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C. Control and Signal Modules

VB7-M, VBx-T—Discrete Control Module Supporting Integrated Valve

1. Product Overview

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

MS-style connectors are provided for interfacing on the Master and Tool modules. When the Tool Changer is coupled, the Master and Tool modules communicate across their interface using a spring-loaded pin block. A flexible boot surrounds the pin block to seal the connection from moisture and liquid while coupled. Several module configurations are available in order to provide the customer with Tool Changer I/O and various pass-through signal capabilities. Refer to *Section 7—Specifications* for the details of each available module.

The Tool-ID feature allows the customer to distinguish between the different tools being coupled by the Tool Changer. The customer may set the Tool-ID by using push button switches on the Tool modules. Refer to *Section 2.5—Setting the Tool-ID on the SA3 and SA4 Tool 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.



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 VB7 Master

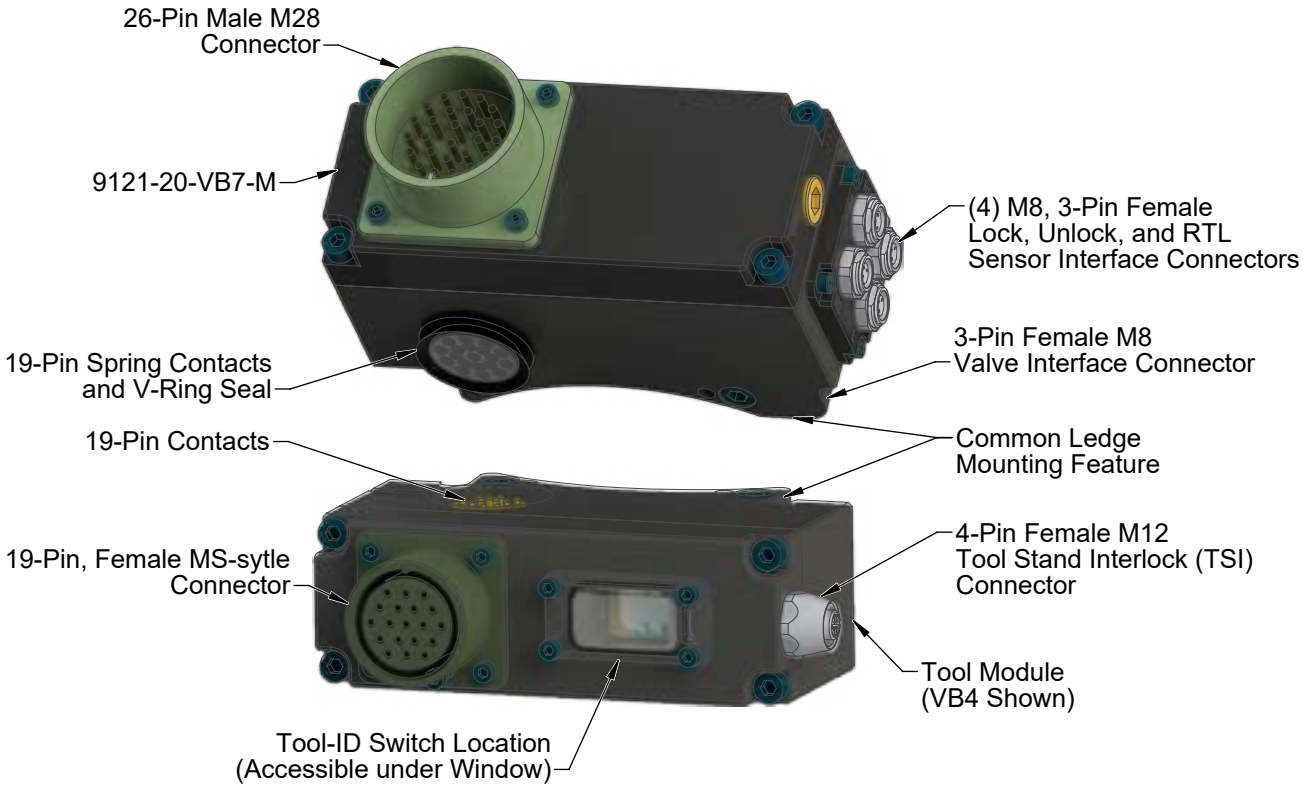
The VB7 modules are designed with special features to afford the user the opportunity to operate the Tool Changer in the safest manner possible. In addition to providing the standard Lock, Unlock, and Ready-to-Lock sensor inputs the VB7 modules are outfitted with patented Tool Stand Interlock (TSI) technology. The TSI feature consists primarily of a physical break in the unlock solenoid valve circuit. The broken circuit is made available to the customer via a TSI connector on the Tool module. Using this connector, a mechanical switch, and trip dog can be integrated by the customer to allow the unlock solenoid valve circuit to be completed only when the Tool is in the Tool Stand. A momentary action single-pole, double-throw switch is suggested.

An electrical interface is provided on the VB7 Master module for support of an integrated solenoid valve (DC Voltage). The integrated valve can be supplied from ATI as part of the valve adapter block, 9121-Jxx-M. Refer to the valve adapter block manual for more information (9620-20-C-Jxx Air and Valve Adapters with Valve Signal Pass Thru). Electrical interface drawings and connector details are provided in the *Section 8—Drawings*.

