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C. Control and Signal Modules

SA12-M, SA2-T—Control Module

1. Product Overview

The control modules are required to provide a means for the customer to communicate with and control the Tool Changer.

NOTICE: The SA12 Master supports the use of PNP sensors only.

Military-style Amphenol connectors allow customer interfacing on the Master and Tool modules. The Master pin block has compliant spring probes, and the Tool pin block has fixed contact pins (refer to *Figure 1.1*). When the Tool Changer is coupled, the Master and Tool modules communicate across the spring probes and contact pins. A flexible boot V-ring seal surrounds the pin block to seal the connection from moisture and liquid while coupled. This seal is water resistant but not waterproof.

On the circuit, the central pin is the first-to-mate and the last-to-break during a tool change. For safety reasons, it is recommended that this pin be used as a designated ground. To avoid unintentional human contact, the Master spring pins are recessed below an insulated surface.



DANGER: This module has a voltage of 50V or greater; always remove power before contacting the module. Arcing and damage occur if power is not removed from the module during maintenance or service. Always remove power before attaching or disconnecting cables, separating or inserting the mating couplers, or making any contact with the Tool Changer or Utility Coupler.



CAUTION: Never couple or uncouple the unit without first disconnecting and discharging the power that passes through the contacts. This is especially true if high voltage circuits are involved. Arcing and contact damage will occur if this is not observed. Always disconnect and discharge electrical power from both upstream and downstream modules.

1.1 SA12 Master

The SA12 Master module uses (4) M8 3-pin female connectors to connect to the Lock, Unlock, and RTL sensors on the Tool Changer. The customer interface connection is a 19-pin male connector which supplies signals and power to the end-of-arm tooling. Refer to *Section 8—Drawings* for more information.

The SA12 Master module is compatible with air adapter modules. The customer must supply the air adapter with both a Lock and Unlock air supply. The Lock and Unlock air supply must be connected to a 2-position 4-way or 5-way valve, refer to the air adapter or Tool Changer manual for detailed information.

1.2 SA2 Tool

The SA2 Tool customer interface connection is a 19-pin female connector which supplies signal and power to the end-of-arm tooling. Refer to *Section 8—Drawings* for more information.

Figure 1.1—SA12 Master and SA2 Tool Modules



2. Installation

The control/signal modules are typically installed by ATI prior to shipment. The steps below outline the field installation or removal as required. For wiring information refer to *Section 8—Drawings*.

DANGER: This module has a voltage of 50V or greater; always remove power before contacting the module. Arcing and damage occur if power is not removed from the module during maintenance or service. Always remove power before attaching or disconnecting cables, separating or inserting the mating couplers, or making any contact with the Tool Changer or Utility Coupler.

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.

