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B. Base Tool Changer

QC-113 Series—Tool Changer

1. Product Overview

ATI Tool Changers enhance the versatility of a robot by enabling the use of multiple customer tools, such as: grippers, vacuum cup tooling, pneumatic and electric motors, weld guns, and more.

The Tool Changer consists of a Master plate, which is attached to the robot arm, and a Tool plate, which is attached to customer tooling. When the robot picks up the customer tooling, a pneumatically-driven locking mechanism couples the two plates. The patented, fail-safe locking mechanism utilizes a multi-tapered cam with ball locking technology to ensure the Tool Changer does not uncouple if air pressure falls below 60 psi (4.1 bar) during operation.

The robot can be programmed to select the desired customer tooling by coupling the Master plate to the Tool plate. Electricity, fluid, and other forces of energy transfer to the customer tooling through optional modules that are attached to the Master and Tool plates. Refer to the ATI website for compatible modules or contact an ATI sales representative for more details.

For the most current product information and specifications on the QC-113 Series of Tool Changers, please click the following link: *QC-113 Series.*

1.1 Master Plate Assembly

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

The body or Master plate has (4) flat sides for mounting of optional modules. In general, flat 'A' is reserved for an air/valve adapter module and a control/signal module. Flats "B", "C", and "D" are fully interchangeable and optional modules can be arranged to suit the application or robot dress, as required.

The locking mechanism consists of a cam, a male coupling, and chrome steel ball bearings.

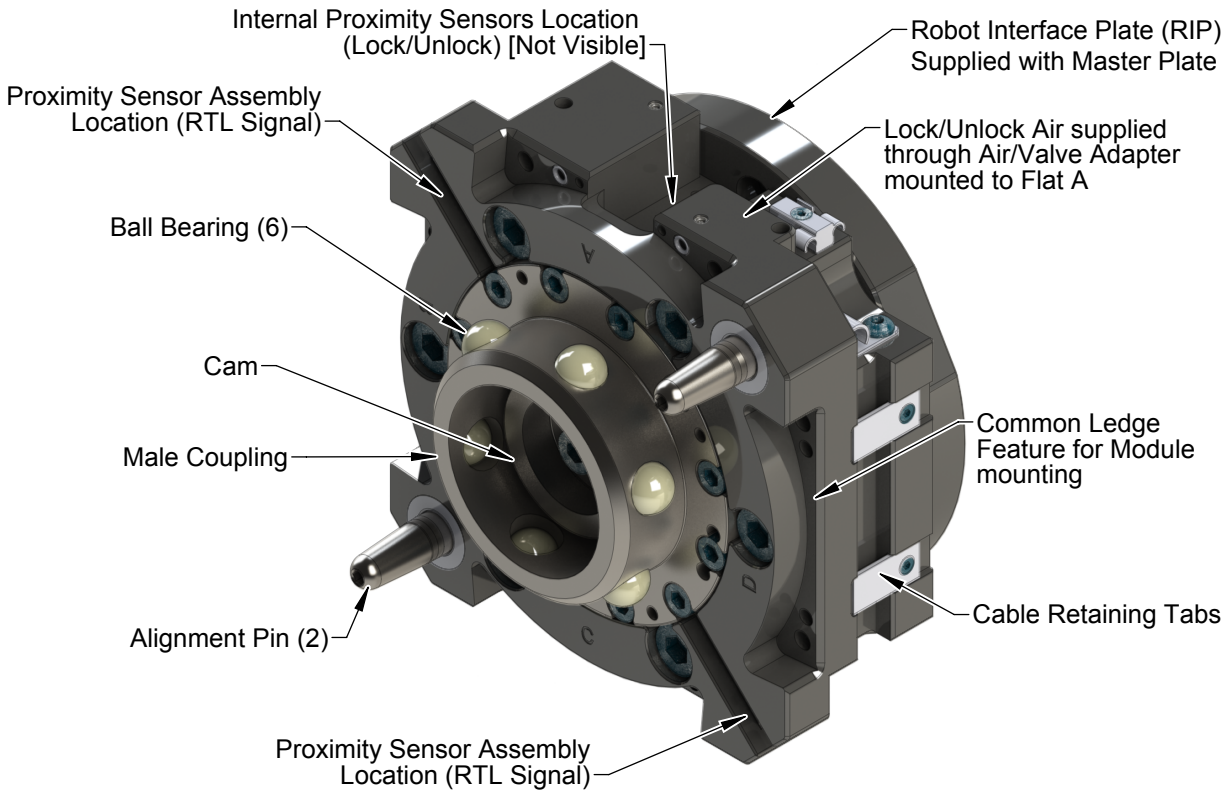
Tapered pins located on the Master plate mate with bushings in the Tool plate to ensure repeatable alignment during the coupling process. An extreme pressure grease is applied to the cam, male coupling, ball bearings, and pins to enhance performance and maximize the life of the Master plate assembly.

Proximity sensors are designed into the body of the Master plate to verify the lock/unlock position of the piston and cam. The sensors provide the lock and unlock (L/U) signals through the control/signal module.

Proximity sensor assemblies are mounted to the body of the Master plate to verify Tool plate presence when coupled. The sensors provide a ready-to-lock (RTL) signal through the control/signal module.

A mounting pattern is machined into the Master plate for mounting to the supplied interface plate. Refer to *Section 8—Drawings* for details.

Figure 1.1— Master plate assembly



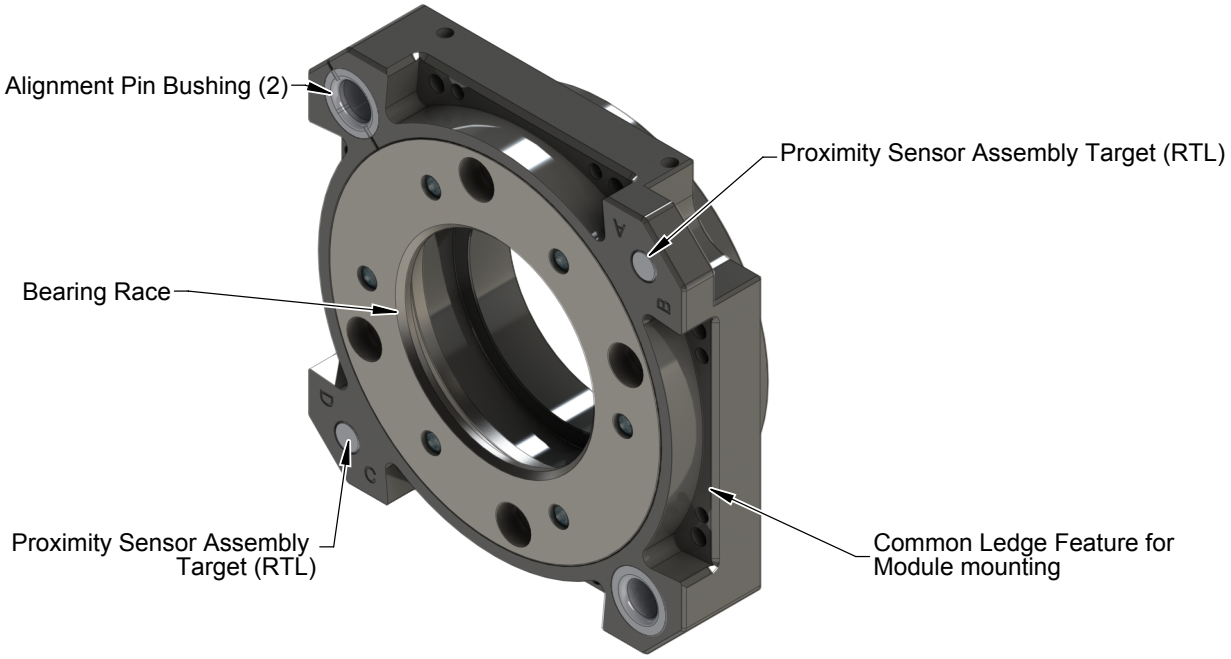
1.2 Tool Plate Assembly

The Tool plate assembly includes an anodized aluminum body, alignment bushings, and a hardened stainless steel bearing race. The Tool plate has (4) flat sides for mounting of optional modules.

Proximity sensor targets are mounted to the body of the Tool plate to verify Tool plate presence when coupled. The targets are used by the proximity sensors in the Master plate to provide a ready-to-lock (RTL) signal.

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

Figure 1.2—Tool Plate Assembly



1.3 Optional Modules

There are (4) flats available for mounting of the optional modules for support of various utility pass through, such as signal, fluid/air, and electric.

For assistance in choosing the right modules for your particular application, visit the QC-113 webpage (*QC-113 Series*) and click on compatible modules tab to see what is available or contact an ATI Sales Representative directly.

In general, flat ‘A’ is reserved for an air/valve adapter module and a control/signal module. Flats “B”, “C”, and “D” are fully interchangeable and optional modules can be arranged to suit the application or robot dress, as required.

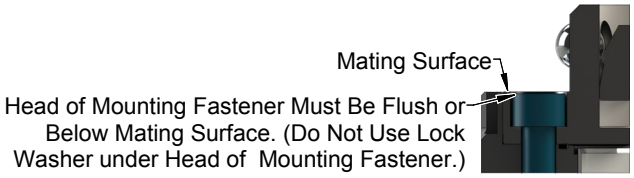
The optional modules are mounted to the Master and Tool plate using a common ledge mounting feature. Only (2) M6 socket head cap screws need to be unscrewed in order to remove the module from the Master/Tool plate.

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.** *Table 2.1* **contains recommended values based on engineering standards.**

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.

