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B. Base Tool Changer

QC-7 Series—Robotic 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-7 Series of Tool Changers, click the following link: *QC-7 Series*.

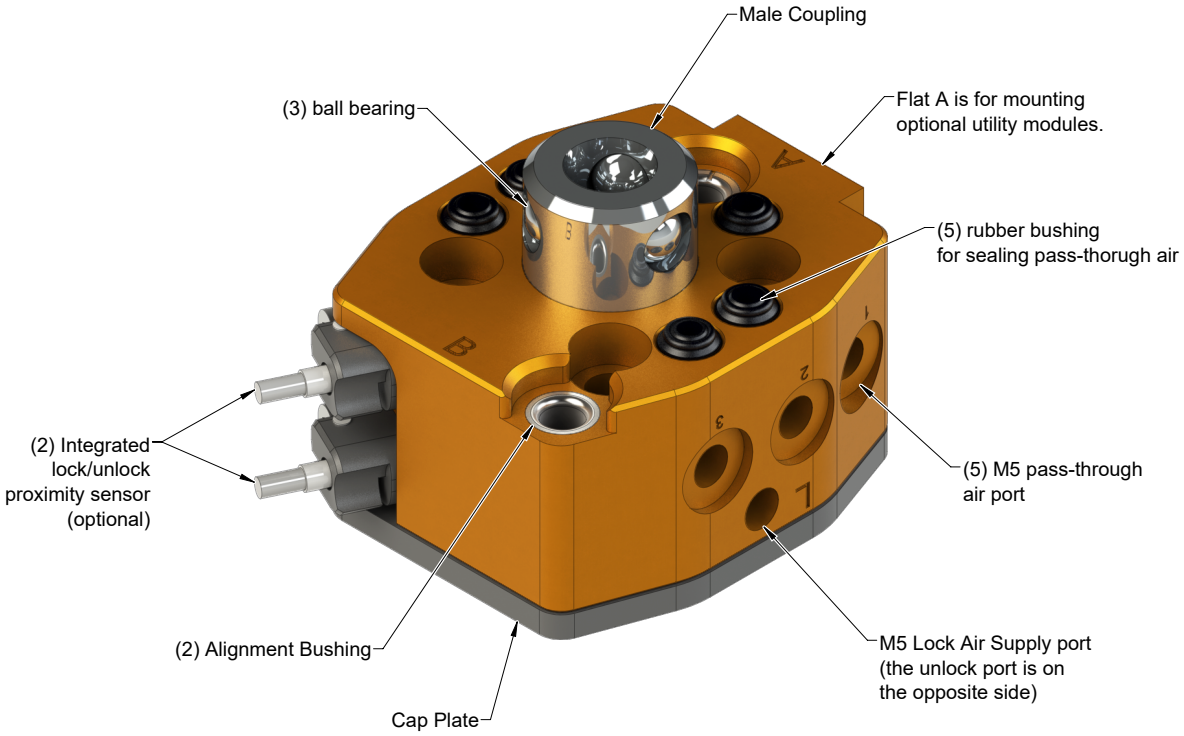
1.1 Master Plate Assembly

The Master plate assembly includes the following features:

- An anodized aluminum body
- A hardened stainless steel locking mechanism (a cam, male coupling, and (3) chrome steel ball bearings)
- (2) Alignment bushings that mate with pins on the Tool plate
- (1) Flat for mounting an optional module
- (2) M5 connections to supply pneumatic pressure for coupling and uncoupling the Tool Changer
- (2) Lock and unlock fittings for 4 mm (5/32”) outer diameter (OD) tubes (refer to *Figure 1.2*)
- (2) Optional integrated proximity sensors are used to verify the lock/unlock position of the piston and cam. For different sensor options, refer to *Section 6.1—Master Plate Assembly Serviceable Parts*.

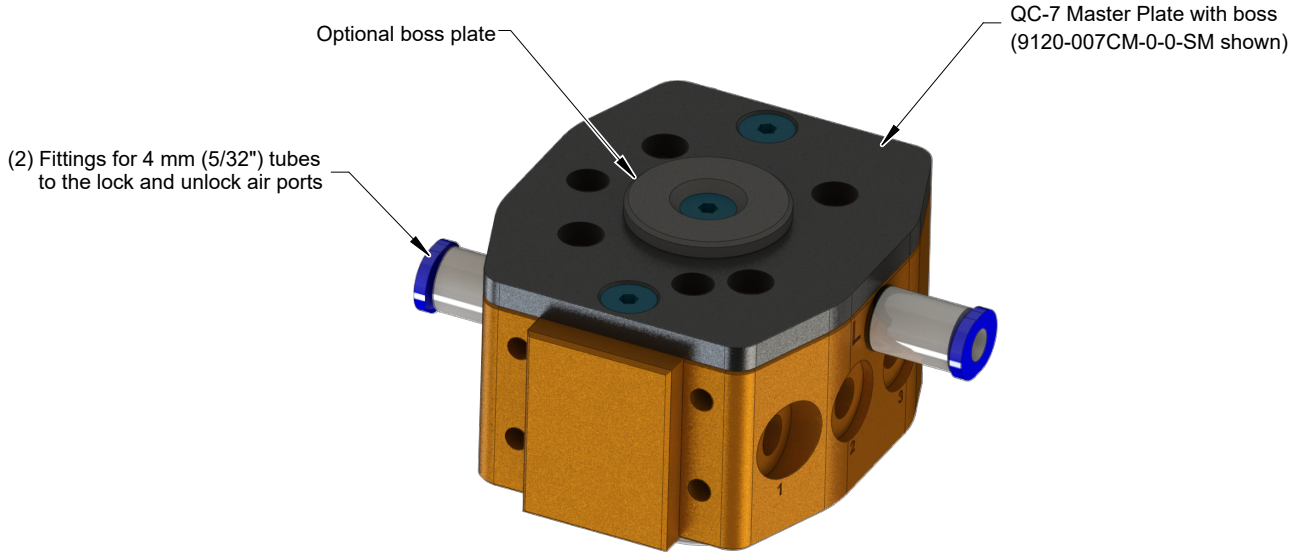
An extreme pressure grease is applied to the cam, male coupling, and ball bearings to enhance performance and maximize the life of the Master plate (refer to *Section 4.2—Cleaning and Lubrication of the Locking Mechanism and Alignment Pins* for details about the cleaning procedure and type of grease).

Figure 1.1—Master Plate Assembly (Shown with Optional Sensors)



The Master plate includes a machined mounting pattern, which is in accordance with ISO-9409-1-31.5-4-M5, for mounting to a robot arm or an interface plate (refer to *Section 8—Drawings* for the mounting pattern details). Additional interface plates are available (refer *Section 6.1—Master Plate Assembly Serviceable Parts*).

