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B. Base Tool Changer

QC-1210 Series—Robotic Tool Changer

1. Product Overview

The QC 1210 Robotic Tool Changer enhances the flexibility and reliability of a robotic cell by enabling a robot to change tooling automatically. Various tooling, such as grippers, weld guns, pneumatic and electric motors etc., can be selected and connected to a robot arm.

The QC-1210's main components are a Master and Tool plate. The Master plate attaches to the robot; the Tool plate attaches to selected end-effectors. When installed on the robot arm, the Master plate locks to the Tool plate using (3) pneumatic locking mechanisms. Each locking mechanism uses a patented, multi-tapered cam with ball-locking technology and a patented fail-safe mechanism. With the Master plate coupled to the Tool plate, the passage of utilities from Master to tooling is enabled. Electrical signals, pneumatic signals, power, and fluids can be transferred to the customer tooling through additional modules and ports. Refer to the respective manuals of each module for details on operation.

The Tool Changer is applicable in both automated and manual tool change processes, providing a method for quick tool change in maintenance operations.

For the most current product information and specifications on the QC-1210 Series of Tool Changers, please click the following link: *QC-1210 Series.*

1.1 Master Plate Assembly

The Master base assembly (Master plate) includes an anodized aluminum body, a set of hardened stainless-steel locking mechanisms, and hardened steel alignment pins (see *Figure 1.1*).

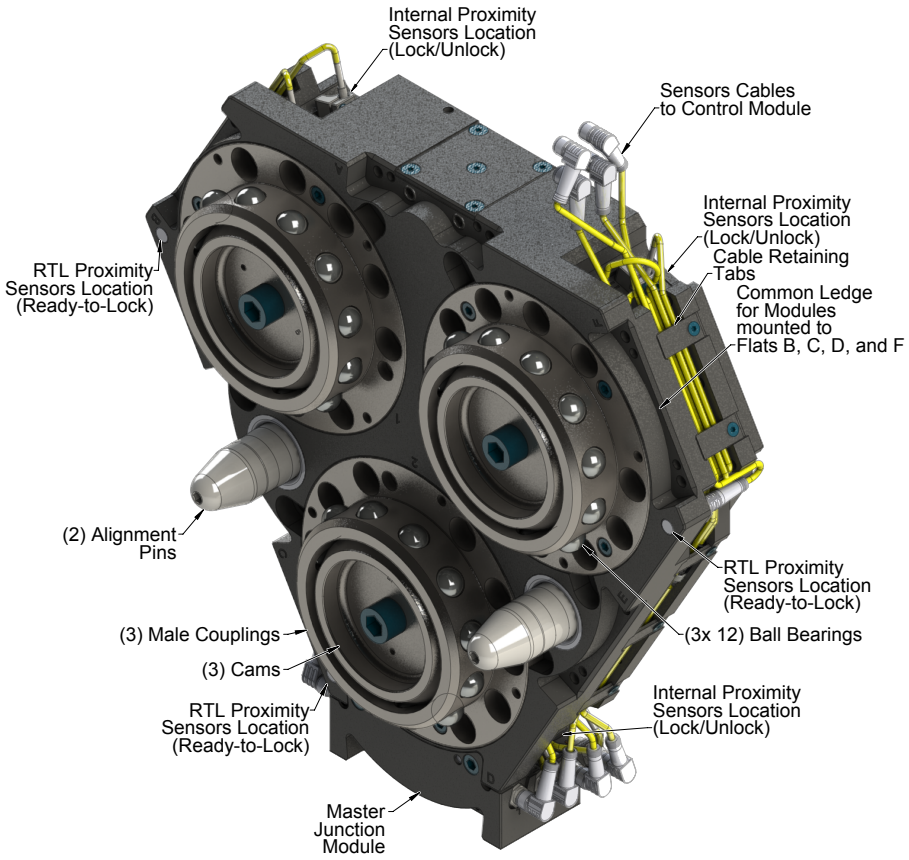
The Master plate has (9) flat sides for mounting optional modules. Flat A is designated for integrated valve assembly and Control module or air adapter and signal module. Flats C, D, E, F, G, H, and J are fully interchangeable; optional modules suited to the application requirements can be installed on interchangeable flats or moved around to what best suits robot dress package. All models come with Lock and Unlock (L/U) sensors which include a master junction box module mounted to Flat B.

The Master plate has (3) locking mechanisms. Each locking mechanism consists of a cam, male coupling, and chrome-steel balls. The tapered alignment pins on the Master plate mate with bushings in the Tool plate to ensure alignment during the coupling process. Extreme pressure grease is applied to the cams, male couplings, ball bearings, and pins to enhance performance and maximize the life of the entire assembly.

The Master plate body contains (6) proximity sensors to verify the lock/unlock position of each locking mechanism. The proximity sensors are arranged such that (3) sensors correspond to ‘lock’ and the other (3) correspond to ‘unlock’. The lock/unlock signal at each locking mechanism is routed to the junction box module. The junction box module informs the control/signal module of the Master plate’s lock/unlock state. For further details on relationships between the sensors, junction box module, and control/signal module, refer to *Section 5.2.1—Lock and Unlock Sensor and Sensor Cable Replacement*.

The Master plate also contains (2) proximity sensors mounted to its body to verify Tool plate presence and provide (2) Ready-To-Lock (RTL) signals to the control/signal module. To accomplish a dual RTL signal, the (2) sensors are wired in series. Refer to *Section 5.2.2—Ready-to-Lock Sensor and Cable Replacement* for a further explanation on the RTL layout.

Figure 1.1—Master Plate Assembly



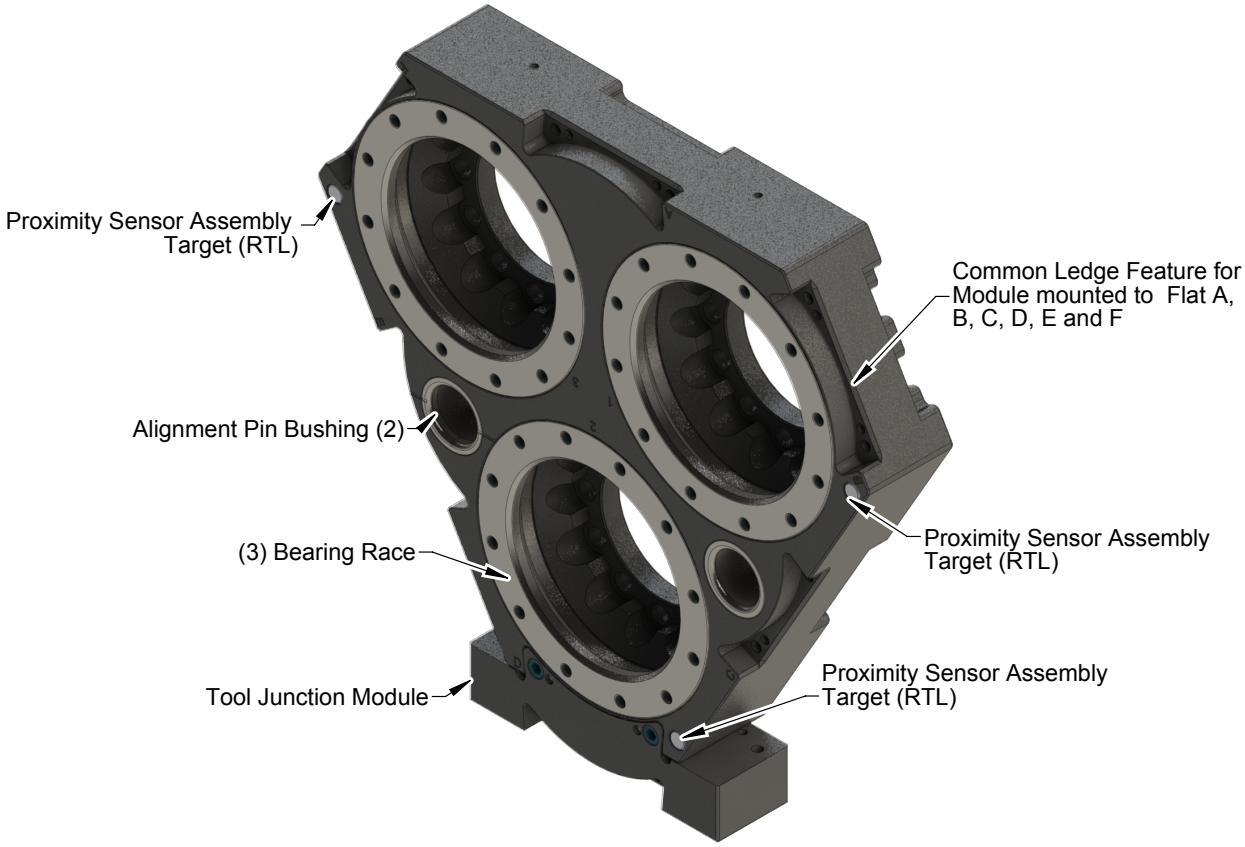
1.2 Tool Plate Assembly

The Tool plate assembly includes an anodized aluminum body and hardened stainless steel bearing races. Flat A of the Tool plate is reserved for the tool-side Control/Signal module and a valve spacer. The Tool plate has (6) flat sides for mounting additional modules (optional).

Proximity sensor targets are mounted to the body of the Tool plate. The targets are used by the Master plate's proximity sensors to verify Tool plate presence when coupled and provide a Ready-To-Lock (RTL) signal.

A mounting pattern is machined into the Tool plate for mounting customer tooling or a tooling interface plate. Refer to *Section 8—Drawings* for details.

Figure 1.2—Tool Plate Assembly



1.3 Optional Modules

The (6) flats available are for mounting optional modules. Modules can support various utility pass through, such as: signal, fluid/air, and power.

Flat A is reserved for an integrated valve/air adapter and Control/Signal module on both the Master and Tool-side. Modules mounted to flats C, D, E, F, G, H, or J are interchangeable to suit the specific robot application.

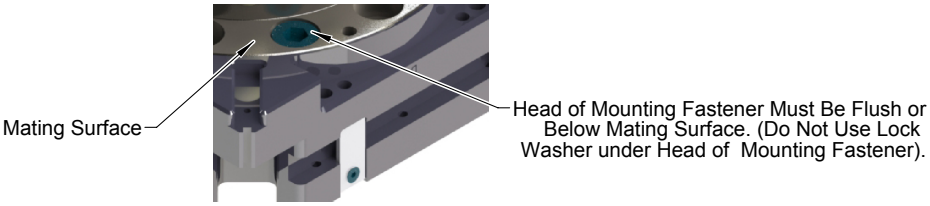
The optional modules are mounted to the Master or Tool plate using a common ledge mounting feature. Detaching modules from the Master/Tool plate requires removing the (2) M6 socket head cap screws securing each module to the Tool Changer body.

Visit the ATI website (*www.ati-ia.com*) to see what modules are available or contact an ATI Sales Representative for assistance in choosing modules specific to particular applications.

2. Installation

All fasteners used to mount the Tool Changer to the robot and to customer's tooling should be tightened to a torque value as indicated. Refer to *Table 2.1*. **Furthermore, removable (blue) Loctite 242 must be used on these fasteners. The following table contains recommended values based on engineering standards.**

WARNING: Do not use lock washer under the head of the mounting fasteners or allow the mounting fasteners to protrude above the mating surfaces of the Master and Tool plates. Allowing fasteners to protrude above the mating surface will create a gap between the Master and Tool plates, preventing the locking mechanism from fully engaging. This can lead to personal injury or equipment damage. Make sure the mounting fasteners are flush or below the mating surfaces of the Master and Tool plates.



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.

Table 2.1—Fastener Size, Class, and Torque Specifications

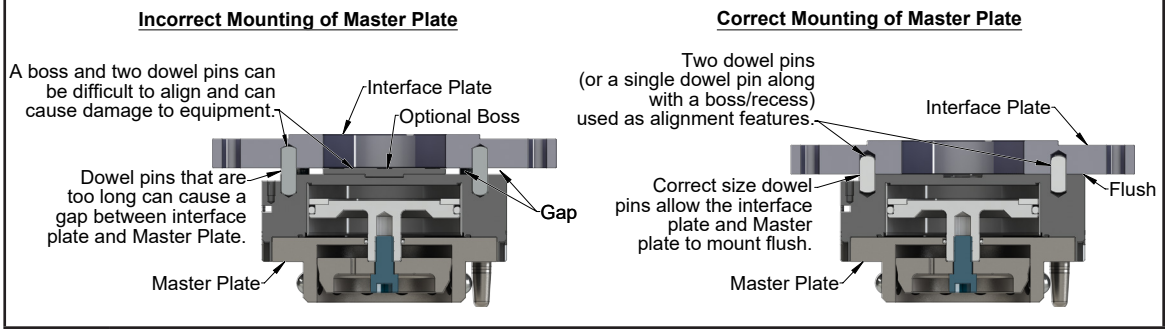
Mounting Conditions	Fastener Size and Property Class	Recommended Torque
Minimum thread engagement: • ≥ 1X fastener Ø for steel • ≥ 1.5X fastener Ø for aluminum (grade 6061 or higher)	M10-1.5 Class 12.9	55 ft-lbs (75 Nm)
Note: 1. Confirm available engagement with the robot manufacturer.		

2.1 Master Interface

The Master plate is typically attached to the robot arm. An interface plate can adapt the Master plate to a specific robot arm. Alignment features (dowel holes and bosses) accurately position and bolt holes secure the Master plate to the robot arm or an interface plate. Custom interface plates are available from ATI upon request (refer to the drawings for technical information on mounting features.)

CAUTION: Do not use more than two alignment features when securing a Master plate to an interface plate. Using more than two alignment features can cause damage to equipment. Use either two dowel pins or a single dowel pin, along with a boss/recess feature to align the Master plate with the interface plate.

CAUTION: Do not use dowel pins that are too long or do not allow the interface plate and Master body to mate flush. Using dowel pins that are too long will cause a gap between the interface plate and Master body and damage the equipment. Use dowel pins that will not extend further than allowed by the Master body.



If the customer chooses to design and build an interface plate, consider the following points:

- The interface plate should include bolt holes for mounting and either two dowel pins or a dowel pin and a boss for accurate positioning on the robot and Master plate. The dowel and boss features prevent unwanted rotation. Refer to the robot manual for robot mounting features.
- The thickness of the interface plate must be sufficient to provide the necessary thread engagement for the mounting bolts.
- Dowel pins must not extend out from the surface of the interface plate farther than the depth of the dowel holes in the Master plate.
- If a boss is used on the Master plate, a recess of proper depth and diameter must be machined into the interface plate to correspond with the boss on the Master plate.
- Mounting bolts that are too long can create a gap between the interface plate and the Master plate, which can damage equipment.
- The interface plate must provide rigid mounting to the Master plate.
- The interface plate design must account for clearances required for Tool Changer module attachments and accessories.

2.2 Master Plate Installation

Tools required: *8 mm hex key*

Supplies required: *Clean rag, Loctite® 242*

2. Make sure mounting surface of the Master plate and robot arm or interface plate are clean and free of debris.
3. Align the dowel pins to the corresponding holes in the Master plate and secure the Master plate to the robot arm or interface plate with customer supplied (36) M10 socket head cap screws using an 8 mm hex key. Apply Loctite 242 to threads (see *Table 2.1* for proper fasteners and torque).

NOTICE: If an ATI interface plate is used, fasteners to mount the Master plate are supplied with the interface plate.

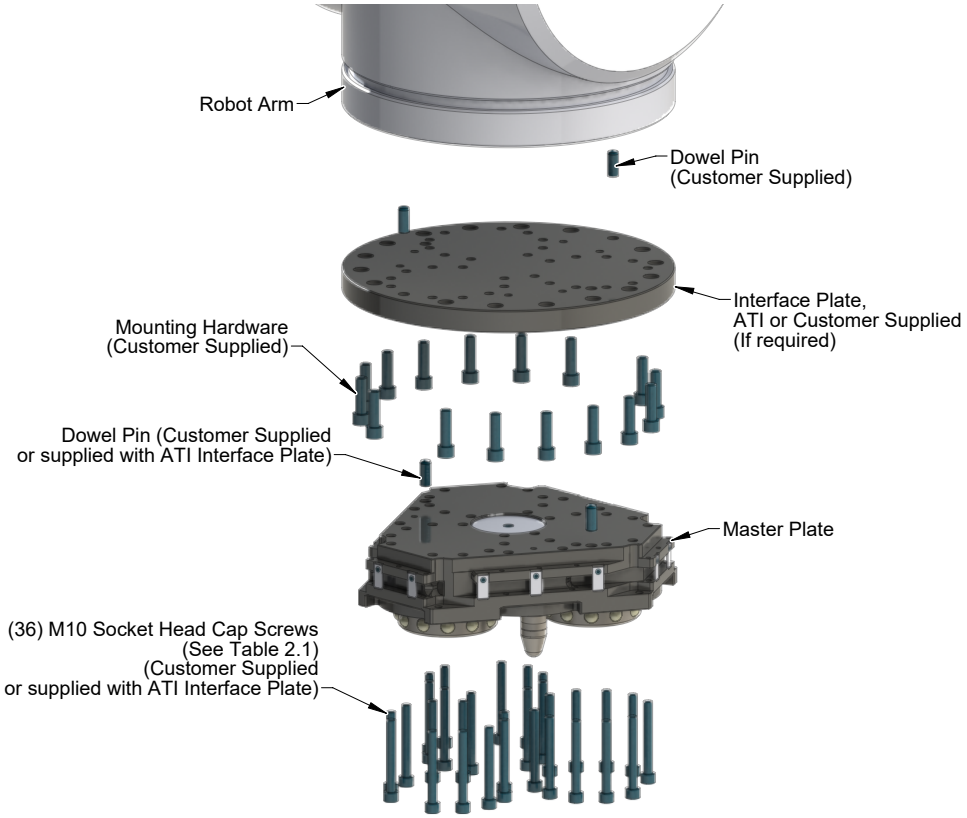
4. Connect utilities to appropriate modules and Master plate connections.
5. When installation is complete, safely resume normal operations.