2.1 Master Module Installation

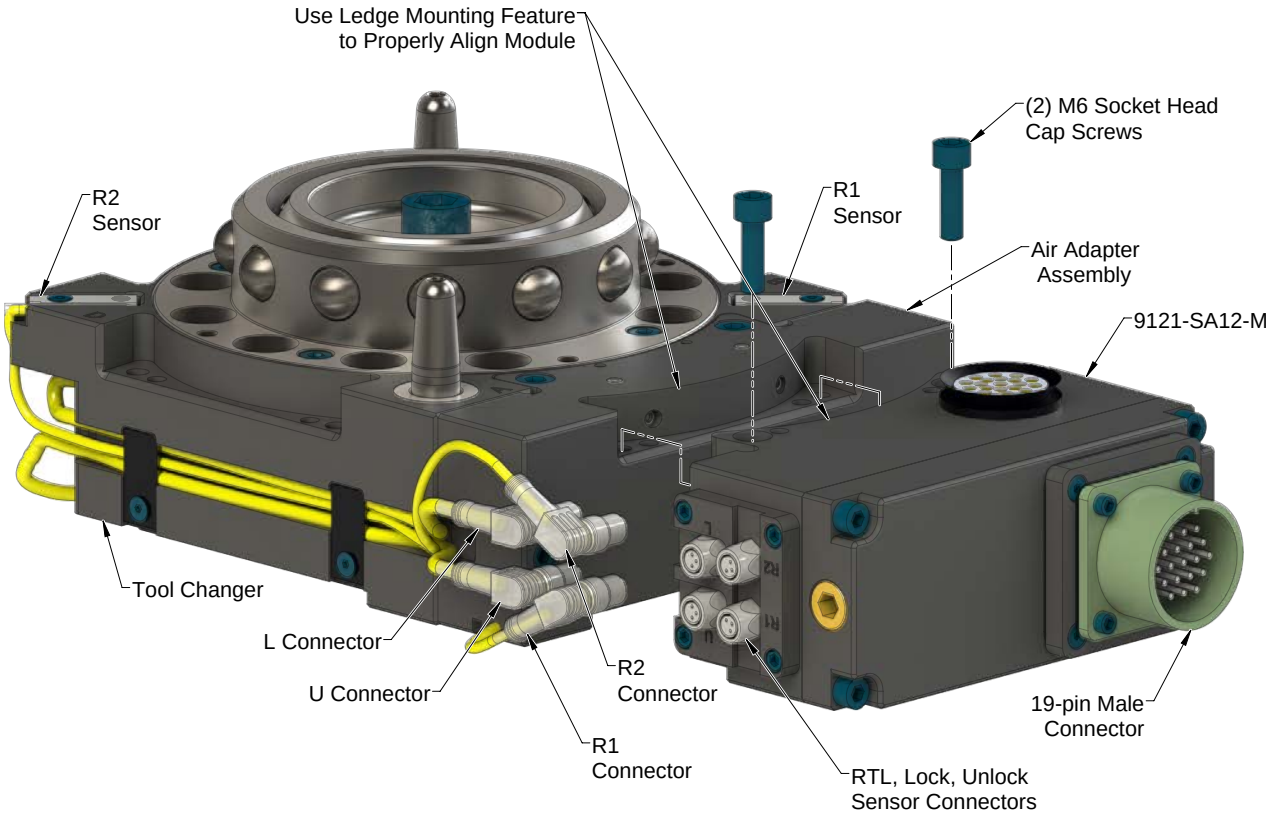
Refer to *Figure 2.1* for Master module installation instructions.

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. Ensure that the mounting surface is clean.
5. Place the module into the appropriate location on the air or valve adapter.
6. Apply Loctite 242 to the supplied M6 socket head cap screws.
7. Install the (2) M6 socket head cap screws and secure the module to the air or valve adapter using a 5 mm hex key. Tighten to 70 in-lbs (7.9 N-m).
8. Ensure the Lock (L), Unlock (U), RTL (R1), and RTL (R2) connectors are clean and connect the sensor cables to the control/signal module.
9. Ensure that the connectors (power, signal, auxiliary, etc.) are clean and connect the cables to the module.
10. Safely resume normal operation.

Figure 2.1—Master Module Installation and Removal



2.2 Master Module Removal

Refer to *Figure 2.1* for Master module removal instructions.

Tools required: *5 mm hex key*

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. Mark the Lock, Unlock, and RTL sensor cables so that the cables can be reinstalled to the appropriate sensor.
5. Disconnect the Lock (L), Unlock (U), and RTL (R1), and RTL (R2) sensor cable connectors from the module.
6. Disconnect (for example: power, signal, auxiliary, etc.) cables from the control/signal module.
7. Support the control/signal module, remove the (2) M6 socket head cap screws using a 5 mm hex key, and lower the module until it clears the guide pin.