Figure 1.2—Master Plate Assembly (Optional Boss and Lock and Unlock Fittings)



1.2 Tool Plate Assembly

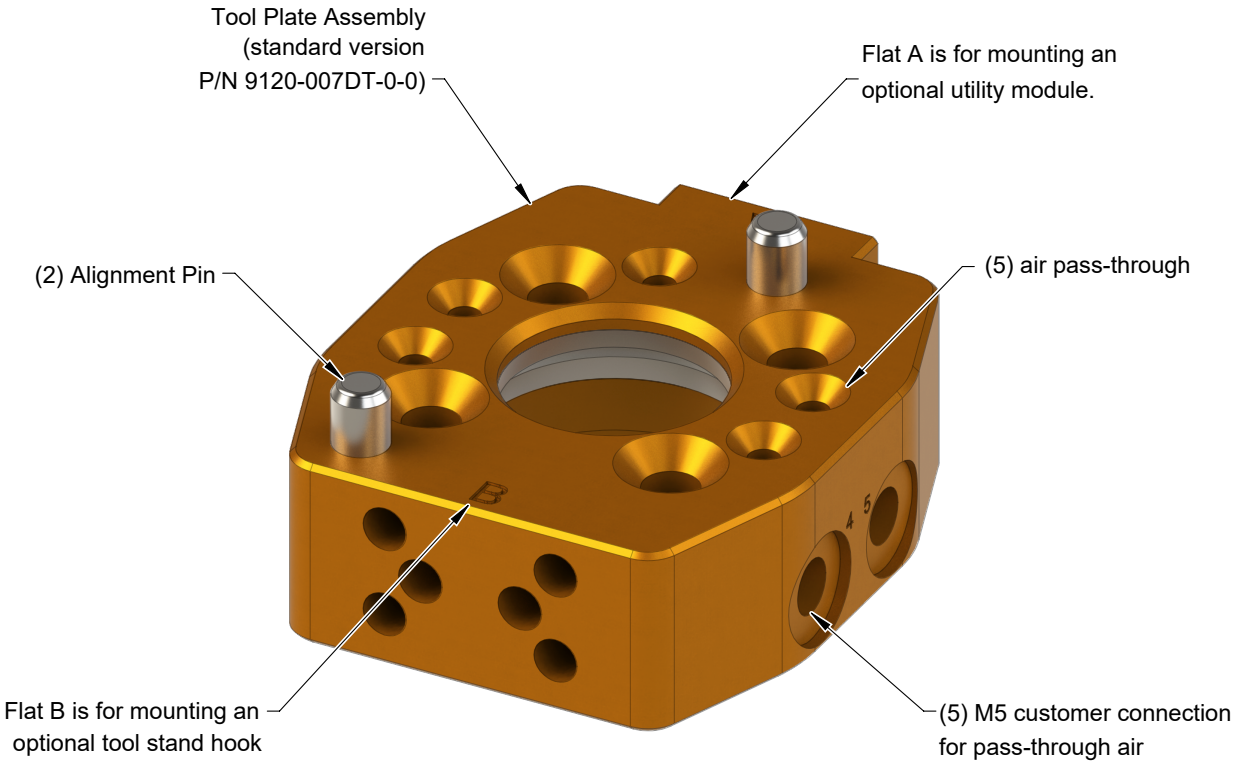
The standard Tool plate assembly includes the following features:

- An anodized aluminum body
- A hardened stainless steel bearing race
- (2) Hardened steel alignment pins that mate with bushings on the Master plate
- (5) M5 radial pass-through air ports that come with removable plugs (refer to *Figure 1.4*)
- Flat A for mounting optional modules (refer to *Figure 1.4*)
- Flat B for mounting a tool stand hook that interfaces with ATI's Tool Stand Small (TSS)
- A machined mounting pattern for mounting to customer tooling or an interface plate (refer to *Section 8—Drawings* for the mounting pattern details)

For more information about the optional tool stand hook or other TSS products, visit the ATI website (*https://www.ati-ia.com/products/toolchanger/toolstand/small/smallstand.aspx*) and refer to the TSS manual 9610-20-1068 (*https://www.ati-ia.com/app_content/Documents/9610-20-1068.pdf*).

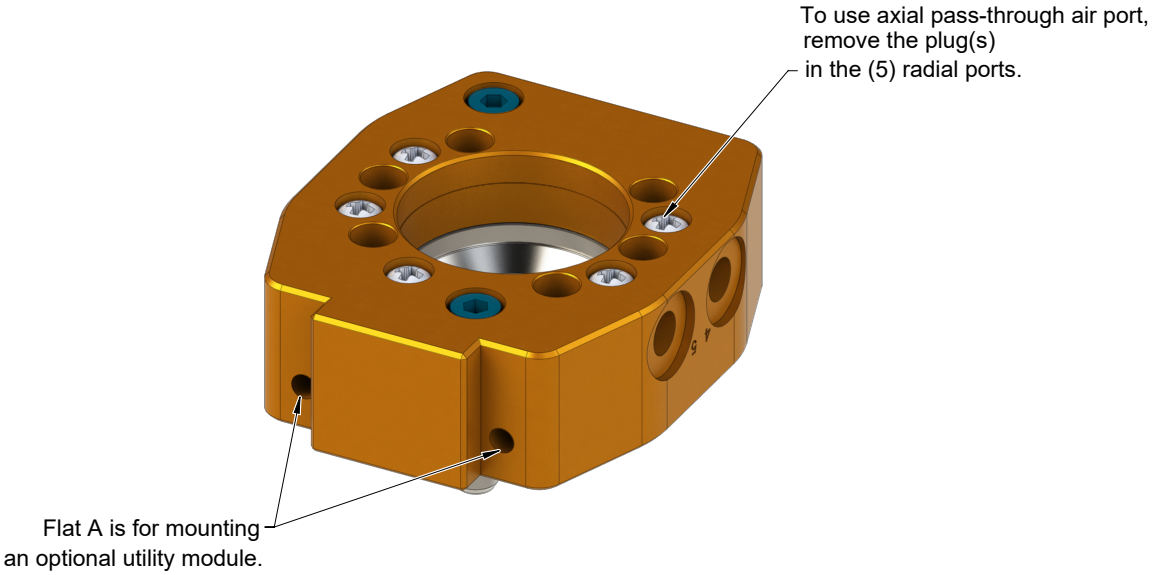
An extreme pressure grease is applied to the alignment pins to enhance performance and maximize the life of the Tool Changer (refer to *Section 4.2—Cleaning and Lubrication of the Locking Mechanism and Alignment Pins* for details about the cleaning procedure and type of grease).

Figure 1.3—Tool Plate Assembly



On the reverse side of the Tool plate assembly, (5) radial ports are plugged. The customer can make these ports axial by removing the phillips head screws. If the customer turns the radial ports to axial ports, the customer must use supplied o-rings to seal these axial ports and plugs to seal the radial port. For the customer interface, refer to the drawing in *Section 8—Drawings*.

