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D. Electrical Modules

FS2—Fluid/Air Module

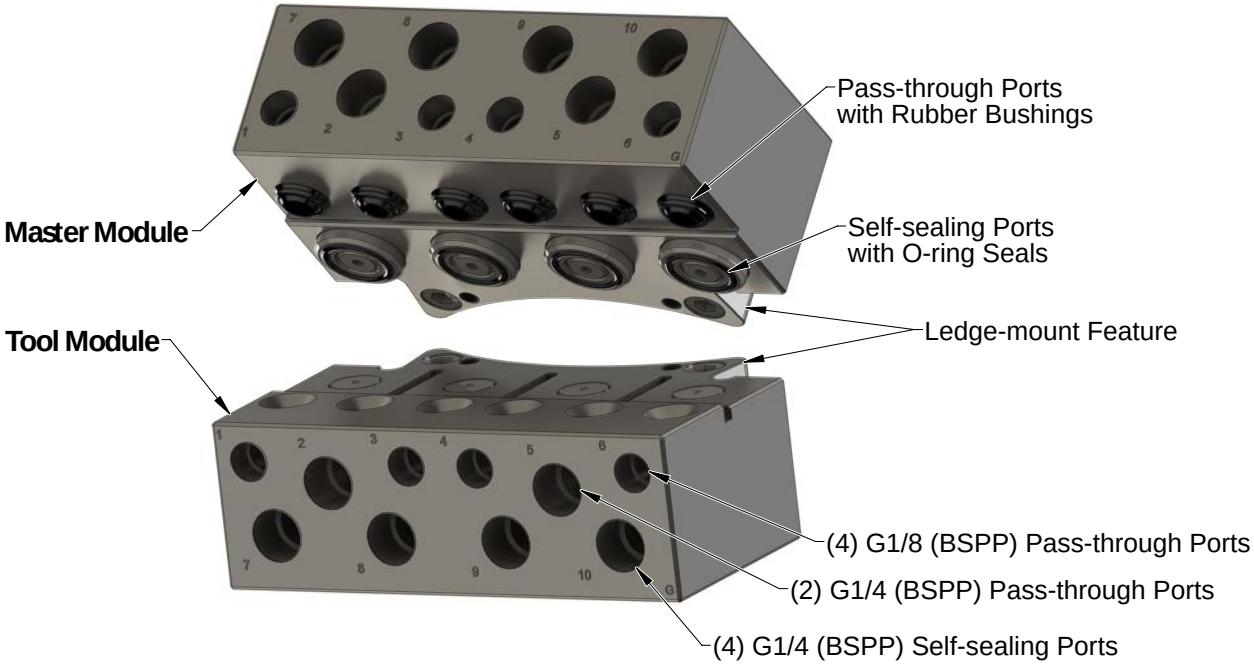
1. Product Overview

Modules providing fluid/air service are attached to the Master and Tool plates. Refer to the table and figure below for a description of the specific modules being presented in this section.

Significant forces are encountered when using the FS2 module. Assistance is required to overcome these forces when coupling the Tool Changer.

Table 1.1—Fluid/Air Modules	
Module	**Description**
FS2-M	Stainless Steel Fluid/Air Module with (4) G1/4 (BSPP) self-sealing, (2) G1/4 (BSPP) and (4) G1/8 (BSPP) pass-through ports – Master side
FS2-T	Stainless Steel Fluid/Air Module with (4) G1/4 (BSPP) self-sealing, (2) G1/4 (BSPP) and (4) G1/8 (BSPP) pass-through ports – Tool side

Figure 1.1—Fluid/Air Module, Stainless Steel Construction



2. Installation

The fluid/air modules are typically installed by ATI prior to shipment. The following steps outline installation or removal.

WARNING: Do not perform maintenance or repair(s) on the Tool Changer or modules unless the Tool is safely supported or placed in the tool stand, all energized circuits (for example: electrical, air, water, etc.) are turned off, pressurized connections are purged and power is discharged from circuits in accordance with the customer specific safety practices and policies. Injury or equipment damage can occur with the Tool not placed and energized circuits on. Place the Tool in the tool stand, turn off and discharge all energized circuits, purge all pressurized connections, and verify all circuits are de-energized before performing maintenance or repair(s) on the Tool Changer or modules.