2.3 Master Plate Removal

Tools required: *8 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. If necessary, disconnect all utilities (for example: electrical, pneumatic, hydraulic). Note: support the Master plate while removing the fasteners.
5. Using an 8 mm hex key, remove the (36) M10 socket head cap screws connecting the Master plate to the robot arm or interface plate.
6. Remove the Master plate.

Figure 2.1—Typical Master Plate Installation



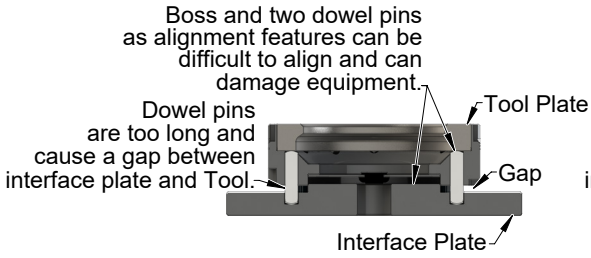
2.4 Tool Interface

The Tool plate is attached to the customer's tooling. An interface plate can adapt the Tool plate to customer tooling. Alignment features (dowel holes and a recess) accurately position and bolt holes to secure the Tool plate to customer tooling. Custom interface plates can be supplied by ATI (refer to the application drawing).

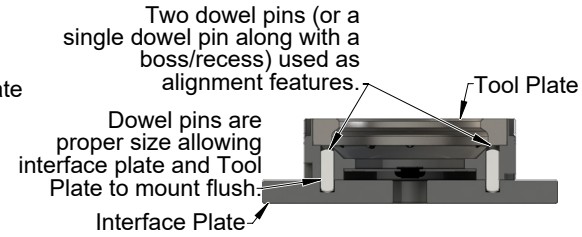
CAUTION: Do not use more than two alignment features when securing a Tool plate to an interface plate. Using more than two alignment features can cause damage to equipment. Use either two dowel pins or a single dowel pin, along with a boss/recess feature to align the Tool plate with the interface plate.

CAUTION: Do not use dowel pins that are too long or do not allow the interface plate and Tool body to mate flush. Using dowel pins that are too long will cause a gap between the interface plate and Tool body and damage the equipment. Use dowel pins that will not extend further than allowed by the Tool body.

Incorrect Mounting of Tool Plate



Correct Mounting of Tool Plate



If the customer chooses to design and build a tool interface plate, consider the following points:

- The interface plate should include bolt holes for mounting and either two dowel pins or a dowel pin and a boss for accurate positioning on the customer tooling and Tool plate. The dowel and boss features prevent unwanted rotation.
- Dowel pins must not extend out from the surface of the interface plate farther than the depth of the dowel holes in the Tool plate.
- The thickness of the interface plate must be sufficient to provide the necessary thread engagement for the mounting bolts. Fasteners should meet minimum recommended engagement lengths while not exceeding the maximum available thread depth. Use of bolts that are too long can cause damage to the tool side changer.
- The plate design must account for clearances required for Tool Changer module attachments and accessories.
- If a boss is to be used on the interface plate, a boss of proper height and diameter must be machined into the interface plate to correspond with the recess in the Tool plate.
- The interface plate must have a hole in its center for manually returning the locking mechanism to the unlocked position under adverse conditions (i.e. unintended loss of power and/or air pressure). The center access hole with a minimum diameter of 1" (25.4 mm) prevents debris from contaminating the locking mechanism. Greater protection is provided by leaving the race cover and grommet in place.

2.5 Tool Plate Installation

Tools required: *8 mm hex key*

Supplies required: *Clean rag, Loctite 242*

1. Make sure mounting surface of the Master plate and robot arm or interface plate are clean and free of debris.
2. Align the dowel pins to the corresponding holes in the Tool plate and secure the Tool plate to the tool interface plate or customer tooling with customer supplied (36) M10 socket head cap screws using an 8 mm hex key. Apply Loctite 242 to threads (see *Table 2.1* for proper fasteners and torque).

NOTICE: If an ATI interface plate is used, fasteners to mount the Tool plate are supplied with the interface plate.

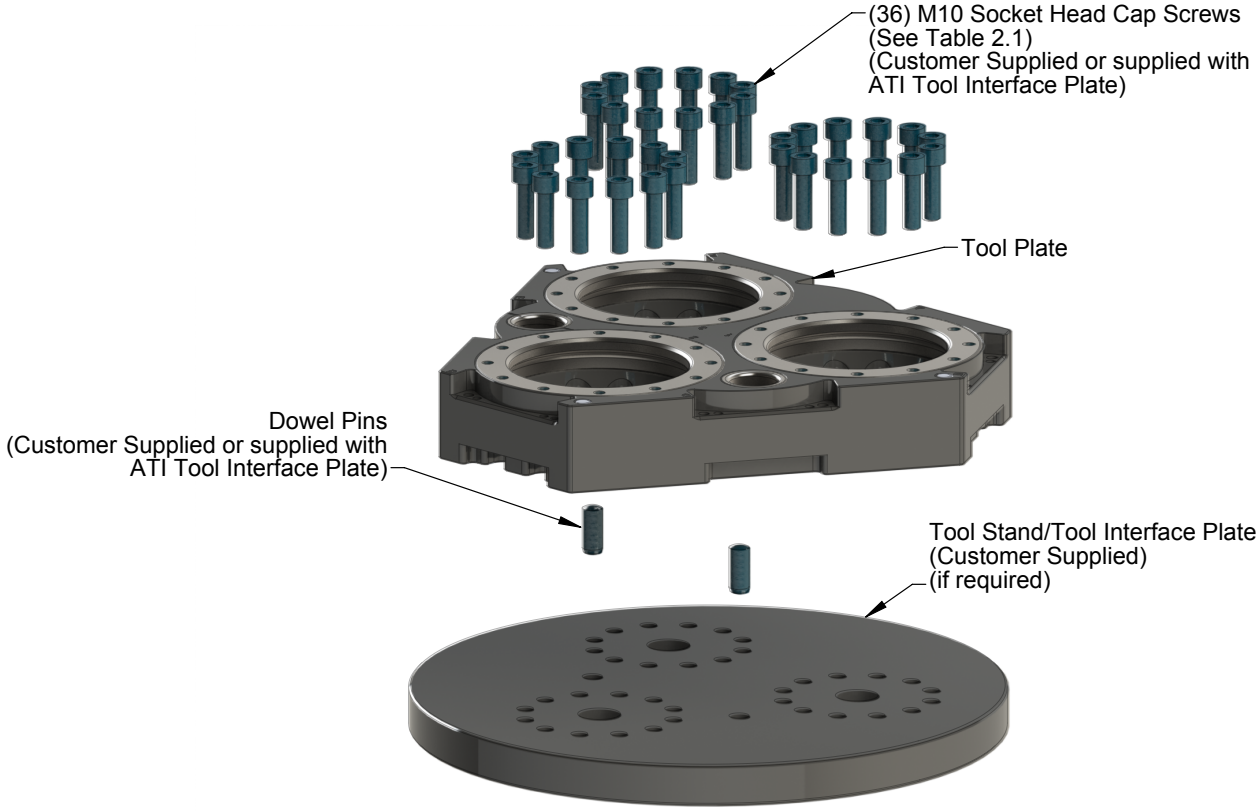
3. Connect utilities to the appropriate module and Master plate connections.
4. When installation is complete, safely resume normal operations.

2.6 Tool Plate Removal

Tools required: *8 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. If needed, disconnect all utilities (for example: electrical, pneumatic, hydraulic).
5. Remove the customer supplied (36) M10 socket head cap screws connecting the Tool plate to the tooling or tool interface plate using an 8 mm hex key.
6. Remove the Tool plate.

Figure 2.2—Tool Plate Installation



2.7 Pneumatic Connections

The air supply used for coupling and uncoupling the Tool Changer should be clean, dry, and non-lubricated. A supply pressure in the range of 70 to 100 psi is acceptable for operation of the locking mechanism, with a setting of 80 psi suggested. The air should be filtered 40 micron or better.

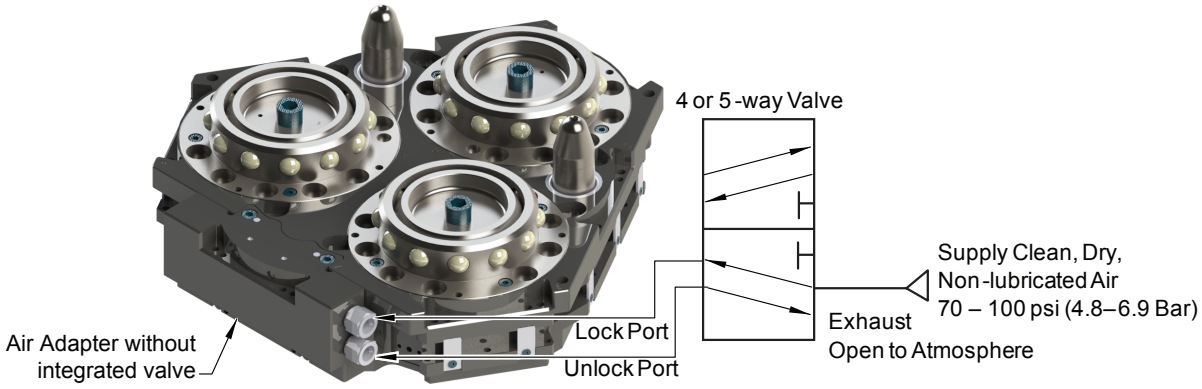
CAUTION: Do not use the Tool Changer in the fail-safe condition for extended periods of time. Do not transport the Tool Changer in the fail-safe condition. Possible damage to the locking mechanism could occur.

2.7.1 Valve Requirements and Connections for the Locking Mechanism

If utilizing an air adapter module that does not contain an integrated solenoid valve, the customer is required to supply a 2-position 4-way or 5-way valve to actuate the locking mechanisms in the Master plate. When air is supplied to the Lock or Unlock Port on the Master plate, the opposite port must be vented to the atmosphere (for example: when air is supplied to the Lock Port, the Unlock Port must be open to the atmosphere). Failure to vent trapped air or vacuum on the inactive port may hinder proper shuttling of the valve and prevent coupling and/or uncoupling from occurring.

CAUTION: The locking mechanism will not function properly when connected to a 3-way valve; a 3-way valve is incapable of venting trapped air pressure from within the Tool Changer. Trapped air pressure could result in injury of personnel or damage to the product and attached tooling. Connect the Lock and Unlock supply air to a 2-position 4-way or 5-way valve.

Figure 2.3—Lock and Unlock Pneumatic Connections



2.8 Electrical Connections

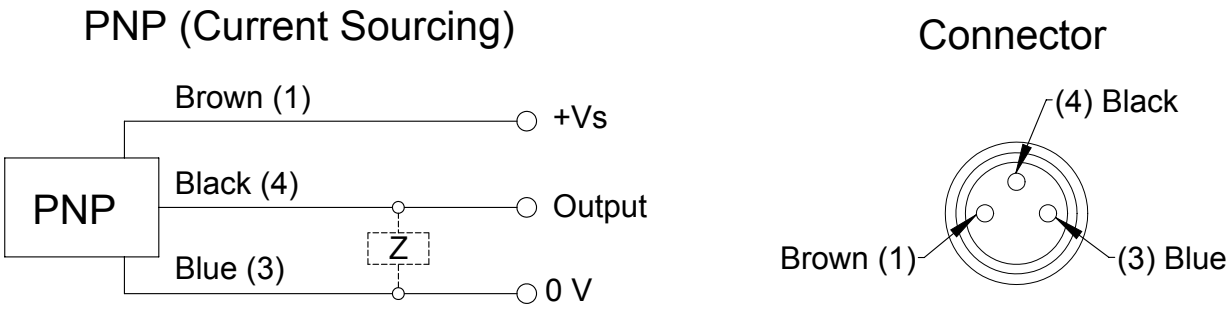
A Tool Changer is available with integrated Lock/Unlock sensors. If sensors are not used, plugs will be provided to seal the locking mechanism. If a Control/Signal module is to be utilized on Flat A when ordered, the sensors will be connected to the module prior to shipping.

2.8.1 PNP Type Lock, Unlock and RTL Sensors (-SL sensor designations)

These sensors are used on 9121-1210AM-0-0-0-0-SL.

Table 2.2—PNP (Current Sourcing)	
Description	**Value**
Voltage Supply Range	10-30VDC
Output Current	< 150 mA
Output Circuit	PNP make function (NO)

Figure 2.4—PNP Type Lock, Unlock and RTL Sensors

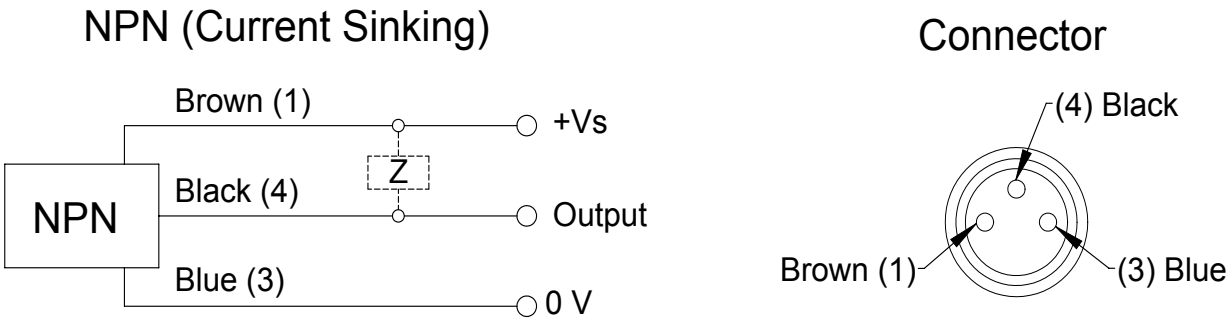


2.8.2 NPN Type Lock, Unlock and RTL Sensors (-SE sensor designations)

These sensors are used on 9121-1210AM-0-0-0-0-SE.

Table 2.3—NPN (Current Sinking)	
Description	**Value**
Voltage Supply Range	10-30VDC
Output Current	< 150 mA
Output Circuit	NPN make function (NO)

Figure 2.5—NPN Type Lock, Unlock and RTL Sensors



3. Operation

The Master locking mechanism is pneumatically driven to couple and uncouple with the bearing race on the Tool plate. The Master plate utilizes air ports from an air or air/valve adapter module to provide lock and unlock pressure to the locking mechanism.

CAUTION: Safe, reliable operation of the Tool Changer is dependent on a continuous supply of compressed air at a pressure of 70 to 100 psi. Robot motion should be halted if the air supply pressure drops below 70 psi for any reason.

The robot should be programmed to minimize misalignment during coupling and uncoupling. Additionally, the tool stand should be durable and not allow deflection under uncoupled Tool weight; should that occur, alignment of the Tool Changer plates will be taken outside of accepted offsets. For recommended maximum allowable offsets prior to coupling, see the following *Figure 3.1* and *Table 3.1*. In some cases, offsets greater than what is shown in *Table 3.1* can be accommodated by the Master and Tool plates; however, this will increase wear.

Lock-up should occur with the Master plate in the No-Touch™ locking zone (see *Table 3.1*) but without the Master plate physically in contact with the Tool plate. As locking occurs, the Master plate should draw the Tool plate into the locked position.

Figure 3.1—Offset Definitions

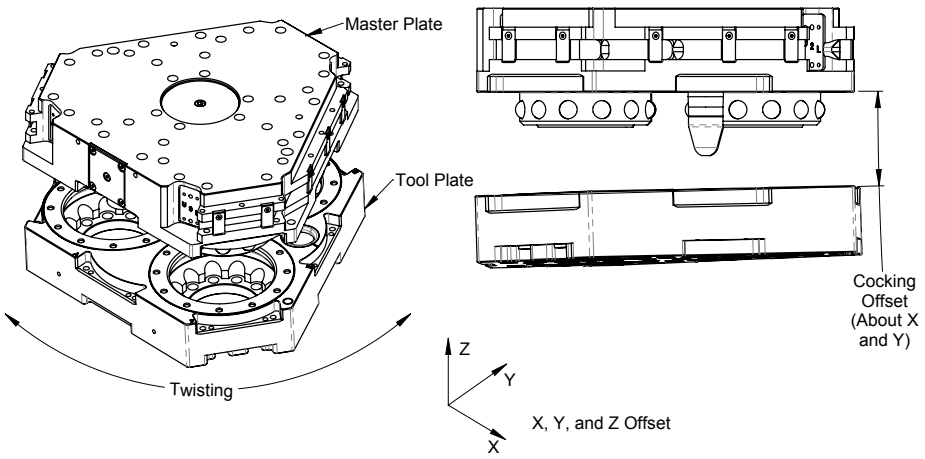


Table 3.1—Maximum Recommended Offsets Prior to Coupling

Model	No-Touch Zone Z Offset (Max)[1]	X and Y Offset (Max) [2]	Cocking Offset (Max)	Twisting Offset (Max)
QC-1210	0.04” (1 mm)	±0.08” (2 mm)	±0.7°	±1°

Notes:
1. Maximum values shown. Decreasing actual values will minimize wear during coupling/uncoupling.
2. Actual allowable values may be higher in some cases but higher offsets will increase wear during coupling.

3.1 Conditions for Coupling

The following conditions should be considered when operating the Tool Changer. For more details about programming the robot, refer to the Operation section of the Control/Signal Module Manual.