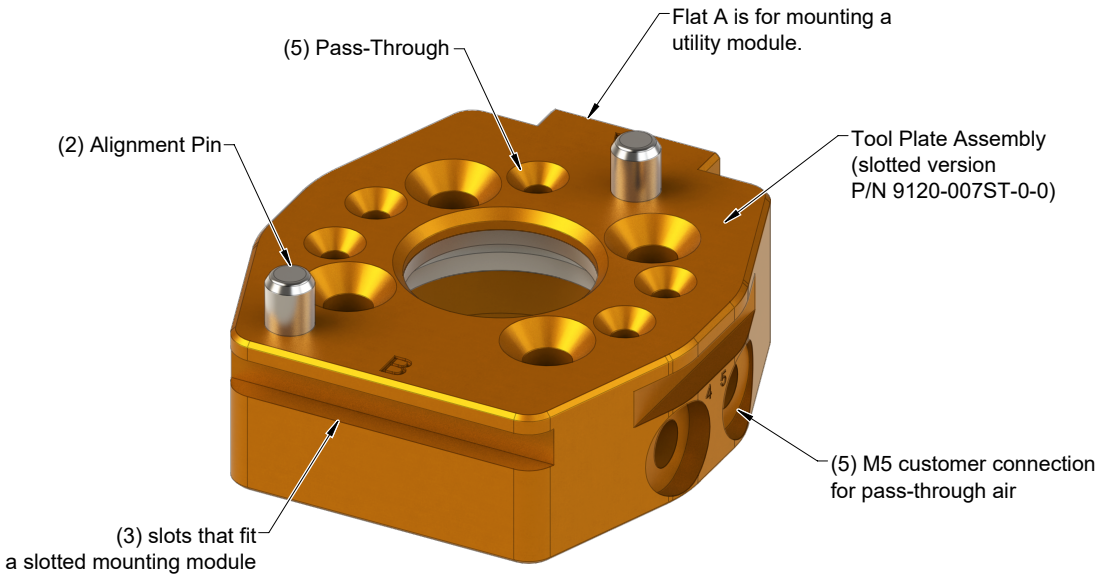
Figure 1.4—Tool Plate Assembly (axial port plugs and flat for mounting optional modules)



1.3 Slotted Tool Plate Assembly

The slotted Tool plate assembly is used with a slotted tool module that interfaces with the TSS. Aside from not being compatible with a hook and hanger module, the slotted Tool plate has the same features as the standard Tool plate assembly.

Figure 1.5—Slotted Tool Plate Assembly

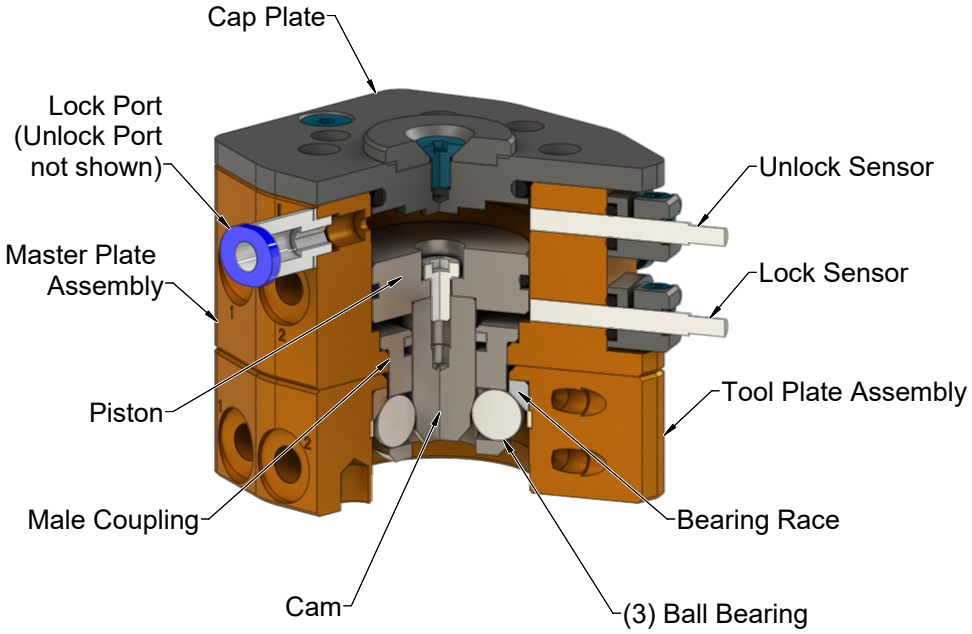


1.4 Master Plate/Tool Plate Locking Mechanism

The coupling of the Master plate and the Tool plate is achieved through a patented high-strength, stainless steel mechanism. During locking, steel balls in the Master plate are driven outward by a circular cam attached to a pneumatically actuated piston. The cam profile has (3) features: A lead-in angle (conical), a reverse angle, and a secondary angle (conical). The lead-in angle initiates the coupling process, the reverse angle prevents uncoupling in case of air loss (fail-safe feature), and the secondary angle provides rigid coupling during normal operation. The balls engage a bearing race (or "locking ring") in the Tool plate and lock the Master plate and Tool plate tightly together.

The lock and unlock proximity sensors detect the position of the piston and indicate when the Tool Changer is in the Locked or Unlocked position.

Figure 1.6—Locking Mechanism



1.5 Optional Modules

On Flat A, users can mount an optional utility module. Some modules may require an adapter plate (refer to the module customer drawing).

On Flat B, users can mount to the Tool plate which interfaces with the ATI TSS. For additional information about ATI's TSS products, refer to the product index on the ATI webpage (*https://www.ati-ia.com/products/toolchanger/toolstand/TS_Index.aspx?type=Small*) and the *TSS manual*.

For assistance in selecting the correct modules, refer to the *ATI website* or contact an ATI representative.

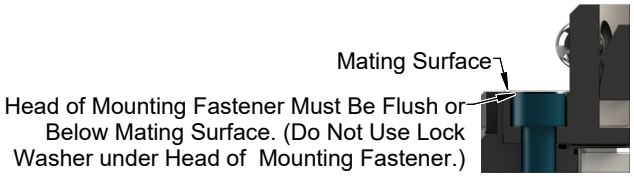
2. Installation

On the Master plate, the QC-7 Tool Changer has a standard ISO 31.5 mm bolt pattern that mounts to many common robot models; for all other robot models and tools, an interface plate can be used.

For information about designing an interface plate, refer to *Section 2.1—Master Interface* and *Section 2.4—Tool Interface*. Custom interface plates are available from ATI upon request.

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.

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.



WARNING: All pneumatic fittings and tubing must be capable of withstanding the repetitive motions of the application without failing. The routing of electrical and pneumatic lines must minimize the possibility of over stressing, pullout, or kinking the lines. Failure to do so can cause critical electrical and/or pneumatic lines to malfunction and might result in injury to personnel or damage to equipment.

