Model Number	C of C (in)	Maximum Load Capacities				Stiffness	
		Vertical (lbs)*	Horizontal (lbs)*	Compression (lbs)	Cocking (in-lbs)	Lateral (lbs/in)	Cocking (in-lbs/rad)
9116-001-A	0.9	5	1.5	80	30	33	1600
9116-111-B	4.8	10	2	290	45	65	3300
9116-112-B	2.7	10	2	120	45	41	1600
9116-113-B	2.4	18	6	290	70	150	5600
9116-211-A	5.5	12	2	300	60	65	4200
9116-211-B	6.1	12	2	310	65	65	4900
9116-211-C	5.8	24	4	610	125	130	9100
9116-212-A	3.2	14	2	140	60	41	2000
9116-212-B	3.6	14	2	160	65	41	2400
9116-212-C	3.4	28	4	300	125	82	4400
9116-213-A	2.9	22	6	300	75	150	7000
9116-213-B	3.2	22	6	310	80	150	8400
9116-213-C	3.1	44	12	610	155	300	15400
9116-413-C	9	44	6	610	350	400	80000
9116-413-D	9	88	12	1220	700	800	160000

* When used in the vertical position, use the Vertical maximum load capacities. When used in the horizontal position, use the Horizontal maximum load capacities.

–A and –B models use (3) shear pads, -C uses (6), -D uses (12).

9116 Series 100 and 200 use three types of shear pads: HCL-11A, -12A and -13A.

9116 Series 000 uses two types of shear pads: HCL-01A2 and -02A.

9116 Series 400 uses one type of shear pad: HCL-13A.

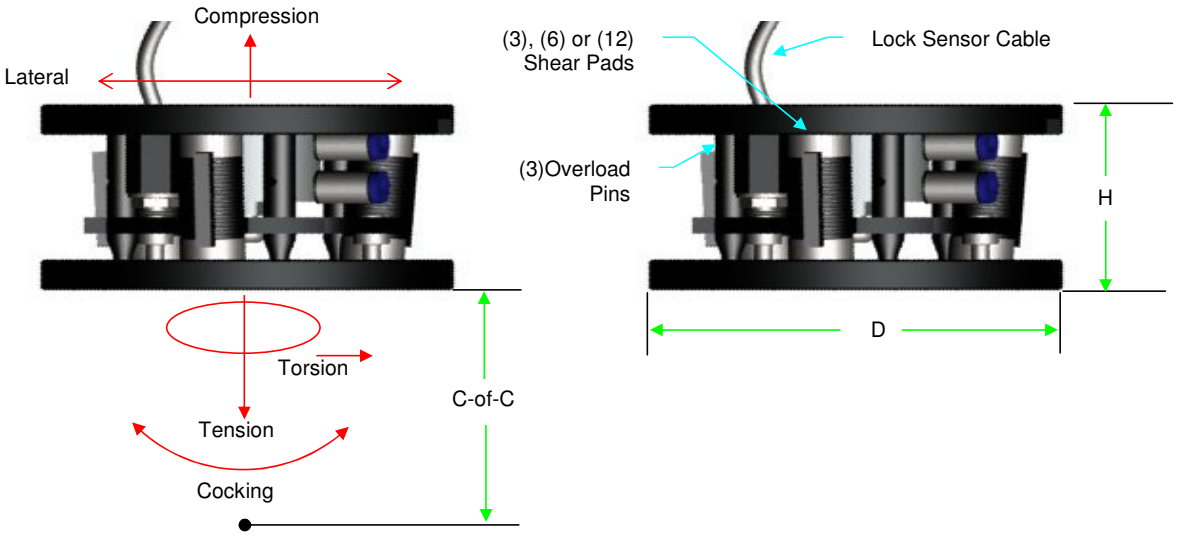


Figure 10.1—9116 Series Compensator Assembly Shown

Lock Sensor

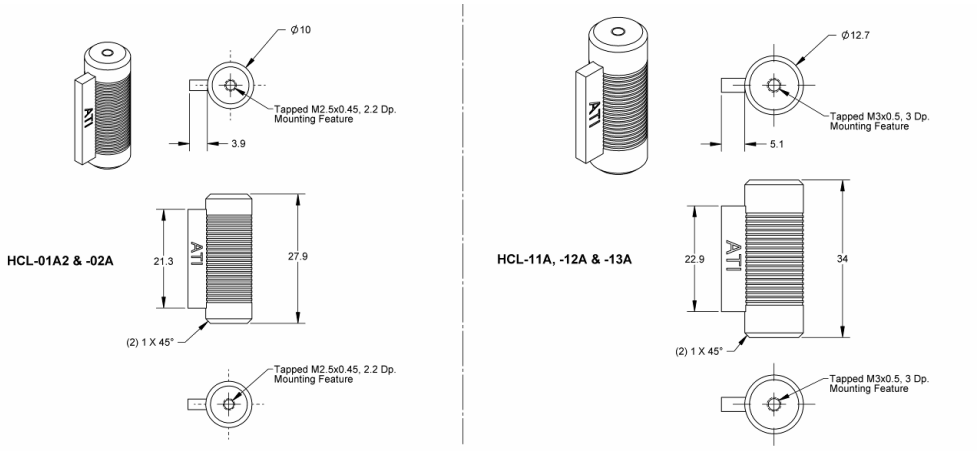
Type	M5x0.5 Threaded Barrel Proximity Sensor, NPN or PNP, Normally Open
Supply Voltage Range	10–30 VDC
Output Current	200mA
Rated Operating Distance (Sensing Range)	1.5mm (.059”)

Air Cylinder

9116 Series 000 and 100	
Force Factor	0.25 lb/psi (15N/bar)
9116 Series 200 and 400	
Force Factor	0.4 lb/psi (28N/bar)

Properties	Shear Pad Number				
	HCL-01A2	**HCL-02A**	**HCL-11A**	**HCL-12A**	**HCL-13A**
Compatible Compensator Size	000	000	100, 200	100, 200	100, 200, 400
Elastomer	Neoprene	Nitrile	Neoprene	Neoprene	Nitrile
Operating Temperature, Celsius	-29 to 82	-29 to 82	-29 to 82	-29 to 82	-29 to 82
Oil Resistance	Good	Excellent	Good	Good	Excellent
Ozone Resistance	Good	Good	Good	Good	Good
Lateral Stiffness (lbs/in)	6 (Very Low)	28 (High)	20 (Low)	14 (Very Low)	34 (High)
Axial Stiffness (lbs/in)	2329	10498	24889	6075	8300