WARNING: Do not use lock washers 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 and not allow the locking mechanism to fully engage, this can cause damage to equipment or personal injury. The mounting fasteners must be flush or below the mating surfaces of the Master and Tool plates.



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.

CAUTION: Do not use fasteners that exceed the thread depth in the Tool Changer. Refer to *Section 8—Drawings* for details on the mounting hole thread depth. Secure the Tool Changer with the proper length fasteners. This is true for both robot and tool interfaces.

Table 2.1—Fastener Size, Class, and Torque Specifications

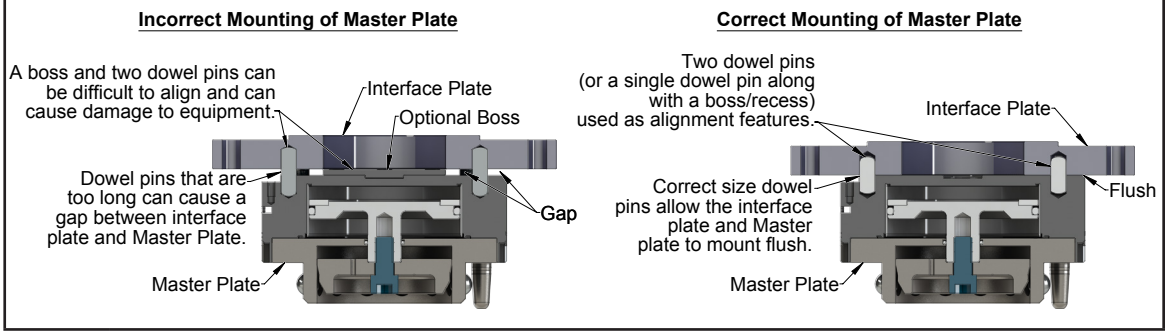
Mounting Conditions	Fastener Size and Property Class	Recommended Torque
Master plate to Interface plate (6061-T6 aluminum) Minimum thread engagement of 0.39" (10 mm) [1.0X fastener Ø].	**M10-1.5 Class 12.9**	**38 ft-lbs (52 Nm)**
Robot Interface to Robot (steel; USS ≥ 90KSI) Minimum thread engagement of 0.59" (12 mm) [1.5X fastener Ø]. *Confirm available engagement with Robot Manufacturer*	**M8-1.25 Class 12.9**	**20 ft-lbs (27 Nm)**
Tool plate (aluminum) to Tool Interface Plate (6061-T6-aluminum) Minimum thread engagement of 0.59" (12 mm) [1.5X fastener Ø]. *Do not exceed maximum available thread depth as shown in Section 8—Drawings*	**M8-1.25 Class 12.9**	**20 ft-lbs (27 Nm)**

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.

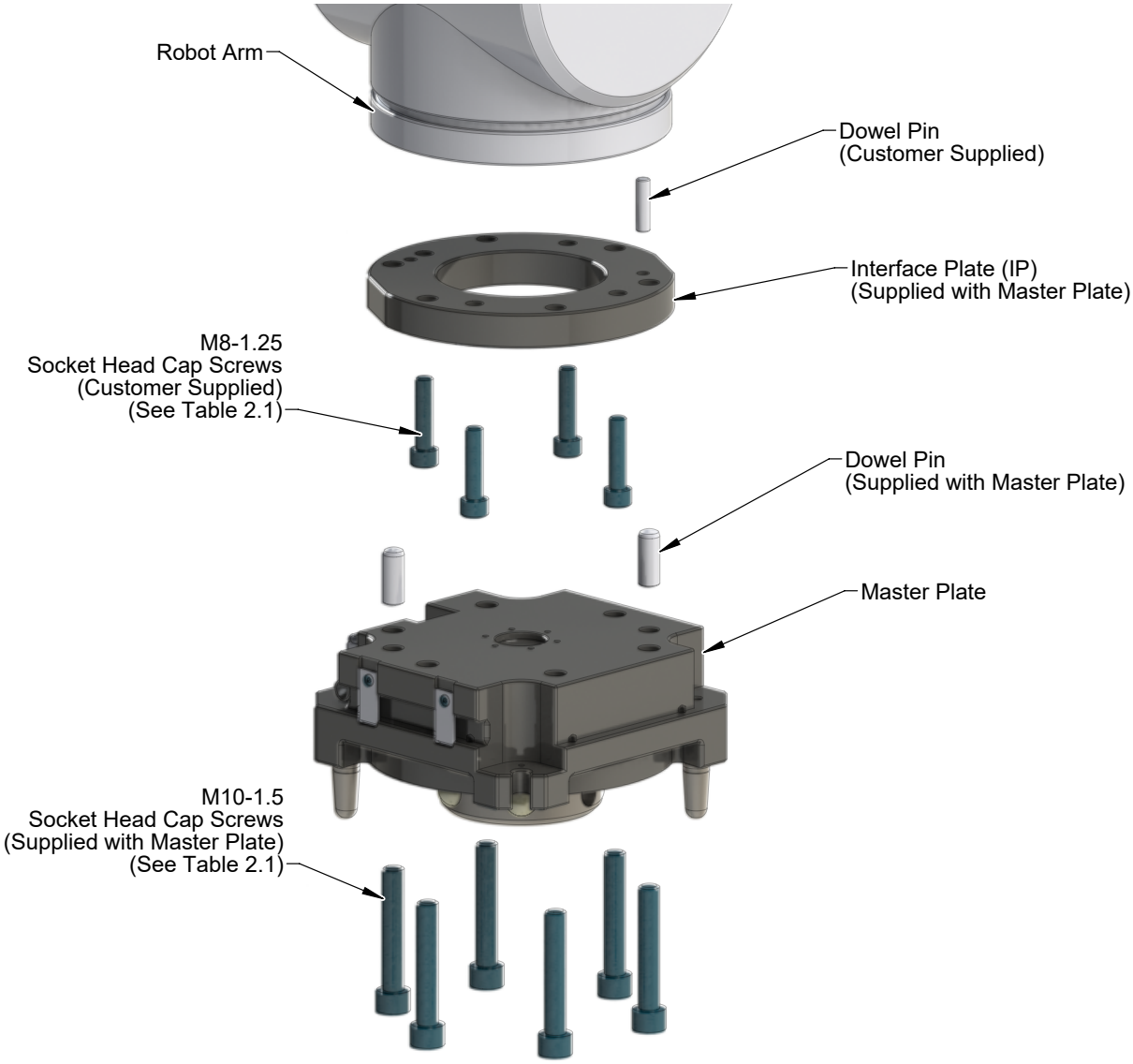
2.2 Master Plate Installation

Tools required: *8 mm hex key, torque wrench*

Supplies required: *Clean rag, Loctite® 242*

1. Wipe down the mounting surfaces with a clean rag.
2. If required, install the interface plate to the robot arm, align using the boss or dowel pins and secure with customer supplied fasteners.
3. Align the dowel pins to the corresponding holes in the interface plate and secure the interface plate to the robot arm with customer supplied fasteners. If not pre-applied, apply Loctite 242 to threads (see *Table 2.1* for proper fasteners and torque).
4. Align the dowel pins to the corresponding holes in the Master plate and secure the Master plate to the interface plate with supplied (6) M10-1.5 socket head cap screws. If not pre-applied, apply Loctite 242 to threads (see *Table 2.1* for proper fasteners and torque).
5. Connect Lock and Unlock air supplies to the appropriate connections. Refer to *Section 2.7—Pneumatic Requirements.*
6. Connect utilities to the appropriate module and Master plate connections.

Figure 2.1— Typical Master Plate Installation



2.3 Master Plate Removal

Refer to *Figure 2.1.*

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. Disconnect all utilities (for example: electrical, pneumatic, and hydraulic).

NOTICE: Support the Master plate while removing the fasteners.

5. Remove the (6) M10-1.5 socket head cap screws connecting the Master plate to the interface plate.

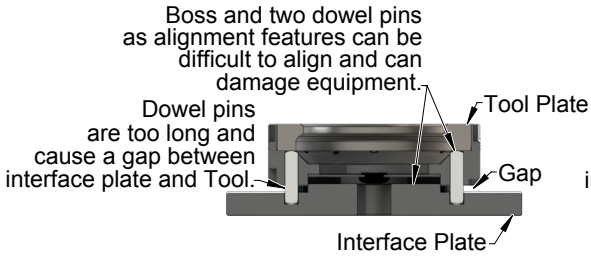
2.4 Tool Interface

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).

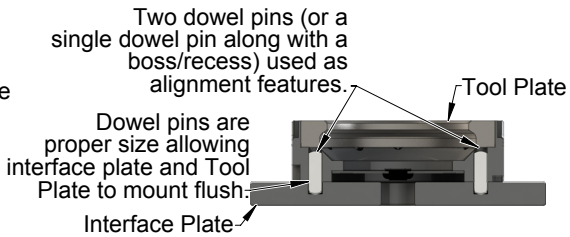
CAUTION: Do not use more than two alignment features when securing a Tool plate to an interface plate. Using more than two alignment features can cause damage to equipment. Use either two dowel pins or a single dowel pin, along with a boss/recess feature to align the Tool plate with the interface plate.