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 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, Property Class, and Type**	**Recommended Torque**	**Thread Locker**
Optional Master interface plate to a robot		M6-1.0 Class 12.9 Socket flat head cap	89 in-lb (10.06 Nm)	Pre-applied Adhesive or Loctite® 242
QC-7 Master plate to an interface plate or robot		M5-0.8 Class 12.9 Socket head cap	52 in-lb (5.88 Nm)	Pre-applied Adhesive or Loctite® 222
Tool Interface Plate to QC-7 Tool plate with a minimum thread engagement of 7.5 mm [1.5X fastener Ø].	Bolt-Up Installation (refer to *Figure 2.2*) Do not exceed maximum available thread depth of 8 mm for M5 screws as shown in *Section 8—Drawings*	M5-0.8 Class 12.9 Socket head cap	52 in-lb (5.88 Nm)	
	Bolt-Down Installation (refer to *Figure 2.2*)	M4 Class 12.9 Socket flat head cap	15 in-lb (1.69 Nm)	
Optional Module or adapter/interface plate to Flat A on the Master or Tool plate		M3 Class 12.9		Pre-applied Adhesive or Loctite® 222
		Socket head cap	10 in-lb (1.13 Nm)	
		Socket flat head cap	8 in-lb (0.9 Nm)	

Note:

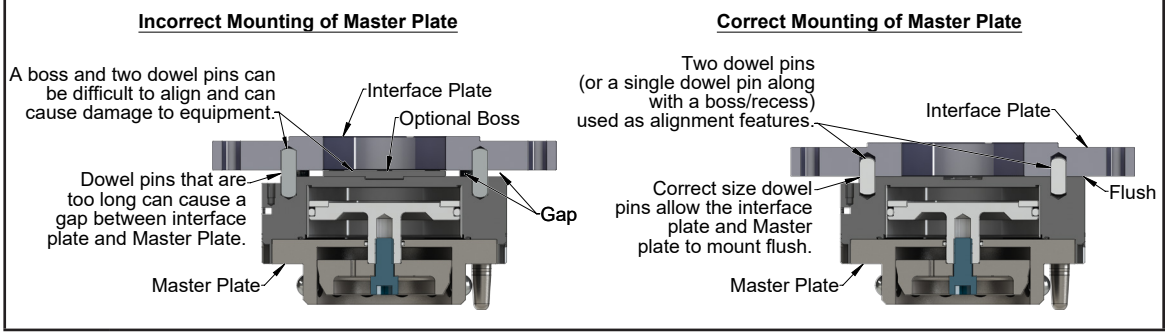
1. Customers should select fasteners for the interface plate that are long enough for maximum thread engagement sot that the interface plate is securely installed to the robot arm or customer tooling. The maximum available thread depth depends on the customer application.
2. For installing modules that interface with the TSS, such as the hook and hanger module, refer to the installation instructions in the *TSS manual*.

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 Assembly Installation

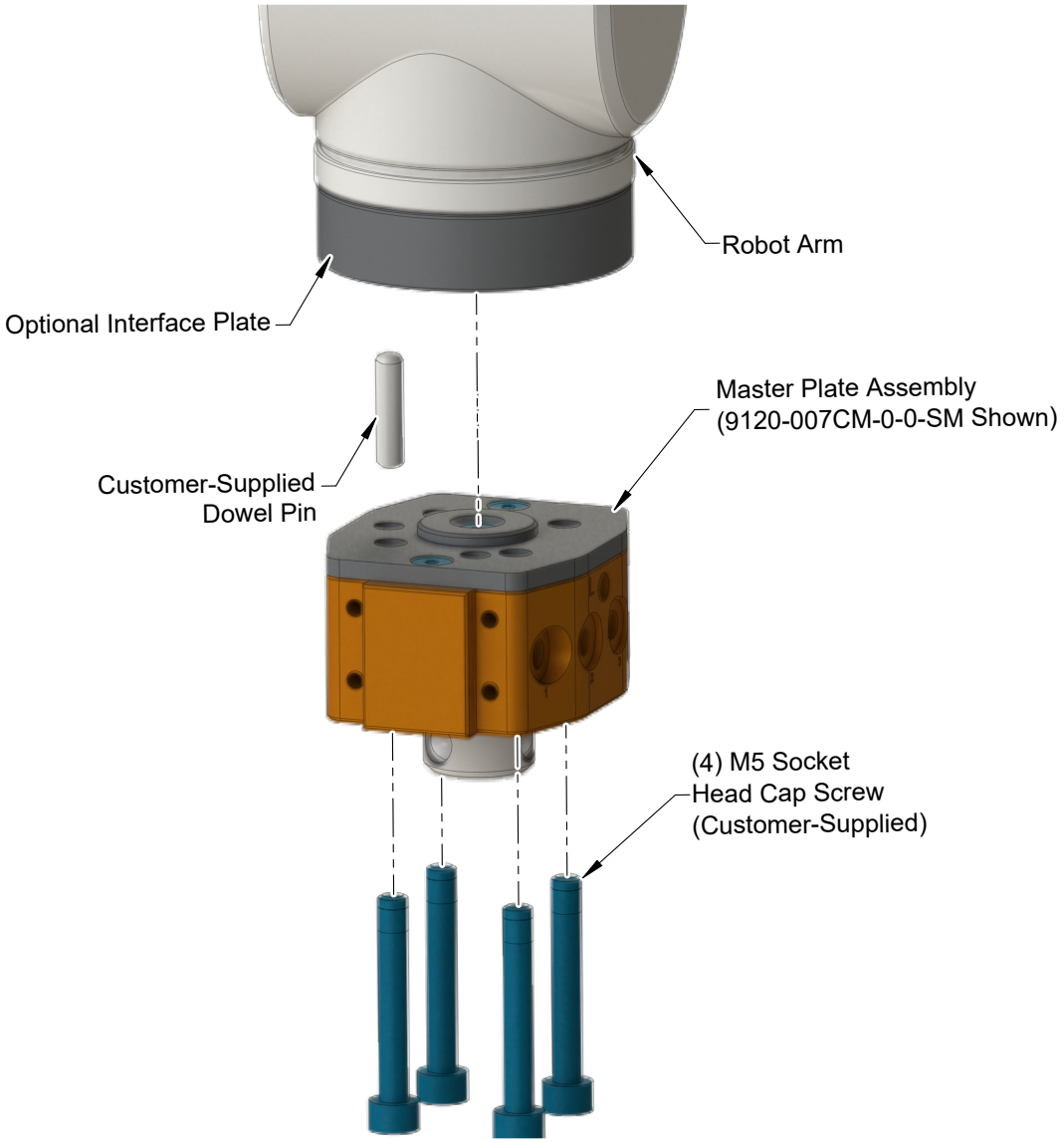
Refer to *Figure 2.1*.

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

Supplies required: *Clean rag, Loctite®242 and Loctite®222*

1. Clean the mounting surfaces.
2. If using an interface plate, install the plate to the robot arm.
3. Install the Master plate assembly to the robot arm or interface plate (see *Table 2.1* for fastener and threadlocker specifications):
   a. Apply the appropriate threadlocker to the fastener threads.
   b. Align the Master plate to the interface plate or robot arm.
   c. Using a 4 mm hex key, secure the Master plate assembly to the robot arm or interface plate with customer-supplied fasteners. Tighten to the appropriate torque value.
4. If equipped, fasten the lock and unlock sensor cable M8 connectors.
5. Connect all lock/unlock and pass through air connections to the Master plate assembly. For lock and unlock air, refer to *Section 2.8—Lock and Unlock Pneumatic and Valve Requirements*.
6. Connect utilities to the optional module and Master plate assembly connections.
7. Safely resume normal operation.