In order to allow the Tool Changer to uncouple when a Tool is not present, a Relay circuit in parallel with the TSI circuit is utilized. This Relay circuit is located in the Master module and is triggered by the RTL sensor. If the RTL sensor is low, indicating no Tool presence, then the Relay circuit is closed, thus allowing the unlock solenoid valve circuit to be completed. If the RTL sensor is high, indicating Tool presence, then the Relay circuit is open and the TSI circuit on the Tool-side must be closed in order to complete the unlock solenoid valve circuit.

Monitoring of the Relay circuit is achieved through the RTLV input. Refer to *Table 3.1* for suggested fault monitoring conditions

Figure 1.1—Modules



1.2 VB2 Tool

TheVB2 Tool module provides up to 19 pass-through signals. The customer interface connection is an Amphenol 19-pin MS-style connector. There is no Tool-ID.

1.3 VB3 Tool

The VB3 Tool module provides up to 19 pass-through signals. The customer interface connection is an Amphenol 19-pin MS-style connector (10) unique Tool-ID values are available (0–9). The Tool-ID is tied into 24VDC from pin B, refer to the details in *Section 8—Drawings*.

1.4 VB4 Tool

The VB4 Tool module provides up to 19 pass-through signals. The customer interface connection is an Amphenol 19-pin MS-style connector (100) unique Tool-ID values are available (0–99). The Tool-ID is tied into 24VDC from pin B, refer to the details in *Section 8—Drawings*.

1.5 Tool Stand Interlock Safety Feature

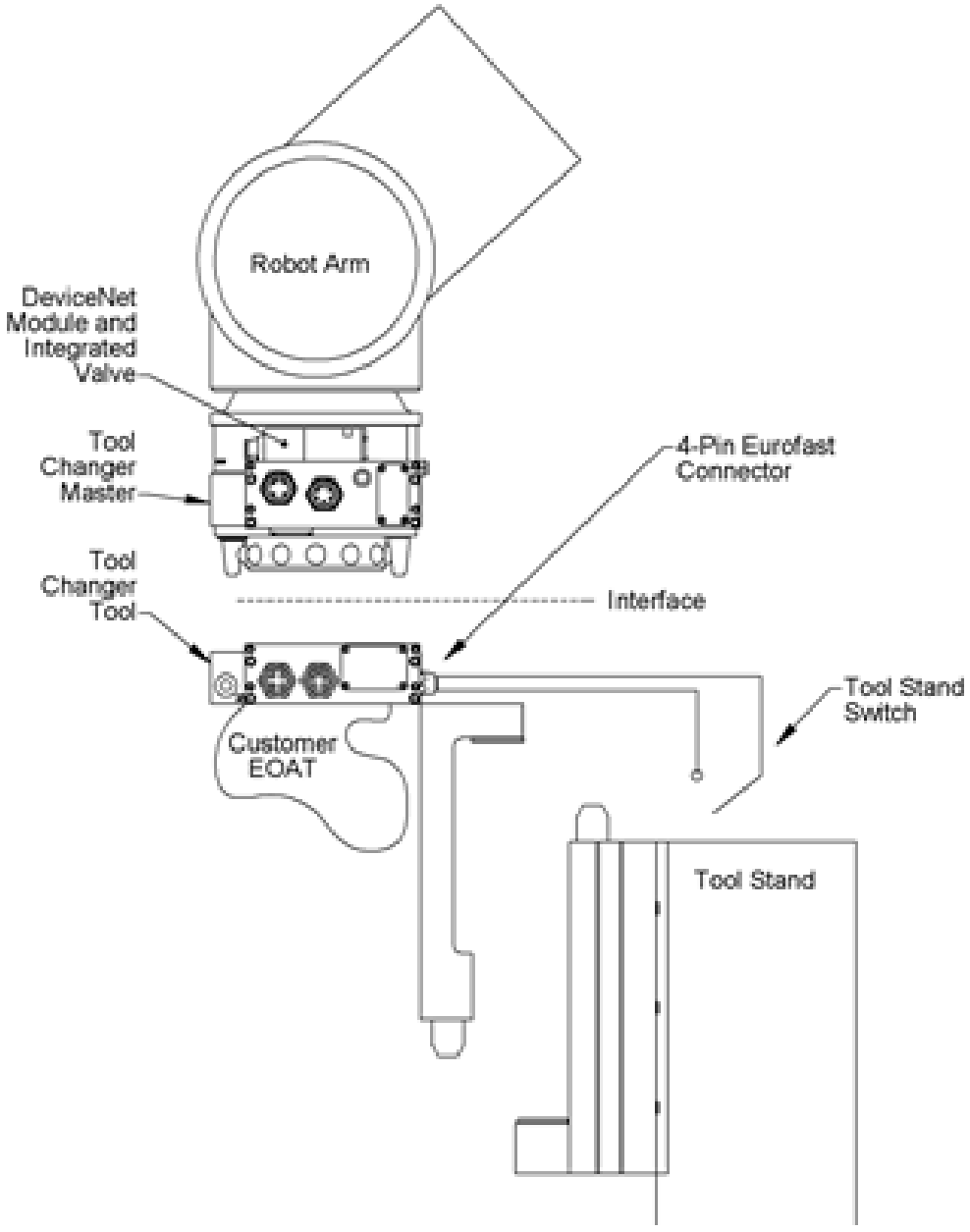
A Tool Stand Interlock (TSI) Safety Circuit is provided with this tool changer.