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: *6 mm hex key, torque wrench*

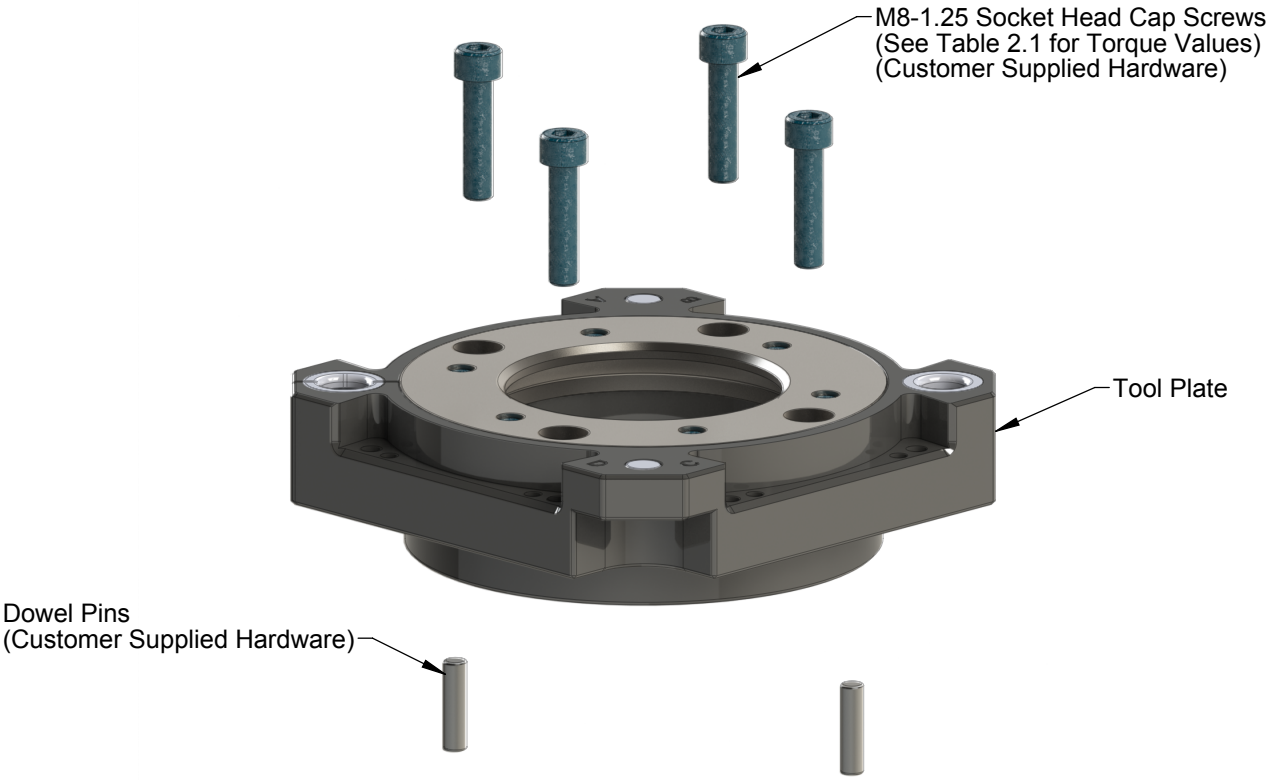
Supplies required: *Clean rag, Loctite 242*

1. Wipe down the mounting surfaces with a clean rag.
2. If required, install the tool interface plate to the customer tooling, align using the boss or dowel pins and secure with customer supplied fasteners.
3. 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 fasteners. If not pre-applied, apply Loctite 242 to threads (see *Table 2.1*).

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

4. Connect utilities to the appropriate module and Tool plate connections.

Figure 2.2— Standard Tool Plate Installation



2.6 Tool Plate Removal

Tools required: *6 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 all utilities (for example: electrical, pneumatic, and hydraulic).
5. Remove the fasteners connecting the Tool plate to the tooling or tool interface plate.

2.7 Pneumatic Requirements

Proper operation of the locking mechanism requires a constant supply of clean, dry, non-lubricated air, with the following conditions:

- Pressure range of 60 to 100 psi (4.1 - 6.9 bar) Suggested 80 psi.
- Filtered minimum: 40 microns.

To lock or unlock the Tool Changer, a constant supply of compressed air is required. If there is a loss of air pressure in the locked state, the cam profile prevents the master plate and tool plate from unlocking, and the Tool Changer goes into the fail-safe condition.

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

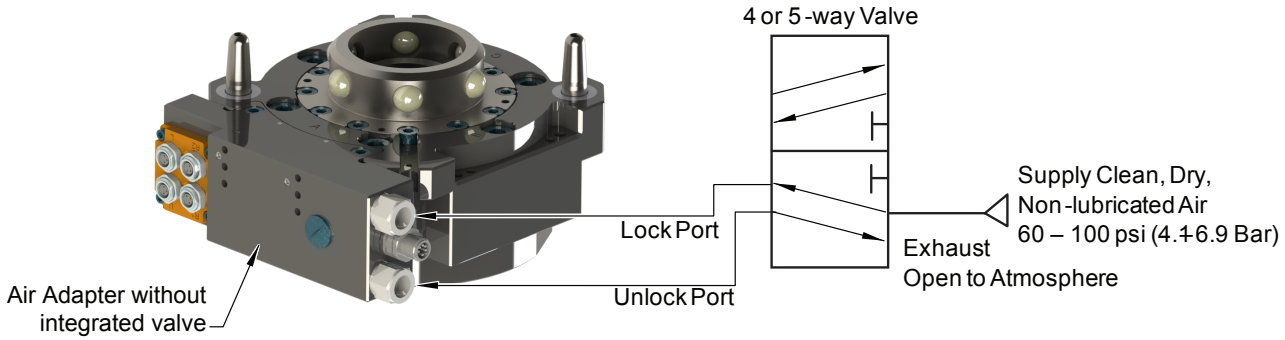
2.7.1 Valve Requirements for Air Adapter Modules

NOTICE: A valve is not required when using a valve adapter module. A valve adapter module has an integrated solenoid valve and only requires the customer to supply a single source of air to the valve adapter.

A customer supplied 2-position 4-way or 5-way valve with either 4-port or 5-port configuration must be used to actuate the locking mechanism 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 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 inhibit operation of the locking mechanism and prevent coupling or uncoupling.

CAUTION: The locking mechanism will not function properly when connected to a 3-way valve as this type of valve is incapable of venting trapped air or vacuum from within the Tool Changer. This could result in injury to 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 with either 4-port or 5-port configuration.

Figure 2.3— Lock and Unlock Pneumatic Connections



2.8 Electrical Connections

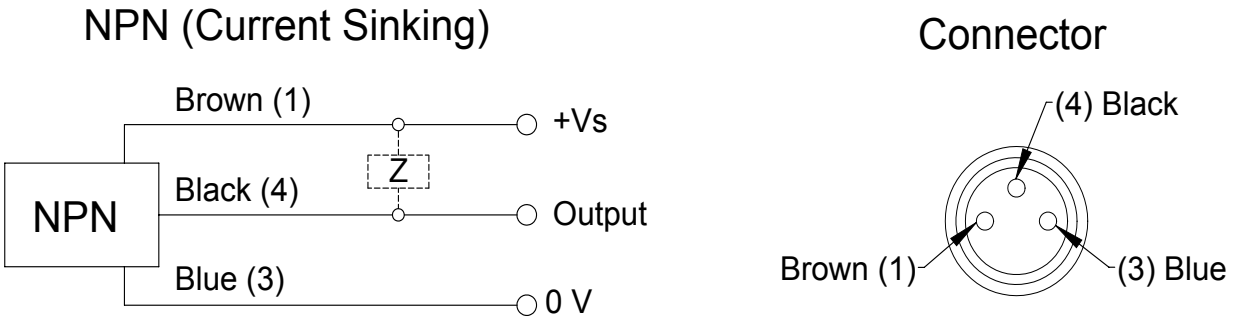
Tool Changer is available with integrated lock/unlock sensors. If sensors are not used, plugs will be provided to seal the locking mechanism. If a control/signal module is to be utilized on Flat A when ordered, the sensors will be connected to the module prior to shipping.

2.8.1 NPN Type Lock and Unlock Sensors (-SP sensor designation)

These sensors are used on 9120-113AM-000-000-SP.

Table 2.2—NPN (Current Sinking)	
Description	**Value**
Voltage Supply Range	10-30 VDC
Output Circuit	NPN make function (NO)

Figure 2.4—NPN Type Lock, Unlock and RTL Sensors



3. Operation

The Master plate locking mechanism is pneumatically driven to couple and uncouple with the Tool plate bearing race.

CAUTION: Operation of the Tool Changer is dependent on maintaining an air pressure of 60 to 100 psi (4.1 - 6.9 bar). Damage to the locking mechanism could occur. Robot motion must be halted if the air supply pressure drops below 60 psi (4.1 bar).

NOTICE: All Tool Changers are lubricated prior to shipment. The customer must apply additional lubricant to the locking mechanism components and alignment pins prior to operation. Tubes of lubricant for this purpose are shipped with every Tool Changer. Standard Tool Changers require MobilGrease XHP222 Special (a NLGI #2 lithium complex grease with molybdenum disulfide). For custom applications, such as food grade or surgical applications, specialized lubricants might be required.

Coupling should occur with the Master plate in the No-Touch™ locking zone. As coupling occurs, the Master plate should pull the Tool plate into the locked position.

Program the robot to minimize misalignment during coupling and uncoupling. Greater offsets can be accommodated by the Master and Tool plates but will increase wear. Misalignments can be caused by improper tool stand design. Refer to Tool Storage Considerations section.