Figure 2.1—Master Plate Assembly Installation



2.3 Master Plate Assembly Removal

Tools required: *4 mm hex key*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plate assemblies.
3. De-energize all energized circuits (e.g. electrical, air, water, etc.).
4. Disconnect all utilities (e.g. electrical, air, water, etc.).

NOTICE: Support the Master plate assembly while removing the fasteners.

5. Using a 4 mm hex key, remove the (4) M5 socket head cap screws that connect the Master plate assembly to the robot arm or interface plate.

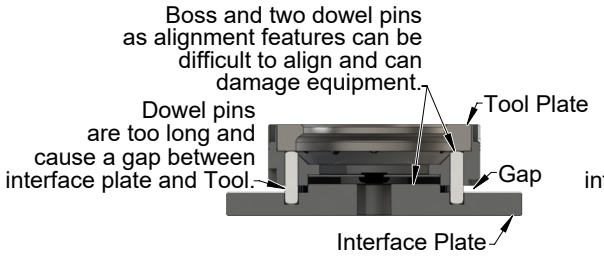
2.4 Tool Interface

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 secure the Tool plate to customer tooling. Custom interface plates can be supplied by ATI (refer to the application drawing).

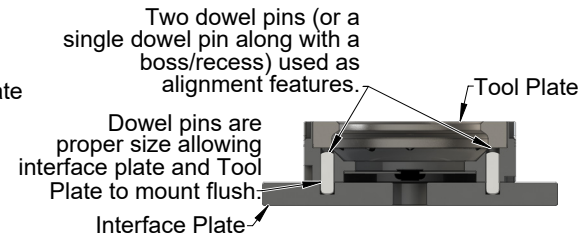
CAUTION: Do not use more than two alignment features when securing a Tool plate to an interface plate. Using more than two alignment features can cause damage to equipment. Use either two dowel pins or a single dowel pin, along with a boss/recess feature to align the Tool plate with the interface plate.

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 diameter between 0.16" and 0.4" (4 mm and 10 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 Assembly Installation

Tools required: *2.5 mm hex key for M4 flat head socket cap screw, 4 mm hex key for M5 socket head cap screw, torque wrench*

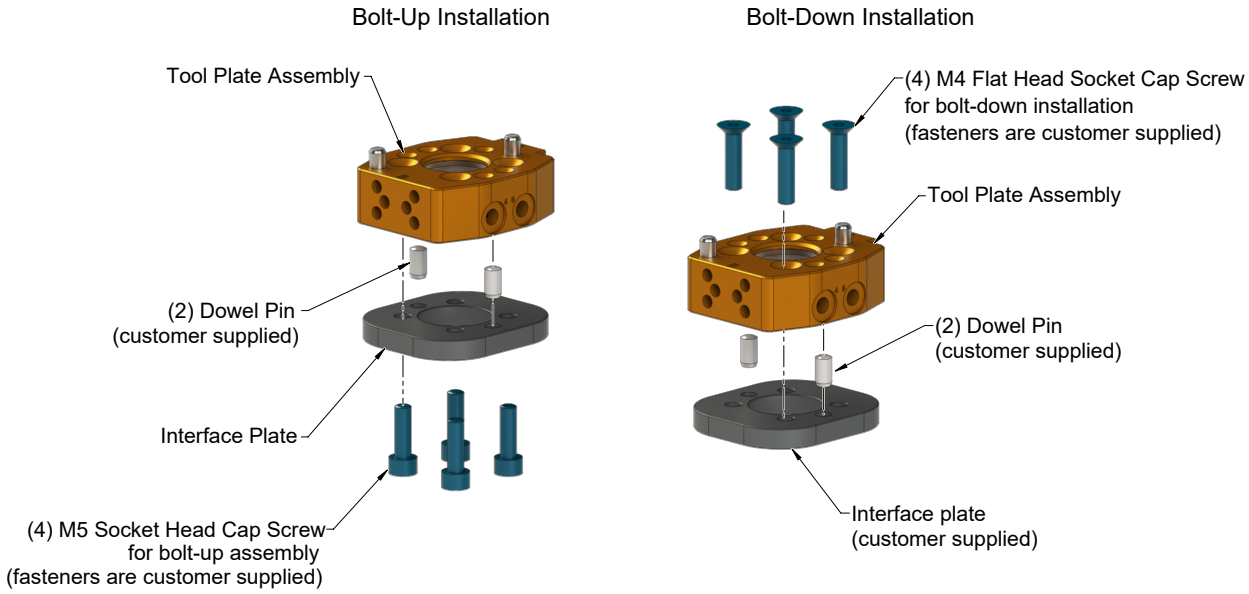
Supplies required: *Clean rag, Loctite 222*

1. Clean the mounting surfaces.

NOTICE: If an interface plate is purchased from ATI, fasteners to mount the Tool plate to the interface plate are supplied by ATI.

2. Install the Tool plate assembly to the customer tooling or an interface plate with customer supplied fasteners (see *Table 2.1* for fastener and threadlocker specifications).
3. Connect utilities to the optional module and Tool plate assembly connections.
4. Safely resume normal operation.

Figure 2.2—Tool Plate Assembly Installation



2.6 Tool Plate Assembly Removal

Tools required: *2.5 mm hex key for M4 flat head socket cap screw, 4 mm hex key for M5 socket head cap screw, torque wrench)*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plate assemblies.
3. De-energize all energized circuits (e.g. electrical, air, water, etc.).
4. Disconnect all utilities (e.g. electrical, air, water, etc.).
5. Remove the fasteners that connect the Tool plate to the tooling or interface plate.

2.7 Optional Module Installation

Tool Changers are compatible with different types of modules. Some modules require an adapter plate to be installed to the Tool Changer. The optional modules are typically installed on Tool Changer by ATI prior to shipment. The following procedure outlines field installation and removal.

NOTICE: If the optional modules interfere with the customer selected application (for example the robot arm), then the customer may need to design an interface plate to provide proper clearance.

2.7.1 Master and Tool Utility Modules Installation

Refer to *Figure 2.3*.