A Eurofast connector is provided on the tool changer tool for use with a tool stand presence switch. Two conductors are wired directly in-line with the valve “unlock” solenoid circuit.

A mechanical or other tpe switch can be integrated into the robot tool changer half to sense the tool when in the stand and therefore to make the circuit.

If an unlock solenoid command is given and the tool isnot docked properly in the stand, the unlock command will not be recognized. This feature prevents the accidental release of a tool from outside the tool stand.

Figure 1.2—Tool Stand Interlock (TSI)



CAUTION: This Tool Changer is equipped with Tool Stand Interlock (TSI). Special procedures are required to uncouple the Tool Changer.

2. Installation

The control/signal modules are typically installed by ATI prior to shipment. Installation and removal are outlined in the following section. 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.

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 Master Module Installation

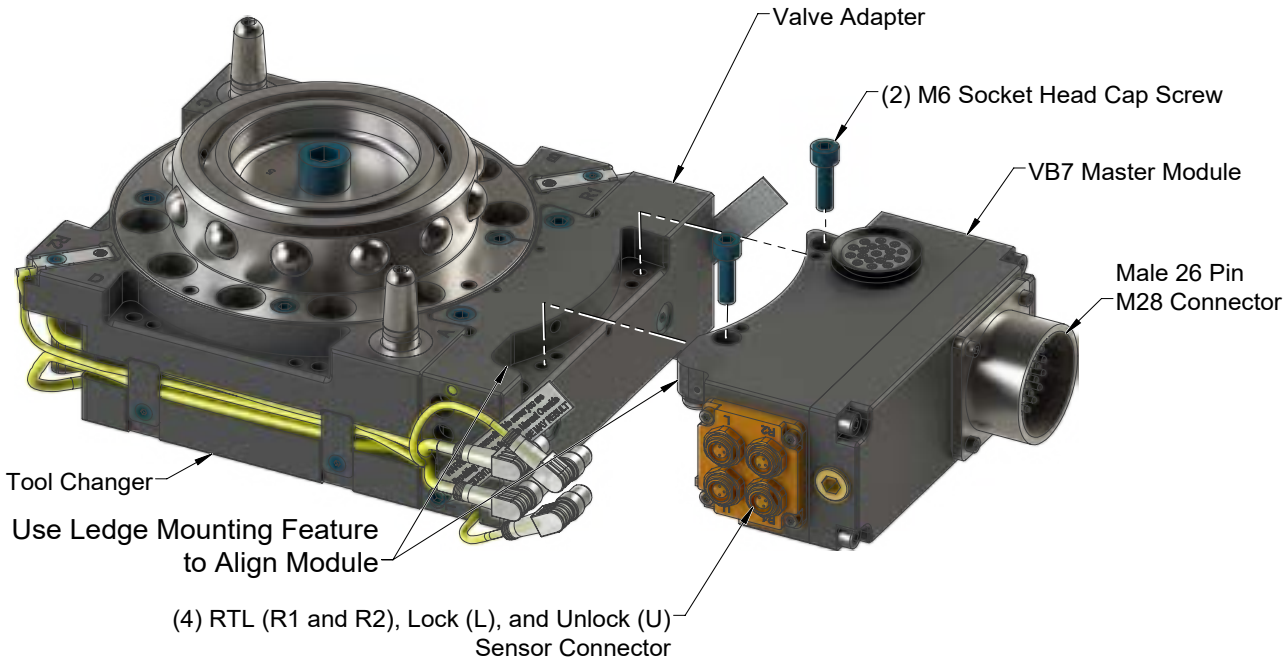
Refer to *Figure 2.1* and *Figure 2.2* for Master module installation instructions.

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. Wipe down the mounting surfaces with a clean rag.
5. Place the module into the appropriate location on the air 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 valve adapter using a 5 mm hex key. Tighten to 70 in-lbs (7.9 N-m).
7. Ensure the Lock (L), Unlock (U), RTL (R1), and RTL (R2) connectors are clean and connect the sensor cables to the control/signal module.

Figure 2.1—Master Module Installation and Removal



2.2 Master Module Removal

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 valve adapter.