Figure 3.1— Offset Definitions

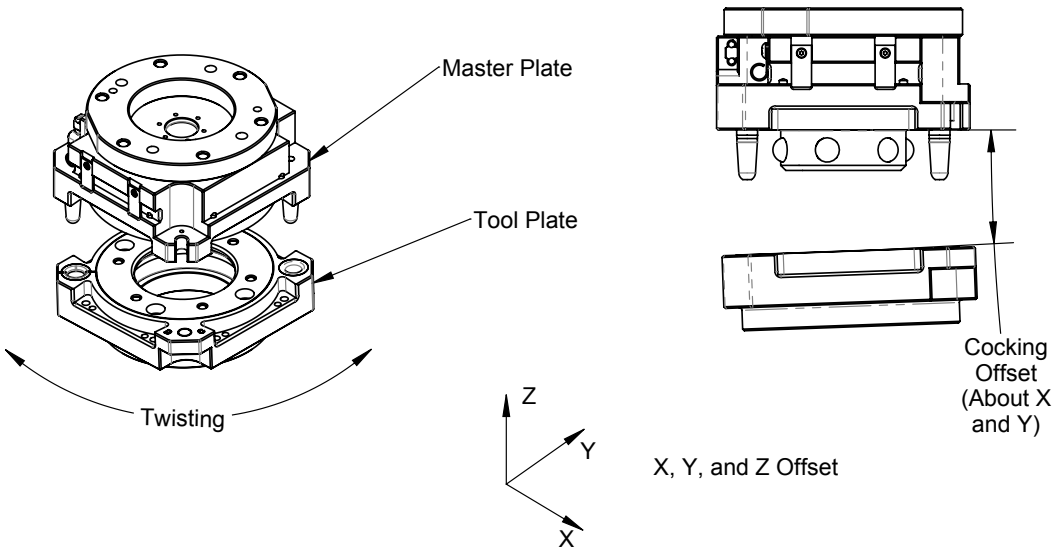


Table 3.1—Maximum Recommended Offsets Prior to Coupling				
Model	No-Touch™ Zone Z Offset (Max)[1]	X and Y Offset (Max) [2]	Cocking Offset (Max)	Twisting Offset (Max)
QC-113	0.04” (1 mm)	±0.08” (2 mm)	±0.7°	±1°

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. Tool-ID can be used to verify that the robot has picked up the proper Tool. Modules with Tool-ID are available for purchase through the ATI website. Go to *http://www.ati-ia.com/products/toolchanger/tool_changer_modules.aspx* for products available or contact ATI for assistance.

3.5 Tool Storage Considerations

NOTICE: Tool stand design is critical to the operation of the Tool Changer. Improperly designed tool stands can cause jamming and excessive wear of the Tool Changer components.

Tool plates with customer tooling attached may be stored in a tool stand. ATI provides compatible tool stands designed for durability, longevity, and maximum adaptability to fit most customers' applications. The ATI TSM (Tool Stand Medium) system is compatible with ATI Tool Changer sizes QC-20 to QC-110. The TSM systems can be equipped with horizontal modules, clamp modules, and different types of tool sensing. Visit the ATI Web Site *http://www.ati-ia.com/products/toolchanger/toolstand/medium/MediumStand.aspx* for products available, or contact ATI for assistance.

If the customer is supplying the tool stand, it must provide a fixed, repeatable, level, and stable position for tool pick-up and drop-off. The tool stand must 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.

Ideally, the tool should be hanging 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, "horizontal-position" tool stands cause more wear on the locking mechanism and locating features of the Tool and tool stand.

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 vital in tool pick-up and drop-off.

A sensor that detects the presence of a Tool in the tool stand is recommended. The sensor may be used prior to coupling to ensure there is a Tool properly seated in the stand. Sensors may also be used as the robot starts to move away after uncoupling. Sensors provide safety measure if a Tool becomes jammed in the stand or if the Tool fails to release from the robot.

Proximity sensors should be positioned 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.

Tool stands debris shields can cover Tools and modules to protect them in dirty environments, such as grinding or welding. Alternatively, positioning tool stands in areas shielded from weld spatter, fluids, adhesives, or other debris would eliminate the need for debris shields.

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 (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.

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 the tool stands away from the 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

A visual inspection and preventive maintenance schedule is provided in table below. Detailed assembly drawings are provided in *Section 8—Drawings* of this manual. Refer to module sections for detailed preventive maintenance steps for all utility modules.

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		

Balls/Alignment Pins/Holes/Bearing Race

- ☐ Inspect for lubrication and wear. A NLGI #2, lithium based grease with molybdenum disulfide additive is suggested for locking mechanism and alignment pin lubrication. Over time, lubricants can become contaminated with process 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.*
- ☐ Excessive alignment pin/bushing wear may be an indication of poor robot position during pickup/drop-off. Adjust robot position as needed. Check tool stand for wear and alignment problems. Replace worn alignment pins, refer to *Section 5.2.1—Alignment Pin Replacement.*
- ☐ Wear on the balls/bearing race could be an indication of excessive loading.

Mounting Fasteners/Interface Connections

- ☐ Inspect for proper torque and interference or wear, abrasions, and cuts of hoses. Tighten and correct as required.

Seals (Modules)

- ☐ Inspect for wear, abrasion, and cuts.
- ☐ Exposed o-rings and rubber bushings may be subject to damage during normal operation. Replace damaged o-rings and rubber bushings as needed. Refer to *Section 5.2.5—Seal Inspection and Replacement*

Sensors and Cables

- ☐ Inspect sensor cables and connectors for any damage, cuts, and abrasion.

Electrical Contacts/Pin Block (Modules)

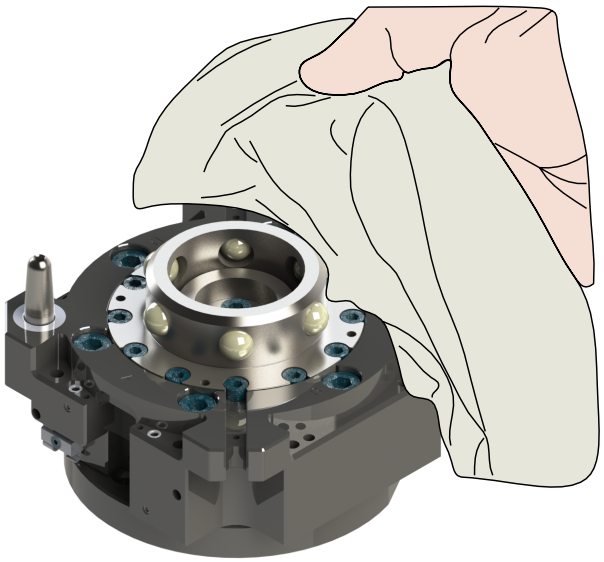
- ☐ Inspect for wear and abrasion.
- ☐ Exposed contacts may be subject to damage during normal operation.
- ☐ Clear debris from the area of the contacts using compressed air.
- ☐ Do not directly clean contacts as abrasion may occur and the performance of the contact may be compromised. Refer to *Section 5—Troubleshooting.*

4.2 Cleaning and Lubrication of the Locking Mechanism and Alignment Pins

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

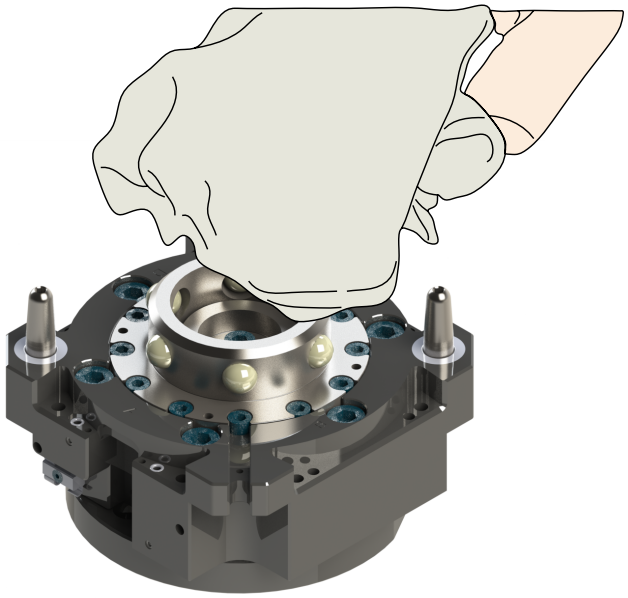
1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Use a clean rag to thoroughly remove any lubricant and debris from the ball bearings, male coupling, cam,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

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



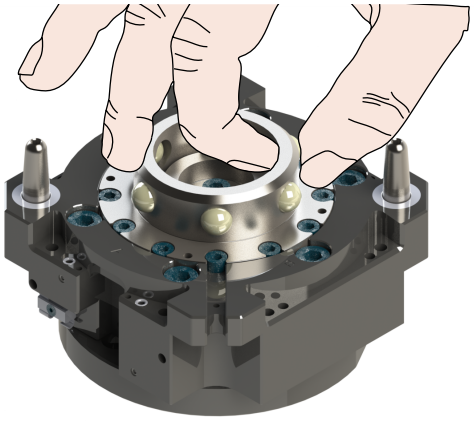
5. Use a clean rag to thoroughly remove any lubricant and debris from the inner surface of the male coupling and cam.