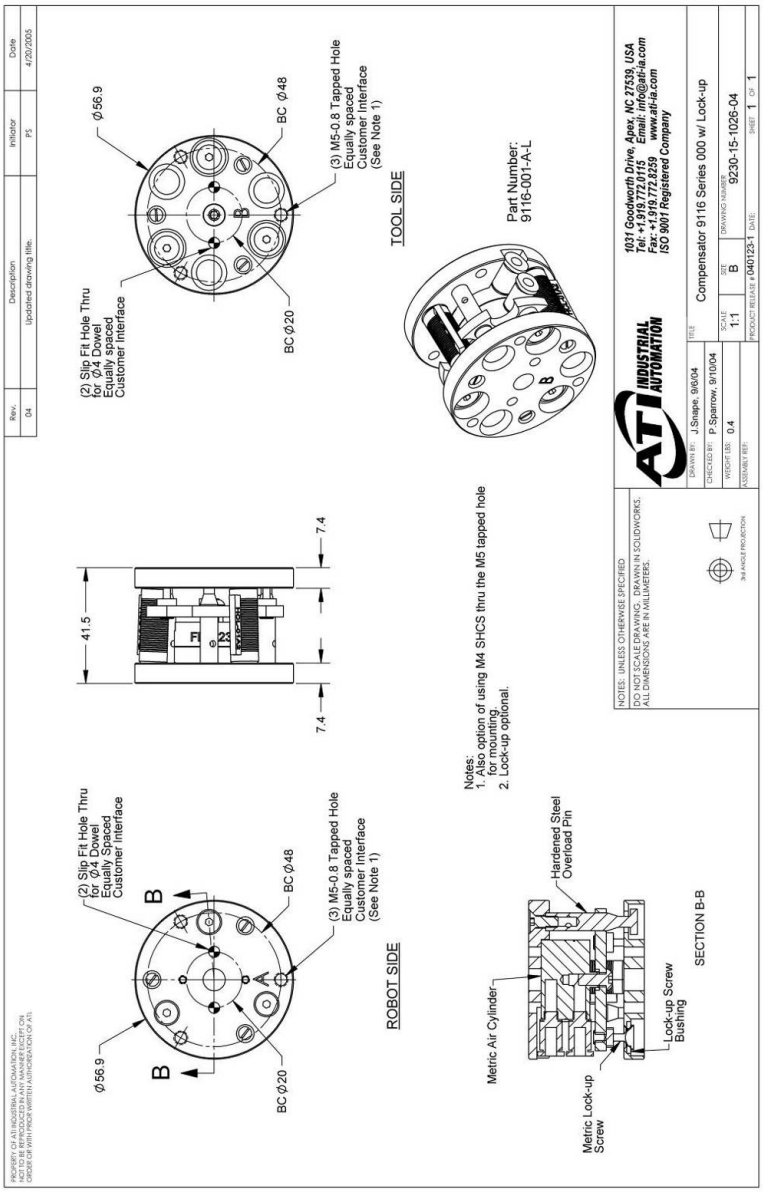
Table 10.1—Shear Pad Specifications



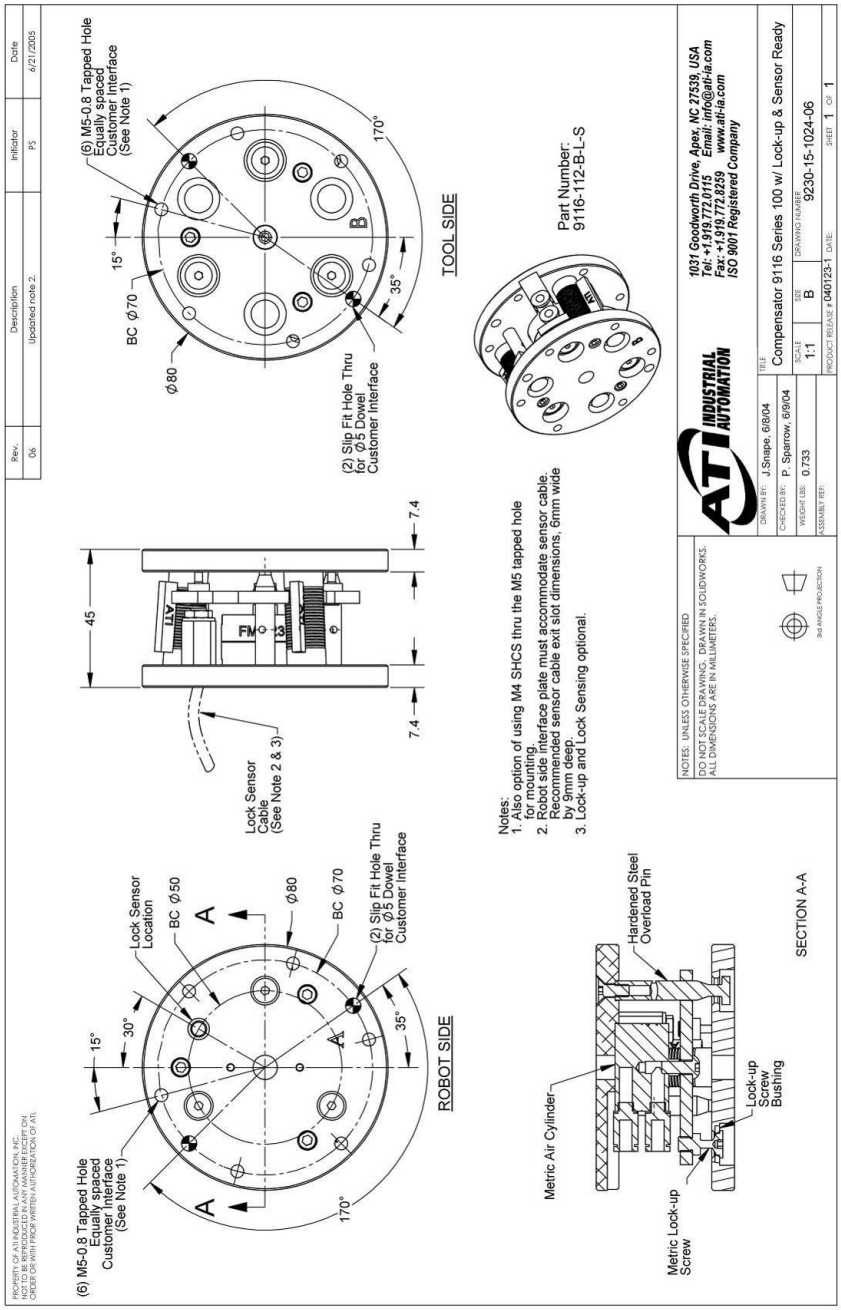
11. Drawings

11.1 Customer Drawings

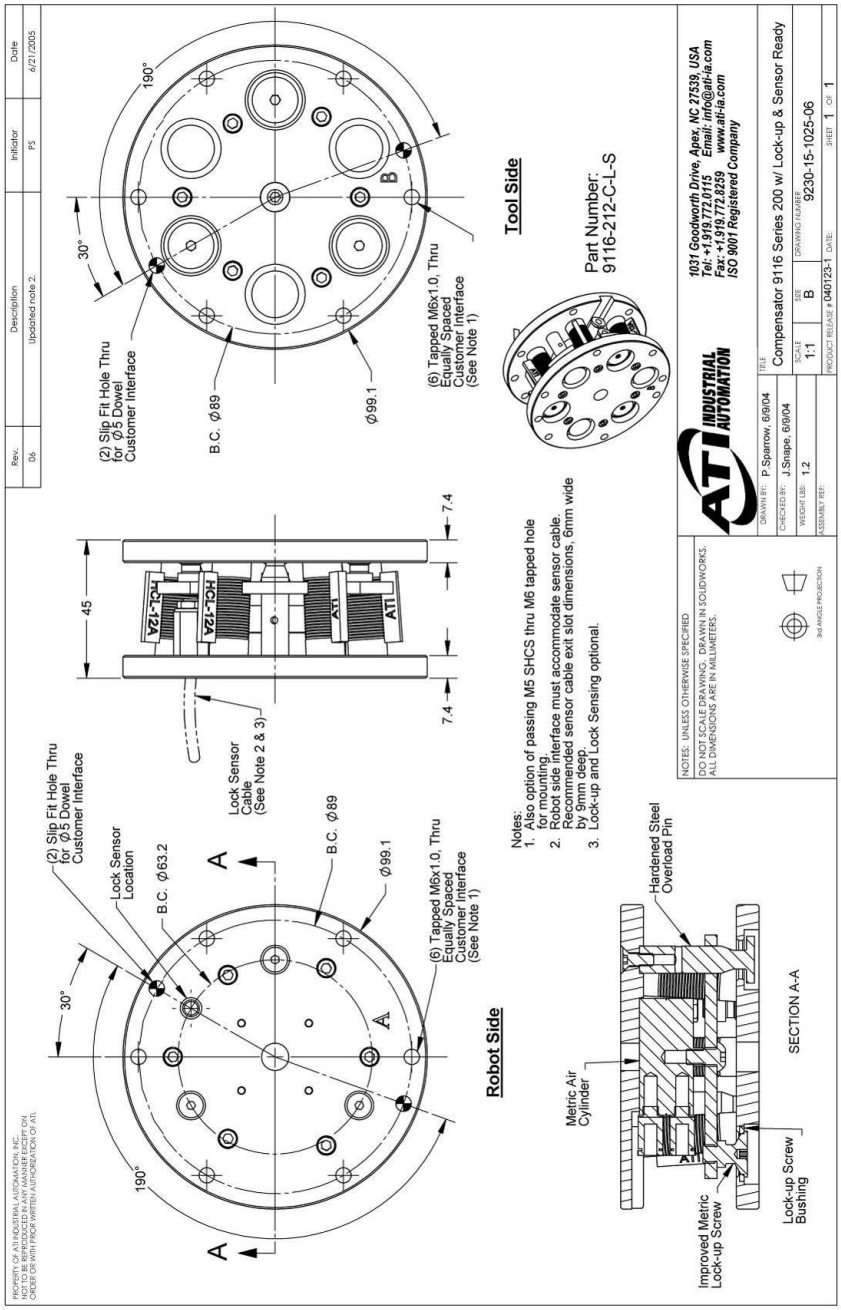
11.1.1 Compensator 9116 Series 000 w/ Lock-up