CAUTION: Do not attempt to couple the Tool Changer when in locked position. The locking mechanism must be in the unlock position when attempting to couple the Tool Changer. Failure to adhere to this condition may result in damage to the unit and/or the robot. Always unlock the Master prior to coupling to a Tool.

1. Unlock the Tool Changer by removing air pressure from the lock port and supplying air pressure to the unlock port (if equipped, the unlock sensor indicates the Tool Changer is unlocked).

NOTICE: For Tool Changers with a control/signal module and air/valve adapters with a double solenoid valve, turn the Unlatch output ON and turn the Latch output OFF. For Tool Changers with a control/signal module and air/valve adapters with a single solenoid valve, turn the Unlatch output ON. Some control/signal modules prevent the Tool Changer from being unlocked unless the Master and Tool are coupled and nested properly in the tool stand, a manual override procedure is required to unlock the Tool Changer. Refer to your Control/Signal Module Manual for instructions.

2. Position the Master above the Tool and move the Master into ready to lock position. The mating surfaces of the Master and Tool should be parallel and not touching. Make sure that the tapered alignment pins from the Master enter the alignment holes on the Tool. The alignment pins should be relatively concentric with the alignment bushings with no contact between the two.
3. It is recommended that the mating faces of the Master and Tool not be touching but be within the No-Touch distance of each other when coupling to minimize stress and wear on the locking mechanism. The locking mechanism allows the Master to “pull up” the Tool with gaps between the two sides.

CAUTION: Direct contact of the Master and Tool mating surfaces is not suggested or required just prior to coupling. Contact may result in damage to the unit and/or the robot. No-Touch locking technology allows the unit to couple with a separation distance between the Master and Tool.

4. The RTL (Ready-To-Lock) sensor and target that are built into the Tool Changer must be positioned within approximately 0.05” (1.5 mm) of each other for the sensors to detect Tool presence. RTL signals are not required to couple the Tool Changer but are recommended as a confirmation of coupling prior to removing the Tool from the tool stand.

NOTICE: At this point, communication is initiated with the ATI Tool and downstream nodes. If equipped, Tool-ID and communications become available. Depending on the type of control/signal module, additional notifications such as RTLV, TSRV, TSIV, Tool Present, Unlatch Enabled, and other notifications can provide verification of properly functioning system components.

5. Couple the Tool Changer by releasing the air pressure from the unlock port and supplying air pressure to the lock port. Air must be maintained on the lock port during operation to assure rigid coupling (if equipped, the lock sensor indicates the Tool Changer is in the locked position).

NOTICE: For Tool Changers with a control/signal module and air/valve adapters with a double solenoid valve, turn the Unlatch output OFF and turn the Latch output ON. For Tool Changers with a control/signal module and air/valve adapters with a single solenoid valve, turn the Unlatch output OFF.

6. A sufficient delay must be programmed between locking valve actuation and robot motion so that the locking process is complete before moving the robot. If equipped with Lock and Unlock sensors, the Lock signal should read “ON” (true) and the Unlock signal should read “OFF” (false).

NOTICE: If the locking mechanism has been actuated and both the Lock and Unlock signals are OFF, then a “missed tool” condition has occurred (for example, the Tool is not in the stand or is not positioned properly). **In this case an error should be generated and the robot program halted.** The situation requires manual inspection to determine the cause of the problem. Some configurations will require a manual unlock of the Master plate before attempting coupling, refer to the Control/Signal Module Manual for instructions.

NOTICE: The locking mechanism must be in the unlock state before another attempt is made to couple or damage could occur to the robot and/or the Tool Changer.

3.2 Fail-Safe Operation

A fail-safe condition occurs when there is an unintended loss of lock air pressure to the Master plate. When air pressure is lost, the Tool Changer relaxes and there may be a slight separation between the Master and Tool plates. The lock sensor may indicate that the unit is not locked. ATI’s patented fail-safe feature utilizes a multi-tapered cam to trap the ball bearings and prevent an unintended release of the Tool plate. Positional accuracy of the tooling is not maintained during this fail-safe condition. Do not operate the Tool Changer in the fail-safe condition. If source air is lost to the unit, movement should be halted until air pressure is restored.

After air pressure is re-established to the Master plate, the locking mechanism will energize and securely lock the Master and Tool plates together. In some cases when the load on the tool changer is significantly off center, it may be necessary to position the load underneath the tool changer or return the tool to the tool storage location to ensure a secure lock condition. If equipped, make sure the lock sensor indicates the Tool Changer is in the locked position before resuming normal operations. Consult your Control/Signal Module Manual for specific error recovery information.

CAUTION: Do not use the Tool Changer in a fail-safe condition. Damage to the locking mechanism could occur. Re-establish air pressure and ensure the Tool Changer is in a secure lock position before returning to normal operations.

3.3 Conditions for Uncoupling

Refer to your Air/Valve Adapter and/or Control/Signal Module Manual's Operation section for operation during coupling/uncoupling.

1. Move the robot to position the Tool plate in the tool stand. The position for coupling and uncoupling are the same.

NOTICE: Depending on the type of control/signal module, additional notifications such as TSRV, TSIV, and other notifications can provide verification of properly functioning system components.

2. Unlock the Tool Changer by releasing the air pressure from the lock port and supplying air pressure to the unlock port. The Tool Changer locking mechanism moves to the unlocked position and the Tool plate releases from the Master plate (If equipped, the unlock sensor indicates the Tool Changer is unlocked).

NOTICE: For Tool Changers with a control/signal module and air/valve adapters with a double solenoid valve, turn the Unlatch output ON and turn the Latch output OFF. For Tool Changers with a control/signal module and air/valve adapters with a single solenoid valve, turn the Unlatch output ON.

CAUTION: This Tool Changer may be equipped with a tool stand Interlock (TSI) feature that physically breaks the Unlatch solenoid circuit. Proper use of the TSI prevents unwanted Unlock software commands from being recognized until the circuit is made. Make sure the Tool Changer is positioned properly to trip actuate the TSI switch when the Tool is in the tool stand.

3. A sufficient delay must be programmed between unlocking valve actuation and robot motion so that the unlocking process is complete before moving the robot. If equipped with lock and unlock sensors, the Unlock signal should read "on" (true) and the Lock signal should read "off" (false). **Any other condition indicates a problem and the robot program should be halted.** Once the Lock and Unlock signals in the proper state, the Master plate may be moved away from the Tool plate in the axial direction.

The robot and Master plate can now proceed to another Tool plate for coupling and subsequent operations.

3.4 Tool Identification

When using multiple Tools, it is good practice to implement a Tool-ID system that identifies each Tool with a unique code. This can be used to verify that the robot has picked up the proper Tool. Modules with Tool-ID are available from ATI, refer to our Web site *http://www.ati-ia.com/products/toolchanger/tool_changer_modules.aspx* for products available or your specific application or contact ATI for recommendations and assistance.

3.5 Tool Storage Considerations

NOTICE: Improperly designed tool stands cause components to become stuck and causes excessive wear of components. Thus, carefully consider tool stand design for optimal operation of the Tool Changer. For assistance, contact an ATI representative.

When Tool plates are not in use, store the Tool plate with attached customer tooling in a tool stand. ATI provides compatible tool stands designed for durability, longevity, and maximum adaptability to fit most customers' applications. The ATI Tool Stand Large (TSL) system is compatible with ATI Tool Changer sizes QC-150 and larger. The TSL systems can be configured in a variety of arrangements and are available with additional modular accessories such as covers and tool sensing. For products available, contact an ATI representative or refer to the following ATI webpage: *http://www.ati-ia.com/products/toolchanger/toolstand/large/LargeStand.aspx*. Another resource is the *ATI TSL manual*: *https://www.ati-ia.com/App_Content/Documents/9610-20-1058.pdf*.

For some Tool Changers, ATI can provide a Teaching Aid to assist users with teaching the robot how to couple the Master with the Tool in a tool stand. For more information, refer to the *ATI Teaching Aid manual* or the *ATI webpage for Teaching Aids: https://www.ati-ia.com/products/toolchanger/TeachingAid.aspx*.

If the customer supplies the tool stand, the tool stand should include the following design considerations:

- Provide a fixed, repeatable, level, and stable position for tool pick-up and drop-off.
- Support the weight of the Tool Changer Tool plate, tool interface plate, optional modules, cables, hoses, and customer tooling without allowing deflection in excess of the offsets specified.
- (Preferred) the Tool should hang vertically in the tool stand so that gravity assists to uncouple the Tool plate from the Master plate during unlocking.
- It is possible to design tool stands that hold tools in the horizontal position, but the necessary compliance must be provided during coupling and uncoupling. In general, horizontally positioned tool stands cause more wear on the locking mechanism and locating features of the Tool Changer and tool stand. Furthermore, horizontal pick-up and drop-off of the Tool plate increases wear on the robot arm.
- A variety of methods may be used to position the Tool in the tool stand. A common method is to use tapered alignment pins and bushings. Robot programming and positional repeatability are critical aspects of successful Tool pick-up and drop-off.
- Install a debris shield to cover Tools and modules to protect them in dirty environments, such as grinding or welding. Alternatively, position tool stands in areas that are shielded from weld spatter, fluids, adhesives, or other debris.
- For proximity sensors, consider the following:
    - Install a proximity sensor that detects the presence of the Tool in the tool stand. The sensor may be used prior to coupling to ensure the Tool is seated in the stand. Sensors may also be used as the robot starts to move away after uncoupling. Sensors provide a safety measure if a Tool becomes jammed in the stand or if the Tool fails to release from the robot.
    - Position the proximity sensor so that the sensing face is vertical to prevent metal shavings, weld spatter, or other debris from falling on the sensor and creating false readings.

4. 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.

NOTICE: The cleanliness of the work environment strongly influences the trouble free operation of the Tool Changer. The dirtier the environment, the greater the need for protection against debris. Protection of the entire EOAT, the Master, the Tool and all of the modules may be necessary. Protective measures include the following:

- Placement of tool stands away from debris generators
- Covers incorporated into the tool stands
- Guards, deflectors, air curtains, and similar devices built into the EOAT and the tool stand

4.1 Preventive Maintenance

The Tool Changer and optional modules are designed for long-term functionality, provided regular maintenance is performed. A visual inspection and preventive maintenance schedule, depending on the application, is supplied in the following table. Detailed assembly drawings are provided in *Section 8—Drawings* . Refer to module sections for detailed preventive maintenance steps for all utility modules.

Table 4.1—Maintenance

Application(s)	Tool Change Frequency	Inspection Schedule
General Usage Material Handling Docking Station	> 1 per minute	Weekly
	< 1 per minute	Monthly
Welding/Servo/Deburring, Foundry Operations (Dirty Environments)	All	Weekly

Checklist

Mounting Fasteners

- ☐ Inspect fasteners for proper torque, interferences, and wear. Tighten and correct as required. Refer to *Table 2.1 — Fastener Size, Class, and Torque Specifications.*

Ball Bearings/Alignment Pins/Bushings/Bearing Race

- ☐ Inspect for wear and proper lubrication. MobilGrease XHP222 Special a NLGI #2 lithium complex grease with molybdenum disulfide additive is suggested for locking mechanism and alignment pin lubrication. Over time, lubricants can become contaminated with debris; therefore, it is recommended to thoroughly clean the existing grease and replace with new as needed. See *Section 4.2—Cleaning and Lubrication of the Locking Mechanism and Alignment Pins.*
- ☐ Inspect for excessive alignment pin/bushing wear—possibly an indication of misaligned robot position during pickup/drop-off. Check tool stand for wear and alignment problems. To replace worn alignment pins, refer to *Section 5.2.2.4—Alignment Pin Replacement.*
- ☐ Inspect for wear on the ball bearings/bearing race—possibly an indication of excessive loading.

Sensors and Cables

- ☐ Inspect sensor cable connectors for tightness. If loose, tighten connections.
- ☐ Inspect sensor cables for any damage, cuts, and abrasion. Replace as necessary. Refer to *Section 5.2.1—Lock and Unlock Sensor and Sensor Cable Replacement*.

Hoses

- ☐ Inspect hose connection for tightness and leaks. If leaking or loose, secure hose connection.
- ☐ Inspect hoses for interferences, abrasions, cuts, and leaks. Replace as necessary.

Electrical Contacts/Pin Block (Modules)

- ☐ Inspect for damage, debris, and stuck/burnt pins. Clean pin blocks as necessary, Refer to *Section 4.3—Pin Block Inspection and Cleaning.*

Seals (Modules)

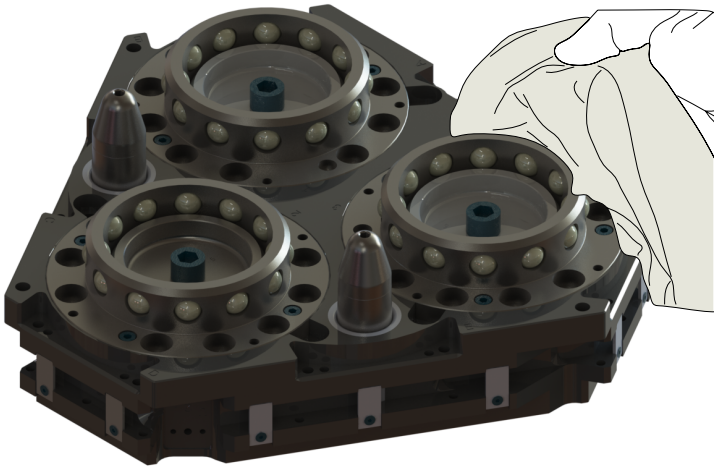
- ☐ Inspect for wear, abrasion, and cuts. Refer to *Section 5.2.3—Seal Inspection and Replacement*

4.2 Cleaning and Lubrication of the Locking Mechanism and Alignment Pins

Supplies required: *Clean rag, MobilGrease® XHP222 Special Grease*

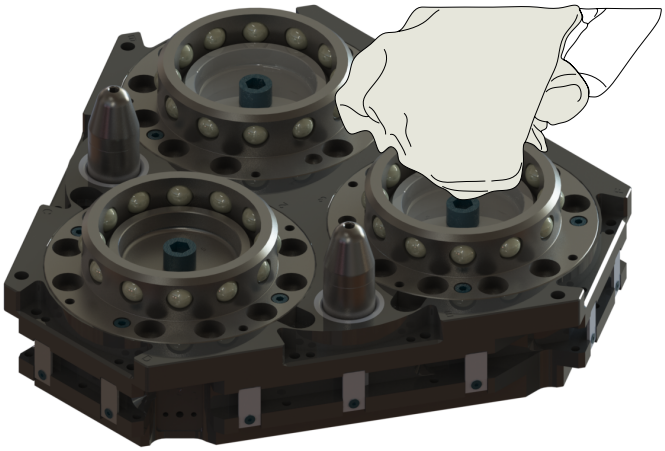
1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Use a clean rag to thoroughly remove any lubricant and debris from the ball bearings, male coupling, cam, and alignment pins.

Figure 4.1—Cleaning Ball Bearings and Outer Surfaces of Male Coupling



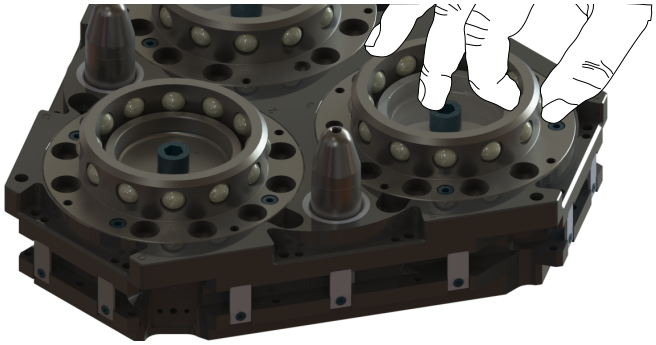
5. Use a clean rag to thoroughly remove any lubricant and debris from the inner surface of the male coupling and cam.

Figure 4.2—Cleaning Ball Bearings, Cam and Inner Surfaces of Male Coupling



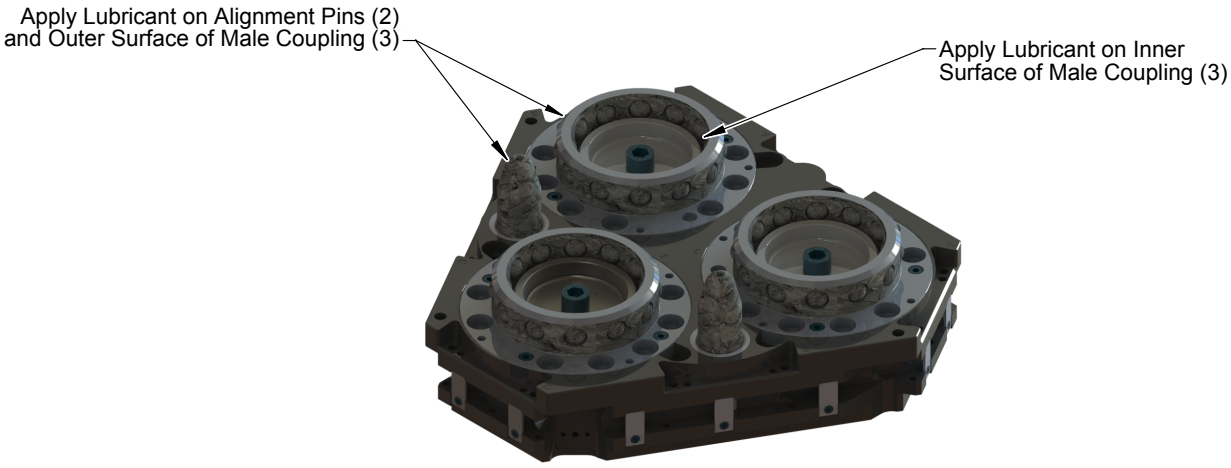
6. Check each ball bearing to make sure it moves freely in the male coupling. Additional cleaning may be necessary to free up any ball bearings that are sticking in place.