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



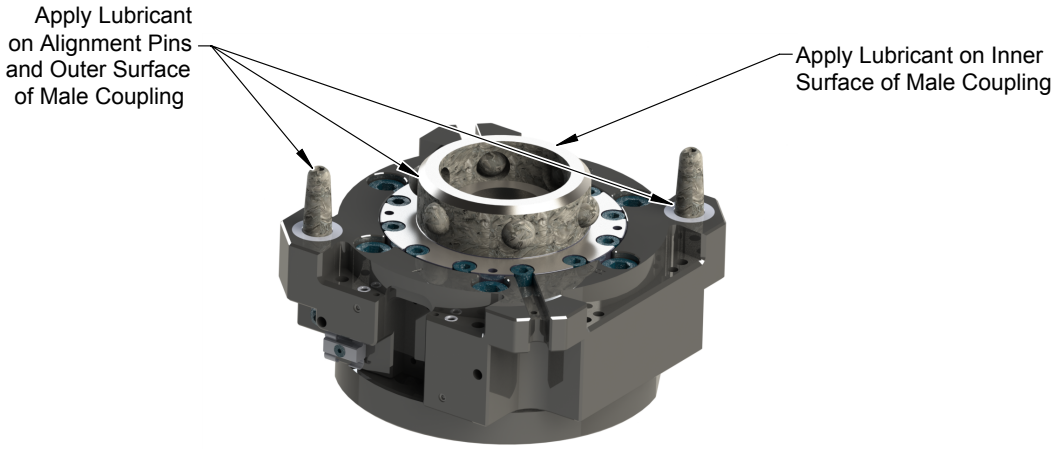
6. Check each ball bearing to make sure it moves freely in the male coupling. Additional cleaning may be necessary to free up any ball bearings that are sticking in place.

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

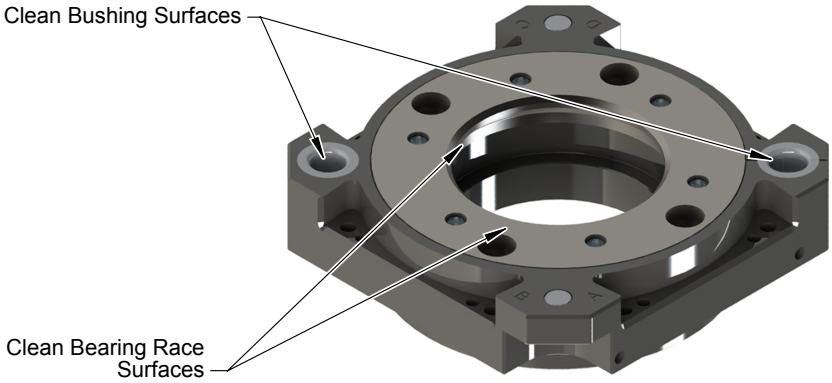


8. Use a clean rag to thoroughly remove any lubricant and debris from the Tool plate bearing race and bushings.

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)*

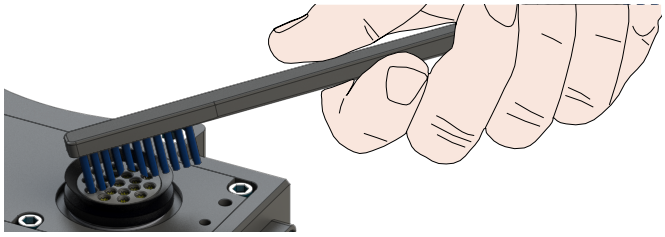
1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Inspect the Master and Tool pin blocks for debris or darkened pins.

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).

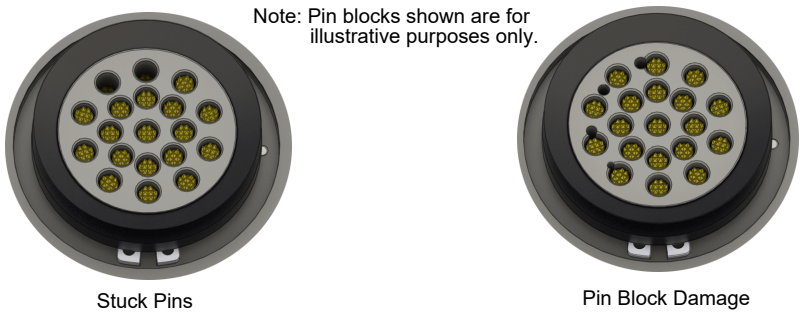
NOTICE: Do not use an abrasive media and/or cleaners or solvents to clean the contact pins. Using abrasive media and/or cleaners or solvents will cause damage to the contact surface or cause pins to stick. Clean contact surfaces with a vacuum or non-abrasive media such as a nylon brush (ATI Part Number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

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 the circuits in accordance with the customer's 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 the 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 Requirements.*
	Air pressure trapped in the de-energized Lock or Unlock ports.	Air pressure must be vented to the atmosphere properly, refer to *Section 2.7—Pneumatic Requirements* 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 the 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" (true).	Lock sensor/cable is damaged.	Replace the lock sensor assembly as necessary. Refer to *Section 5.2.2—Lock and Unlock Sensor Replacement Procedures.*
	Lock sensor is out of position.	Replace the lock sensor assembly as necessary. Refer to *Section 5.2.2—Lock and Unlock Sensor Replacement Procedures.*
Unit is unlocked but Unlock signal does not read "on" (true).	Unlock sensor/cable is damaged.	Replace the unlock sensor sub-assembly as necessary. Refer to *Section 5.2.2—Lock and Unlock Sensor Replacement Procedures.*
	Unlock sensor is out of position.	Replace the unlock sensor sub-assembly as necessary. Refer to *Section 5.2.2—Lock and Unlock Sensor Replacement Procedures.*
Read-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 5.2.3—RTL Flat Pack Style Sensor Replacement (R2 Sensor)* or *Section 5.2.4—RTL Flat Pack Style Sensor Replacement (R1 Sensor).*

5.2 Service Procedures

The following service procedures provide instructions for component replacement.

5.2.1 Alignment Pin Replacement

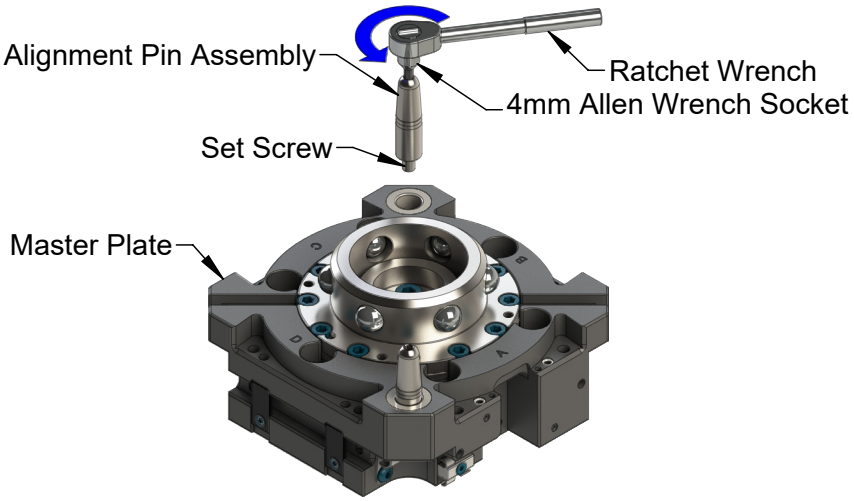
Parts required: *Refer to Section 6—Serviceable Parts*

Tools required: *3 mm and 4 mm hex key socket, torque wrench*

Supplies required: *Clean rag, MobilGrease XHP222, 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. 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 *5*. If alignment was remove go to step *6*.

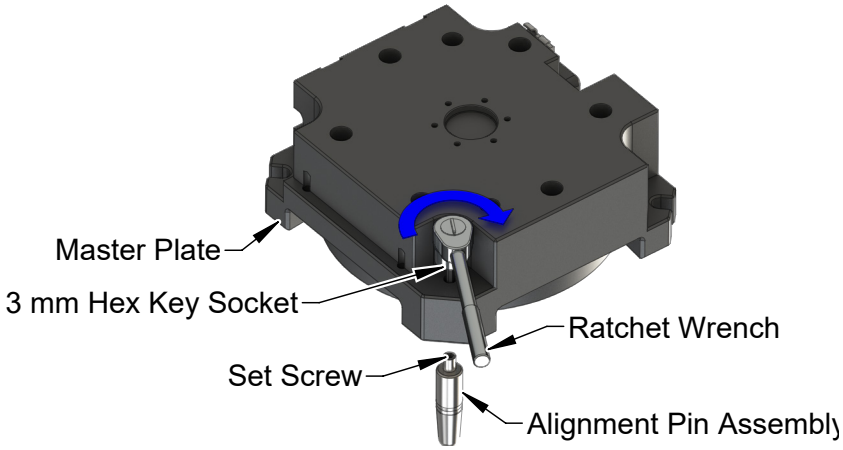
Figure 5.1—Remove Alignment Pin



5. 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 3 mm hex key to remove the alignment pin from the back side of the Master plate.