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

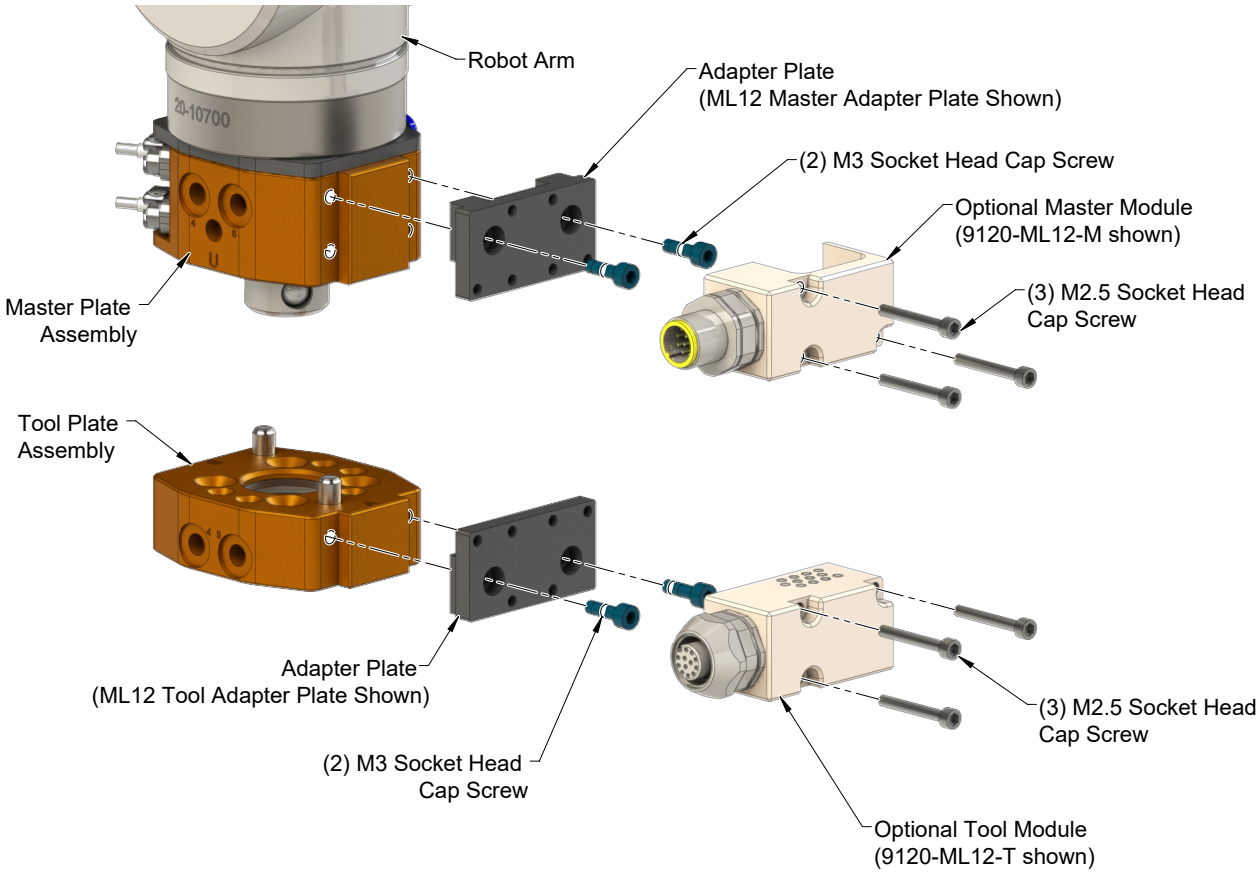
Supplies required: *Clean rag, Loctite 222*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plate assemblies.
3. De-energize all energized circuits (e.g. electrical, air, water, etc.).
4. Clean the mounting surfaces.

NOTICE: If the module has an adapter or interface plate, refer to the module customer drawing for additional information about module fastener type and thread/loctite specifications.

5. Apply Loctite 222 to the threads of the M3 socket screws.
6. Using a 2.5 mm hex key, secure the module to flat. For torque specs, refer to *Table 2.1*.
7. Remove all protective caps, plugs, and tape from the module prior to operation.
8. If required, connect any cables, electrical lines, etc.
9. Safely resume normal operation.

Figure 2.3—Module Installation



2.7.2 Master and Tool Utility Modules Removal

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

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates assemblies.
3. De-energize all energized circuits (e.g. electrical, air, water, etc.).
4. If required, disconnect any cables, air lines, etc.

NOTICE: If the module has an adapter or interface plate, refer to the module customer drawing for additional information about module fastener type.

5. Use a 2.5 mm hex key to remove the M3 socket head cap screws securing each module to the Master or Tool Plate assembly.

2.8 Lock and Unlock Pneumatic and Valve Requirements

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 or transport the Tool Changer in the fail-safe condition, a state where the master plate is locked to a tool plate with no air pressure supplied. Damage to the locking mechanism might occur. Restore proper air pressure and confirm a locked condition before continuing to use the Tool Changer.

2.8.1 Air Requirements

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

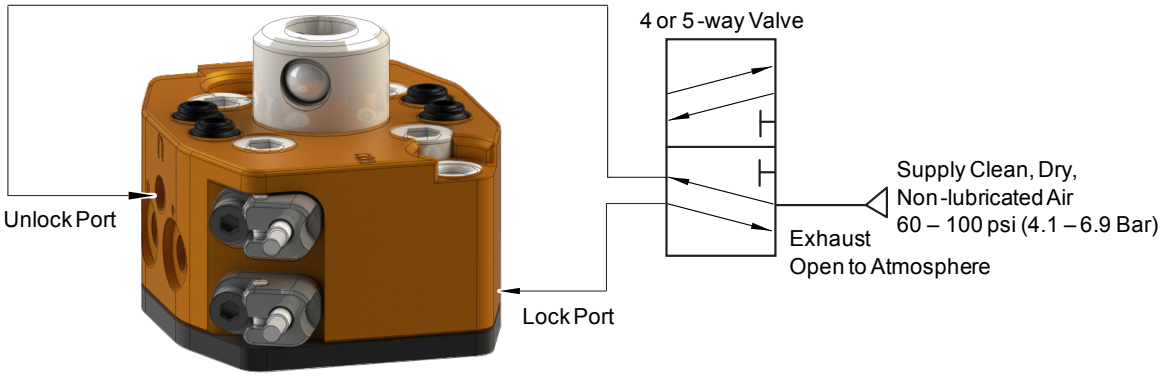
- Pressure range: 60-100 psi (4.1–6.9 Bar)
- Filter minimum: 40 microns
- Flow maximum: 1/3 CFM at 70 psi (4.8 Bar), when cycled continuously
- Lock and Unlock fittings (ATI supplied) are for 4 mm (5/32”) tubes (refer to *Figure 1.2*)

2.8.2 Valve Requirements and Connections

To lock the Tool Changer, air must vent to the atmosphere from the unlock port and be supplied to the lock port. Conversely, to unlock the Tool Changer, air must vent to the atmosphere from the lock port and be supplied to the unlock port. Therefore, a single, 2-position, with either a 4-port or 5-port valve configuration is required.

CAUTION: Do not use a single, 3-port valve to supply air to the Tool Changer, as this type of valve can not vent trapped air. Improper venting might result in damage to the product and attached tooling, or injury to personnel. Connect the lock and unlock air supplies to a single, 2-position, with either a 4-port or 5-port valve configuration.