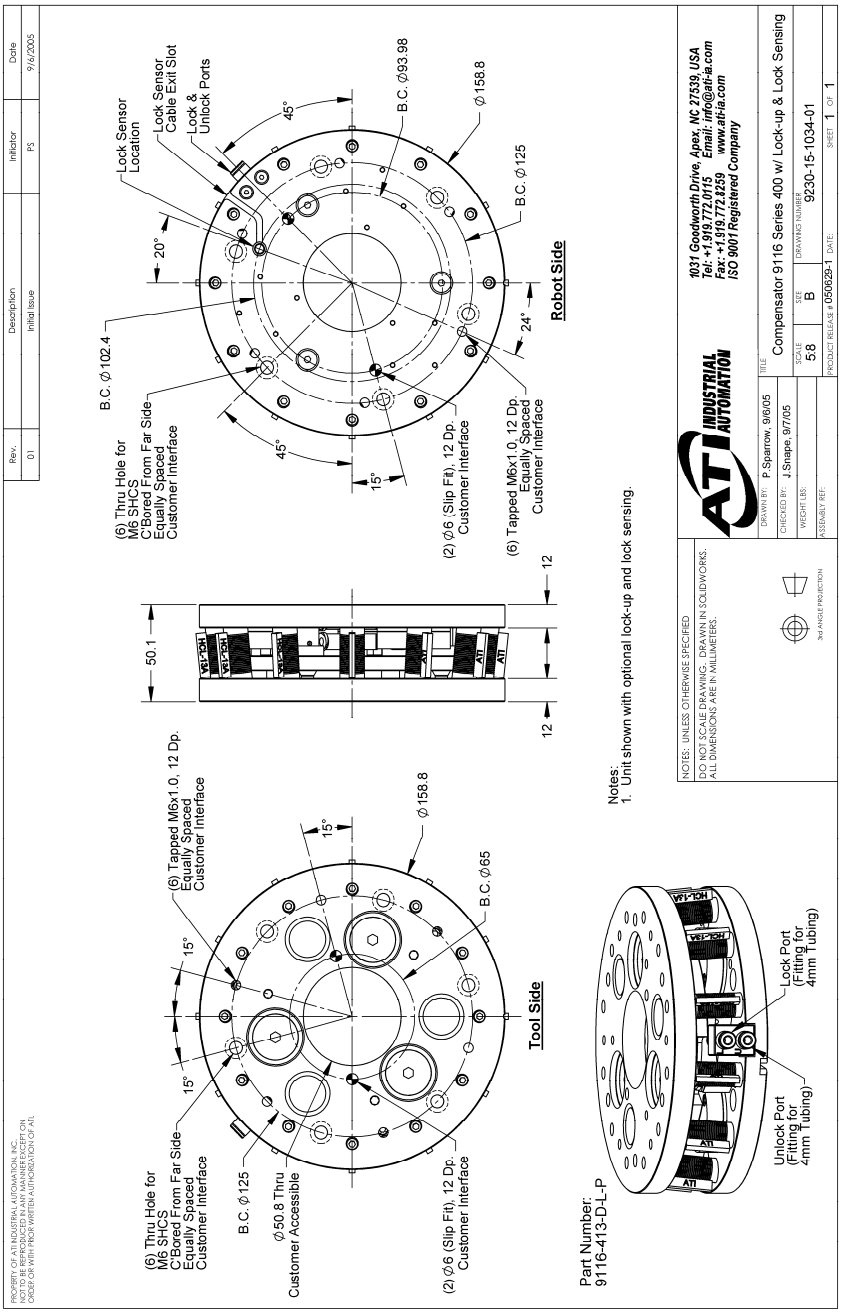
11.1.2 Compensator 9116 Series 100 w/ Lock-up and Sensor Ready



11.1.3 Compensator 9116 Series 200 w/ Lock-up and Sensor Ready

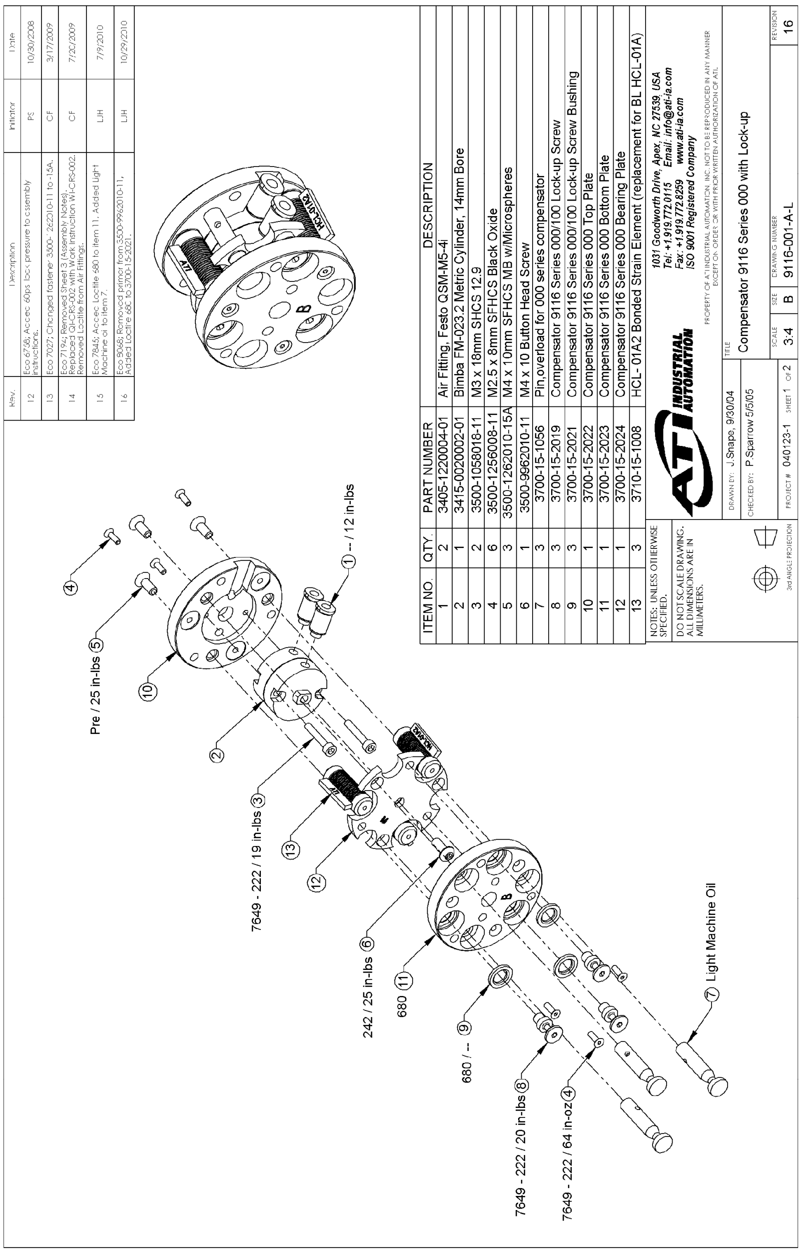


11.1.4 Compensator 9116 Series 400 with Lock-up and Lock Sensing



11.2 Assembly Drawings

11.2.1 Compensator 9116 Series 000 with Lock-up



Rev.	Description	Initiator	Date
12	Eco 6758; Accec 60psi lock pressure to assembly instructions.	PS	10/30/2008
13	Eco 7027; Changed fastener 3500-1262010-11 to -15A.	CF	3/17/2009
14	Eco 7194; Removed Sheet 3 (Assembly Notes). Replaced QI-CRS-002 with Work Instruction WI-CRS-002. Removed Loctite from Air Fittings.	CF	7/20/2009
15	Eco 7845; Accec Loctite 680 to item 11. Added Light Machine oi to item 7.	LJH	7/9/2010
16	Eco 8068; Removed primer from 3500-9962010-11. Added Loctite 680 to 3700-15-2021.	LJH	10/29/2010

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	2	3405-1220004-01	Air Fitting, Festo QSM-M5-4i
2	1	3415-0020002-01	Bimba FM-023.2 Metric Cylinder, 14mm Bore
3	2	3500-1058018-11	M3 x 18mm SHCS 12.9
4	6	3500-1256008-11	M2.5 x 8mm SFHCS Black Oxide
5	3	3500-1262010-15A	M4 x 10mm SFHCS MB w/Microspheres
6	1	3500-9962010-11	M4 x 10 Button Head Screw
7	3	3700-15-1056	Pin,overload for 000 series compensator
8	3	3700-15-2019	Compensator 9116 Series 000/100 Lock-up Screw
9	3	3700-15-2021	Compensator 9116 Series 000/100 Lock-up Screw Bushing
10	1	3700-15-2022	Compensator 9116 Series 000 Top Plate
11	1	3700-15-2023	Compensator 9116 Series 000 Bottom Plate
12	1	3700-15-2024	Compensator 9116 Series 000 Bearing Plate
13	3	3710-15-1008	HCL- 01A2 Bonded Strain Element (replacement for BL HCL-01A)