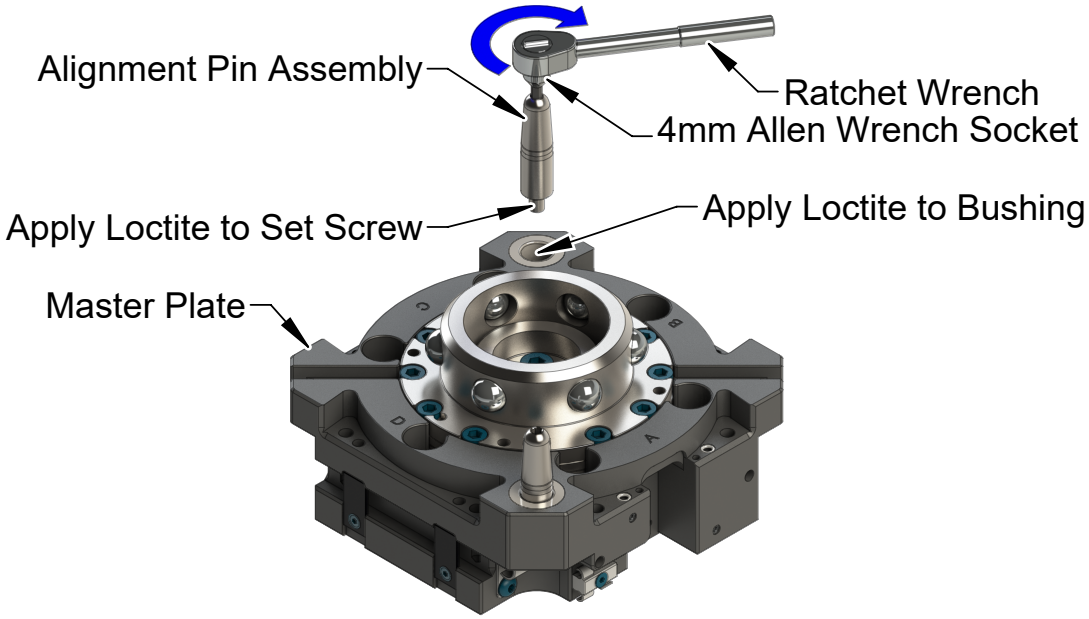
NOTICE: If for any reason the pin cannot be removed using the hex key in the tip, it may be necessary to remove it by other means, such as locking pliers.

Figure 5.2—Remove Alignment Pin From Back Side



6. 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.
7. Apply Loctite 242 to the inside of the alignment pin bushing and the threads if the alignment pin.
8. Install the alignment pin assembly into the bushing on the Tool Changer. Tighten to 60 in-lbs (6.8 Nm).
9. Apply MobilGrease XHP222 Special grease to the alignment pin, refer to *ection 4.2—Cleaning and Lubrication of the Locking Mechanism and Alignment Pins.*
10. Safely resume normal operation.

Figure 5.3—Alignment Pin Installation



5.2.2 Lock and Unlock Sensor Replacement Procedures

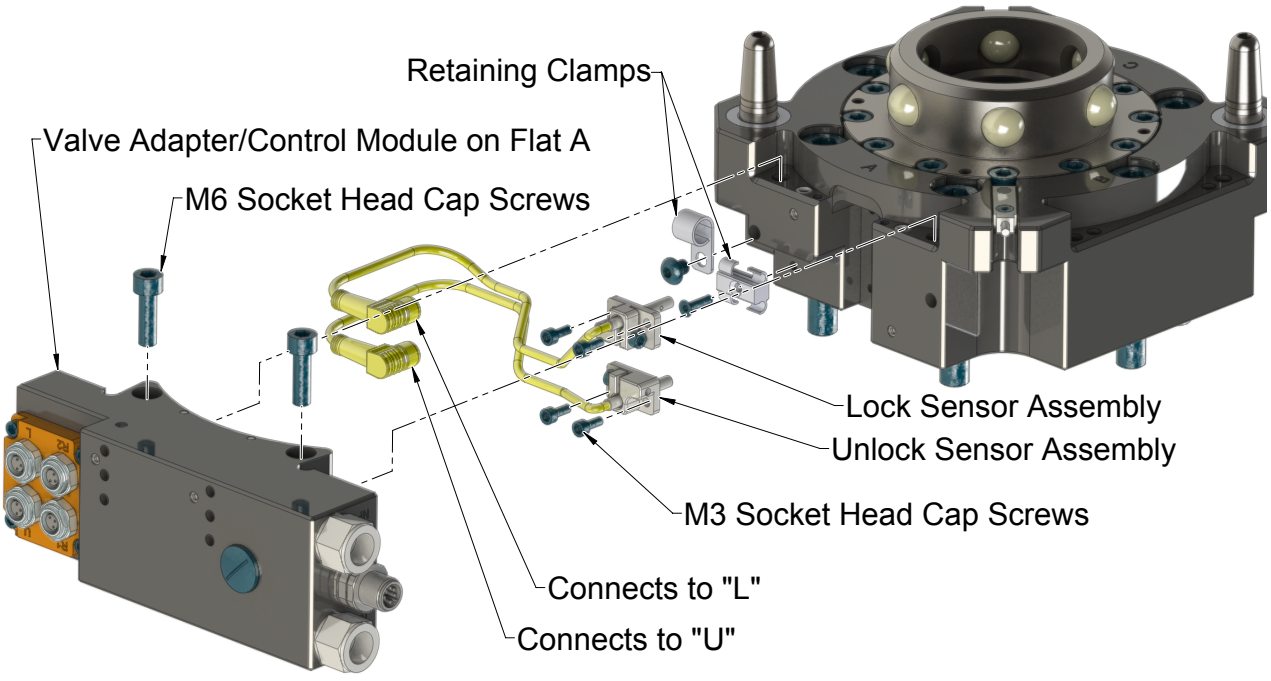
Parts required: *Refer to Section 6—Serviceable Parts*

Tools required: *2 mm, 2.5 mm, 3 mm, and 5 mm hex keys, torque wrench*

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 the Lock and/or Unlock sensor cable connector from the Valve Adapter/ Control Module.
5. On the Valve Adapter/Control module on Flat A, remove the (2) M6 socket head cap screws securing the module(s) to the Tool Changer body using a 5 mm hex key. Refer to *Figure 5.4.*
6. Lift off the Valve Adapter/Control module from Flats A.
7. Remove the M5 button head cap screw and cable clip on Flat A of the Tool Changer body using a 3 mm hex key.
8. Remove the M3 socket flat head cap screw and cable holder on Flat A of the Tool Changer body using a 2 mm hex key.
9. Remove the (2) M3 socket head cap screws that secure the Lock and/or Unlock sensor assembly to the Tool Changer body using a 2.5 mm hex key.
10. Pull the sensor assembly straight out from 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.

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

Figure 5.4— Lock and Unlock Sensor Assembly Replacement



11. Install the new Lock and/or Unlock sensor assembly, routing the cable through the (2) retaining clamps.

12. Secure the sensor assembly using the (2) M3 socket flat head screws using a 2.5 mm hex key. Tighten to 12 in-lbs (1.4 Nm).
13. Route the sensor cable on Flat A with the cable clip to secure to the Tool Changer body using the M5 button head cap screw with a 3 mm hex key. Tighten screws to contact
14. Route the sensor cable on Flat A with the cable holder to secure to the Tool Changer body using the M3 socket flat head cap screw with a 2 mm hex key. Tighten screws to contact
15. Install the Valve Adapter/Control module on Flats A.
16. Apply Loctite 242® to the M6 socket head cap screws fasteners.
17. Install the (2) (2) M6 socket head cap screws securing the module to the Tool Changer body using a 5 mm hex key. Tighten to 40–70 in-lbs (4.5–7.9 Nm).
18. Attach the Lock and/or Unlock sensor cable connectors to the proper connector on the Valve Adapter/Control module.
19. Confirm the operation of the Unlock sensor by issuing the Unlock command and then checking to see that the LED in the Unlock sensor body is on.
20. Confirm the operation of the Lock sensor by issuing the Lock command to lock a Tool to the Master and then checking to see that the LED in the Lock Sensor body is on.

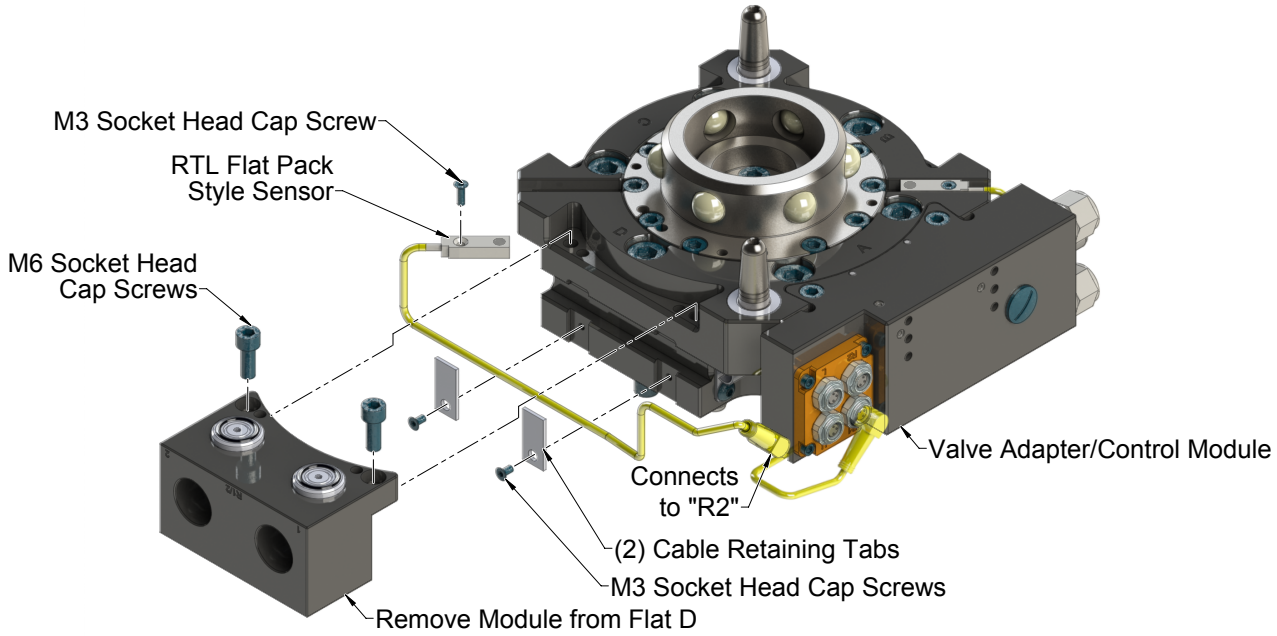
5.2.3 RTL Flat Pack Style Sensor Replacement (R2 Sensor)

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

Tools required: *2 mm and 5 mm hex keys, torque wrench*

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 there is an optional module on Flat D, remove the (2) M6 socket head cap screws securing the module to the Tool Changer body using a 5 mm hex key.
5. If equipped, lift off the optional modules from Flat D.
6. Remove the (2) M3 socket flat head cap screws and two cable retaining tabs on Flat D of the Tool Changer body using a 2 mm hex key.
7. Remove the M3 socket flat head cap screw securing the RTL sensor to the Tool Changer body using a 2 mm hex key.