Figure 2.4—Lock and Unlock Pneumatic Connections



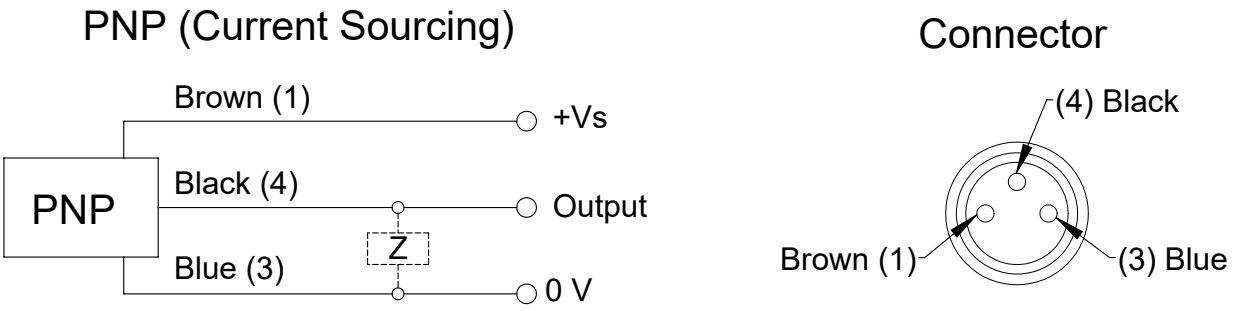
2.9 Electrical Connections

The Tool Changer is available with integrated lock/unlock sensors. The proximity sensor is hard wired to a 20 cm (7.87 in) cable that has a 3-pin male M8 end cable connector.

2.9.1 PNP Type Lock and Unlock Sensors

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

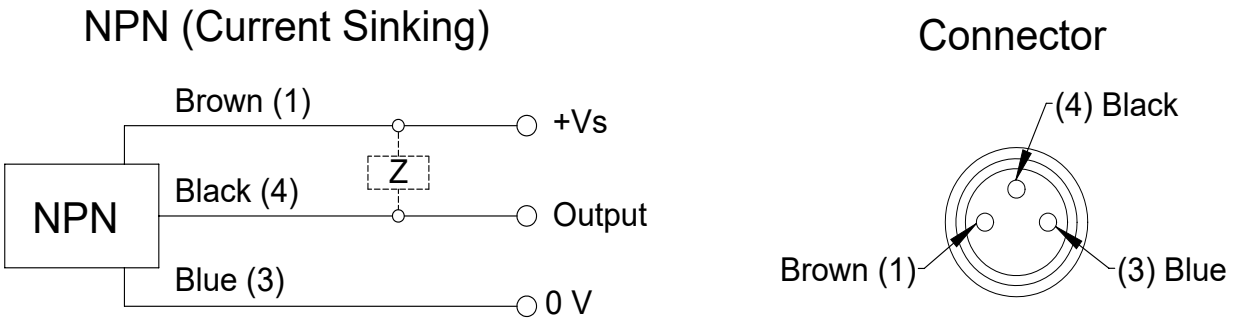
Figure 2.5—PNP Type Lock and Unlock Sensors



2.9.2 NPN Type Lock and Unlock Sensors

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

Figure 2.6—NPN Type Lock and Unlock 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

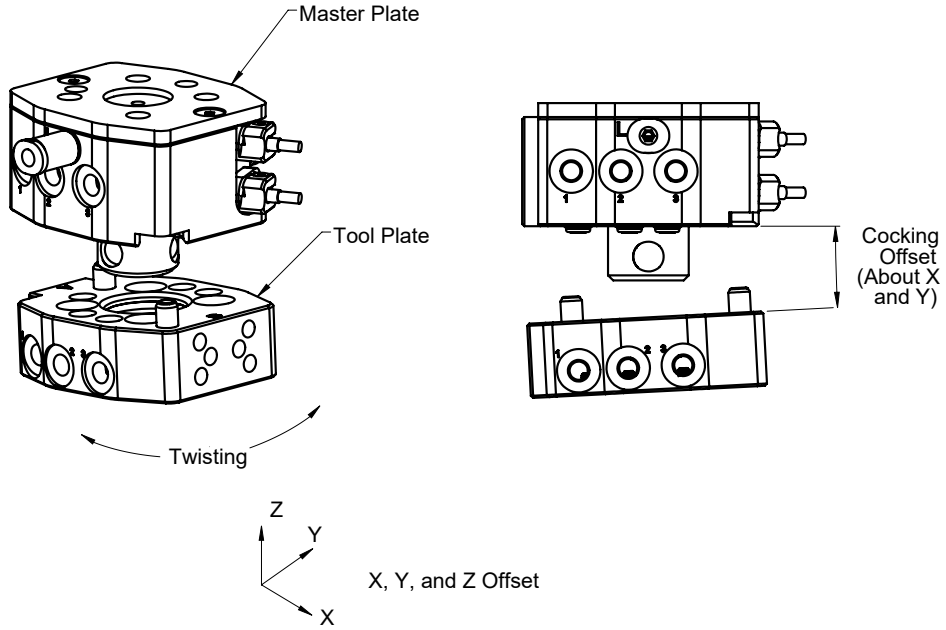


Table 3.1—Maximum Recommended Offsets Prior to Coupling
(These values are for a Master plate assembly that is used with a slotted Tool plate assembly)

Model	No-Touch Zone Z Offset (Max)[1]	X and Y Offset (Max) [2]	Cocking Offset (Max)	Twisting Offset (Max)
QC-7	0.06” (1.5 mm)	±0.039” (1 mm)	±0.8°	±2°

Notes:
1. Maximum values shown. Decreasing the actual values minimizes wear during coupling and uncoupling.
2. Actual allowable values may be higher in some cases, but higher offsets increase wear during coupling.

3.1 Conditions for Coupling

CAUTION: During coupling, do not allow the male coupling to be struck. If struck, the male coupling can be dislodged and not function properly. The Tool Changer will not be able to lock and unlock properly. Be sure that the male coupling has clearance and is not struck, during coupling.

CAUTION: 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.

1. Position the Master plate above the Tool plate with the air supplied to the Unlock Port (if equipped, the Unlock sensor indicates the Tool Changer is Unlocked).
2. Move the Master plate toward the Tool plate so that the (2) alignment pins enter the alignment holes on the opposite plate. Program the robot so that the Master plate and Tool plate are aligned axially and are parallel to each other (as closely as possible). This will minimize Tool movement and subsequent wear during lock-up.

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

3. When the (2) faces are within the specified No-Touch™ distance, release the pressure from the Unlock port and supply air to the Lock port. The Tool plate is drawn toward the Master plate and coupled. 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).
4. A sufficient delay must be programmed between locking valve actuation and robot motion so that the locking process is complete before moving the robot.

CAUTION: If air pressure is lost during operation, ATI's patented fail-safe design prevents the Tool plate from being released. Do not use the Tool Changer in a fail-safe condition. Re-establish air pressure and ensure the Tool Changer is in a secure lock position before returning to normal operations.

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.

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

1. Position the Tool plate in the tool stand so that there is little or no contact force between the Tool plate and tool stand.
2. Release air on the Lock port and apply air to the Unlock Port (if equipped, the Unlock sensor will indicate the Tool Changer is in the Unlocked position).

NOTICE: The air will cause the locking mechanism to be released and the weight of the Tool plate and attached tooling will assist in its removal. The Tool weight assists in uncoupling if the Tool is released in the vertical position only.