2.3 Tool Module Installation

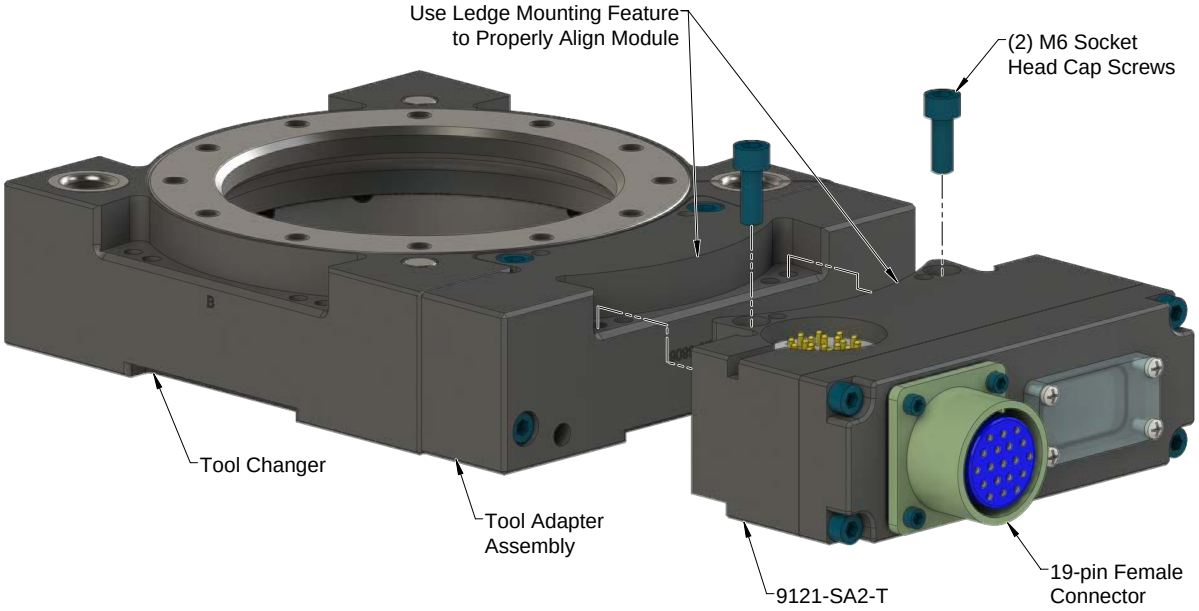
Refer to *Figure 2.2* for Tool module installation instructions.

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 onto the tool adapter.
6. Apply Loctite 242 to the supplied M6 socket head cap screws. Install the (2) M6 Socket Head Cap Screws and secure the module to the tool adapter using a 5 mm hex key. Tighten to 70 in-lbs (7.9 N-m).
7. Ensure the power, signal, auxiliary, and other connectors are clean and connect cables to the module.
8. Safely resume normal operation.

Figure 2.2—Tool Module Installation and Removal



2.4 Tool Module Removal

Refer to *Figure 2.2* for Tool module removal instructions.

Tools required: *5 mm hex key*

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. Disconnect (for example: power, signal, auxiliary, etc.) cables from the control/signal module.
5. Support the control/signal module, remove the (2) M6 socket head cap screws using a 5 mm hex key, and lift the module from the tool adapter.

3. Operation

Various Tool Changer I/O are provided to the customer through the military-style connector on the control/signal Master module. Lock, Unlock, and Ready-to-Lock proximity sensor inputs are provided for confirmation of the Tool Changer and locking mechanism positions. Other, customer assigned discrete I/O points are available through the connector.

NOTICE: The 0 and 24 VDC supply lines are required to be on certain pin locations of the customer interface connector. Refer to *Section 8—Drawings* for pin out information and location of the I/O signals.

Refer to the specific Tool Changer manual for conditions for coupling of the Tool Changer and *Section 3.1—Lock, Unlock, and RTL Sensor Cable LED Behavior*. When coupled, the discrete module Tool can be communicated with and attached end-effectors can be used.

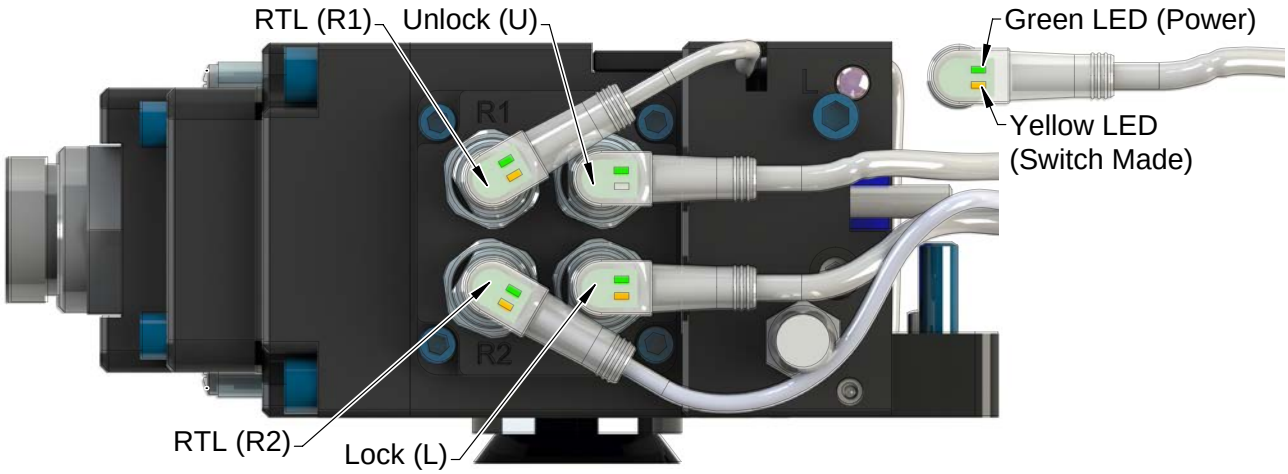
3.1 Lock, Unlock, and RTL Sensor Cable LED Behavior