CAUTION: Do not use the Tool Changer with air pressure below 60 psi. Safe, reliable operation of the Tool Changer is dependent on a continuous supply of compressed air at a pressure of 60 to 100 psi. Robot motion should be halted if the air supply pressure is below 60 psi.

CAUTION: Thread locker applied to fasteners must not be used more than once. Fasteners might become loose and cause equipment damage. Always apply new thread locker when reusing fasteners.

2.1 Module Installation

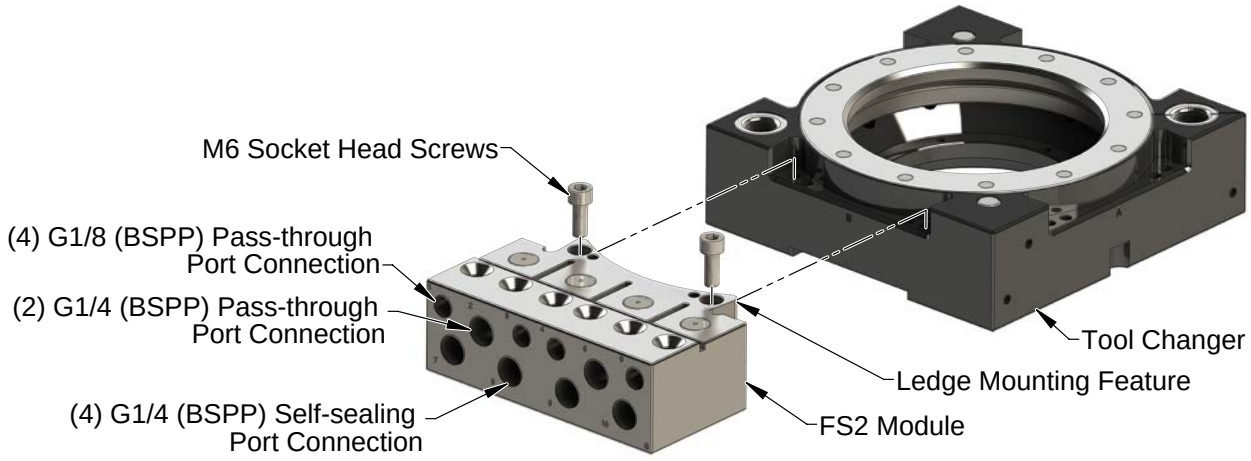
Refer to *Figure 2.1* for installation.

Tools required: *5 mm hex key, torque wrench*

Supplies required: *clean rag, Loctite® 242*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Wipe down the mounting surfaces with a clean rag.
5. Place the module into the appropriate location on the Tool Changer or Utility Coupler body. Align the module with the Tool Changer using the dowels in the bottom of the ledge feature.
6. Apply Loctite 242 to the supplied M6 socket head cap screws. Using a 5 mm hex key, install the (2) M6 socket head cap screws securing the module to the Tool Changer or Utility Coupler and tighten to 89 in-lbs (10.0 Nm).
7. Ensure the air connectors are clean and connect to the module.
8. Safely resume normal operation.

Figure 2.1—Module Installation



2.2 Module Removal

Tools required: *5 mm hex key*

Supplies required: *clean rag, paint marker*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).

NOTICE: Debris can be expelled at high velocity during the purge, take all required safety precautions.

4. All customer plumbing connections to the module must be purged.
   a. Verify that the supply lines are turned off.
   b. Cover the valves with a rag for safety.
   c. Manually actuate the self-sealing valves to purge the line pressure.
5. Use a paint marker to indicate where the module is to be re-installed.
6. Disconnect air plumbing to the module.
7. Remove the (2) M6 socket head cap screws using a 5 mm hex key.
8. Remove the module from the Tool Changer or Utility Coupler.

3. Operation

The fluid/air modules are designed to pass fluid/air utilities from the Master to the Tool for use by the customer's tooling.

Four (4) self-sealing valves are provided on the Master side so that the fluid/air circuits do not discharge during tool changes.

Typically, self-sealing valves are specified on the Tool for ports being used for fluid service.