Figure 4.3—Check Ball Bearing Movement



7. Apply a liberal coating of lubricant to the ball bearings, the male coupling (inside and out), and the alignment pins.

Figure 4.4—Apply Lubricant to Locking Mechanism

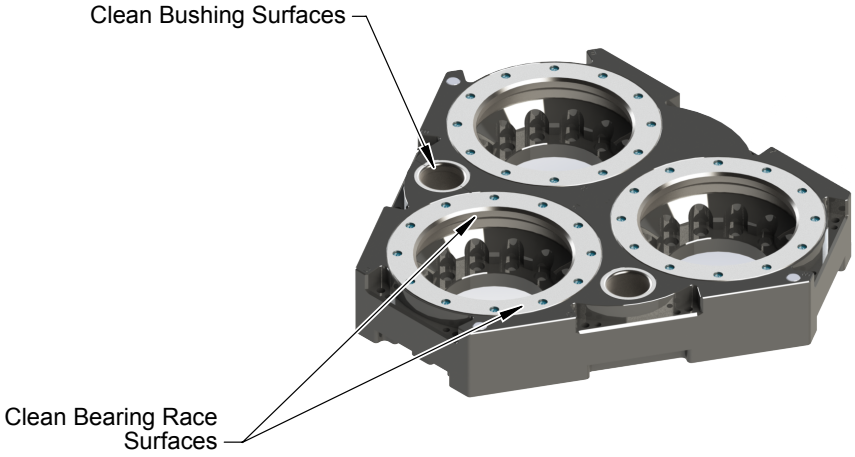


8. Use a clean rag to thoroughly remove any lubricant and debris from the Tool plate bearing race and bushings.

NOTICE: No application of lubrication is necessary on the Tool plate components.

9. Safely resume normal operation.

Figure 4.5—Clean Tool Plate Surfaces of locking Mechanism



4.3 Pin Block Inspection and Cleaning

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

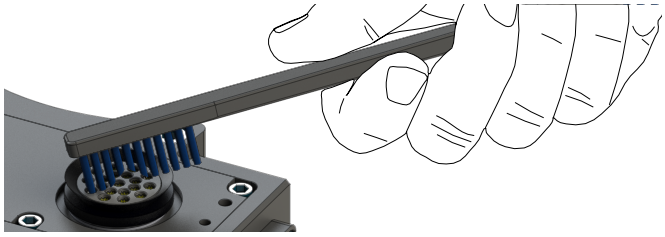
1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Inspect the Master and Tool pin blocks for debris or darkened pins.

Figure 4.6—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).

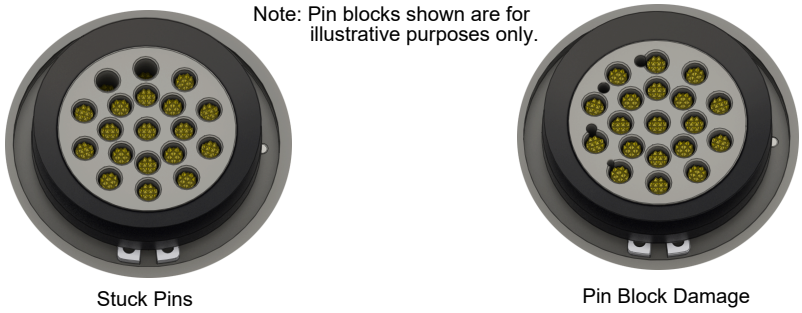
NOTICE: Do not use an abrasive media and/or cleaners or solvents to clean the contact pins. Using abrasive media and/or cleaners or solvents will cause damage to the contact surface or cause pins to stick. Clean contact surfaces with a vacuum or non-abrasive media such as a nylon brush (ATI part number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

Figure 4.7—Clean Pin Blocks with a Nylon Brush



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

Figure 4.8—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

The following section provides troubleshooting and service information to help diagnose conditions and repair the Tool Changer or control/signal module.

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 (e.g. 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

The troubleshooting table is provided to assist in diagnosing issues that may cause the Tool Changer not to function properly.

Table 5.1—Troubleshooting

Symptom	Cause	Resolution
Tool Changer will not lock and/or unlock (or Lock sensor does not indicate Tool Changer is Locked)	Insufficient or no air pressure supply to the lock or unlock ports.	Verify proper air pressure and pneumatic valve is supplied. Refer to *Section 2.7—Pneumatic Connections.*
	Air pressure trapped in de-energized Lock or Unlock ports.	Air pressure must be vented to the atmosphere properly, refer to *Section 2.7—Pneumatic Connections* or refer to the troubleshooting section of the air/valve adapter manual for more information.
	Pneumatic connections loose or damaged, solenoid cable damaged.	Refer to the air/valve adapter manual for more information.
	Debris caught between the Master and Tool plates.	Clean debris from between Master and Tool plates. Verify mounting fasteners is secure and does not protrude above the mating surfaces.
	The ball bearings and/or cam are not moving freely in the male coupling.	Clean and lubricate as needed to restore smooth operation (see *Section 4.2—Cleaning and Lubrication of the Locking Mechanism and Alignment Pins*)
	The Master plate and Tool plate are not within the specified No-Touch zone when attempting to lock.	Check that the Tool is properly seated in the tool stand. Refer to *Section 3.5—Tool Storage Considerations.* Re-teach the robot to bring the Master plate and Tool plate closer together prior to attempting to lock.
	The control/signal module or air/valve adapter is not operating correctly.	Check the troubleshooting section of the manual for the specific module.
Unit is locked but Lock signal does not read “on”.	Lock sensor/cable is damaged.	Replace the lock sensor assembly as necessary. Refer to *Section 5.2.1—Lock and Unlock Sensor and Sensor Cable Replacement.*
Unit is unlocked but unlock signal does not read “on”	Unlock sensor/cable is damaged.	Replace the unlock sensor assembly as necessary. Refer to *Section 5.2.1—Lock and Unlock Sensor and Sensor Cable Replacement.*
Ready-To-Lock (RTL) does not read “on” when Master and Tool plates are mated.	Ready-To-Lock (RTL) sensors not activated indicating Tool is not positioned properly.	Re-teach the robot to bring the Master plate and Tool plate closer together prior to attempting to lock. Refer to *Section 3—Operation* Check that both RTL sensors and cables are not damaged and sensor connection to the control/signal module or air adapter are tight. Replace damaged RTL sensors as necessary. Refer to *Section 5.2.2—Ready-to-Lock Sensor and Cable Replacement* .
Units Equipped with Electrical/Servo/Control/Signal Modules		
Loss of Communication	Debris in and around contact pins. Contact Pin worn or damaged.	Inspect V-ring seal for damage, replace damaged seal. Refer to *Section 4.3—Pin Block Inspection and Cleaning*
	Cable connections loose or cables damaged	Check that cable connection are secure and cables are not damaged.

5.2 Service Procedures

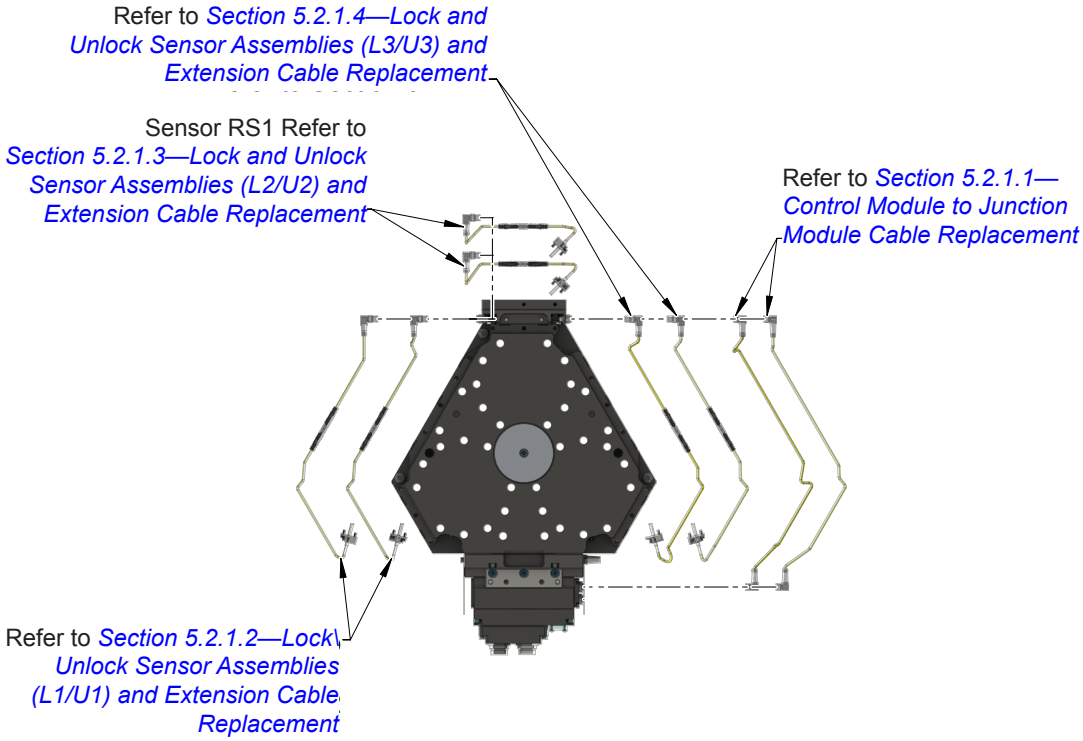
Component replacement procedures are provided in the following section.

5.2.1 Lock and Unlock Sensor and Sensor Cable Replacement

The proximity sensors are designed for reliability and therefore, should not require frequent replacement. If problems arise, examine all other possible solutions before replacing the sensor. Check continuity, air supply, lubrication, pneumatic components, etc. For links to sensor and sensor cable replacement, refer to *Figure 5.1*.

CAUTION: The lock and unlock sensor assemblies are precision aligned and permanently assembled at the factory. Do not attempt to disassemble and rebuild.

Figure 5.1—Lock and Unlock Sensors and Sensor Cable Replacement



5.2.1.1 Control Module to Junction Module Cable Replacement

Refer to *Figure 5.2*

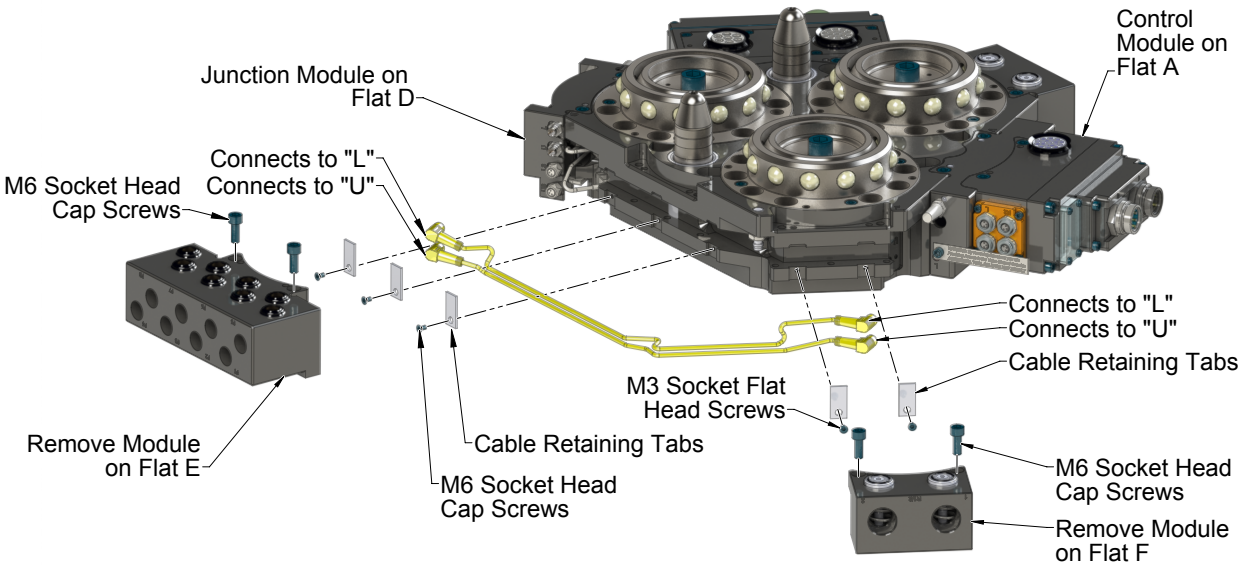
Parts required: *Section 6—Serviceable Parts*

Tools required: *2 mm and 5 mm hex key, electrical tester*

Supplies required: *Clean rag, Loctite 242*

1. Place the Tool in a secure location.
2. Inspect the sensor cable for damage, check the cable continuity, check the cable connection. If loose, reconnect the cable, go to step *20* to confirm sensor operation. If cable is damaged, continue with this procedure.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Disconnect the cable connectors from the control/signal module on Flat A.
5. Disconnect the cable connectors from the junction module on Flat D.
6. If there is an optional module on Flat E and/or Flat F, remove the (2) M6 socket head cap screws securing the module(s) to the Tool Changer body using a 5 mm hex key.
7. If equipped, lift off the optional modules from Flat E and/or Flat F.
8. Using a 2 mm hex key, remove the (3) M3 socket flat head cap screws and (3) cable retaining tabs on Flat E of the Tool Changer body.
9. Using a 2 mm hex key, remove the (2) M3 socket flat head cap screws and (2) cable retaining tabs on Flat F of the Tool Changer body.
10. Remove the cable(s) from the cable channel of the Tool Changer body. Discard the damaged cable.

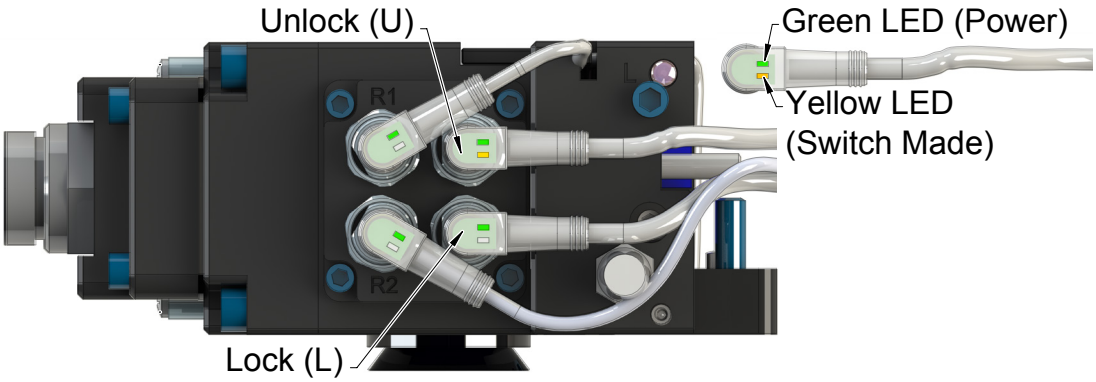
Figure 5.2—Control/Signal Module to Junction Module Cable Replacement



11. Route the new cable into the cable channel of the Tool Changer body.
12. Connect the cable connectors to the junction module on Flat D.
13. Connect the cable connectors to the control/signal module on Flat A.

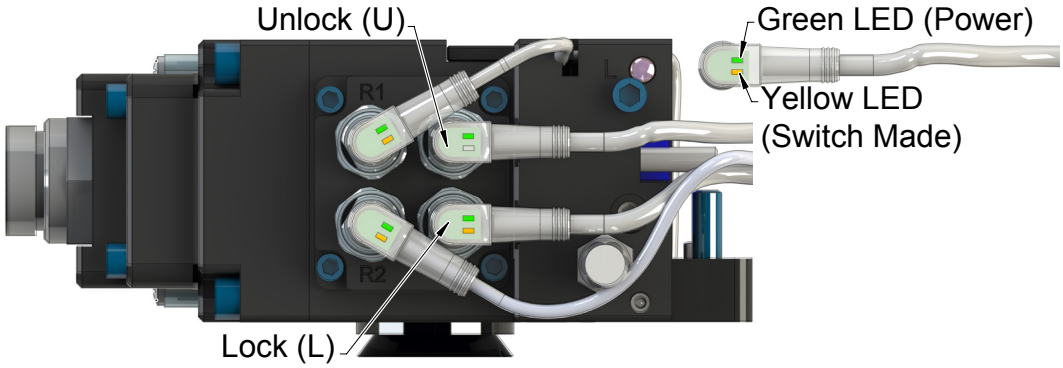
14. Secure the cables to Flat F using the (2) M3 socket flat head cap screws and (2) cable retaining tabs. Tighten to contact using a 2 mm hex key.
15. Secure the cables to Flat E using the (3) M3 socket flat head cap screws and (3) cable retaining tabs. Tighten to contact using a 2 mm hex key.
16. If optional modules were installed on Flats E and/or Flat F, install modules.
17. If fasteners do not have pre-applied adhesive, apply Loctite 242 to the M6 socket head cap screws.
18. Install the (2) M6 socket head cap screws securing the module to the Tool Changer body using a 5 mm hex key. Tighten to 70 in-lbs (7.9 Nm).
19. Safely resume normal operation.
20. Confirm the operation of the unlock sensor by unlocking the Tool Changer and then checking to see if the unlock sensor cable LED is on.

Figure 5.3—Unlock Sensor Cable LEDs



21. Confirm the operation of the Lock sensor by locking the Tool Changer and then checking to see if the lock sensor cable LED is on.