The Lock, Unlock, and RTL sensor cables are equipped with two LEDs. The Green LED indicates the sensor has power and the yellow LED indicates the switch has been made. The LED behavior is affected by the control/signal module.

Table 2.1—Sensor Cable LED Behavior for Common Tool Changer Positions

Tool Changer Position	Sensor cable LED Behavior			
Unlocked (Tool Changer Master plate free of stand with no Tool plate attached)	RTL (R1) Sensor	ON / OFF	ON / ON	Unlock (U) Sensor
	RTL (R2) Sensor	ON / OFF	ON / OFF	Lock (L) Sensor
Ready to Lock (Tool Changer Master plate with Tool plate parallel and at a distance of 1.22 mm or less from each other)	RTL (R1) Sensor	ON / ON	ON / ON	Unlock (U) Sensor
	RTL (R2) Sensor	ON / ON	ON / OFF	Lock (L) Sensor
Locked (Tool Changer Master plate with Tool plate attached in fully locked position)	RTL (R1) Sensor	ON / ON	ON / OFF	Unlock (U) Sensor
	RTL (R2) Sensor	ON / ON	ON / ON	Lock (L) Sensor
Missed Tool (Tool Changer Master plate locked with no Tool plate attached)	RTL (R1) Sensor	ON / OFF	ON / OFF	Unlock (U) Sensor
	RTL (R2) Sensor	ON / OFF	ON / OFF	Lock (L) Sensor

Figure 2.3—Lock, Unlock, and RTL Sensor cable LED Behavior (Shown in Locked Position)



(Control module shown for reference only)

3.2 Recommended Sequence of Operations

This recommended sequence of operations procedure is a general guide when programming a robot or PLC for use with a Tool Changer and a control/signal module. This procedure is intended for "automatic" modes used during normal application processes.

1. Start→ The robot and Tool Changer Master are free of the stand or storage location. The Tool Changer is uncoupled and the Tool Changer locking mechanism may be fully retracted (unlocked condition) or fully extended (missed Tool condition, i.e., Locked and Unlocked inputs are OFF). The Tool is by itself in the Tool Stand.
   a. The **RTL1** and **RTL2** inputs are OFF
   b. The ATI Tool and any downstream device(s) are offline.
2. Ensure the Master is Unlocked. (The Master must be unlocked prior to entering the Tool to prevent the ball bearings from impinging on the Tool bearing race.)
   a. Activate the solenoid valve to send air pressure to the "unlock" port of the Tool Changer.
   b. The "lock" port of the Tool Changer should be properly exhausted.
   c. The **Unlocked** input goes ON and remains ON, indicating that the Tool Changer locking mechanism is fully retracted and the unlock operation is complete.
3. Robot and Master move parallel towards the Tool and are within 0.06" of the Tool (i.e., the module contact pins are touching, the **RTL** sensors have sensed the targets on the Tool).
   a. 'Input' power connections become available on the Tool.
   b. The **RTL1** and **RTL2** inputs go ON, indicating that it is okay to couple the Tool.
   c. Communications with downstream device(s) should now be established.
4. Couple the Tool Changer.
   a. Activate the solenoid valve to send air pressure to the "lock" port of the Tool Changer.
   b. The "unlock" port of the Tool Changer should be properly exhausted.
   c. The **Unlocked** input goes OFF a short time later, indicating piston travel. Subsequently, the **Locked** input goes ON and remains ON, indicating that the coupling operation is complete.
5. Robot moves away from the tool stand with the Tool Changer coupled.