The compressibility of gasses makes it unnecessary to isolate and discharge lines during a tool change. However, liquids are incompressible and therefore coupling lines while pressurized is to be avoided. Liquid displaced by mating coupler components creates extremely high pressure spikes and fluid velocities potentially causing seal damage. These problems become more pronounced as the operating pressure is increased.

In all liquid coupling applications, the customer is advised to take the following steps:

- Plumb the ports on the fluid/air modules using flexible hoses, which are able to absorb pressure spikes and pulses. Highly reinforced hoses and hard pipe must not be used.
- Turn off the supply pump to the circuit and discharge pressure in the lines prior to a tool change.
- Accumulators can be installed on both the Master and Tool side plumbing. This is particularly important on the Tool side, even with the pump turned off and Master side pressure discharged.
- During routine maintenance of the Tool Changer, the fluid/air modules should be inspected and re-lubricated. Water and most solvents will wash away lubricants necessary to prolong seal life.



CAUTION: Failure to follow these steps will result in premature seal failure, jetting of fluid from the couplers during tool changes, and significant pressure pulses in customer tooling.



CAUTION: To maximize the life and performance of fluid/air components, read and follow the steps in the Operations section of this manual.

4. Maintenance

Once installed, the operation of the fluid/air modules is generally trouble free. Periodically, the condition of the self-sealing valves should be checked. Refer to *Section 4.1—Preventive Maintenance*

WARNING: Do not perform maintenance or repair(s) on the Tool Changer or modules unless the Tool is safely supported or placed in the tool stand, all energized circuits (for example: electrical, air, water, etc.) are turned off, pressurized connections are purged and power is discharged from circuits in accordance with the customer specific safety practices and policies. Injury or equipment damage can occur with the Tool not placed and energized circuits on. Place the Tool in the tool stand, turn off and discharge all energized circuits, purge all pressurized connections, and verify all circuits are de-energized before performing maintenance or repair(s) on the Tool Changer or modules.

4.1 Preventive Maintenance

A visual inspection and preventive maintenance schedule is provided in *Table 4.1*.

Table 4.1—Preventive Maintenance Schedule

Tool Change Frequency	Inspection Schedule	Action Required
< 1/minute	Weekly	Clean and inspect
	6 months	Seal replacement
> 1/minute	6 months or 500,000 cycles	Seal replacement
Checklist		
Weekly Maintenance:		
☐ Clean mating surfaces.		
☐ Inspect modules for fluid/air leaks. Replace components as necessary.		
☐ Inspect rubber bushings on the master module for cuts or damage replace as necessary. Refer to *Section 5.2.3—Rubber Bushing Replacement*.		
6 months or 500,000 cycle Maintenance:		
☐ Remove and replace self sealing valve O-rings and U-cup seal in both the Master and Tool Module. Refer to *Section 5.2.1—Master Side Self-Sealing Valve* and *Section 5.2.2—Tool Side Self-Sealing Valve*.		
☐ During O-ring and seal replacement inspect valve stem and dowel pin for straightness.		
☐ During O-ring and seal replacement re-lubricate bores.		
☐ Check that module mounting bolts are secure.		

5. Troubleshooting and Service Procedures

This troubleshooting section provides information to help diagnose conditions with the Tool Changer or air module as well as service procedures for component replacement.

WARNING: Do not perform maintenance or repair(s) on the Tool Changer or modules unless the Tool is safely supported or placed in the tool stand, all energized circuits (for example: electrical, air, water, etc.) are turned off, pressurized connections are purged and power is discharged from circuits in accordance with the customer specific safety practices and policies. Injury or equipment damage can occur with the Tool not placed and energized circuits on. Place the Tool in the tool stand, turn off and discharge all energized circuits, purge all pressurized connections, and verify all circuits are de-energized before performing maintenance or repair(s) on the Tool Changer or modules.

5.1 Troubleshooting Procedures

Refer to the following table for troubleshooting information.