Figure 5.5— RTL Sensor Replacement (R2 Sensor)



8. Unscrew the RTL sensor cable connector from the Valve Adapter/Control Module.
9. Remove the RTL sensor from the cable channel of the Tool Changer body. Discard the removed RTL sensor.
10. Install the new RTL sensor, routing the cable into the cable channel of the Tool Changer body.
11. Attach the RTL sensor cable to the R2 connector on the Valve Adapter/Control Module.
12. Install the RTL sensor to the Tool Changer body.
13. Apply Loctite 222® to the M3 socket flat head screw. Secure the sensor to the Tool Changer body using a 2 mm hex key. Tighten to 60 in-ozs (0.4 Nm).
14. Install the (2) cable retaining tabs on Flat D of the Tool Changer body and secure with the (2) M3 socket flat head cap screws using a 2 mm hex key. Tighten to contact.
15. If optional module was removed from Flat D, install the module.
16. Apply Loctite 242® to the M6 socket head cap screws fasteners.
17. Install the (2) (2) M6 socket head cap screws securing the module to the Tool Changer body using a 5 mm hex key. Tighten to 40–70 in-lbs (4.5–7.9 Nm).
18. 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.

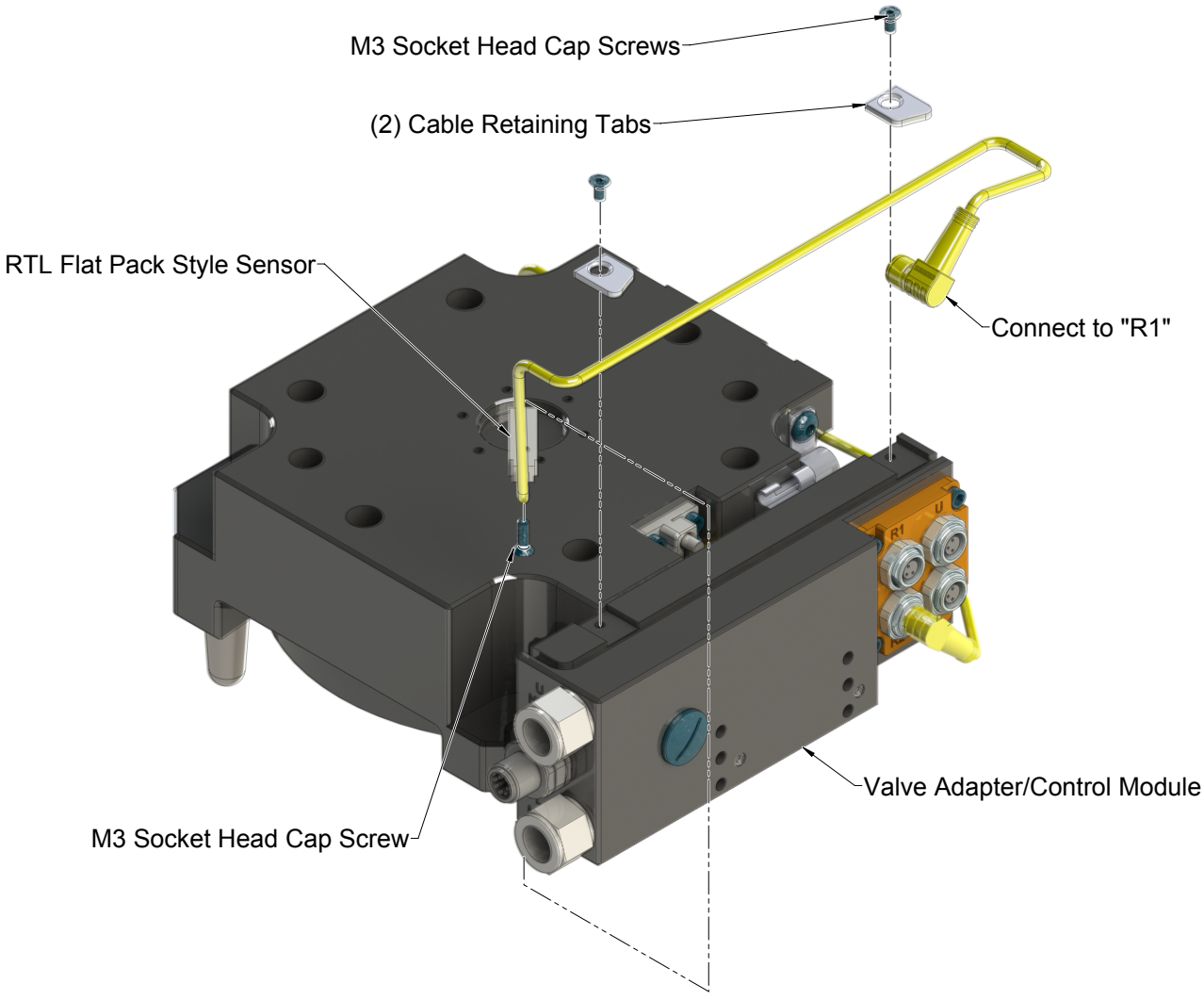
5.2.4 RTL Flat Pack Style Sensor Replacement (R1 Sensor)

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

Tools required: *2 mm hex key, torque wrench*

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. Depending on the robot and interface plate used the Tool Changer Master plate may have to be removed. Refer to *Section 2.3—Master Plate Removal*.
5. Remove the (2) M3 socket flat head cap screws and two cable retaining tabs on the Valve Adapter/Control Module using a 2 mm hex key.
6. Remove the M3 socket flat head cap screw securing the RTL sensor assembly to the Tool Changer body using a 2 mm hex key.
7. Unscrew the RTL sensor cable connector from the Valve Adapter/Control Module.
8. Remove the RTL sensor from the cable channel of the Valve Adapter/Control Module. Discard the removed RTL sensor.

Figure 5.6— RTL Sensor Assembly Replacement (R1 Sensor)



9. Install the new RTL sensor, routing the cable into the cable channel of the Valve Adapter/ Control Module.
10. Route the RTL sensor cable in the channel on the Valve Adapter/Control Module.
11. Install the RTL sensor assembly to the Tool Changer body.
12. Apply Loctite 222® to the M3 socket flat head screw. Secure the sensor to the Tool Changer body using a 2 mm hex key. Tighten to 60 in-ozs (0.4 Nm).
13. Install the (2) cable retaining tabs on the Valve Adapter/Control Module and secure with the (2) M3 socket flat head cap screws using a 2 mm hex key. Tighten to contact.
14. Confirm the operation of the new 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.
15. Install the Tool Changer Master plate to the robot arm or interface plate, refer to *Section 2.2—Master Plate Installation*.

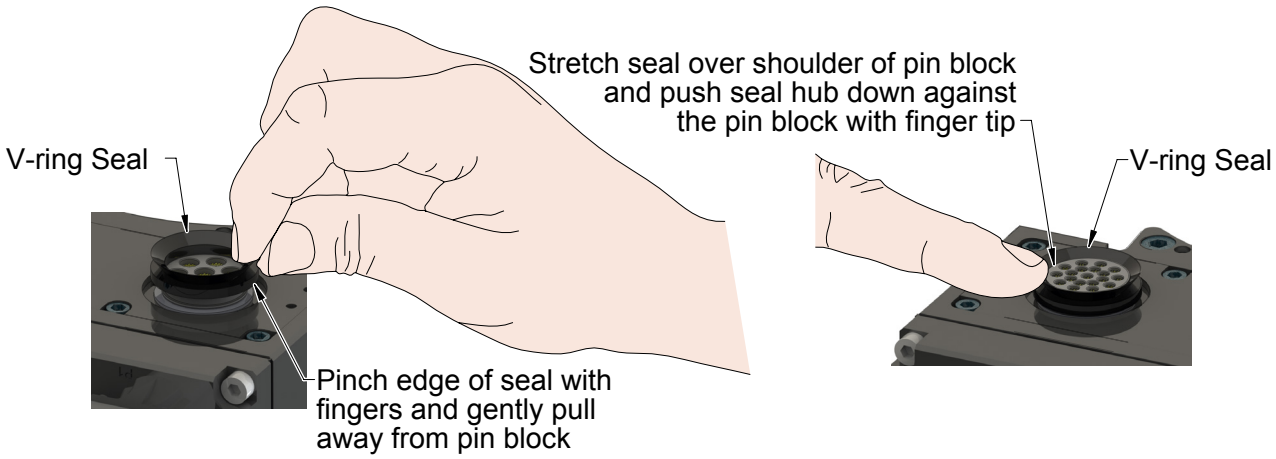
5.2.5 Seal Inspection and Replacement

Parts required: *Refer to Electrical or control/signal module manual.*

The seal protects the electrical connection between the Master and Tool module. If the seal becomes worn or damaged, it must be replaced.

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 with your fingers and pull the seal away from the pin block on the Master.
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 using your finger tip.
7. Safely resume normal operation.