Figure 5.4—Lock Sensor Cable LEDs



5.2.1.2 Lock\Unlock Sensor Assemblies (L1/U1) and Extension Cable Replacement

Refer to *Figure 5.5*

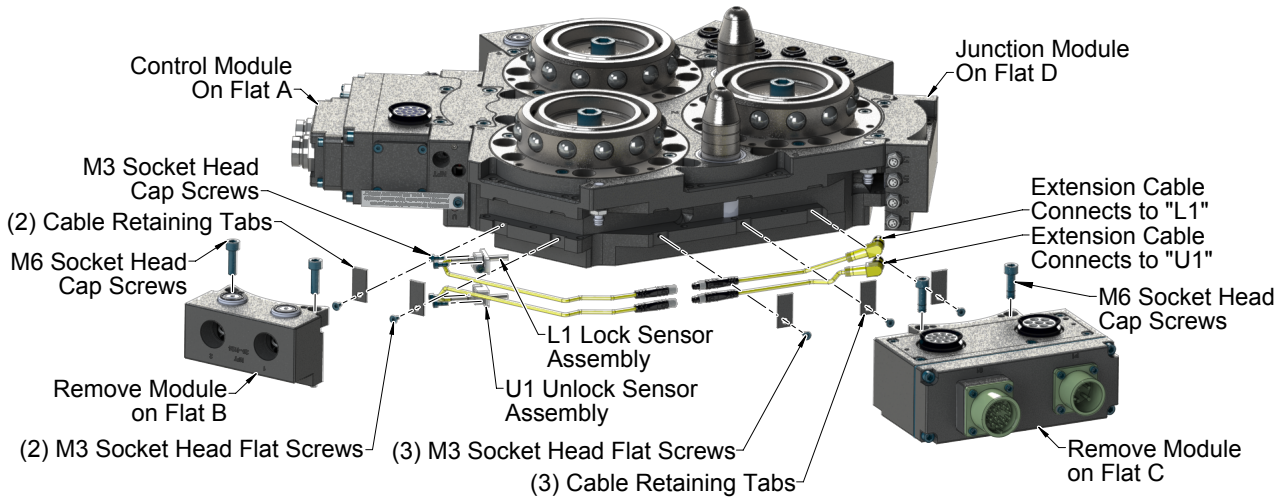
Parts required: *Section 6—Serviceable Parts*

Tools required: *2 mm, 2.5 mm, and 5 mm hex key, electrical tester*

Supplies required: *Clean rag, Loctite 242*

1. Place the Tool in a secure location.
2. Inspect the sensor cable for damage, check the cable continuity, check the cable connection. If loose reconnect the cable, go to step *26* to confirm sensor operation. If cable is damaged, continue with this procedure.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. If there is an optional module on Flat B and/or Flat C, remove the (2) M6 socket head cap screws securing the module(s) to the Tool Changer body using a 5 mm hex key.
5. If equipped, lift off the optional modules from Flat B and/or Flat C.
6. Using a 2 mm hex key, remove the (3) M3 socket flat head cap screws and (3) cable retaining tabs on Flat C of the Tool Changer body.
7. Disconnect the extension cables from the lock/unlock sensor assemblies.
8. If replacing the sensor assemblies, continue with procedure. If replacing the extension cables, continue to Step *17*.
9. Using a 2 mm hex key, remove the (2) M3 socket flat head cap screws and (2) cable retaining tabs on Flat B of the Tool Changer body.
10. Using a 2.5 mm hex key, remove the (2) M3 socket head cap screws that secure the lock and/or unlock sensor assembly to the Tool Changer body.

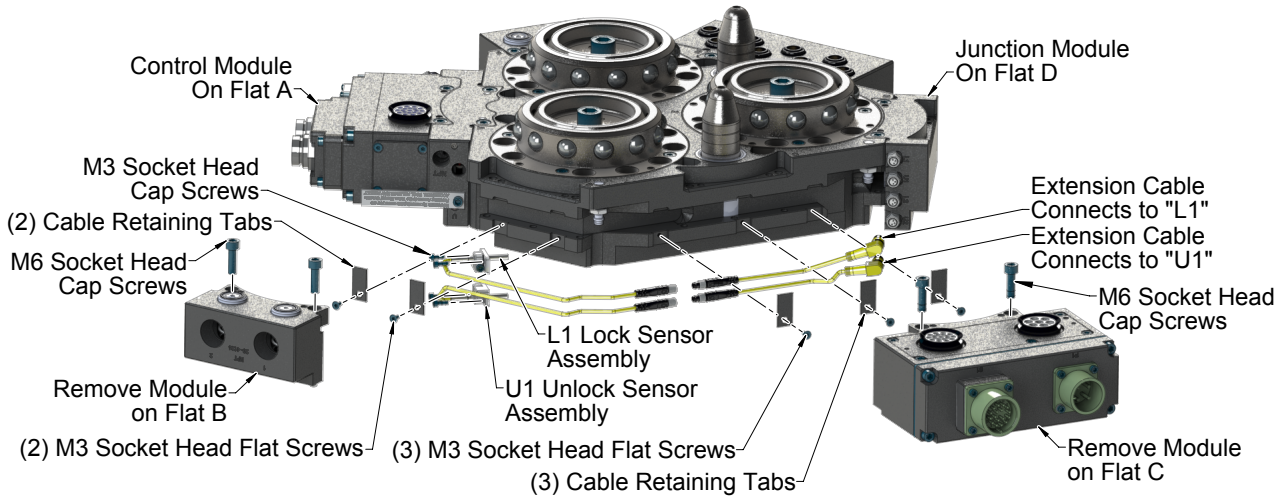
Figure 5.5—Lock and Unlock Sensor Assemblies (L1/U1) Replacement



11. Pull the sensor assembly straight out from the Tool Changer body to remove the Lock and/or Unlock sensor assembly from the cable channel of the Tool Changer body. There is an O-ring around the cylinder barrel, ensure O-ring came off with old sensor before continuing. Discard the removed sensor assembly.

12. Install the new lock and/or unlock sensor assembly, routing the cable into the cable channel of the Tool Changer body.
13. Connect the lock and/or unlock sensor cable connectors to the proper extension cable on Flat C.
14. Insert the lock and/or unlock sensor assembly into the Tool Changer body as shown in *Figure 5.5.* Ensure that new O-ring is in place before inserting sensor.
15. Secure the sensor assembly with the (2) M3 socket head cap screws using a 2.5 mm hex key. Tighten to 12 in-lbs (1.4 Nm).
16. Secure the cables to Flat B using the (2) M3 socket flat head cap screws and (2) cable retaining tabs. Tighten to contact using a 2 mm hex key. Continue to Step *21.*
17. Disconnect the extension cable from the connectors on the junction module (Flat D) and from the lock and unlock sensor assemblies.
18. Connect the new extension cable connectors to the proper lock and unlock sensor assembly on Flat C.
19. Connect the new extension cable connectors to the proper connections on the junction module (Flat D).
20. Route the new extension cable into the cable channel of the Tool Changer body.
21. Secure the cables to Flat C using the (3) M3 socket flat head cap screws and (3) cable retaining tabs. Tighten to contact using a 2 mm hex key.
22. If optional modules were removed from Flat B and/or Flat C, install modules.
23. If fasteners do not have pre-applied adhesive, apply Loctite 242 to the M6 socket head cap screws fasteners.
24. Install the (2) M6 socket head cap screws securing the module to the Tool Changer body using a 5 mm hex key. Tighten to 70 in-lbs (7.9 Nm).

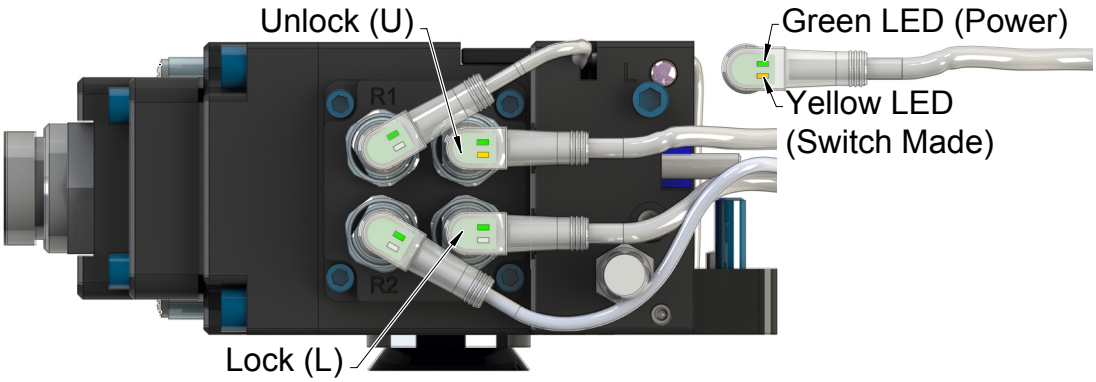
Figure 5.6—Lock and Unlock Sensor Assemblies (L1/U1) Replacement



25. Safely resume normal operation.

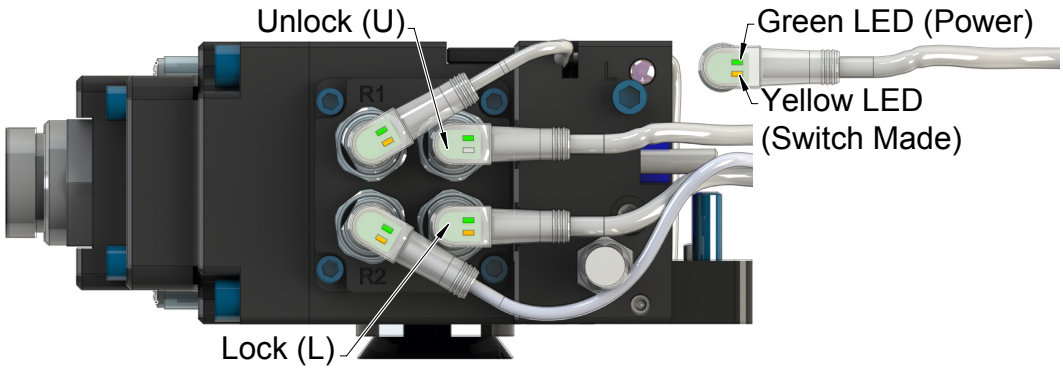
26. Confirm the operation of the unlock sensor by unlocking the Tool Changer and then checking to see if the unlock sensor cable LED is on.

Figure 5.7—Unlock Sensor Cable LEDs



27. Confirm the operation of the lock sensor by locking the Tool Changer and then checking to see if the lock sensor cable LED is on.

Figure 5.8—Lock Sensor Cable LEDs



5.2.1.3 Lock and Unlock Sensor Assemblies (L2/U2) and Extension Cable Replacement

Refer to *Figure 5.9*

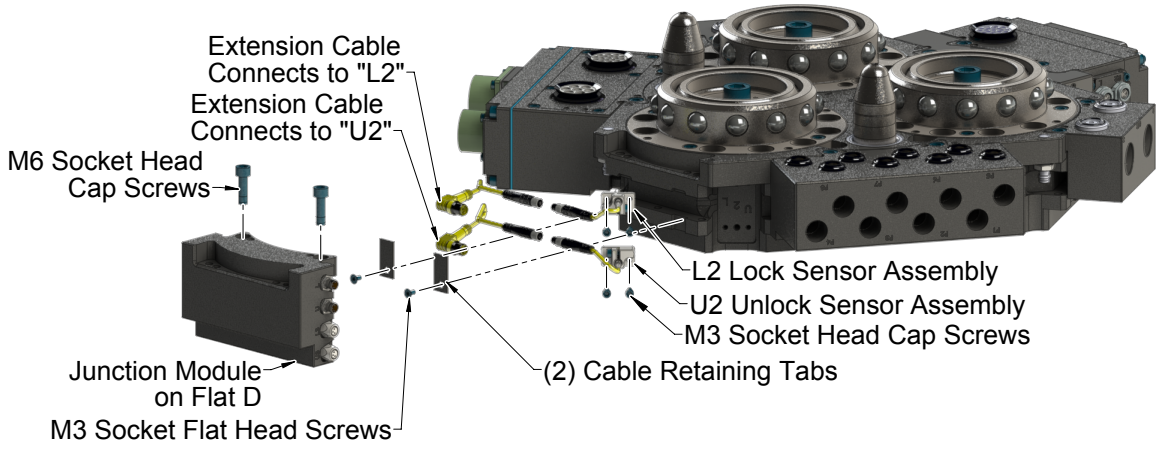
Parts required: *Section 6—Serviceable Parts*

Tools required: *2 mm, 2.5 mm and 5 mm hex key, electrical tester*

Supplies required: *Clean rag, Loctite 242*

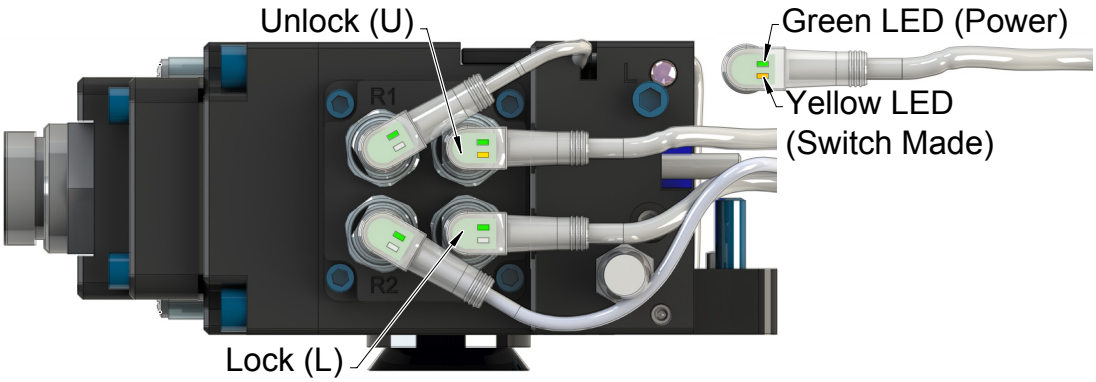
1. Place the Tool in a secure location.
2. Inspect the sensor cable for damage, check the cable continuity, check the cable connection. If loose reconnect the cable, go to step *26* to confirm sensor operation. If cable is damaged, continue with this procedure.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Using a pen or marker, mark the cable connections with the corresponding connectors on the junction module (Flat D), for ease of reassembly.
5. Disconnect all the cable connections from the junction module (Flat D).
6. Using a 5 mm hex key, remove the (2) M6 socket head cap screws securing the junction module to the Flat D of the Tool Changer body.
7. Lift off the junction module from Flat D.
8. Using a 2 mm hex key, remove the (2) M3 socket flat head cap screws and (2) cable retaining tabs on Flat D of the Tool Changer body.
9. Disconnect the cable extensions from the lock and/or unlock sensor assemblies.
10. If replacing the sensor assemblies, continue with procedure. If replacing the extension cables, continue to Step *15*.
11. Using a 2.5 mm hex key, remove the (2) M3 socket head cap screws that secure the lock and/or unlock sensor assembly to the Tool Changer body.
12. Pull the sensor assembly straight out from the Tool Changer body.
13. Remove the lock and/or unlock sensor assembly from the cable channel of the Tool Changer body. There is an O-ring around the cylinder barrel, ensure O-ring came off with old sensor before continuing. Discard the removed sensor assembly.

Figure 5.9—Lock and Unlock Sensor Assemblies (L2/U2) Replacement



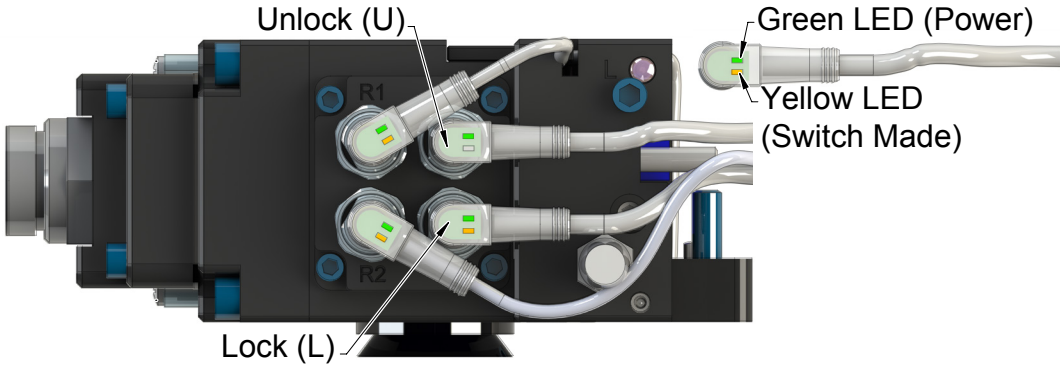
14. Insert the lock and/or unlock sensor assembly into the Tool Changer body as shown in *Figure 5.9*. Ensure that new O-ring is in place before inserting sensor.
15. Secure the sensor assembly with the (2) M3 socket head cap screws using a 2.5 mm hex key. Tighten to 12 in-lbs (1.4 Nm). Go to step *17*.
16. Replace old extension cables with new extension cable.
17. Connect the cable connectors to the proper cable.
18. Route the cables into the cable channel of the Tool Changer body.
19. Secure the cables to Flat D using the (2) M3 socket flat head cap screws and (2) cable retaining tabs. Tighten to contact using a 2 mm hex key.
20. Install the junction module on Flat D.
21. If fasteners do not have pre-applied adhesive, apply Loctite 242 to the M6 socket head cap screws fasteners.
22. Install the (2) M6 socket head cap screws securing the module to the Tool Changer body using a 5 mm hex key. Tighten to 70 in-lbs (7.9 Nm).
23. Connect all cable connection to corresponding connectors on the junction module, as previously marked.
24. Safely resume normal operation.
25. Confirm the operation of the unlock sensor by unlocking the Tool Changer and then checking to see if the unlock sensor cable LED is on.