6. Normal operation:
    a. The following inputs are ON:
        i. **Locked**
        ii. **RTL1**
        iii. **RTL2**
    b. The following inputs are OFF:
        i. **Unlocked**
7. Robot moves into the tool stand with the Tool Changer coupled.
8. Uncouple the Tool Changer. **IMPORTANT: It is critical that the Tool be nested securely in the tool stand prior to uncoupling the Tool Changer.**
    a. Activate the solenoid valve to send air pressure to the “unlock” port of the Tool Changer.
    b. The “lock” port of the Tool Changer should be properly exhausted.
    c. The **Locked** input goes OFF a short time later and subsequently the **Unlocked** input goes ON and remains ON, indicating that the uncoupling operation is complete.
9. Robot and Master move up and away and are at a distance greater than 0.048” (1.22 mm) from the Tool (the module contact pins are no longer touching).
    a. The **RTL1** and **RTL2** inputs go OFF.
    b. ‘Input’ power connections become unavailable on the Tool.
    c. Communications with downstream device(s) should now be lost.
10. Robot and Master in free space.
    a. The following input is ON:
        i. **Unlocked**
    b. The following inputs are OFF:
        i. **Locked**
        ii. **RTL1**
        iii. **RTL2**

4. Maintenance

The modules are not designed to be field serviced as all point-to-point wiring connections are soldered. Component replacement is limited to the V-ring seal on the Master.

DANGER: This module has a voltage of 50V or greater; always remove power before contacting the module. Arcing and damage occur if power is not removed from the module during maintenance or service. Always remove power before attaching or disconnecting cables, separating or inserting the mating couplers, or making any contact with the Tool Changer or Utility Coupler.

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.

If the Tool Changer is used in dirty environments (for example: welding or deburring applications), limit the exposure of the Tool Changer. Idle Tool assemblies should be covered to prevent debris from settling on the mating surface. Also, the Master assembly should be exposed for only a short period of time during Tool change and down time.

Under normal conditions, no special maintenance is necessary; however, perform periodic inspections to assess for unexpected damage and assure long-lasting performance. Perform the following visual inspection monthly:

- Inspect mounting fasteners to verify they are tight and if loose; then tighten to the proper torque. Refer to *Section 2—Installation*.
- Cable connections should be inspected during maintenance periods to ensure they are secure. Loose connections should be cleaned and re-tightened as appropriate. Inspect cable sheathing for damage, repair or replace damaged cabling. Loose connections or damaged cabling are not expected and may indicate improper routing and/or strain relieving.
- Inspect the Master and Tool pin blocks for any pin damage, debris or darkened pins. Refer to *Section 4.1—Pin Block Inspection and Cleaning*.
- Inspect V-ring seals for wear, abrasion, and cuts. If worn or damaged, replace. Refer to *Section 5.2.1—Seal Replacement*.

4.1 Pin Block Inspection and Cleaning

Tools required: *Nylon Brush (ATI part number 3690-0000064-60)*

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. Inspect the Master and Tool pin blocks for debris or darkened pins.

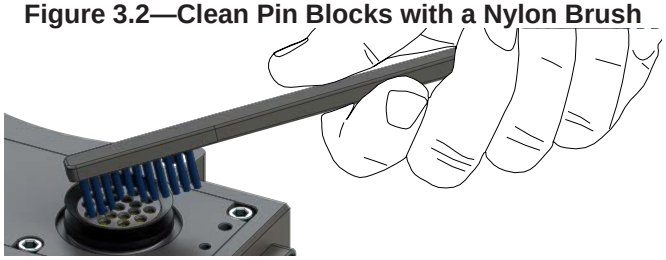
Figure 3.1—Inspect Master and Tool Pin Blocks



5. If debris or darkened pins are present, use a vacuum to remove the debris, and clean using a nylon brush (ATI part number 3690-0000064-60).