Figure 5.7—V-ring Seal Replacement



6. Serviceable Parts

6.1 Common Master Parts

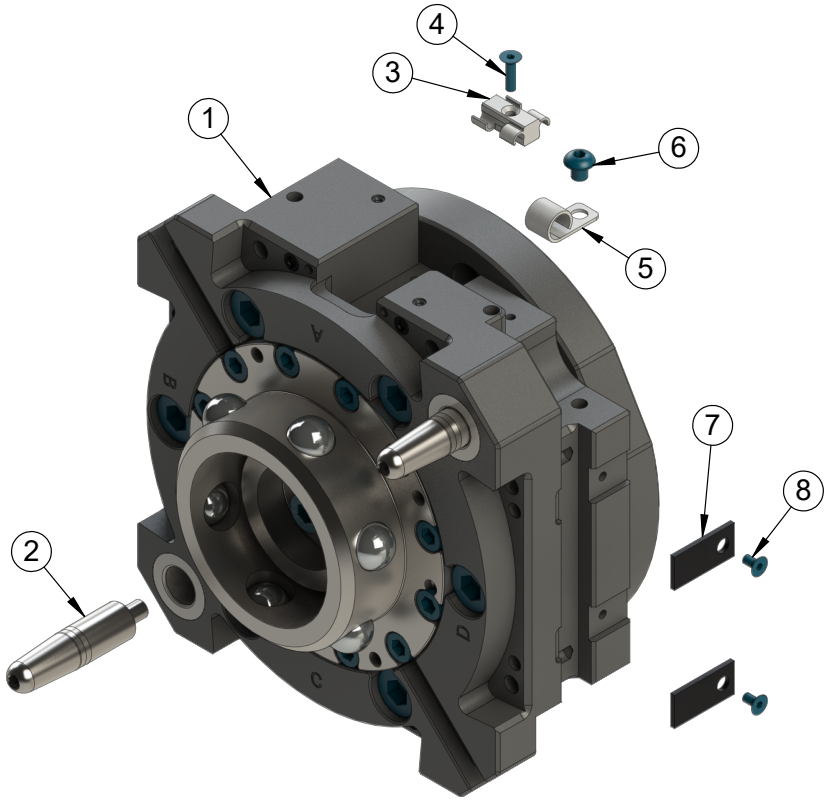


Table 5.2—Common Master Parts			
Item No.	**Qty**	**Part Number**	**Description**
1	1	9121-113xMX-0-0-0-0	Complete QC-113 Master plate, No Options
2	2	9005-20-2241	7/8” Two Piece Alignment Pin
3	1	3690-0000084-01	Cable Holder, Two-Line, 5/32”-1/4” OD, Plastic, M3 Flat Head Socket Cap Screw Attachment
4	1	3500-1258012-15	M3 x 12 mm Socket Flat Head Cap Screw Blue Dyed Magni-565
5	1	3690-0000068-61	Cable Clip, Nylon, Flexible, 1/4” Max Bundle
6	1	3500-1164006-21	M5 x 6 mm Button Head Socket Cap Screw, SS
7	2	3700-20-4092	Large Cable Retaining Tab
8	2	3500-1258006-11	M3 x 6 mm Socket Flat Head Cap Screw Black Oxide
Notes: x = A, B, C, D, E, or F for boss size designation.			

6.2 Models 9121-113xM-0-0-0-0-SP

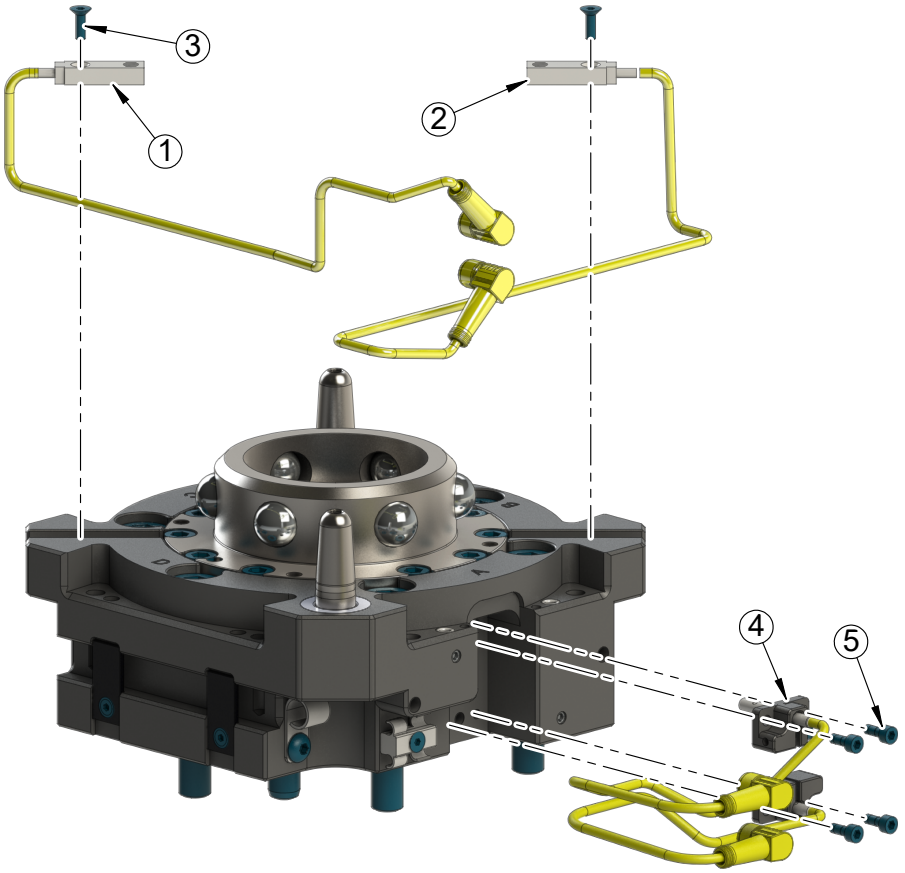


Table 5.3—9121-113xM-0-0-0-0-SP			
Item No.	**Qty**	**Part Number**	**Description**
1	1	8590-9909999-198	LED NPN Flat Pack Sensor .28M (90 Pico)
2	1	8590-9909999-199	LED NPN Flat Pack Sensor .30M (90 Pico)
3	2	3500-1258010-11	M3 x 10 mm Socket Flat Head Cap Screw Black Oxide
4	2	9005-20-1744	Lock/Unlock Sensor Assembly, QC-210 (NPN) includes (2) of item 5
5	4	3500-1058008-15A	M3 X 8 Socket Head Cap Screw Blue Dyed Magni-565, ND Microspheres
Notes: x = A, B, C, D, E, or F for boss size designation.			

6.3 Tool plate

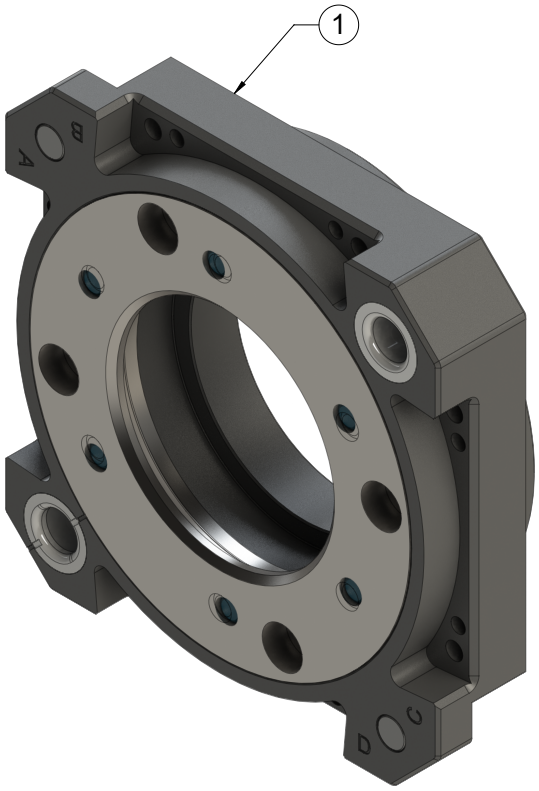


Table 5.4—Tool plate			
Item No.	**Qty**	**Part Number**	**Description**
1	1	9121-113xT-0-0-0-0	QC-113 Base Tool Assembly, No Options
Notes: x = A, B, C, D, E, or F for boss size designation.			

7. Specifications

Table 5.5—Master and Standard Tool Plates		
Recommended Max Payload	150 lbs (330kg)	The mass attached to the Tool Changer.
Operating Temperature Range	-20–150°F (-30–66°C)	Operating Temperature
Operating Pressure Range	60–100 psi (4.1–6.9 bar)	Locking mechanism supply pressure operating range. Supply to be clean, dry, and filtered to 40 micron or better.
Coupling Force @ 80 psi	2,730 lbs. 1,235 (N)	Axial holding force
Recommended Max Moment X-Y (Mxy) **Recommended Max Torque about Z (Mz)**	**6940 lb-in** **784 (Nm)** **5000 lb-in** **565 (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.)	13.79 lbs (6.26 kg)	Master 8.75 lbs (3.97 kg) Tool 5.04 lbs (2.29 kg)
Max. Recommended distance between Master and Tool plate	0.10” (2.5 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 (2) with cable and connector for direct wiring to the control/signal module to indicate locking mechanism position. Flat Pack proximity sensor 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 Interface plate	125 mm BC, (6) M10 socket head cap screws, (2) 10 mm Dowels 115 mm BC, (4) M8 socket head cap screws, (2) 6 mm Dowels 125 mm to 115 mm BC, (4) M8 socket head cap screws, (2) 6 mm Dowels

8. Drawings

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