2.3 Tool Module Installation

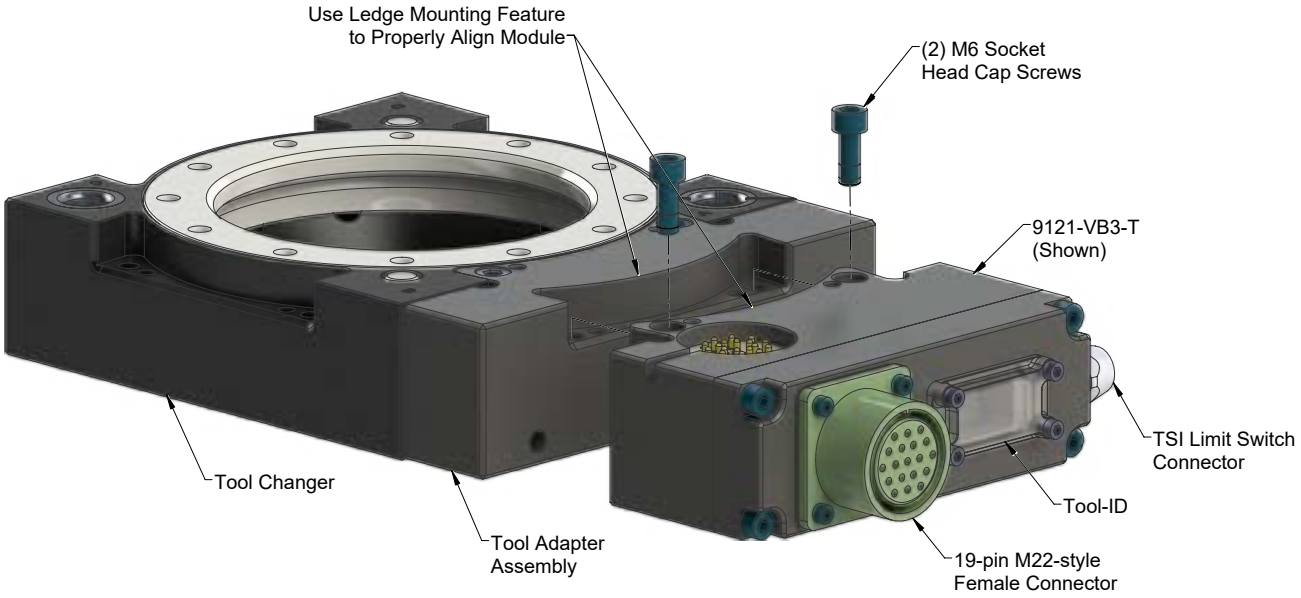
Refer to *Figure 2.2* for Tool module installation instructions. Set the Tool-ID by using push button switches on the Tool modules. Refer to *Section 2.5—Setting the Tool-ID on the SA3 and SA4 Tool Module*.

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. Ensure the TSI limit switch connection is clean and connect to the control/signal module.
9. Safely resume normal operation.

Figure 2.2—Tool Module Installation and Removal



2.4 Tool Module Removal

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. Disconnect the cable from the control/signal module to the TSI limit switch.
6. 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.

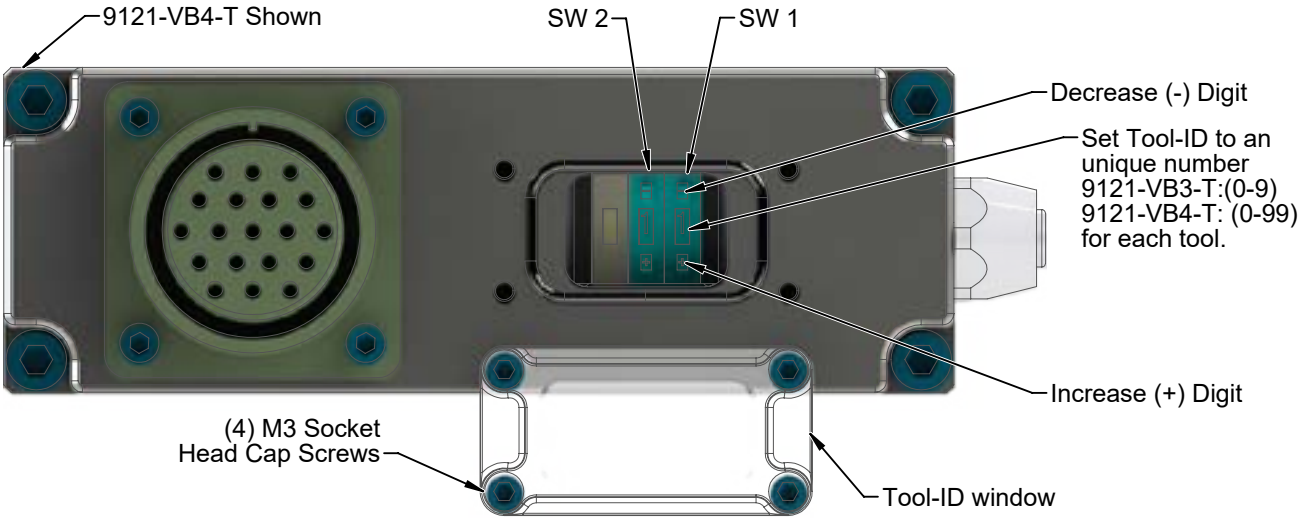
2.5 Setting the Tool-ID on the VB3 and VB4 Tool Module

Push button switches are provided on the Tool module for setting of a unique digit Tool-ID number.