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

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ISO 9001 Registered Company

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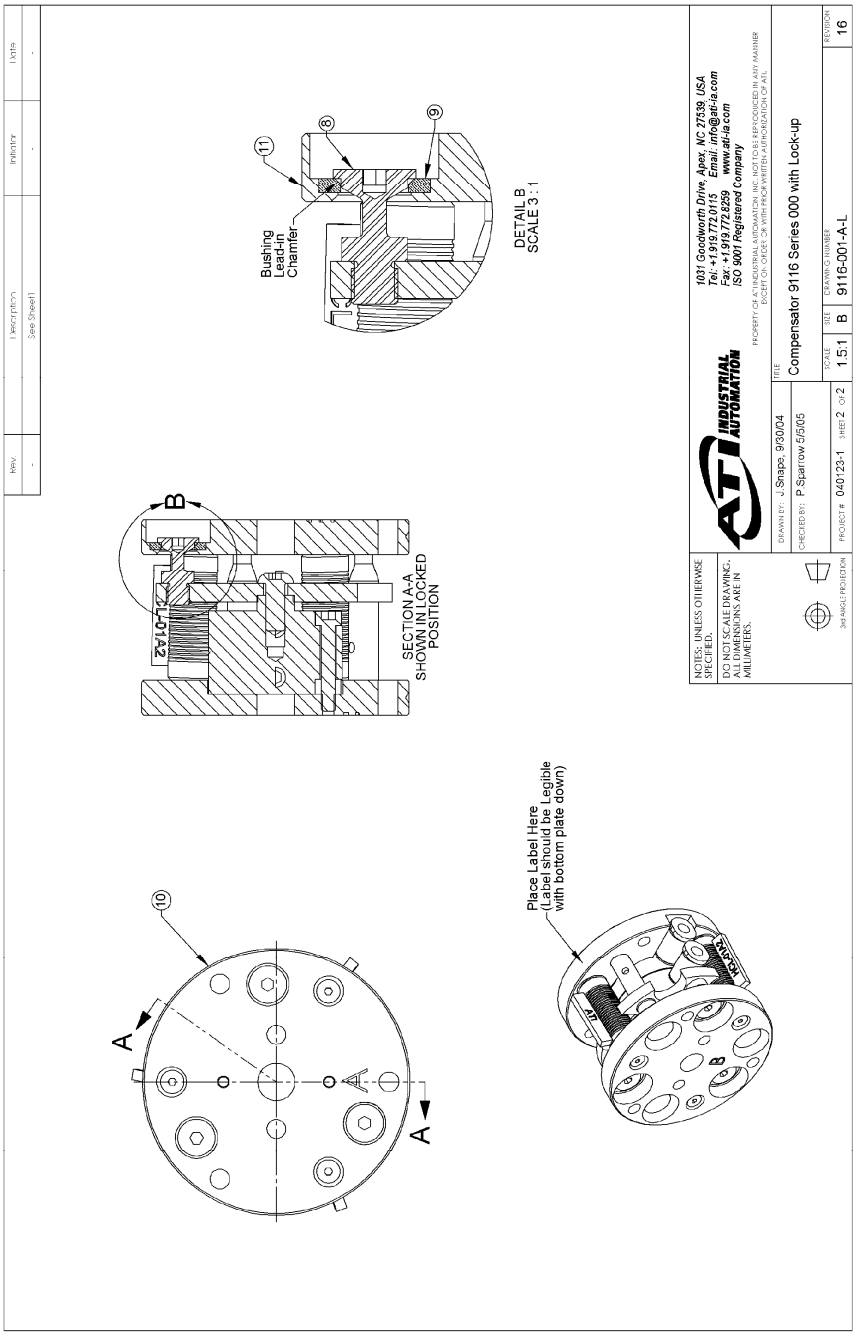
DRAWN BY:	J.Snape, 9/30/04
CHECKED BY:	P.Sparrow 5/5/05
PROJECT #	040123-1 SHEET 1 OF 2
TITLE	Compensator 9116 Series 000 with Lock-up
SCALE	3:4
SIZE	B
DRAWING NUMBER	9116-001-A-L
REVISION	16

3rd ANGLE PROJECTION


Rev
Description
Initials
See Sheet1
Bushing
Lead-in
Chamfer
DETAIL B
SCALE 3 : 1
SECTION A-A
SHOWN IN LOCKED
POSITION
Place Label Here
(Label should be Legible
with bottom plate down)
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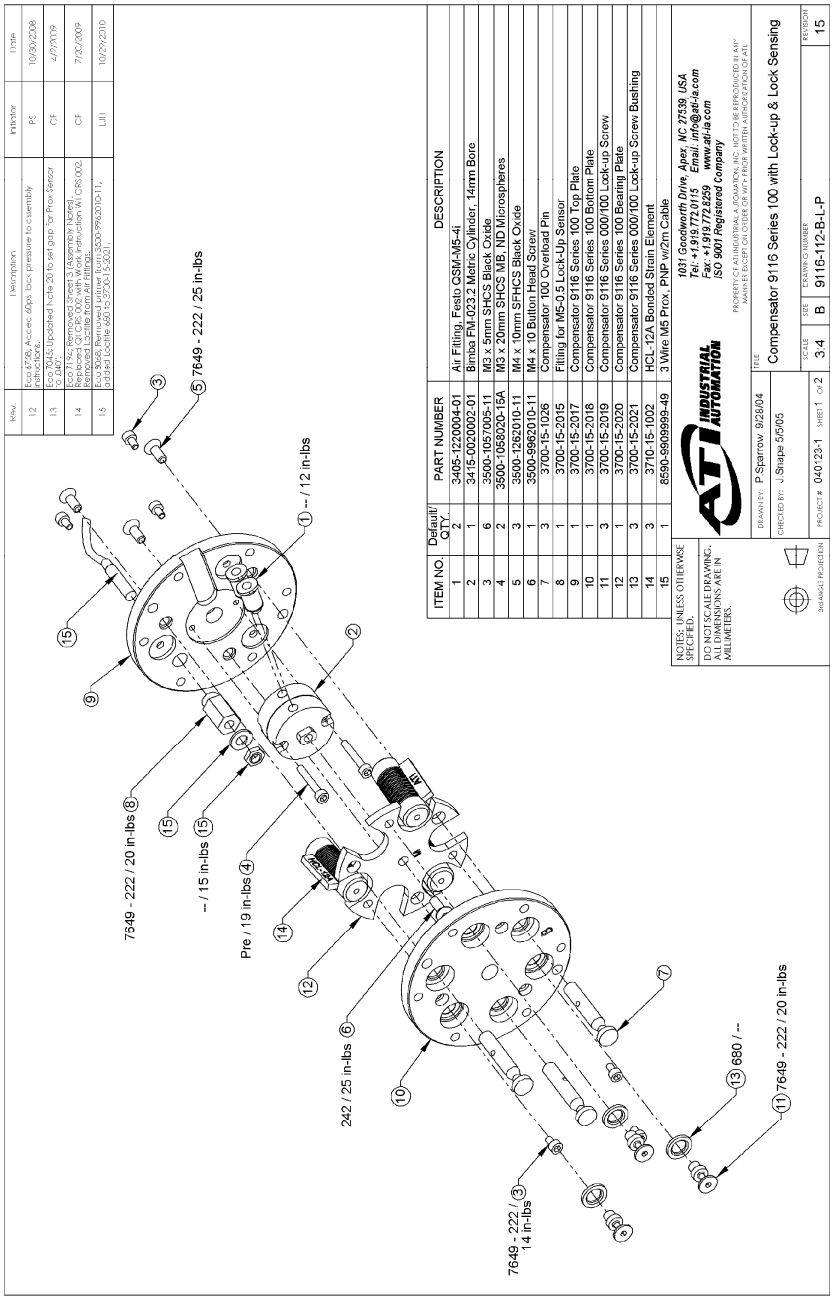
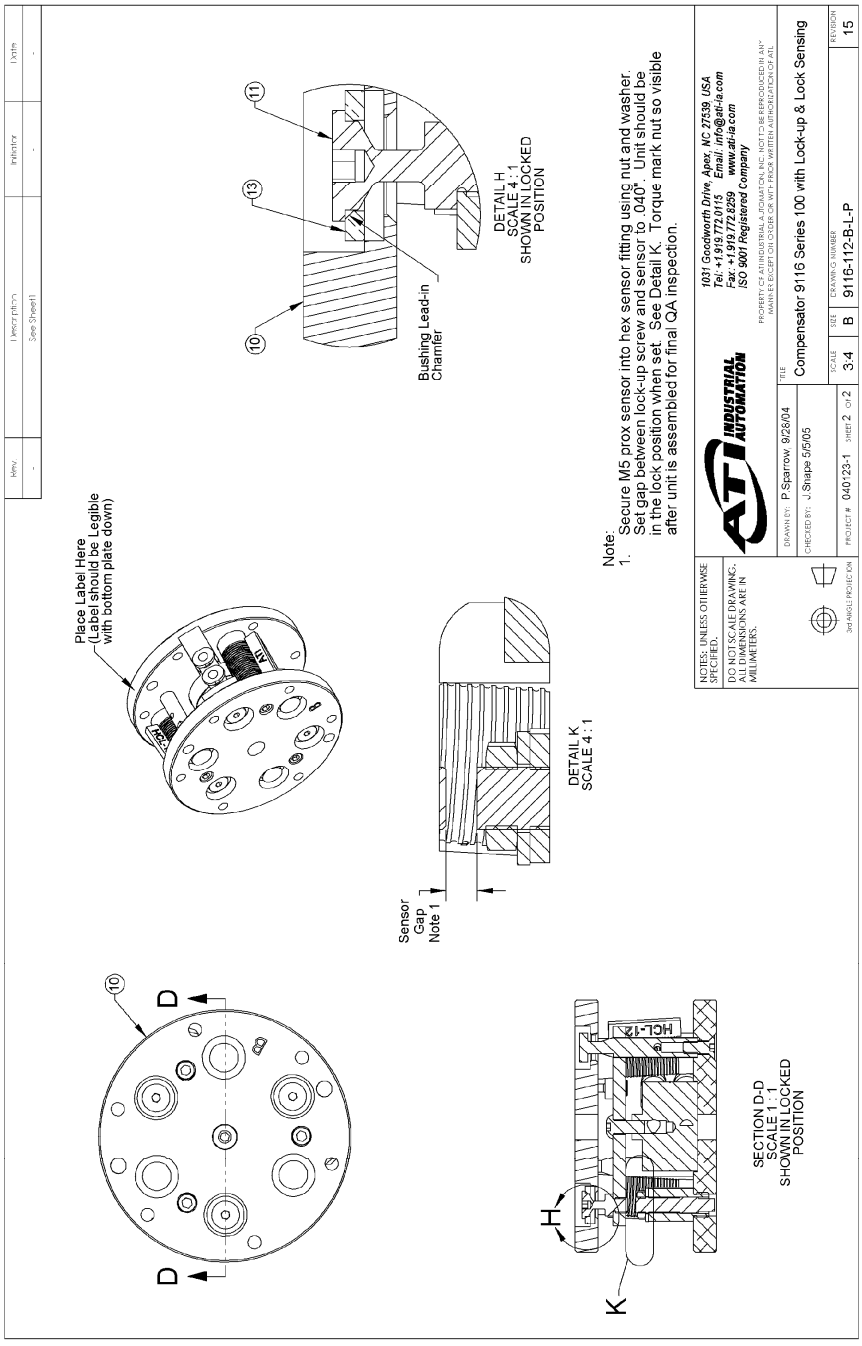
DRAWN BY: J. Snapp, 9/30/04
CHECKED BY: P. Sparrow 5/5/05
TITLE
Compensator 9116 Series 000 with Lock-up
SCALE: 1.5:1
SIZE: B
DRAWING NUMBER
9116-001-A-L
REVISION
16
PROJECT # 040-123-1
SHEET 2 OF 2
3rd ANGLE PROJECTION