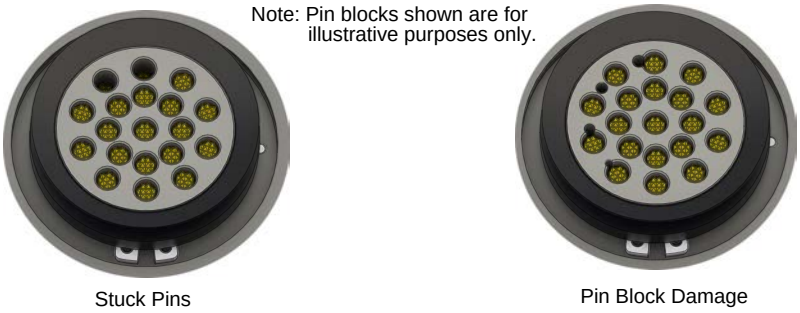
NOTICE: Do not use an abrasive media and/or cleaners or solvents to clean the contact pins. Using abrasive media and/or cleaners or solvents will cause damage to the contact surface or cause pins to stick. Clean contact surfaces with a vacuum or non-abrasive media such as a nylon brush (ATI part number 3690-0000064-60).

Figure 3.2—Clean Pin Blocks with a Nylon Brush



6. Inspect the Master and Tool pin blocks for stuck pins or pin block damage.

Figure 3.3—Stuck Pin and Pin Block Damage



7. If pins become stuck or if there is damage to the pin block, contact ATI for either a possible pin replacement procedure or module replacement.
8. Safely resume normal operation.

5. Troubleshooting and Service Procedures

This troubleshooting section provides information to help diagnose conditions with the Tool Changer or control module.

DANGER: This module has a voltage of 50V or greater; always remove power before contacting the module. Arcing and damage occur if power is not removed from the module during maintenance or service. Always remove power before attaching or disconnecting cables, separating or inserting the mating couplers, or making any contact with the Tool Changer or Utility Coupler.

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

Refer to the table below for troubleshooting information.

Table 4.1—Troubleshooting Procedures

Symptom	Possible Cause	Correction
Unit will not lock or unlock	Verify that ball bearings are moving freely. Clean and lubricate as needed.	Verify that ball bearings are moving freely. Clean and lubricate as needed. Refer to the *Maintenance section of the Tool Changer Manual* for instructions.
	Air supply not to specifications.	Check air supply. Refer to the Installation section of the *Tool Changer Manual* for specifications.
	Check that exhaust port is properly vented.	Check that exhaust port is properly vented. *Refer to Pneumatic Connection section of the Base Tool Changer Manual* for valve requirements.
	Master and Tool are within the specified No-Touch zone.	Verify that the Master and Tool are within the specified No-Touch zone when attempting to lock. Refer to the *Installation – Tool Stand Design Section of the Tool Change Manual* for specifications.
	Air is trapped in the Unlock (U) port.	Ensure that there is no air trapped in the Unlock (U) air port. Refer to the *Air and Valve adapter section* for pneumatic specification and requirements.
Sensors not operating properly	Sensor cables damaged or incorrectly connected.	Verify that cables are connected correctly and not damaged, replace if damaged. Refer to the *Troubleshooting Section of the Tool Change Manual*.
	Tool Plate is not secured properly or debris is trapped between surfaces.	Ensure that the Tool Plate is securely held to the Master plate, that nothing is trapped between their surfaces.

Table 4.1—Troubleshooting Procedures		
Symptom	**Possible Cause**	**Correction**
Loss of Communication	Damaged signal cabling	Check/Replace signal cabling upstream and downstream of Tool Changer modules.
	Worn or damaged contact pins	Inspect module contact pins for debris/wear/damage. Refer to *Section 4.1—Pin Block Inspection and Cleaning*. V-ring seal damaged and allowing debris in the contact pins. Replace V-ring seal, refer to *Section 5.2.1—Seal Replacement*.
	Product upstream and downstream of Tool Changer failed or is damaged	Check product upstream and downstream of Tool Changer for failure. This failure can “appear” to be caused by the Tool Changer or affect Tool Changer performance.

5.2 Service Procedures

The following service procedures provide instructions for component replacement and adjustment.