Tools Required: *Phillips screwdriver*

1. Loosen (4) M3 socket head cap screws and remove Tool-ID window.

Figure 2.3—Set Tool-ID



2. Use a non-conductive tool (e.g., plastic stylus) to press on the Tool-ID push buttons to increase (+) or decrease (-) the digit value. Set the Tool-ID to the desired unique digit number. Refer to *Section 8—Drawings* for Tool-ID output tables.
3. Re-install the Tool-ID window and torque the (4) M3 socket head cap screws to 6 in-lb.

3. Operation

Various Tool Changer I/O are provided to the customer through the military-style Amphenol 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 I/O points are available through the connector.

Output signals need to be provided to the discrete control module to actuate the solenoid valve in order to provide pneumatic pressure to lock or unlock the Tool Changer.

> The 0 and 24VDC 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 details on the operation of the Tool Changer and recommended procedure for coupling.

When coupled, the module Tool can be communicated with, Tool-ID can be read (if equipped), and attached end-effectors can be used

3.1 Fault Monitoring

Table 3.1 is provided below with suggested fault monitoring conditions for the TSI circuitry.

Table 3.1—Fault Monitoring

Sensor/Input 1	State 1		Sensor/Input 2	State 2		Comment
RTL	Low		Slave Module	Present*		**RTL Not Operating Properly
RTL	Low		RTLV	High		**Relay or RTL Not Operating Properly
RTL	High		RTLV	Low		Relay or RTL Not Operating Properly

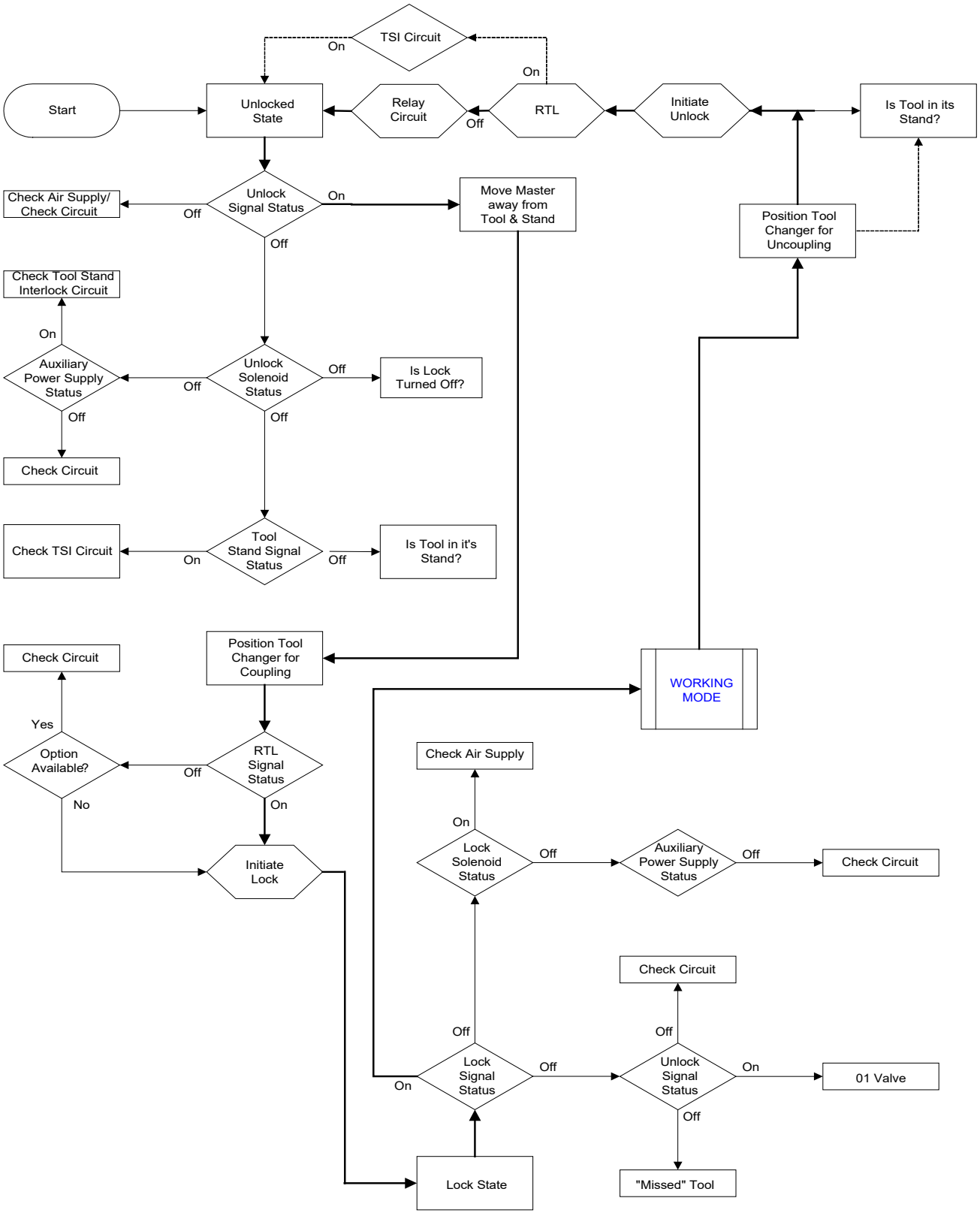
*Slave Module Present as evidenced by Node online or ability to read Tool-ID

**Dangerous situation where an unintentional Unlock command could result in Tool release.

3.2 Operation Flow Chart

Refer to the flow chart *Figure 3.1*for a logical description of the Tool Changer lock/unlock procedure and diagnostic checks.