11.2.2 Compensator 9116 Series 100 with Lock-up and Lock Sensing




Place Label Here
(Label should be Legible
with bottom plate down)
Bushing Lead-in
Chamfer
DETAIL H
SCALE 4 : 1
SHOWN IN LOCKED
POSITION
Sensor
Gap
Note 1
DETAIL K
SCALE 4 : 1
SECTION D-D
SCALE 1 : 1
SHOWN IN LOCKED
POSITION
Note:
1. Secure M5 prox sensor into hex sensor fitting using nut and washer.
Set gap between lock-up screw and sensor to .040". Unit should be
in the lock position when set. See Detail K. Torque mark nut so visible
after unit is assembled for final QA inspection.
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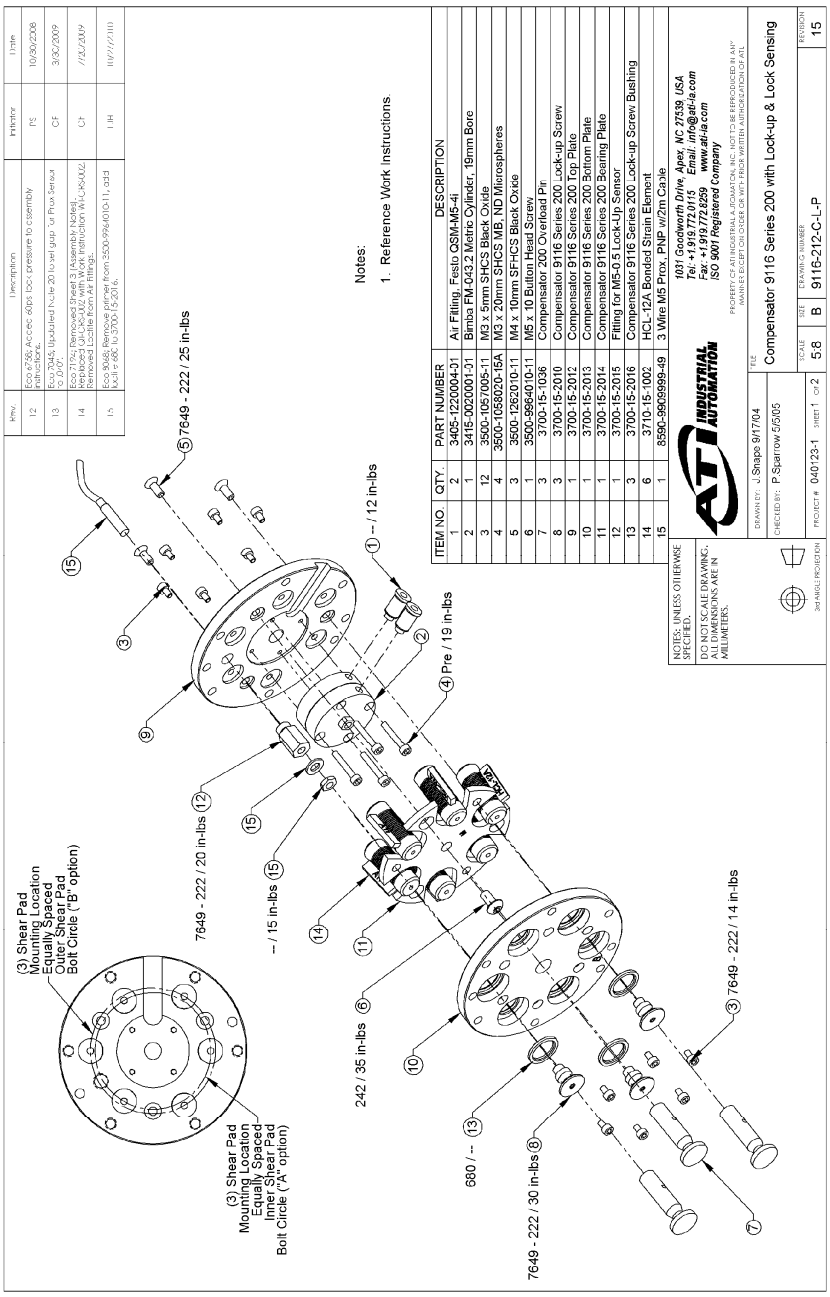
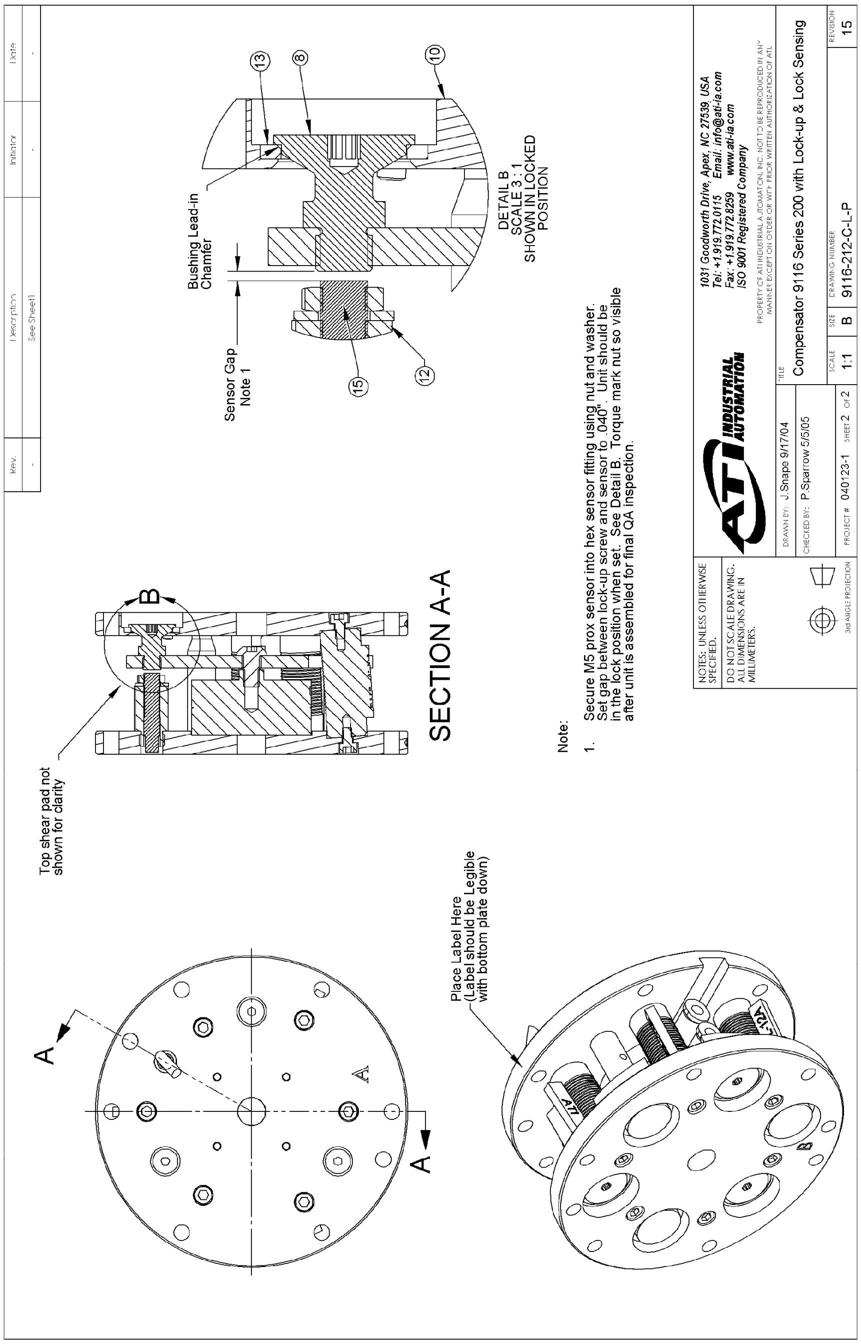
Fax: +1.919.772.8259 www.ati-ia.com
ISO 9001 Registered Company
INDUSTRIAL AUTOMATION
DRAWN BY: P.Sparrow 9/26/04
CHECKED BY: J.Shape 5/5/05
TITLE
Compensator 9116 Series 100 with Lock-up & Lock Sensing
SCALE 3:4
SIZE B
DRAWING NUMBER 9116-112-B-L-P
REVISION 15
PROJECT # 040123-1
SHEET 2 OF 2
3rd ANGLE PROJECTION