Table 5.1—Troubleshooting

Symptom	Possible Cause	Correction
Fluid/Air Leakage	Damaged/Worn seals	Replace O-rings, U-cup seal, and rubber bushings as needed. Refer to *Section 5.2.1—Master Side Self-Sealing Valve* and *Section 5.2.2—Tool Side Self-Sealing Valve* and *Section 5.2.3—Rubber Bushing Replacement*
	Debris blocking valve seal	Clean in and around valve components. Ensure fluid stream is free of large particulates; filter as necessary.
	Bent stem	Replace stem. Refer to *Section 5.2.1—Master Side Self-Sealing Valve.* Check module attachment to Tool Changer. Check robot program and ensure parallel approach trajectory during Tool Changer coupling.
	Corrosion	Consult ATI for assistance.
Fluid spray during uncoupling	Surge/Water Hammer	Decrease pressure differential between supply and return lines or install pressure compensation system (e.g., accumulator or surge suppressor as close as possible to spraying port).
Poor Flow	Flow path blockage	Inspect valve components and supply/return lines for blockage, clean/repair as necessary.
	Debris blocking valve seal	Clean in and around valve components. Ensure fluid stream is free of large particulates; filter as necessary.
Modules Won't Couple	Bent stem, dowel pin	Replace stem, dowels as necessary. Check module attachment to Tool Changer. Check robot program and ensure parallel approach trajectory during Tool Changer coupling. Refer to *Section 5.2.1—Master Side Self-Sealing Valve* and *Section 5.2.2—Tool Side Self-Sealing Valve.*

5.2 Service Procedures

The following service procedures provide instructions for replacement of components.

5.2.1 Master Side Self-Sealing Valve

Parts required: *Refer to Section 8—Drawings.*

Tools required: *2.5 mm hex key, torque wrench*

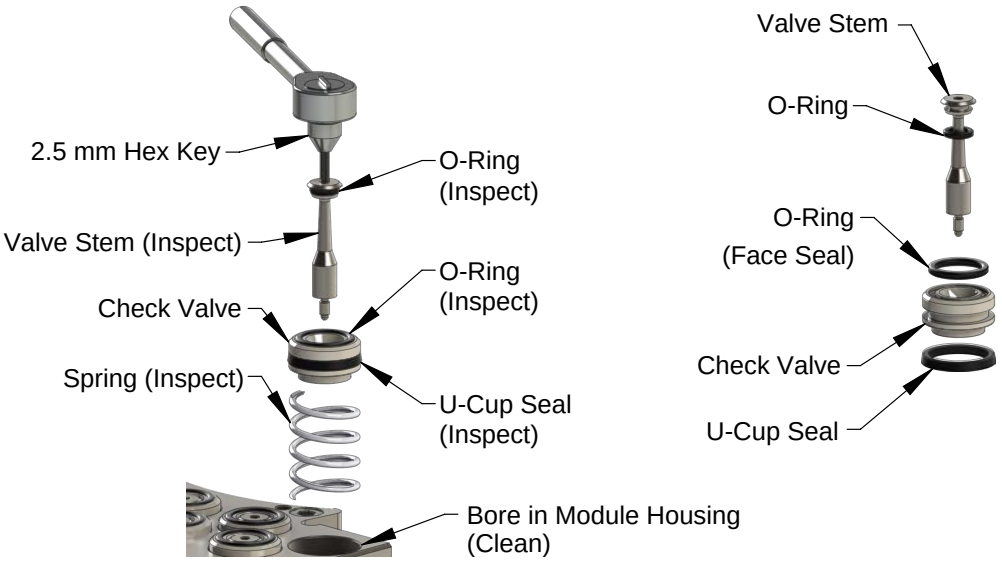
Supplies required: *Clean rag, Magnalube G lubricant*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).

NOTICE: Debris can be expelled at high velocity during the purge, take all required safety precautions.

4. Purge and disconnect all customer plumbing connections to the module.
   a. Turn the supply lines off.
   b. Cover the valves with a rag for safety.
   c. Manually actuate the module's self-sealing valves to purge the line pressure. Note: Debris can be expelled at high velocity during the purge, take all required safety precautions.
5. Depending on the type of service or repair, connections to the module might also need to be disconnected.
6. Remove the valve stem using a 2.5 mm hex key. Do not strip the hex on the valve stem during removal.
7. Remove the check valve piston and spring. Clean any lubrication from the check valve piston, valve stem, spring, and bore in the module housing using a clean rag.
8. Inspect the valve stem for straightness, and replace, if bent.
9. Inspect the o-rings and u-cup seal on the valve stem and check valve piston for wear and damage. Replace components that are damaged or worn.
10. Inspect the spring in the assembly and replace if damaged or worn.