Figure 3.1—Logical Operation and Diagnostics



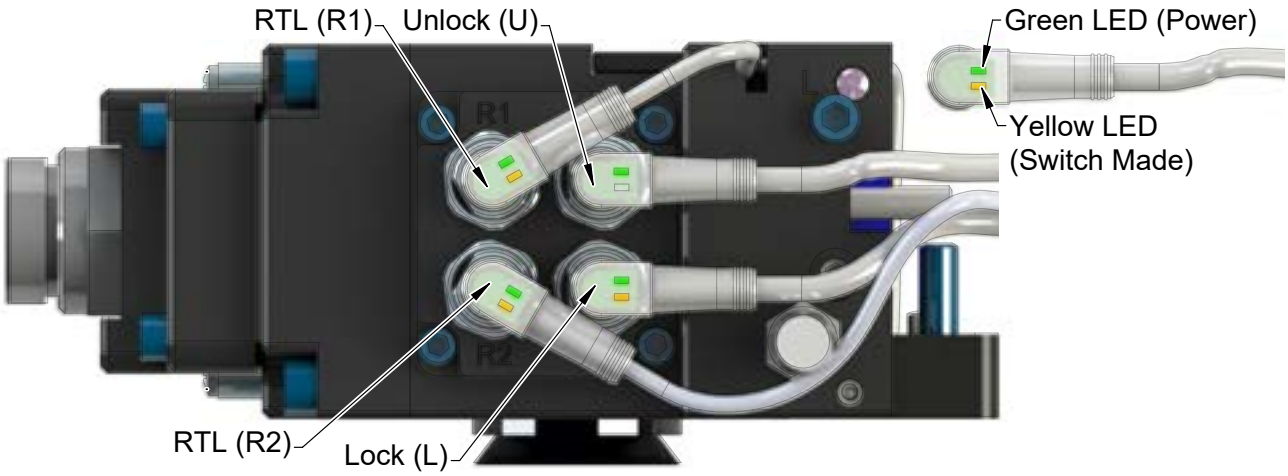
3.3 Lock, Unlock, and RTL Sensor Cable LED Behavior

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 3.2—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 3.2—Lock, Unlock, and RTL Sensor cable LED Behavior (Shown in Locked Position)



(Control module shown for reference only)

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:

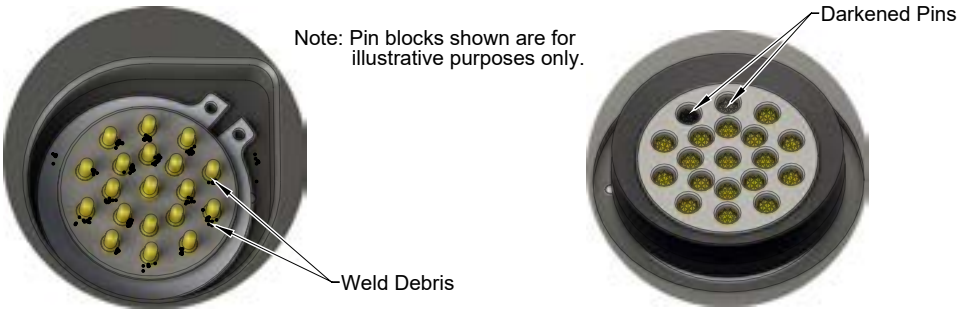
- Inspect mounting fasteners to verify they are tight and if loose; then tighten to the proper torque. Refer to *Section 2—Installation*.
- Cable connections should be inspected during maintenance periods to ensure they are secure. Loose connections should be cleaned and retightened. Inspect cable sheathing for damage, repair or replace damaged cabling. Loose connections and/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 *Section 5.2.2—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.

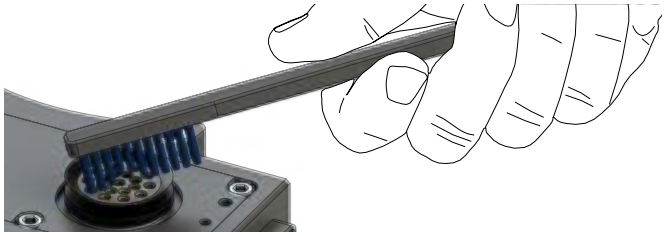
Figure 4.1—Inspect Master and Tool Pin Blocks



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).