11.2.3 Compensator 9116 Series 200 with Lock-up and Lock Sensing



ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	2	3405-1220004-01	Air Fitting, Festo QSM-M5-4I
2	1	3415-0020001-01	Bimba FM-042.2 Metric Cylinder, 19mm Bore
3	12	3500-1067005-11	M3 x 5mm SHCS Black Oxide
4	4	3500-1058020-15A	M3 x 20mm SHCS MB, ND Microspheres
5	3	3500-1262010-11	M4 x 10mm SFHCS Black Oxide
6	1	3500-9964010-11	M5 x 10 Button Head Screw
7	3	3700-15-1036	Compensator 200 Overload Pin
8	3	3700-15-2010	Compensator 9116 Series 200 Lock-up Screw
9	1	3700-15-2012	Compensator 9116 Series 200 Top Plate
10	1	3700-15-2013	Compensator 9116 Series 200 Bottom Plate
11	1	3700-15-2014	Compensator 9116 Series 200 Bearing Plate
12	1	3700-15-2015	Fitting for M5-0.5 Lock-Up Sensor
13	3	3700-15-2016	Compensator 9116 Series 200 Lock-up Screw Bushing
14	6	3710-15-1002	HCL-12A Bonded Strain Element
15	1	8590-9909999-49	3 Wire M5 Prox. PNP w/2m Cable


SECTION A-A
Top shear pad not shown for clarity
Place Label Here (Label should be Legible with bottom plate down)
Bushing Lead-in Chamfer
Sensor Gap Note 1
DETAIL B SCALE 3 : 1 SHOWN IN LOCKED POSITION
Note:
1. Secure M5 prox sensor into hex sensor fitting using nut and washer. Set gap between lock-up screw and sensor to .040". Unit should be in the lock position when set. See Detail B. Torque mark nut so visible after unit is assembled for final QA inspection.
NOTES: UNLESS OTHERWISE SPECIFIED.
DO NOT SCALE DRAWING.
ALL DIMENSIONS ARE IN MILLIMETERS.
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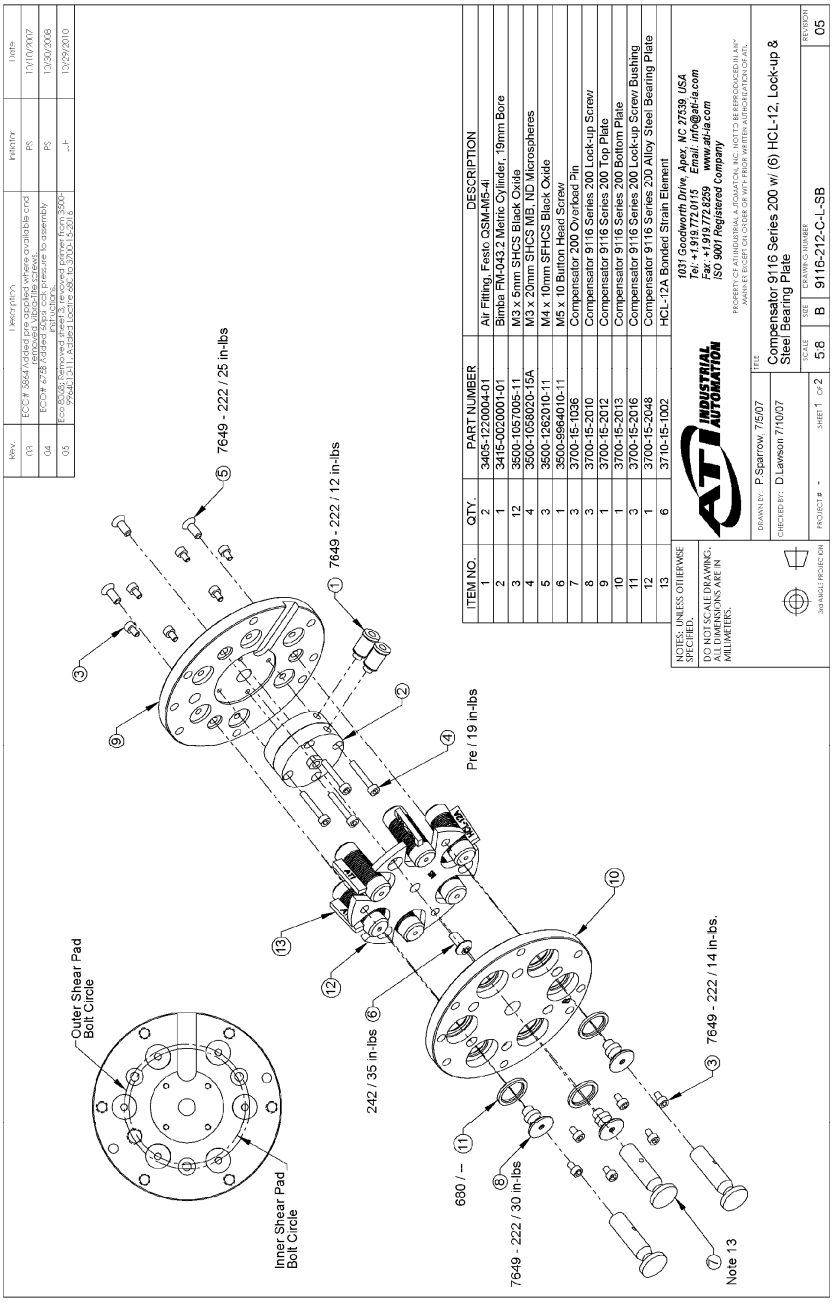
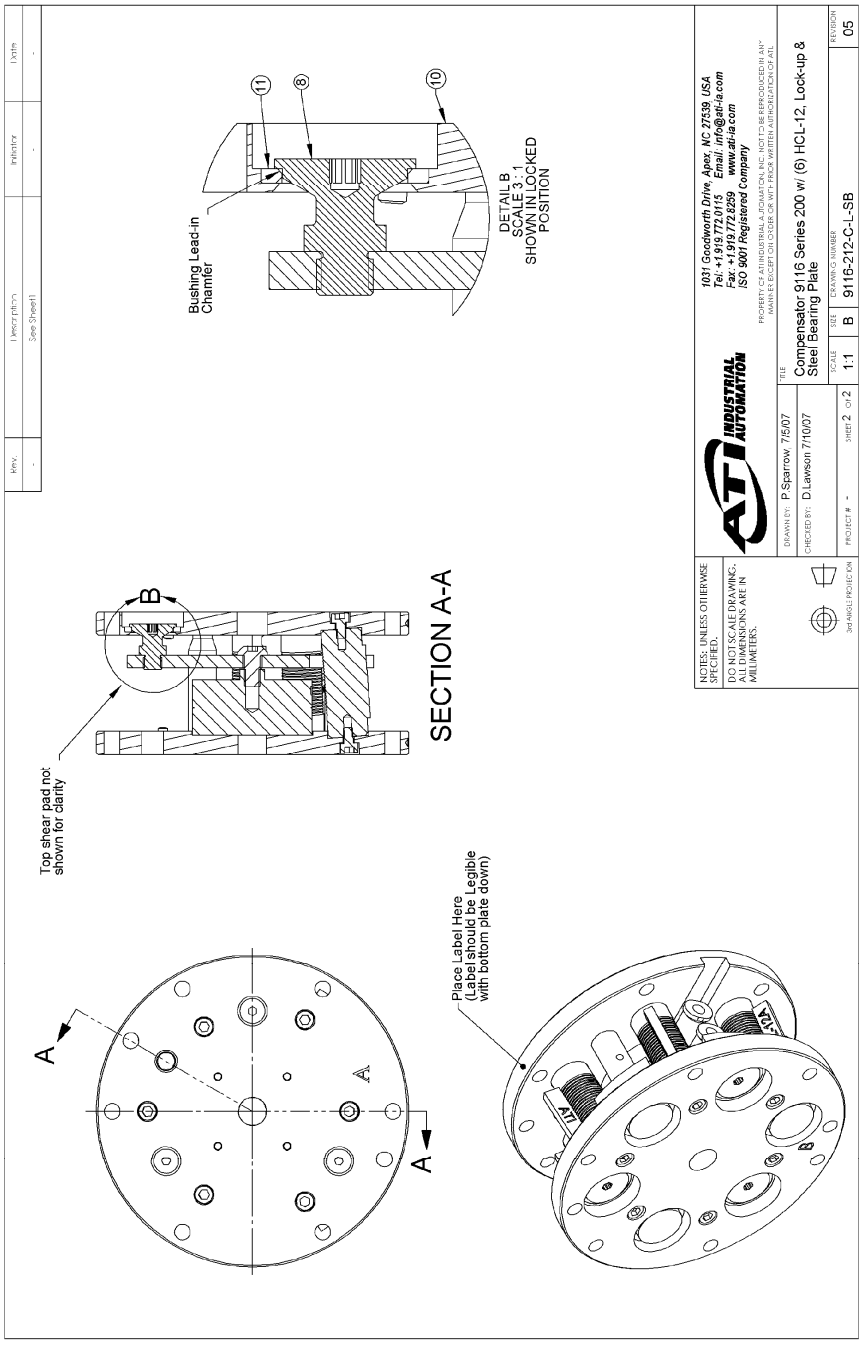
Tel: +1.919.772.0115 Email: info@ati-ia.com
Fax: +1.919.772.8259 www.ati-ia.com
ISO 9001 Registered Company
DRAWN BY: J.Snape 9/17/04
CHECKED BY: P.Sparrow 5/5/05
PROJECT # 040123-1 SHEET 2 OF 2
Compensator 9116 Series 200 with Lock-up & Lock Sensing
SCALE 1:1
SIZE B
DRAWING NUMBER 9116-212-C-L-P
REVISION 15