Figure 5.1—Master Self-Sealing Valve

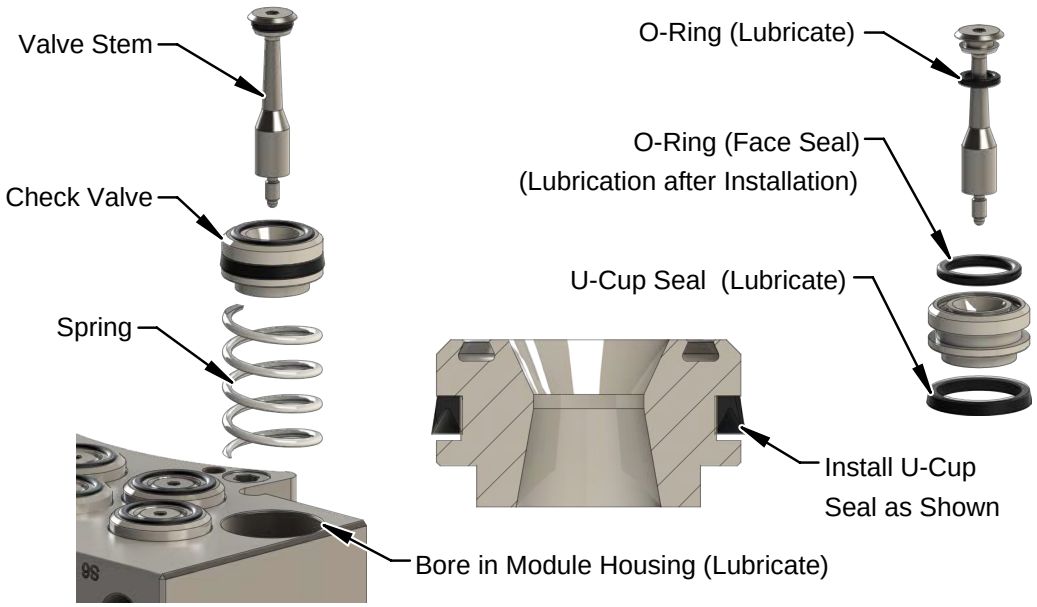


11. Lubricate the bore in the module housing with Magnalube G (Teflon/Petroleum based grease).

NOTICE: Do not lubricate the O-ring face seal until after installation. Lubricating the O-ring before installation can cause the O-ring to blow out during coupling and uncoupling.

12. If replacing seals, lubricate the valve stem O-ring and the check valve piston U-cup seal with Magnalube G (Teflon/Petroleum based grease).
13. Install the O-ring on the valve stem.
14. Install the U-cup seal on the check valve. Do not get lubrication in the face seal groove in the check valve.
15. Install the non-lubricated O-ring (face seal) into the check valve.
16. Install the spring into the bore in the module housing, seat the check valve on the spring.
17. If the threaded end of the valve stem does not have pre-applied adhesive, apply Loctite 7649 primer and then Loctite 222 or similar thread locker to the threaded end of the valve stem. If the module housing is stainless steel, also add Loctite 7649 primer to the housing threads.

Figure 5.2—Master Self-Sealing Valve Installation



18. Install the valve stem. The check valve piston must be pushed down flush with the mating surface of the Master housing in order to install the threaded end of the valve stem. Do not damage the U-cup seal around the check valve piston. A small, flat-head screwdriver can be used to ensure that the U-cup seal is fully located in the recess and not folded over itself prior to screwing in the valve stem. Tighten the stem to 10 in-lbs (1.1 Nm).
19. Lubricate the installed O-ring (face seal) with Magnalube G (Teflon/Petroleum based grease).
20. Safely resume normal operation.

5.2.2 Tool Side Self-Sealing Valve

Parts required: *Refer to Section 8—Drawings.*

Tools required: *10 mm hex key, Torque wrench*

Supplies required: *Clean rag, Magnalube G lubricant*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).