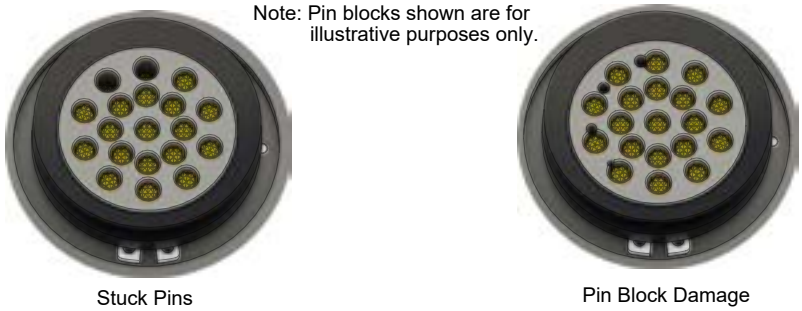
NOTICE: Do not use an abrasive media and/or cleaners or solvents to clean the contact pins. Using abrasive media and/or cleaners or solvents will cause damage to the contact surface or cause pins to stick. Clean contact surfaces with a vacuum or non-abrasive media such as a nylon brush (ATI part number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

Figure 4.2—Clean Pin Blocks with a Nylon Brush



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

Figure 4.3—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

Troubleshooting information is provided in the following table.

Table 5.1—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.
	Discrete signals are mapped incorrectly.	Verify that discrete signals are mapped and are communicating properly. Refer to *Section 8—Drawings* for electrical schematic.
	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.*
Master plate is Locked without the Tool plate or in a missed Tool condition, and cannot be Unlocked using the Unlatch command.	The Latch command was sent to the Robot without the Tool plate coupled to the Master plate.	Refer to *Section 5.2.1—Solenoid Valve Manual Override Procedure*.
Sensors not operating properly	Sensor cables damage 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 5.1—Troubleshooting Procedures		
Symptom	**Possible Cause**	**Correction**
Loss of Communication	Damaged signal cabling	Check/Replace signal cabling up- and down-stream 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 5.2.2—Seal Replacement*.
	Product upstream and downstream of Tool Changer failed or 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

Component replacement and adjustment procedures are provided in the following section.

5.2.1 Solenoid Valve Manual Override Procedure

The manual override procedure should be used when the Tool Changer is locked without the Tool plate attached. The control module safety circuit does not allow the Tool Changer to be unlatched without the Tool plate attached and the tool in the tool stand.

WARNING: Do not use the solenoid valve manual override if the tool is locked to the Master. Using the manual override will release the Tool and may cause bodily injury or damage to equipment. If the Tool is attached to the Master, it must be secured in the tool stand or in a location where the tool weight is supported before using the manual override.

CAUTION: The manual override is not intended for normal operations. Manual override is to be used in situations where no alternative is available to unlock the Master. Do not execute the Latch command unless the Master and the Tool are ready to be coupled.

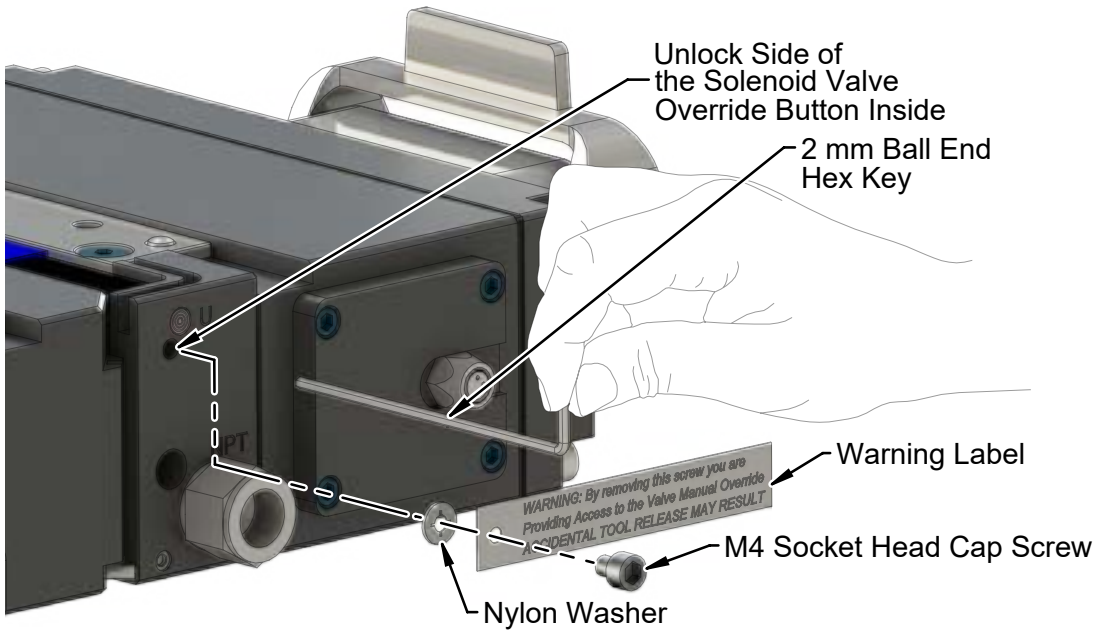
Tools required: *3 mm hex key, 2 mm ball end hex key*

1. Using a 3 mm hex key, remove the M4 socket head cap screws, warning label, and nylon washer from the Unlock side of the solenoid valve. The Unlock side is marked with a “U”.