11.2.4 Compensator 9116 Series 200 with Lock-up and Steel Bearing Plate




Rev
Description
Initials
-
See Sheet1
-
-
Bushing Lead-in Chamfer
11
8
10
DETAIL B
SCALE 3 : 1
SHOWN IN LOCKED POSITION
B
Top shear pad not shown for clarity
SECTION A-A
A
A
A
A
Place Label Here (Label should be Legible with bottom plate down)
NOTES: UNLESS OTHERWISE SPECIFIED.
DO NOT SCALE DRAWING. ALL DIMENSIONS ARE IN MILLIMETERS.
3rd ANGLE PROJECTION
DRAWN BY: P.Sparrow 7/5/07
CHECKED BY: D.Lawson 7/10/07
PROJECT # -
SHEET 2 OF 2
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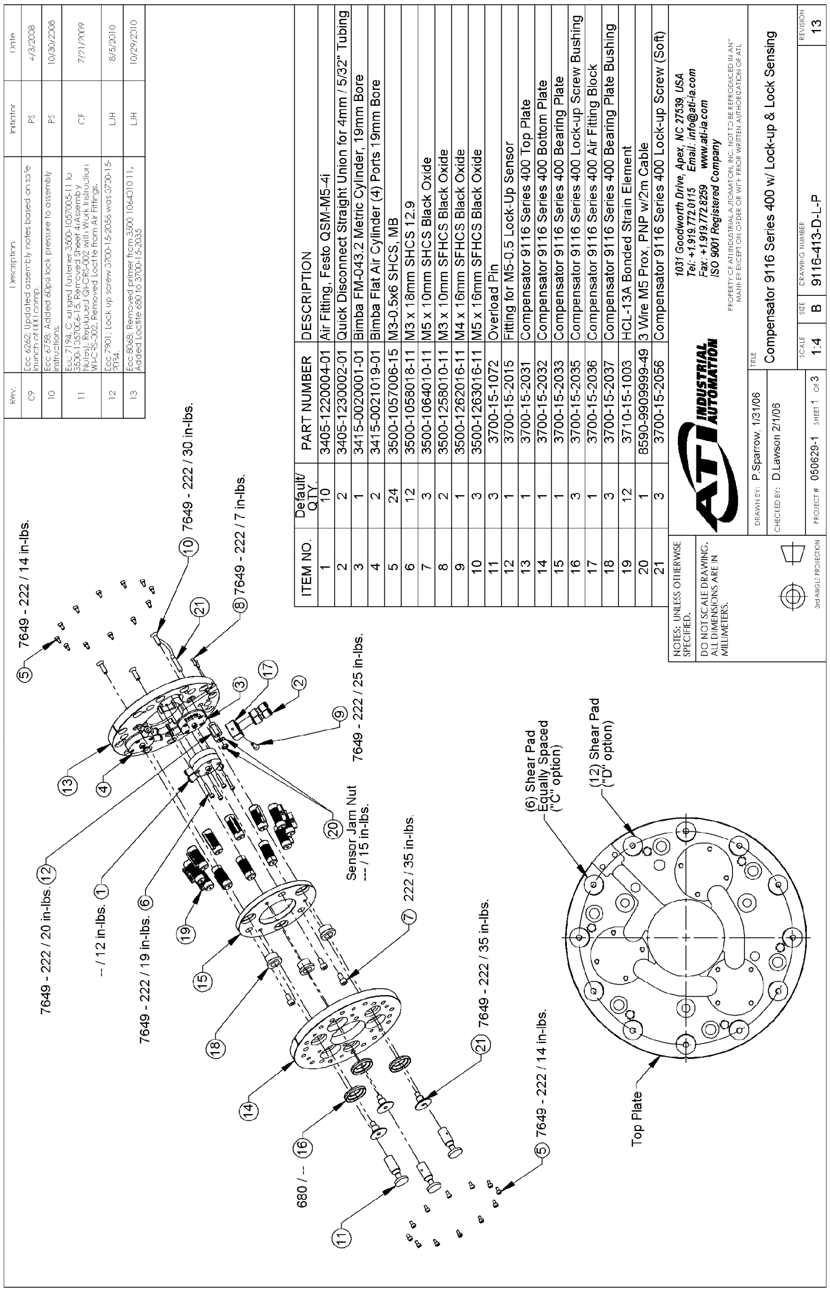
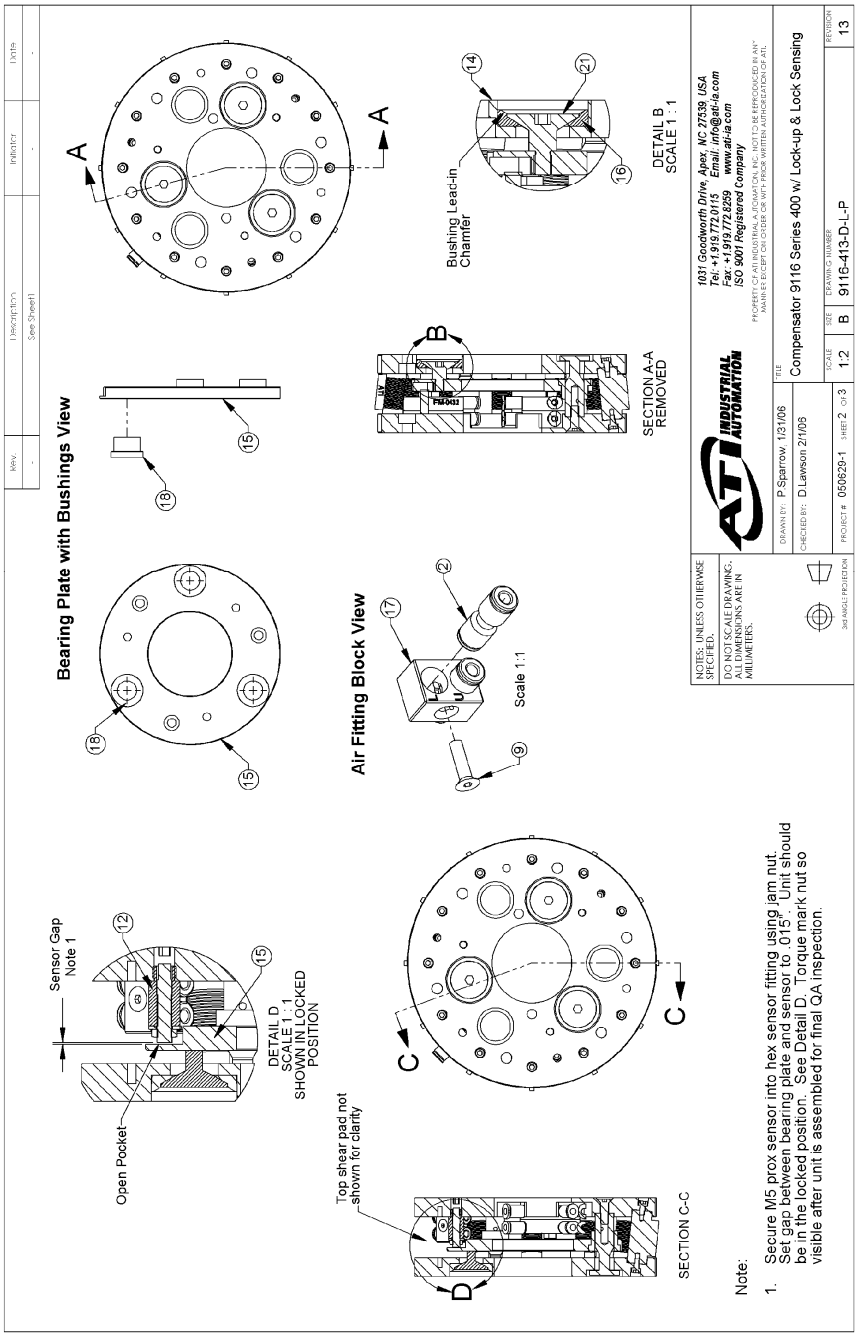
TITLE
Compensator 9116 Series 200 w/ (6) HCL-12, Lock-up & Steel Bearing Plate
SCALE 1:1
SIZE B
DRAWING NUMBER 9116-212-C-L-SB
REVISION 05

11.2.5 Compensator 9116 Series 400 with Lock-up and Lock Sensing (PNP)



Rev.	Description	Initiator	Date
C9	Ecc 6262; Updated assembly notes based on safe launch of 000 comp.	PS	4/3/2008
10	Ecc 6758; Added 60psi lock pressure to assembly instructions.	PS	10/30/2008
11	Ecc 7194; Changed fastener 3500-1057005-11 to 3500-1057006-15. Removed Sheet 4 (Assembly Notes). Replaced QI-CRS-002 with Work Instruction WI-CRS-002. Removed Loctite from Air Fittings.	CF	7/21/2009
12	Ecc 7901; Lock up screw 3700-15-2056 was 3700-15-2034.	LJH	8/5/2010
13	Ecc 8068; Removed primer from 3500-1064010-11, Added Loctite 680 to 3700-15-2035	LJH	10/29/2010