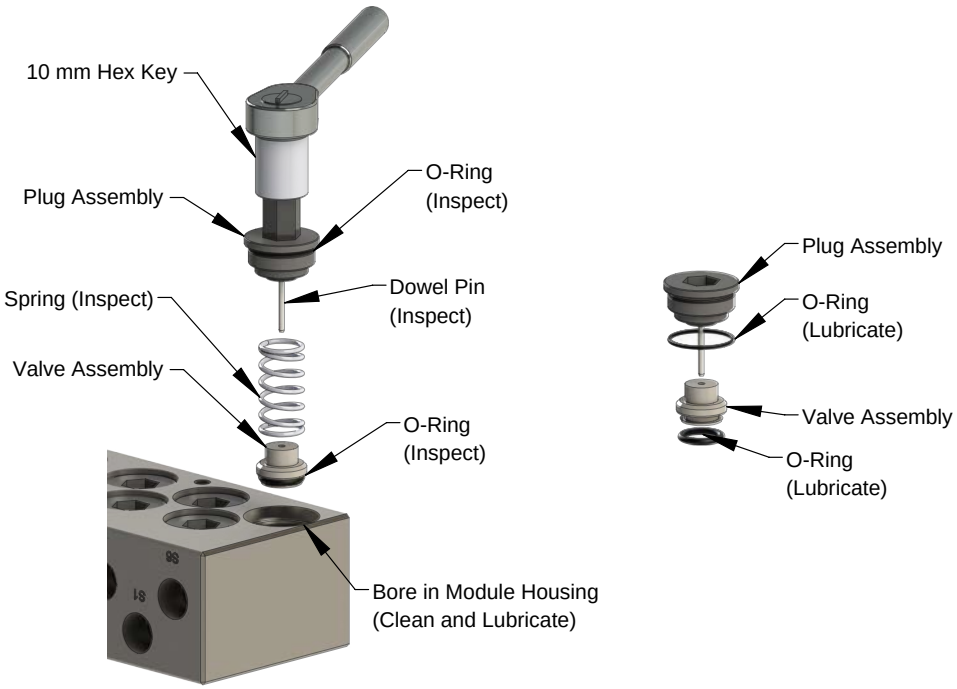
NOTICE: Debris can be expelled at high velocity during the purge, take all required safety precautions.

4. All customer plumbing connections to the module must be purged.
   a. Verify that the supply lines are turned off.
   b. Cover the valves with a rag for safety.
   c. Manually actuate the self-sealing valves to purge the line pressure.
5. If required disconnect connections to the module.

NOTICE: You might need to remove the Tool side module to access the plug.

6. Remove the plug assembly from the bottom of the air module using a 10 mm hex key.
7. Remove the spring and valve assembly from the housing.

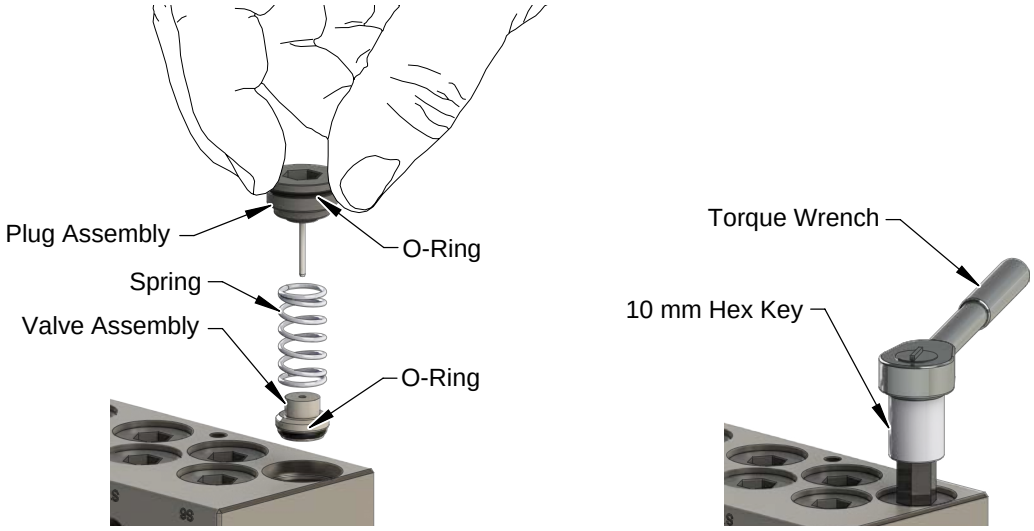
Figure 5.3—Tool Self-Sealing Valve (Disassembly)



8. Clean all lubrication from the plug assembly, valve assembly, spring, and bore in the housing using a clean rag.
9. Inspect the dowel pin that is contained in the plug assembly for straightness. Replace the plug assembly if the dowel pin is bent.
10. Inspect the O-rings on the plug and valve assemblies, replace if worn or damaged.
11. Inspect the spring in the assembly and replace if worn or damaged.