CAUTION: Applying excess force can damage the solenoid or cause the override button to stick in one position. Actuation of valve override buttons requires about 1 mm of travel and minimal of force. Use a non-sharp object, similar to ball nose 2 mm hex key, to gently depress the override button; an air release should be heard when the solenoid is activated.

2. Insert a 2 mm ball end hex key in the unlock valve screw hole and gently depress the valve override button. An air release should be heard when the solenoid is actuated. Make sure the locking mechanism is fully retracted.
3. Using a 3 mm hex key, replace the M4 socket head cap screws, warning label, and nylon washer and tighten the screw.

Figure 5.1—Manual Override



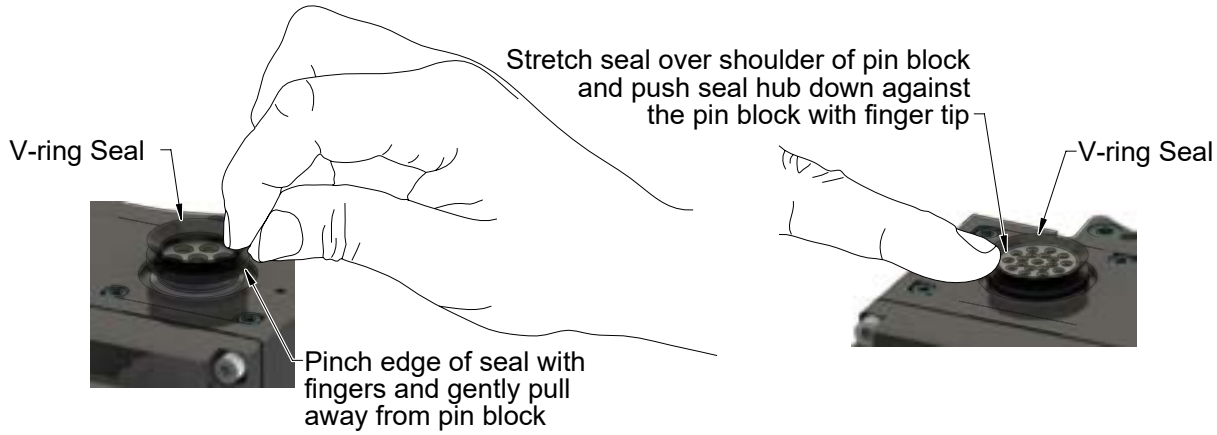
5.2.2 Seal Replacement

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 5.2—V-ring Seal Replacement



6. Serviceable Parts

6.1 Master and Tool Serviceable Parts

Refer to *Section 8—Drawings.*

6.2 Accessories

Table 6.1—Accessories

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

7. Specifications

Table 7.1—Master Module Specifications	
9121-VB7-M	Discrete Signal Module with 26-Pin Amphenol, 19-Pin Block, supports L/U/R1/R2 Sensors with Integrated Valve Pass-Through. Supports Tool Stand Interlock on Tool Side and Works w/VB Series Tools.
Interface Connections	Amphenol MS3102E28-12P 26-pin Connector for power and signal. 13A maximum current rating. Integrated Tool Changer I/O: (4) 3-pin M8 female connectors supporting Tool Changer Lock, Unlock, and Ready-to-Lock proximity sensors. 3-pin M8 female connector for valve interface with the valve adapter (Latch and Unlatch)
Electrical Rating	5A, 250V maximum Tool Changer Control: 24VDC
Weight	1.5 lbs (0.7 kg)

Table 7.2—VB2 Tool Module Specifications	
9121-VB2-T	Discrete signal module with 16-pin pass-through. Supplied with TSI Connector with pins 2 to 3 breaking solenoid circuit. Red Teach Plug (1700-0545501-01) sold separately.
Interface Connections	Amphenol MS3102E22-14S 19-Socket Connector. 13A maximum current rating for power and signal
Electrical Rating	5A, 250V maximum
Weight	1.3 lbs (0.6 kg)

Table 7.3—VB3 Tool Module Specifications	
9121-VB3-T	Discrete signal module with 12-pin pass-through. Supplied with TSI Connector with pins 2 to 3 breaking solenoid circuit. Red Teach Plug 1700-0545501-01, sold separately.
Interface Connections	Amphenol MS3102E22-14S 19-Socket Connector. 13A maximum current rating. 4-pin M12 female connector for TSI.
Electrical Rating	5A, 250V maximum Tool-ID: 50V and 100 mA
Tool-ID	10 Tool-ID Values Available (0-9), Factory Setting = 1
Weight	1.3 lbs (0.6 kg)

Table 7.4—VB4 Tool Module Specifications	
9121-VB4-T	Discrete signal module with 8-pin pass-through. Supplied with TSI Connector with pins 2 to 3 breaking solenoid circuit. Red Teach Plug 1700-0545501-01, sold separately.
Interface Connections	Amphenol MS3102E22-14S 19-Socket Connector. 13A maximum current rating. 4-pin M12 female connector for TSI.
Electrical Rating	5A, 250V maximum Tool-ID: 50V and 100 mA
Tool-ID	100 Tool-ID Values Available (0-99), Factory Setting = 1
Weight	1.3 lbs (0.6 kg)

8. Drawings

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