Figure 5.10—Unlock Sensor Cable LEDs



26. Confirm the operation of the lock sensor by locking the Tool Changer and then checking to see if the lock sensor cable LED is on.

Figure 5.11—Lock Sensor Cable LEDs



5.2.1.4 Lock and Unlock Sensor Assemblies (L3/U3) and Extension Cable Replacement

Refer to *Figure 5.12*

Parts required: *Section 6—Serviceable Parts*

Tools required: *2 mm, 2.5 mm and 5 mm hex key, electrical tester*

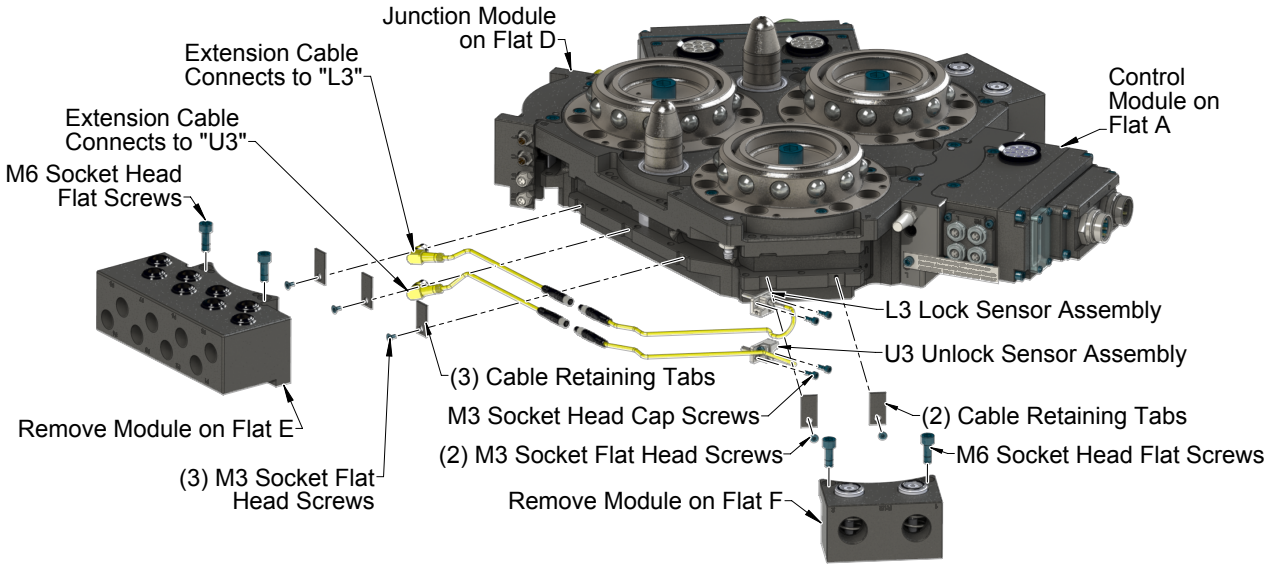
Supplies required: *Clean rag, Loctite 242*

1. Place the Tool in a secure location.
2. Inspect the sensor cable for damage, check the cable continuity, check the cable connection. If loose reconnect the cable, go to step *26* to confirm sensor operation. If cable is damaged, continue with this procedure.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).

NOTICE: If replacing the extension cable only remove the module from Flat E.

4. If there is an optional module on Flat E and/or Flat F, remove the (2) M6 socket head cap screws securing the module(s) to the Tool Changer body using a 5 mm hex key.
5. If equipped, lift off the optional modules from Flat E and/or Flat F.
6. Using a 2 mm hex key, remove the (3) M3 socket flat head cap screws and (3) cable retaining tabs on Flat E of the Tool Changer body.
7. Disconnect the cable extensions from the lock and unlock sensor assemblies.
8. If replacing the sensor assemblies, continue to Step *10*. If replacing the extension cables, continue to step *16*.
9. Using a 2 mm hex key, remove the (2) M3 socket flat head cap screws and (2) cable retaining tabs on Flat F of the Tool Changer body.
10. Using a 2.5 mm hex key, remove the (2) M3 socket head cap screws that secure the lock and/or unlock sensor assembly to the Tool Changer body.

Figure 5.12—Lock and Unlock Sensor Assemblies (L3/U3) Replacement

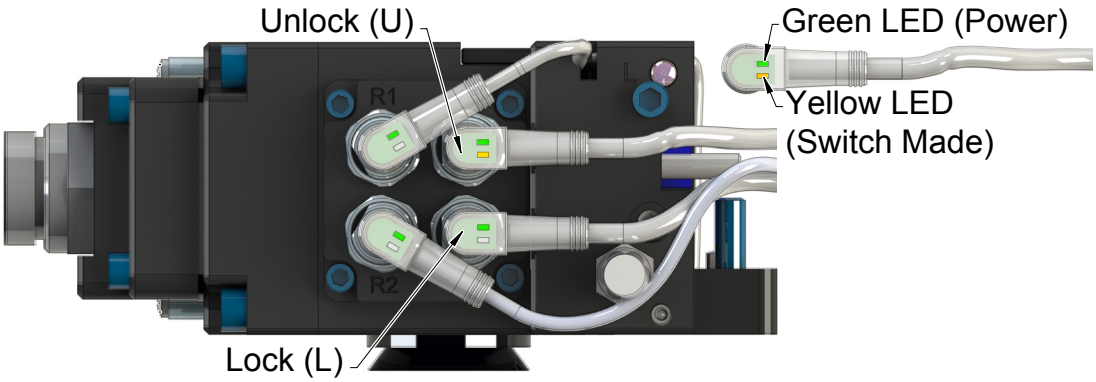


11. Pull the sensor assembly straight out from the Tool Changer body.
12. Remove the lock and/or unlock sensor assembly from the cable channel of the Tool Changer body. There is an O-ring around the cylinder barrel, ensure O-ring came off with old sensor before continuing. Discard the removed sensor assembly.
13. Install the new lock and/or unlock sensor assembly, routing the cable into the cable channel of the Tool Changer body.
14. Insert the lock and/or unlock sensor assembly into the Tool Changer body as shown in *Figure 5.12*. Ensure that new O-ring is in place before inserting sensor. Go to step *17*.
15. Secure the cables to Flat F using the (2) M3 socket flat head cap screws and (2) cable retaining tabs. Tighten to contact using a 2 mm hex key.
16. Disconnect the extension cable from the junction module Flat D, remove and discard old cable.
17. Connect new extension cable to the proper connector on the junction module on Flat D.
18. Connect the extension cable to the lock and/or unlock sensor assembly and route the cable into the cable channel in the Tool Changer body (Flat E).
19. Secure the cables to Flat F using the (2) M3 socket flat head cap screws and (2) cable retaining tabs. Tighten to contact using a 2 mm hex key.
20. Secure the cables to Flat E using the (3) M3 socket flat head cap screws and (3) cable retaining tabs. Tighten to contact using a 2 mm hex key.
21. If optional modules were installed on Flats E and/or Flat F, install modules.
22. If fasteners do not have pre-applied adhesive, apply Loctite 242 to the M6 socket head cap screws fasteners.
23. Install the (2) M6 socket head cap screws securing the module to the Tool Changer body using a 5 mm hex key. Tighten to 70 in-lbs (7.9 Nm).

24. Safely resume normal operation.

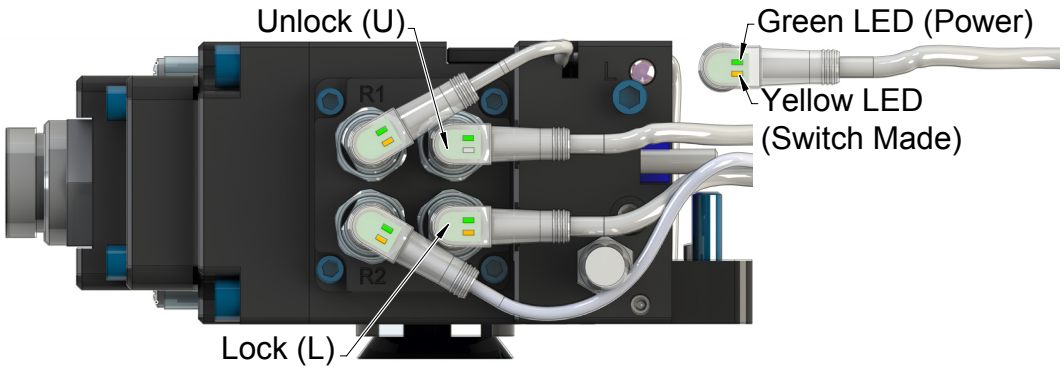
25. Confirm the operation of the unlock sensor by unlocking the Tool Changer and then checking to see if the unlock sensor cable LED is on.

Figure 5.13—Unlock Sensor Cable LEDs



26. Confirm the operation of the lock sensor by locking the Tool Changer and then checking to see if the lock sensor cable LED is on.

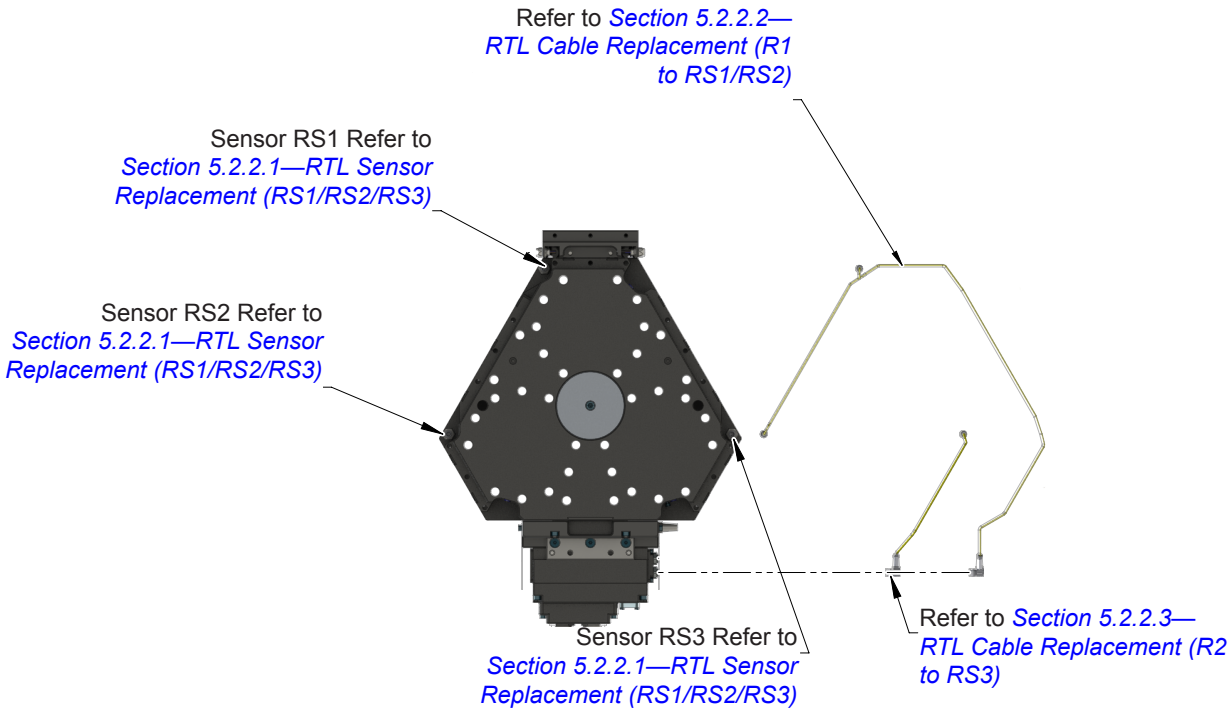
Figure 5.14—Lock Sensor Cable LEDs



5.2.2 Ready-to-Lock Sensor and Cable Replacement

The proximity sensors are very reliable and normally do not need to be replaced. Exhaust all other possible solutions, check continuity, air supply, lubrication, and pneumatic components prior to testing or replacing the sensor. For links to sensor and sensor cable replacement, refer to *Figure 5.15*.

Figure 5.15—Sensors and Sensor Cable Replacement



5.2.2.1 RTL Sensor Replacement (RS1/RS2/RS3)

Refer to *Figure 5.18*

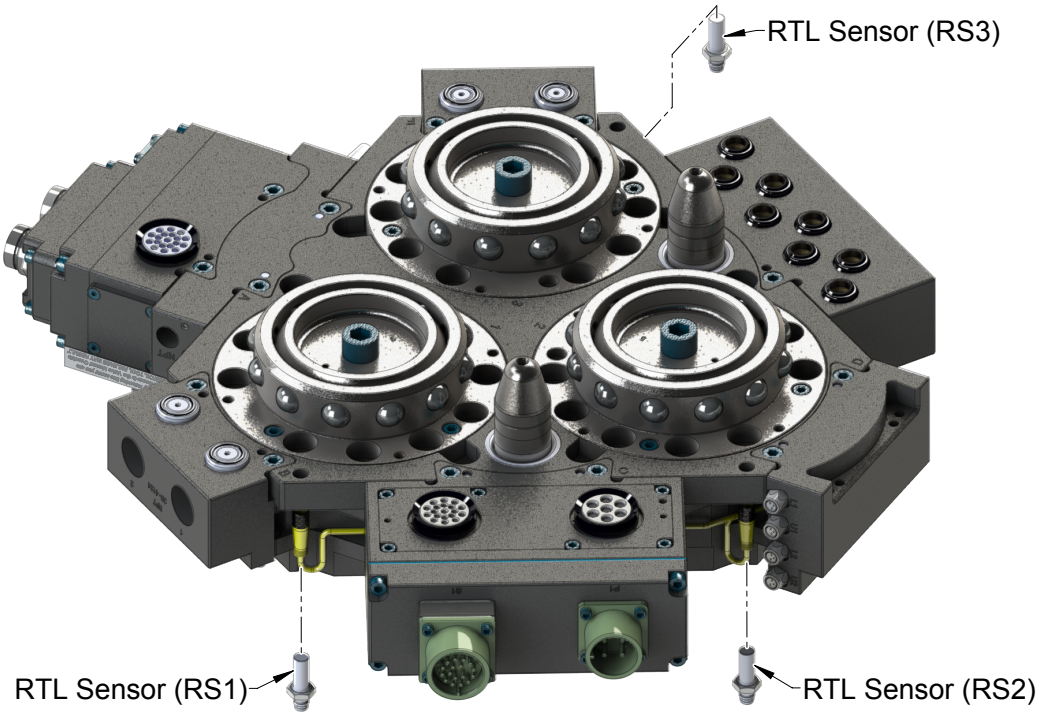
Parts required: *Section 6—Serviceable Parts*

Tools required: *1/2” hex key*

Supplies required: *Clean rag, Loctite 222*

1. Inspect the sensor cable for damage, check the cable continuity, check the cable connection. If loose reconnect the cable, if damaged replace the cable and test functionality. Go to step *12* to confirm sensor operation.
2. Place the Tool in a secure location.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Disconnect the RTL sensor cable from the sensor.
5. Loosen the jam nut securing the sensor to the Tool Changer body.
6. Unscrew the RTL sensor from the Tool Changer body.
7. Discard the removed RTL sensor.

Figure 5.16—RTL Cable Replacement (R1 to RS1/RS2)

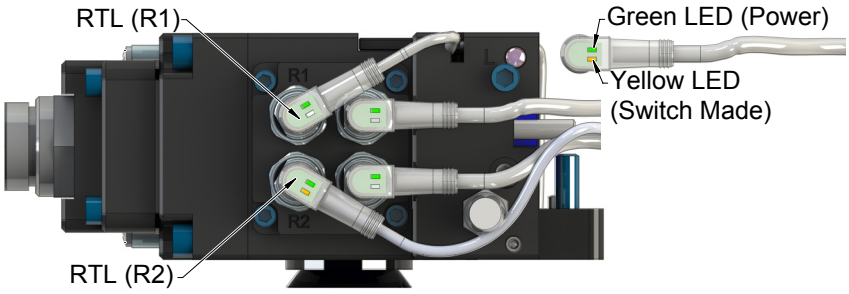


8. Apply Loctite 222 to and screw the new RTL sensor into the Tool Changer body until the face of the sensor is flush with the surrounding face of the Master body.
9. Using a 1/2” hex key, tighten the jam nut securing the sensor to the Tool Changer body. Torque to 20 in-lbs (2.3 Nm).
10. Connect the RTL sensor cables the new sensor.
11. Safely resume normal operation.

12. Confirm the operation of the RTL sensor by bringing a metallic object into close proximity to the face of the sensor and watching for the LED in the body of the sensor to light up.

NOTICE: Some control/signal modules supply power to the RTL sensors in series. The RTL (R2) sensor will have to be switched before power is supplied to the RTL (R1) sensor. If this is the case bring a metallic object into close proximity of both the RTL (R1 and R2) sensor.