12. If replacing the O-rings, lubricate both new O-rings with Magnalube G (Teflon/Petroleum based grease).
13. Install the O-rings on the plug assembly and the valve assembly.

Figure 5.4—Tool Self-Sealing Valve (Assembly)



14. Install the check valve piston, make sure it is seated properly in the housing.
15. Install the spring into the housing, make sure it is installed over the step on the check valve.

> **CAUTION:** Do not use excess force when installing the plug assembly into the housing. Using excessive force can damage the O-ring and strip the threads on the plug assembly. Thread the plug assembly into the Tool housing by hand, until several threads are engaged into the housing. Then use a 10 mm hex key to complete the installation. Torque the plug to 30 in-lbs (3.39 Nm).

16. Carefully install the plug assembly aligning the dowel pin into the check valve piston. Thread the plug assembly into the housing by hand until several threads are engaged in the housing.
17. Tighten the plug assembly using a 10 mm hex key to 30 in-lbs (3.39 Nm).
18. Verify the check valve piston is seated properly in the housing.
19. Safely resume normal operation.

5.2.3 Rubber Bushing Replacement

Parts required: *Refer to Section 8—Drawings.*

The rubber bushings seal the air passage from the Master module. If the bushing become cut or damaged, they need to be replaced.

1. Remove damaged rubber bushing by grasping with fingers and pulling the bushing out of the body.
2. Dip new bushing in water to aid in installation.
3. Insert the beveled (chamfered) end of the rubber bushing into the bore, leaving ribbed end of the bushing facing outward.
4. Press the bushing in by hand until it is seated completely in the bore. If necessary, use a plastic or rubber soft-faced mallet to tap the bushings into place.
5. After the procedure is complete, resume normal operation.

Figure 5.5—Master Rubber Bushing Replacement



6. Recommended Spare Parts

Refer to *Section 8—Drawings*.

Table 6.1—Master Module Mounting Hardware	
Part Number	**Description**
3500-1066020-21A	M6 x 20 Socket Head Cap Screw, SS, ND Microspheres, 0-3 uncoated lead thds. 5-7 coated thds. IFI525

Table 6.2—Tool Module Mounting Hardware	
Part Number	**Description**
3500-1066016-21A	M6 x 16 Socket Head Cap Screw, SS, ND Microspheres Epoxy, Yellow. 0-3 uncoated lead thds. 5-7 coated thds. IFI525

7. Specifications

Table 7.1—Master Module Specifications				
Module	**Description**	**Weight**	**Air Ports, (qty) Size (C_v)**	**Pressure (Maximum)**
9121-FS2-M	Stainless Steel Fluid/ Air module with (4) G1/4 Checked, (2) G1/4 and (4) G1/8 Pass-Thru ports - Master	4.56 lbs (2.07 kg)	(4) G1/4 (BSPP) (1.50) (2) G1/4 (BSPP) (1.03) (4) G1/8 (BSPP) (0.65)	100 psi (6.9 bar)

Table 7.2—Tool Module Specifications				
Module	**Description**	**Weight**	**Air Ports, (qty) Size (C_v)**	**Pressure (Maximum)**
9121-FS2-T	Stainless Steel Fluid/ Air module with (4) G1/4 Checked, (2) G1/4 and (4) G1/8 Pass-Thru ports - Tool	4.37 lbs (1.98 kg)	(4) G1/4 (BSPP) (1.50) (2) G1/4 (BSPP) (1.03) (4) G1/8 (BSPP) (0.65)	100 psi (6.9 bar)

8. Drawings

Drawings are available on the *ATI website* or by contacting an ATI representative.