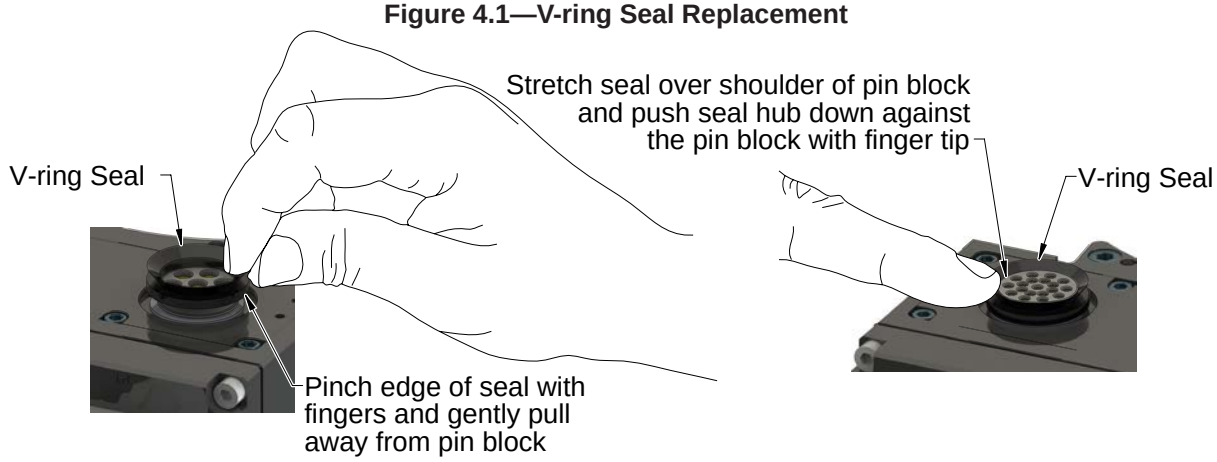
5.2.1 Seal Replacement

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

The seal protects the electrical connection between the Master and Tool module. Replace the seal if it becomes worn or damaged.

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. To remove the existing seal, pinch the edge of the seal and pull the seal away from the pin block on the Master module.
5. To install a new seal, stretch the new seal over the shoulder of the pin block.
6. Push the seal hub down against the pin block.
7. Safely resume normal operation.

Figure 4.1—V-ring Seal Replacement



6. Serviceable Parts

Refer to *Section 8—Drawings*.

6.1 Master Module Serviceable Parts

For mounting fasteners, refer to *Table 5.1*. For additional serviceable parts, refer to *Section 8—Drawings*.

Table 5.1—Master Module Serviceable Parts

Item No.	Qty	Part Number	Description
*	*	3500-1066020-15	M6X20 SHCS, 12.9, ISO4762/DIN912, ES-ATI-007, YL M-spheres/IFI 525

6.2 Tool Module Serviceable Parts

For mounting fasteners, refer to *Table 5.2*. For additional serviceable parts, refer to *Section 8—Drawings*.

Table 5.2—Tool Module Serviceable Parts

Item No.	Qty	Part Number	Description
*	*	3500-1066016-15A	M6x16 SHCS, 12.9, ISO4762/DIN912, ES-ATI-007, YL M-spheres/IFI 525

6.3 Accessories

Table 5.3—Accessories

Item No.	Qty	Part Number	Description
*	*	3690-0000064-60	Brush, Blue Nylon All Purpose (Contact Pin Cleaning)

7. Specifications

Table 6.1—Master Module Specifications	
9121-SA12-M	Discrete, 19-Pin MS3102 Connector, Supports Lock, Unlock, and RTL Sensors, No Integrated Valve Control - Master Side
Interface Connections	**Customer Interface:** 19-pin male connector for power and signals **Integrated Tool Changer I/O:** (4X) 3-Pin M8 female connectors supporting Tool Changer Lock, Unlock, and Ready-to-Lock proximity sensors.
Electrical Rating	**Pass Through to Tool:** 5 A 250 V maximum **Tool Changer Control:** 24 VDC
Weight	1.6 lbs (0.7 kg)

Table 6.2—Tool Module Specifications	
9121-SA2-T	Discrete signal module with 19-pin Amphenol, 19-pin Block, 19 Pass-Through Signals - Tool Side
Interface Connections	**Customer Interface:** 19-pin female connector for power and signal
Electrical Rating	**Pass Through to Tool:** 5 A 250 V maximum
Weight	1.3 lbs (0.6 kg)

8. Drawings

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