Figure 5.17—RTL (R1 and R2) Sensor Cable LEDs



5.2.2.2 RTL Cable Replacement (R1 to RS1/RS2)

Refer to *Figure 5.18*

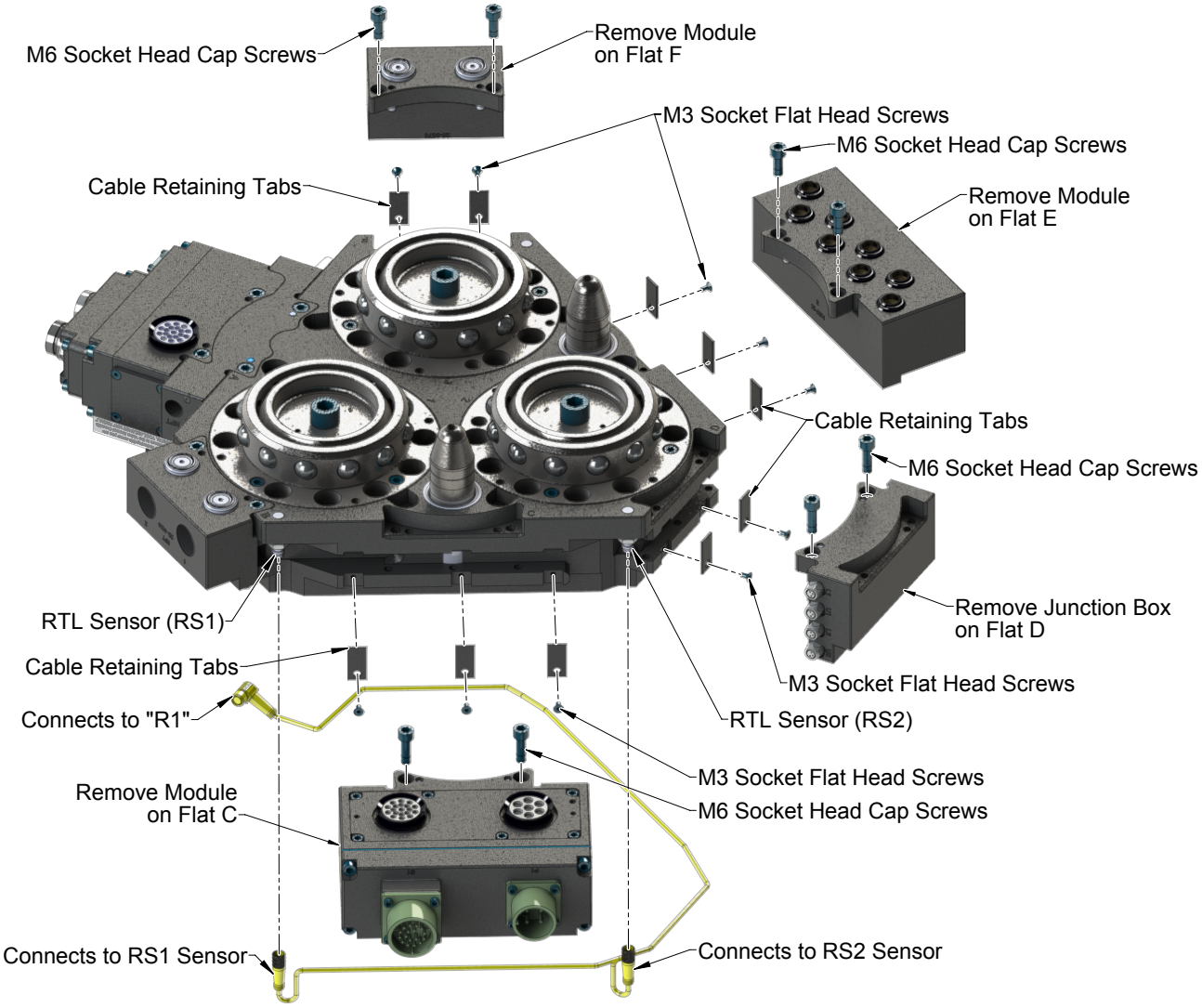
Parts required: *Section 6—Serviceable Parts*

Tools required: *2 mm and 5 mm hex key*

Supplies required: *Clean rag, Loctite 242*

1. Place the Tool in a secure location.
2. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
3. Using a pen or marker, mark the cable connections with the corresponding connectors on the junction module on Flat D, for ease of reassembly.
4. Disconnect all the cable connections from the junction module on Flat D.
5. Using a 5 mm hex key, remove the (2) M6 socket head cap screws securing the junction module to the Flat D of the Tool Changer body.
6. Lift off the junction module from Flat D.
7. If there is an optional module on Flat C, Flat E, and/or Flat F, remove the (2) M6 socket head cap screws securing the module(s) to the Tool Changer body using a 5 mm hex key.
8. If equipped, lift off the optional modules from Flat C, Flat E, and/or Flat F.
9. Using a 2 mm hex key, remove the (3) M3 socket flat head cap screws and (3) cable retaining tabs on Flat C of the Tool Changer body.
10. Using a 2 mm hex key, remove the (2) M3 socket flat head cap screws and (2) cable retaining tabs on Flat D of the Tool Changer body.
11. Using a 2 mm hex key, remove the (3) M3 socket flat head cap screws and (3) cable retaining tabs on Flat E of the Tool Changer body.
12. Using a 2 mm hex key, remove the (2) M3 socket flat head cap screws and (2) cable retaining tabs on Flat F of the Tool Changer body.
13. Disconnect the cable from the RS1 and RS2 sensors.
14. Disconnect the cable from the control/signal module (R1) on Flat A.
15. Remove the cable from the cable channel of the Tool Changer body. Discard the worn cable.

Figure 5.18—RTL Cable Replacement (R1 to RS1/RS2)

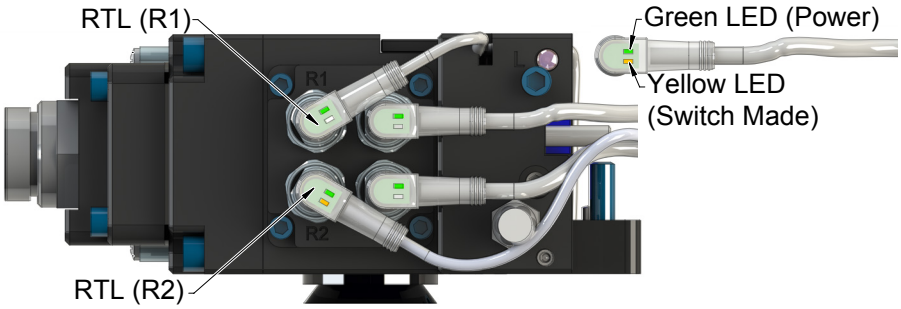


16. Connect the new cable connector to the control/signal module (R1) on Flat A.
17. Connect the new cable to the RS1 and RS2 Sensors.
18. Route the new cable into the cable channel of the Tool Changer body.
19. Secure the cables to Flat C using the (3) M3 socket flat head cap screws and (3) cable retaining tabs. Tighten to contact using a 2 mm hex key.
20. Secure the cables to Flat D using the (2) M3 socket flat head cap screws and (2) cable retaining tabs. Tighten to contact using a 2 mm hex key.
21. Secure the cables to Flat E using the (3) M3 socket flat head cap screws and (3) cable retaining tabs. Tighten to contact using a 2 mm hex key.
22. Secure the cables to Flat F using the (2) M3 socket flat head cap screws and (2) cable retaining tabs. Tighten to contact using a 2 mm hex key.
23. If optional modules were installed on Flats E and/or Flat F, install modules.
24. Install the junction module on Flat D.
25. If fasteners do not have pre-applied adhesive, apply Loctite 242 to the M6 socket head cap screws fasteners.

26. Install the (2) M6 socket head cap screws securing the module to the Tool Changer body using a 5 mm hex key. Tighten to 70 in-lbs (7.9 Nm).
27. Connect all cable connection to corresponding connectors on the junction module, as previously marked.
28. If repairs are complete, return circuits to normal operation
29. Confirm the operation of the RTL sensor by bringing a metallic object into close proximity to the face of the sensor and watching for the LED in the sensor cable to light up.

NOTICE: Some control/signal modules supply power to the RTL sensors in series. The RTL (R2) sensor will have to be switched before power is supplied to the RTL (R1) sensor. If this is the case bring a metallic object into close proximity of both the RTL (R1 and R2) sensor.

Figure 5.19—RTL (R1 and R2) Sensor Cable LEDs



5.2.2.3 RTL Cable Replacement (R2 to RS3)

Refer to *Figure 5.20*

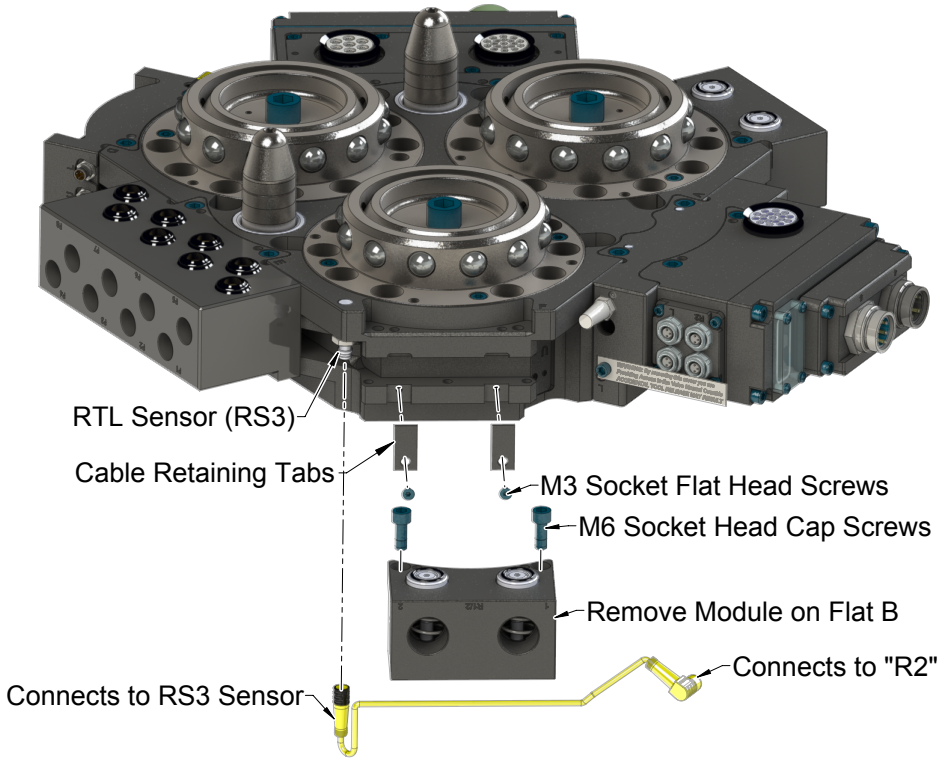
Parts required: *Section 6—Serviceable Parts*

Tools required: *2 mm and 5 mm hex key*

Supplies required: *Clean rag, Loctite 242*

1. Place the Tool in a secure location.
2. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
3. If there is an optional module on Flat B, remove the (2) M6 socket head cap screws securing the module(s) to the Tool Changer body using a 5 mm hex key.
4. If equipped, lift off the optional modules from Flat B.
5. Using a 2 mm hex key, remove the (2) M3 socket flat head cap screws and (2) cable retaining tabs on Flat B of the Tool Changer body.
6. Disconnect the cable from the RS3 Sensor.
7. Disconnect the cable from the control/signal module (R2) on Flat A.
8. Remove the cable(s) from the cable channel of the Tool Changer body. Discard the worn cable.

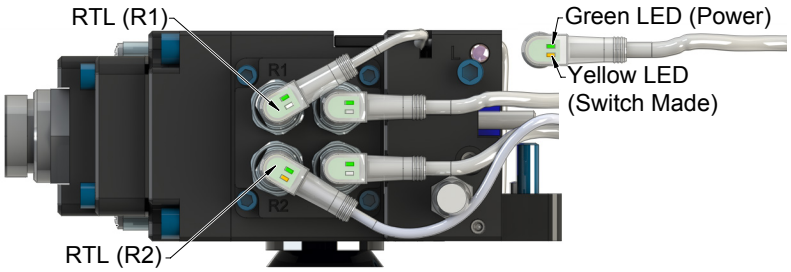
Figure 5.20—RTL Cable Replacement (R1 to RS1/RS2)



9. Connect the new cable connector to the control/signal module (R2) on Flat A.
10. Connect the new cable to RS3 Sensor.
11. Route the new cable into the cable channel of the Tool Changer body.

12. Secure the cables to Flat B using the (2) M3 socket flat head cap screws and (2) cable retaining tabs. Tighten to contact using a 2 mm hex key.
13. If optional modules were installed on Flats B, install modules.
14. If fasteners do not have pre-applied adhesive, apply Loctite 242 to the M6 socket head cap screws fasteners.
15. Install the (2) M6 socket head cap screws securing the module to the Tool Changer body using a 5 mm hex key. Tighten to 70 in-lbs (7.9 Nm).
16. Safely resume normal operation.
17. Confirm the operation of the RTL sensor by bringing a metallic object into close proximity to the face of the sensor and watching for the LED in the sensor cable to light up.

Figure 5.21—RTL (R1 and R2) Sensor Cable LEDs



5.2.2.4 Alignment Pin Replacement

Refer to *Figure 5.22* and *Figure 5.23*

Parts required: *Refer to Section 6—Serviceable Parts*

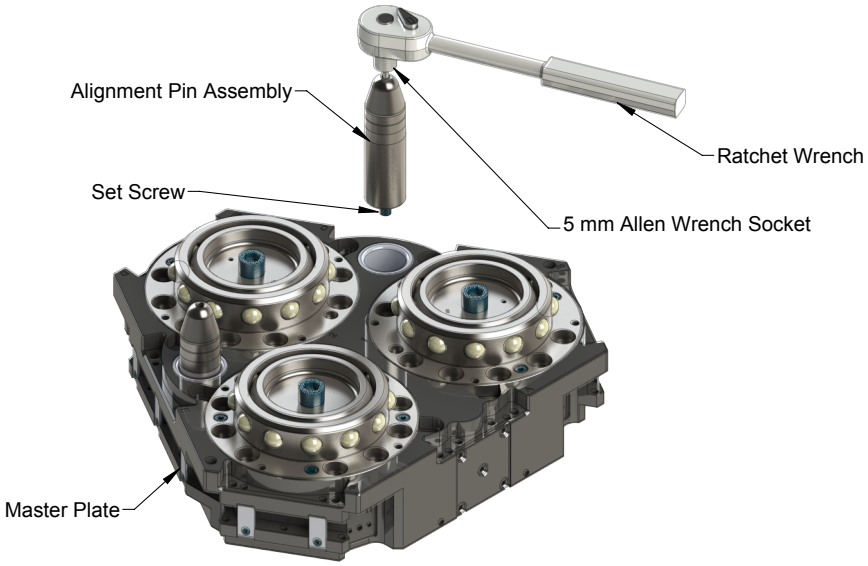
Tools required: *4 mm and 5 mm hex key, torque wrench*

Supplies required: *Clean rag, MobilGrease XHP222, Loctite 242*

1. Place the Tool in a secure location.
2. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
3. Unscrew the alignment pin assembly from the Master plate using a 4 mm hex key. If alignment pin cannot be removed using the hex key in the tip, go to step *4*. If alignment was remove go to step *6*.

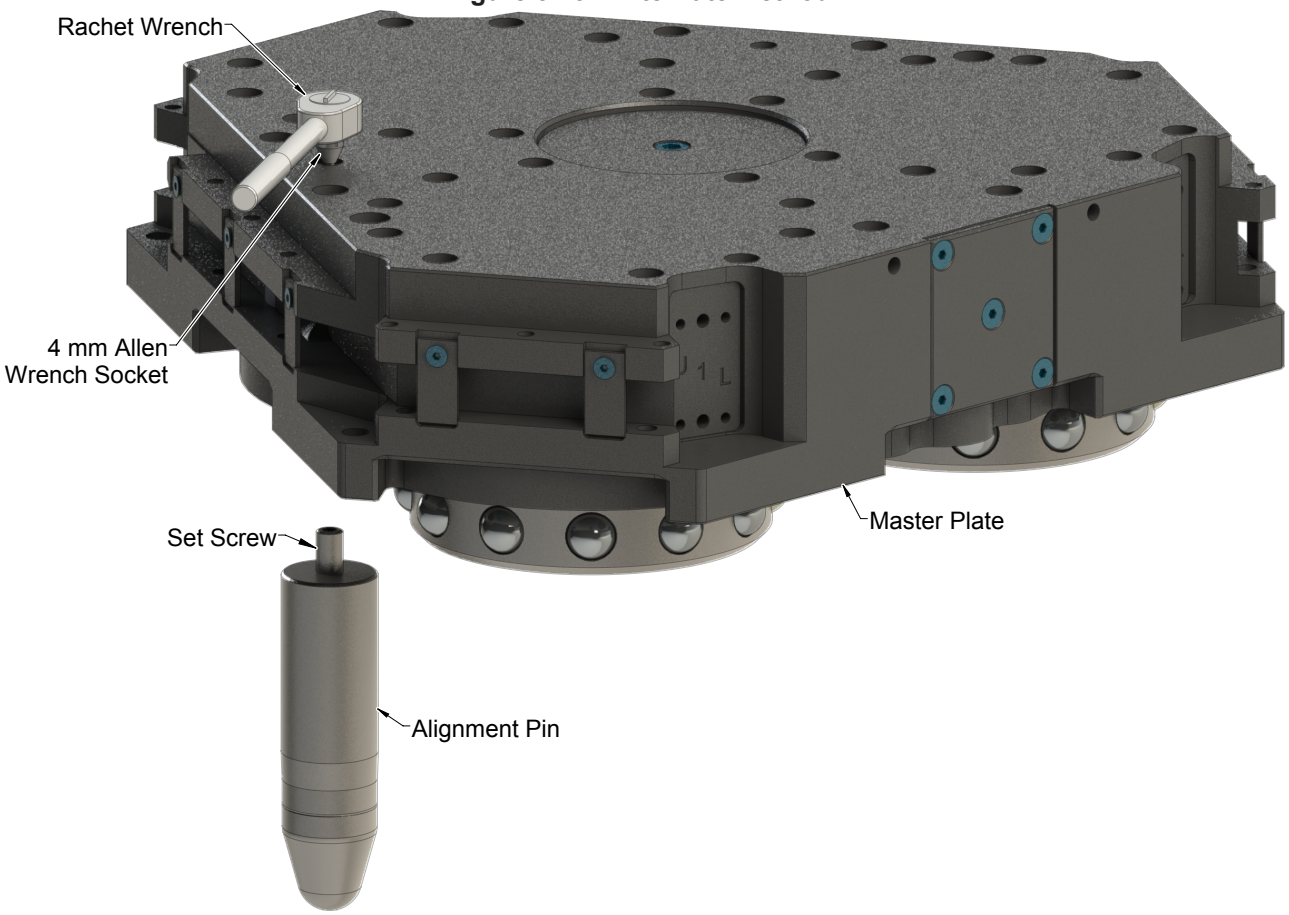
NOTICE: If for any reason the pin cannot be removed using the hex key in the tip, it may be necessary to remove it by other means, such as locking pliers.