ITEM NO.	Default/ QTY.	PART NUMBER	DESCRIPTION
1	10	3405-1220004-01	Air Fitting, Festo QSM-M5-4i
2	2	3405-1230002-01	Quick Disconnect Straight Union for 4mm / 5/32" Tubing
3	1	3415-0020001-01	Bimba FM-043.2 Metric Cylinder, 19mm Bore
4	2	3415-0021019-01	Bimba Flat Air Cylinder (4) Ports 19mm Bore
5	24	3500-1057006-15	M3-0.5x6 SHCS, MB
6	12	3500-1058018-11	M3 x 18mm SHCS 12.9
7	3	3500-1064010-11	M5 x 10mm SHCS Black Oxide
8	2	3500-1258010-11	M3 x 10mm SFHCS Black Oxide
9	1	3500-1262016-11	M4 x 16mm SFHCS Black Oxide
10	3	3500-1263016-11	M5 x 16mm SFHCS Black Oxide
11	3	3700-15-1072	Overload Pin
12	1	3700-15-2015	Fitting for M5-0.5 Lock-Up Sensor
13	1	3700-15-2031	Compensator 9116 Series 400 Top Plate
14	1	3700-15-2032	Compensator 9116 Series 400 Bottom Plate
15	1	3700-15-2033	Compensator 9116 Series 400 Bearing Plate
16	3	3700-15-2035	Compensator 9116 Series 400 Lock-up Screw Bushing
17	1	3700-15-2036	Compensator 9116 Series 400 Air Fitting Block
18	3	3700-15-2037	Compensator 9116 Series 400 Bearing Plate Bushing
19	12	3710-15-1003	HCL-13A Bonded Strain Element
20	1	8590-9909999-49	3 Wire M5 Prox, PNP w/2m Cable
21	3	3700-15-2056	Compensator 9116 Series 400 Lock-up Screw (Soft)


Bearing Plate with Bushings View
Air Fitting Block View
Scale 1:1
Sensor Gap
Note 1
Open Pocket
DETAIL D
SCALE 1 : 1
SHOWN IN LOCKED
POSITION
Top shear pad not
shown for clarity
SECTION C-C
SECTION A-A
REMOVED
DETAIL B
SCALE 1 : 1
Bushing Lead-in
Chamfer
NOTES: UNLESS OTHERWISE SPECIFIED.
DO NOT SCALE DRAWING; ALL DIMENSIONS ARE IN MILLIMETERS.
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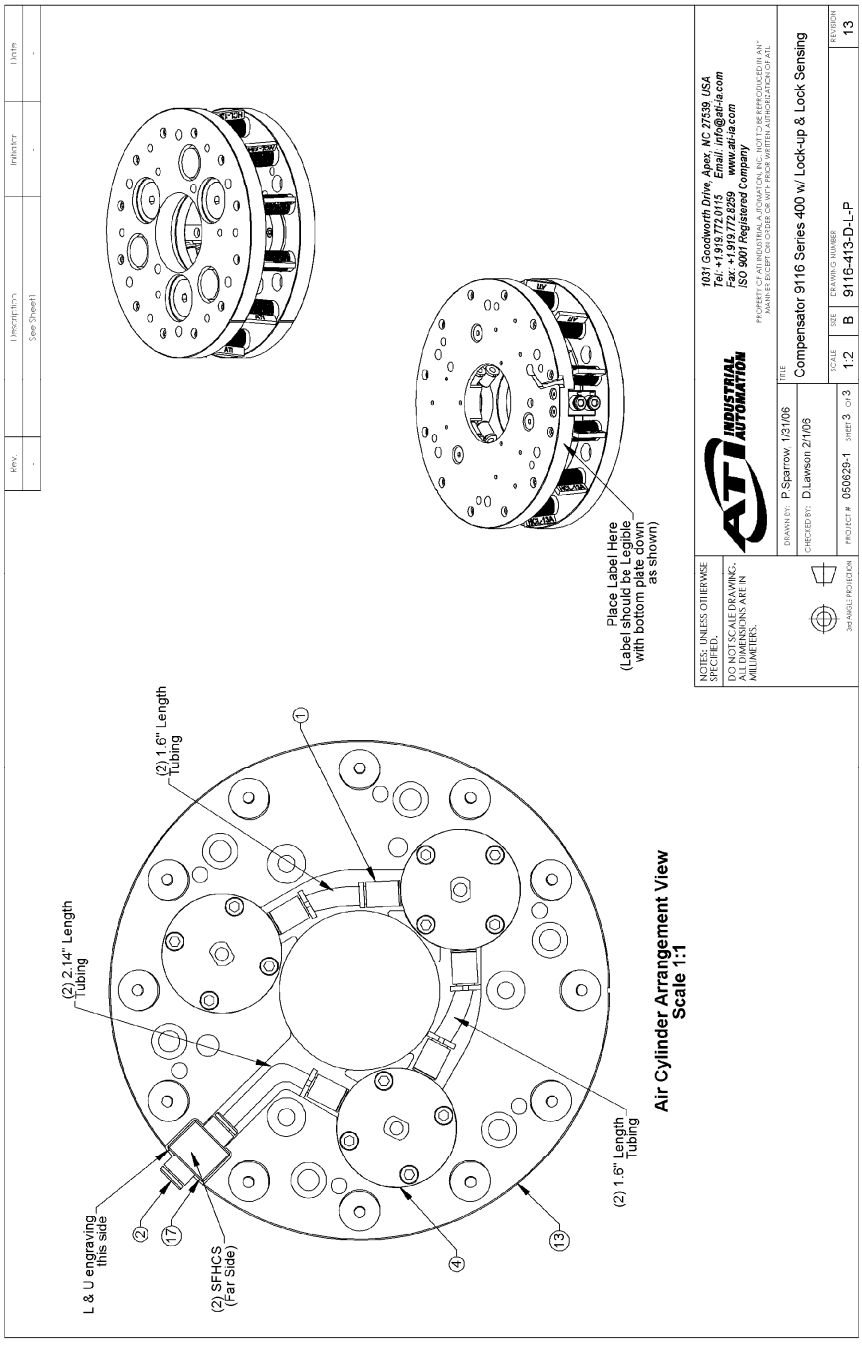
Fax: +1.919.772.8259
ISO 9001 Registered Company
www.ati-ia.com
Email: info@ati-ia.com
DRAWN BY: P.Sparrow 1/31/06
CHECKED BY: D.Lawson 2/1/06
PROJECT # 050629-1
SHEET 2 of 3
TITLE
Compensator 9116 Series 400 w/ Lock-up & Lock Sensing
SCALE 1:2
SIZE B
DRAWING NUMBER 9116-413-D-L-P
REVISION 13
Note:
1. Secure M5 prox sensor into hex sensor fitting using jam nut. Set gap between bearing plate and sensor to .015". Unit should be in the locked position. See Detail D. Torque mark nut so visible after unit is assembled for final QA inspection.


Rev.
Description
Initials
-
See Sheet1
-
-
Place Label Here
(Label should be Legible
with bottom plate down
as shown)
(2) 1.6" Length
Tubing
(2) 2.14" Length
Tubing
L & U engraving
this side
(2) SFHCS
(Far Side)
(2) 1.6" Length
Tubing
2
17
1
4
13
Air Cylinder Arrangement View
Scale 1:1
NOTES: UNLESS OTHERWISE SPECIFIED:
1) DO NOT SCALE DRAWING.
ALL DIMENSIONS ARE IN MILLIMETERS.
3rd ANGLE PROJECTION
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Fax: +1.919.772.8259 www.ati-ia.com
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DRAWN BY: P.Sparrow 1/31/06
CHECKED BY: D.Lawson 2/1/06
TITLE
Compensator 9116 Series 400 w/ Lock-up & Lock Sensing
SCALE 1:2
SIZE B
DRAWING NUMBER 9116-413-D-L-P
REVISION 13
PROJECT # 050629-1
SHEET 3 OF 3

12. 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 robotic Compensator products purchased hereunder will be free from defects in material and workmanship under normal use for a period of three (3) years from the date of shipment. This warranty does not cover components subject to wear and tear under normal usage or those requiring periodic replacement. ATI will have no liability under this warranty unless: (a) ATI is given written notice of the claimed defect and a description thereof within thirty (30) days after Purchaser discovers the defect and in any event not later than the last day of the warranty period; and (b) the defective item is received by ATI not later ten (10) days after the last day of the warranty period. ATI's entire liability and Purchaser's sole remedy under this warranty is limited to repair or replacement, at ATI's election, of the defective part or item or, at ATI's election, refund of the price paid for the item. The foregoing warranty does not apply to any defect or failure resulting from improper installation, operation, maintenance or repair by anyone other than ATI.

ATI will in no event be liable for incidental, consequential or special damages of any kind, even if ATI has been advised of the possibility of such damages. ATI's aggregate liability will in no event exceed the amount paid by purchaser for the item which is the subject of claim or dispute. ATI will have no liability of any kind for failure of any equipment or other items not supplied by ATI.

No action against ATI, regardless of form, arising out of or in any way connected with products or services supplied hereunder may be brought more than one (1) year after the cause of action accrued.

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