Figure 5.22—5 mm hex key



4. Another approach would be to use the access hole in the back side of the Master plate. If not already removed, remove the Master plate refer to *Section 2.3—Master Plate Removal*. Use a 4 mm hex key to remove the alignment pin from the back side of the Master plate. Refer to *Figure 5.23*).

Figure 5.23—Alternate Method



5. Once the alignment pin has been removed, verify that the assembly (pin and set screw) are intact. If the set screw portion of the assembly did not come out, it will be necessary to remove it separately using the access hole in the back plate of the Master plate.
6. Apply Loctite 242 and install the alignment pin assembly into the bushing on the Tool Changer. Tighten to 60 in-lbs (6.8 Nm).
7. Apply MobilGrease XHP222 Special grease to the alignment pin (see *Section 4.2—Cleaning and Lubrication of the Locking Mechanism and Alignment Pins*).
8. Safely resume normal operation.

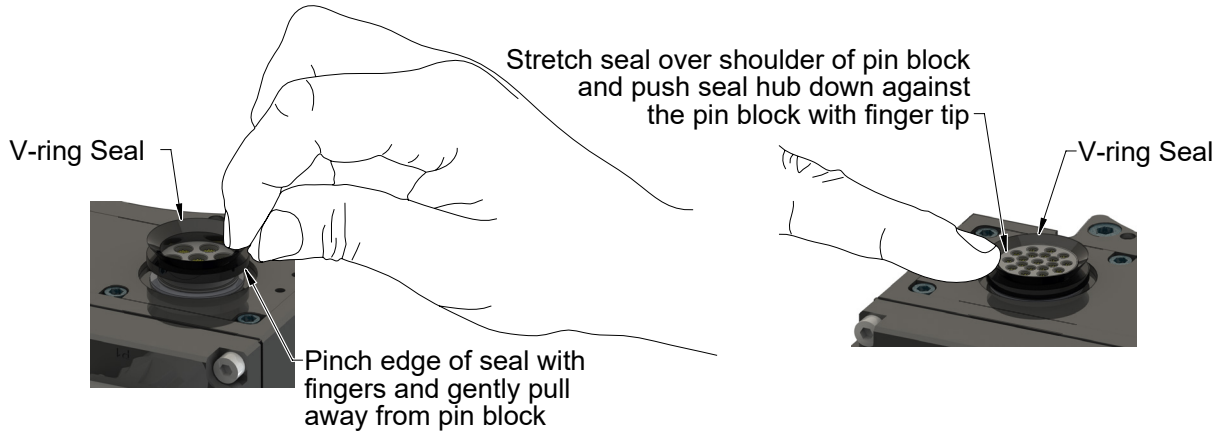
5.2.3 Seal Inspection and Replacement

Parts required: *Refer to Section 6—Serviceable Parts*

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 5.24—V-ring Seal Replacement



6. Serviceable Parts

6.1 Common Master Parts

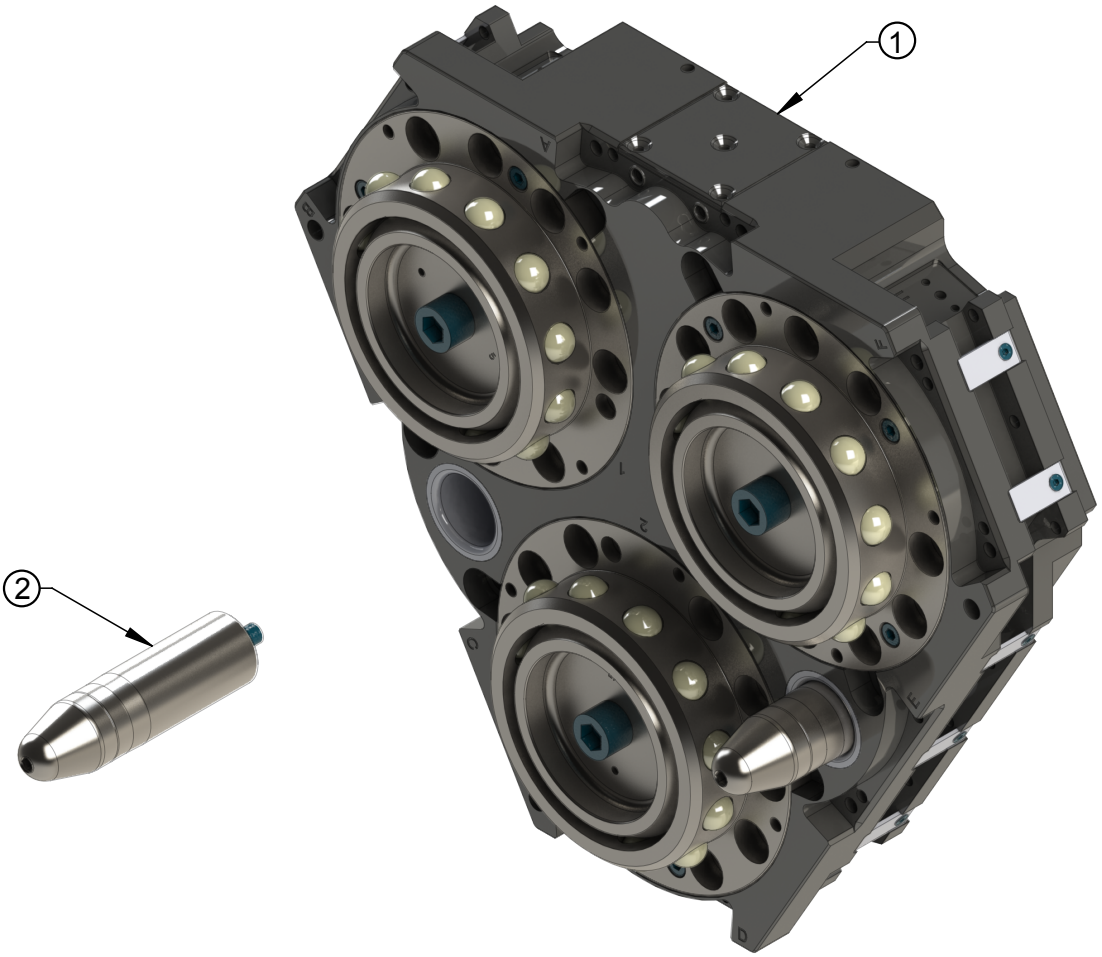


Table 6.1—Common Master Parts			
Item No.	**Qty**	**Part Number**	**Description**
1	**1**	9121-1210AM-0-0-0-0-0-0-SE	QC-1210 Master Base Assembly with No Options and NPN lock/ unlock sensors with LED cables
		9121-1210AM-0-0-0-0-0-0-SG	REPLACED BY 9121-1210AM-0-0-0-0-0-0-SL
		9121-1210AM-0-0-0-0-0-0-SL	QC-1210 Master Base Assembly with No Options and PNP lock/ unlock and ready-to-lock sensing with LED Cables
2	1	9005-20-1569	Alignment Pin, Two Piece, 1-1/8” Dia., Stepped

6.2 Cables for Models 9121-1210AM-0-0-0-0-0-0-SL and 9121-1210AM-0-0-0-0-0-0-SE

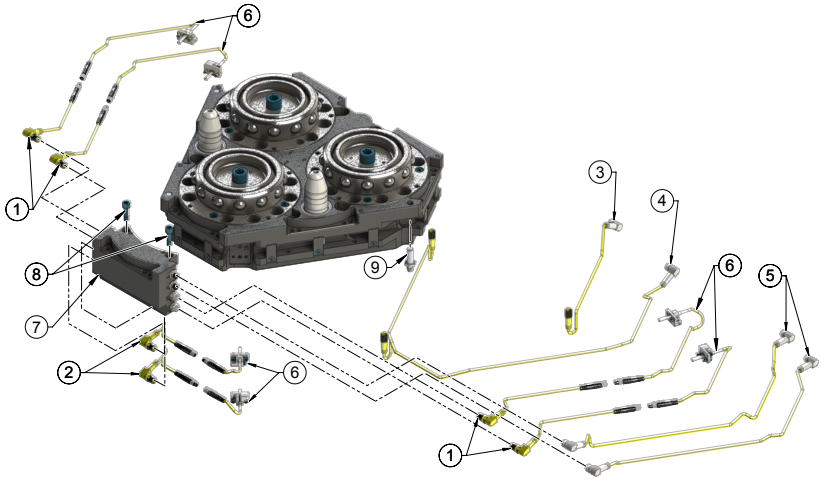


Table 6.2—9121-1210AM-0-0-0-0-0-0-SL				
Item No.	**Qty**	**Part Number**	**Description**	**Connections**
1	4	9120-C-3M5F-3PM90-0020	Cordset, Pentafast 3-pin Straight Female to Picofast 3-pin Male Right Angle Threaded to, 0.2 m	L1 to L1, U1 to U1, L3 to L3, U3 to U3
2	2	9120-C-3M5F-3PM90-0016	Cordset, Pentafast 3-pin Straight Female to Picofast 3-pin Male Right Angle Threaded, 0.16 m	L2 to L2, U2 to U2
3	1	9120-C-0321103-0311203-00-0.30	Picofast Cordset, 3-Pin Straight Female Q-Conn to 3-Pin Male Right Angle LED Threaded, 0.30 m, screw	R2 to RS3
4	1	9120-C-0321103-0321103-0311203-00-0.78	QC-1210 Picofast Cable for Series Wiring of RS1 and RS2 Sensors, Screw Type	R1 to RS1 and RS2
5	2	9120-C-3PF90-3PM90-0044-PNP	Picofast Cordset, 3-Pin Right Angle Female Threaded to 3-Pin Male Right Angle LED Threaded, 0.44 m, PNP	L to L, U to U
6	6	9005-20-1613	Lock/Unlock Sensor Assembly, QC-1210 (PNP)	Sensor
7	1	9005-20-1604	QC-1210 Master Junction Module Assembly,Potted	-
8	2	3500-1066020-15A	M6 x 20 mm socket head cap screws Blue Microspheres	-
9	3	8590-9909999-34	Turck Prox (PNP True 2 mm Range, Quick Disc.)	Sensor

Table 6.3—9121-1210AM-0-0-0-0-0-0-SE				
Item No.	**Qty**	**Part Number**	**Description**	**Connections**
1	4	9120-C-3M5F-3PM90-0020	Cordset, Pentafast 3-pin Straight Female to Picofast 3-pin Male Right Angle Threaded to, 0.2 m	L1 to L1, U1 to U1, L3 to L3, U3 to U3
2	2	9120-C-3M5F-3PM90-0016	Cordset, Pentafast 3-pin Straight Female to Picofast 3-pin Male Right Angle Threaded, 0.16 m	L2 to L2, U2 to U2
3	1	9120-C-0321103-0311203-01-0.30	Picofast Cordset, 3-Pin Straight Female Q-Conn to 3-Pin Male Right Angle NPN LED Threaded, 0.30 m, screw	R2 to RS3
4	1	9120-C-0321103-0321103-0311203-01-0.78	QC-1210 Picofast Cable for Series Wiring of RS1 and RS2 NPN Sensors, Screw Type	R1 to RS1 and RS2
5	2	9120-C-3PF90-3PM90-0044-NPN	Picofast Cordset, 3-Pin Right Angle Female Threaded to 3-Pin Male Right Angle LED Threaded, 0.44 m, NPN	L to L, U to U
6	6	9005-20-1780	Lock/Unlock Sensor Assembly, NPN Wired .17M Straight, Male Penta	Sensor
7	1	9005-20-1781	QC-1210 Master Junction Module Assembly, NPN Sensors	-
8	2	3500-1066020-15A	M6 x 20 mm socket head cap screws Blue Microspheres	-
9	3	8590-9909999-120	Turck Prox (NPN True 2 mm Range, Quick Disc.)	Sensor

6.3 Tool Plate

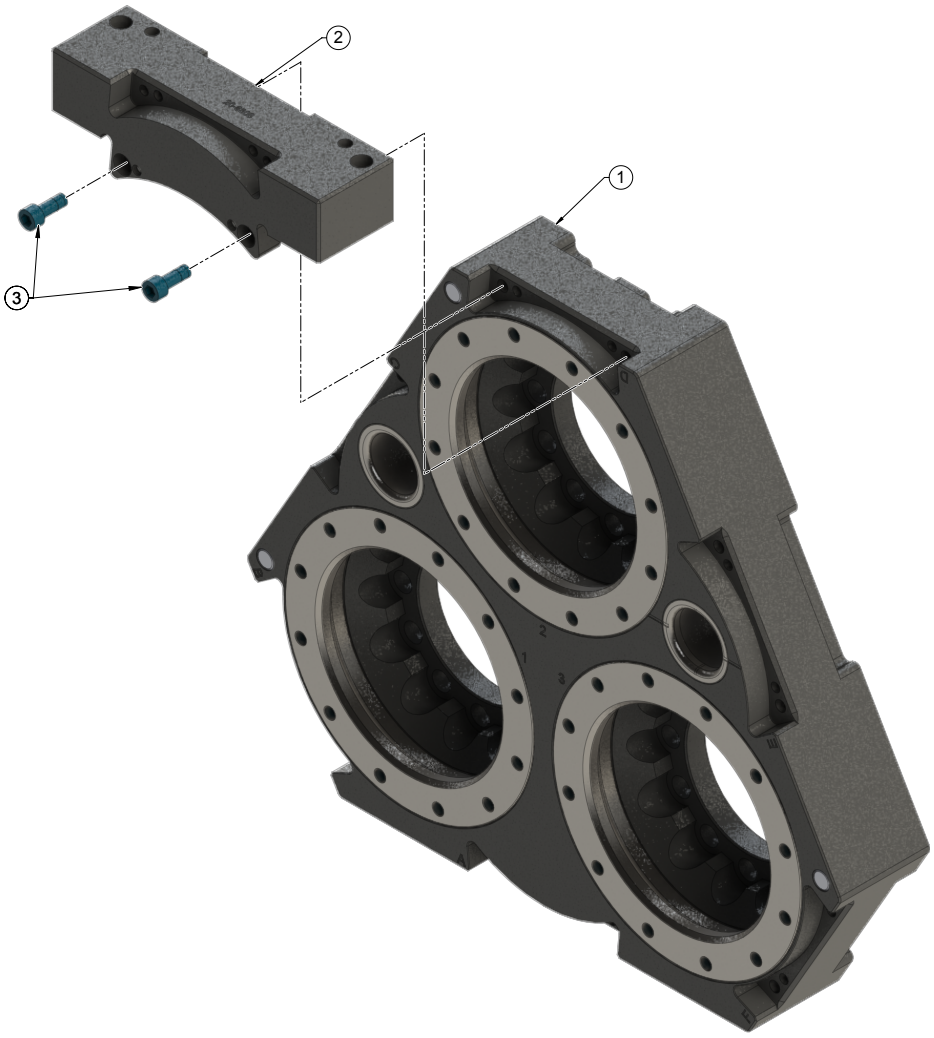


Table 6.4—Tool Plate			
Item No.	**Qty**	**Part Number**	**Description**
1	1	9121-1210AT-0-0-0-0-0-0	QC-1210 Base Tool Assembly, No Options
2	1	9005-20-1605	QC-1210 Tool Junction Module Adapter Assembly
3	2	3500-1066020-15A	M6 x 20 mm socket head cap screws Blue Microspheres

7. Specifications

Table 7.1—Master and Tool Plates		
Recommended Max Payload	2980 lbs. (1350 kg)	The mass attached to the Tool Changer.
Operating Temperature Range	-20–150°F (-30–66°C)	Optimal operating temperature.
Operating Pressure Range	70–100 psi (4.8–6.9 bar)	Locking mechanism supply pressure operating range. Supply to be clean, dry, and filtered to 40 micron or better.
Coupling Force @ 80 psi	21,000 lbs. (9, kg)	Axial holding force
Recommended Max Moment X-Y (Mxy) **Recommended Max Torque about Z (Mz)**	48,000 in-lb (5,423 Nm) 48,000 in-lb (5,423 Nm)	Maximum recommended working load for optimum performance of the Tool Changer Maximum recommended working torque for optimum performance of the Tool Changer
Positional Repeatability	0.0006” (0.015 mm)	Repeatability tested at rated load at one million cycles.
Weight (coupled, no access.)	61.2 lbs. (27.8 kg)	Master 39.1 lbs (17.7 kg) / Tool 22.2 lbs (10 kg)
Max. Recommended distance between Master and Tool plate	0.04” (1 mm)	No-Touch locking technology allows the Master and Tool plates to lock with separation when coupling.
Sensor Information, signal name	L/U (Lock/Unlock) RTL (Ready-To-Lock)	Internal proximity sensors (6) with cable and connector to indicate locking mechanism position. Proximity sensors (3) with cable and connector for direct wiring to control/signal module to indicate Master and Tool mating surfaces within close proximity of each other.
Mounting/Customer Interface	Master plate Tool plate	See *Section 8—Drawings*

8. Drawings

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