3. A sufficient delay must be programmed between unlocking valve actuation and robot motion, so that the unlocking process is complete and the Tool plate is fully released before moving the robot.
4. Move the Master plate axially away from the Tool plate.
5. In automated Tool change applications, it is recommended that a Tool presence sensor(s) be used in the tool stand to verify that the Tool is present and that the Tool remains in place as the robot moves away after the unlocking process.

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 *https://www.ati-ia.com/products/toolchanger/tool_changer_accessories.aspx* for products available or contact ATI for assistance.

3.5 Tool Storage Considerations

NOTICE: Tool stand design is critical to 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 Tool Stand Small (TSS) system is compatible with ATI Tool Changer sizes QC-001 to QC-41. The TSS systems ystems 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/small/SmallStand.aspx*. Another resource is the *ATI TSS manual*: *https://www.ati-ia.com/app_content/Documents/9610-20-1068.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.

NOTICE: When a Tool plate assembly is placed in a slotted tool stand configuration, the Tool will have some movement or tilt in the stand. This movement could make coupling the Master plate assembly to the Tool plate assembly difficult with certain robot types. Therefore, gantry or non-6 axis robots should not be used with slotted tool stand configurations. The following robot types can not accommodate a slotted tool stand configuration: Catesian, SCARA, and Pick and Place.

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

A visual inspection and preventive maintenance schedule is provided in the following table. 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.

Table 4.1—Preventive Maintenance Check List

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/Interface Connections

- ☐ Inspect fasteners for proper torque, interference, or wear. Tighten and correct as required. Refer to *Section 2—Installation*.

Balls/Alignment Pins/Holes/Bearing Race

- ☐ Inspect for lubrication and wear. 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 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*.
- ☐ Inspect pin and bushing for excessive wear, which 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 5.2.3—Alignment Pin Replacement*.
- ☐ Inspect for wear on the balls/bearing race, which could be an indication of excessive loading.

Sensors and Cables

- ☐ Inspect sensor cable connectors for tightness, and if loose, tighten connections.
- ☐ Inspect sensor cables for any damage, cuts, and abrasion. Replace as necessary.

Hoses

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

Seals (Pass-Through Air)

- ☐ Inspect for wear, abrasion, and cuts. Replace damaged rubber bushings as needed. Refer to *Section 5.2.2—Rubber Bushing Inspection and Replacement*.

Electrical Contacts/Pin Block (Optional Modules)

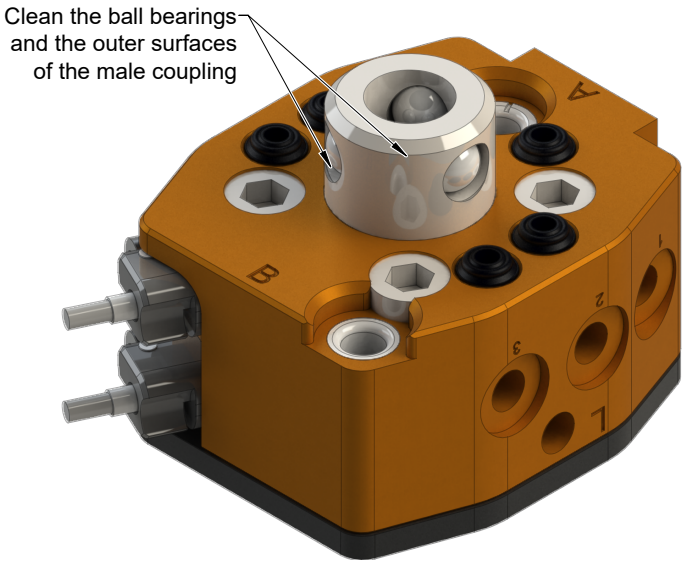
- ☐ Inspect for damage, debris, and stuck/burnt pins. Clean pin blocks as required. Refer to *Section 4.3—Pin Block Inspection and Cleaning*.

4.2 Cleaning and Lubrication of the Locking Mechanism and Alignment Pins

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

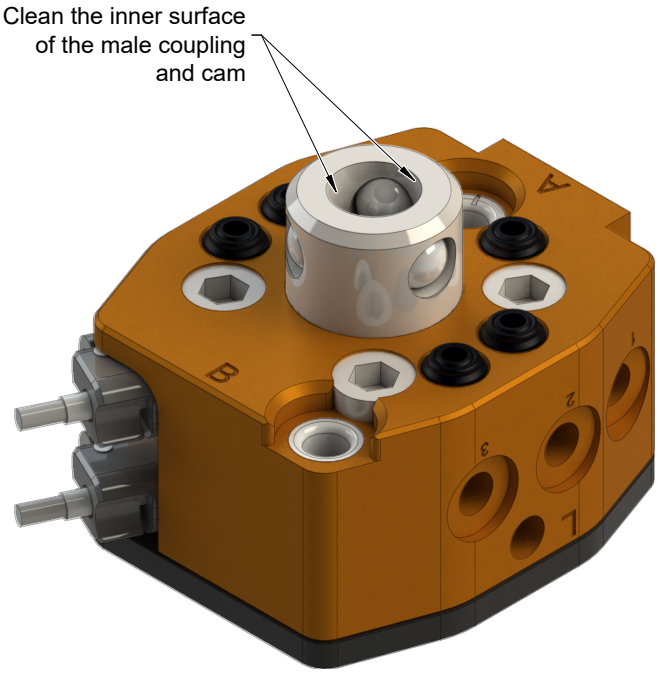
1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Use a clean rag to thoroughly remove any lubricant and debris from the ball bearings, male coupling, cam,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

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



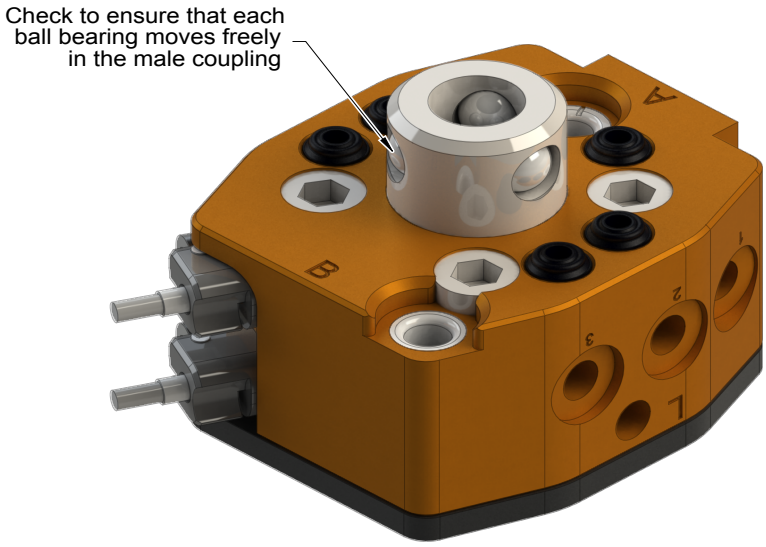
5. Use a clean rag to thoroughly remove any lubricant and debris from the inner surface of the male coupling and cam.

Figure 4.2—Cleaning the Inner Surfaces of Male Coupling or Cam



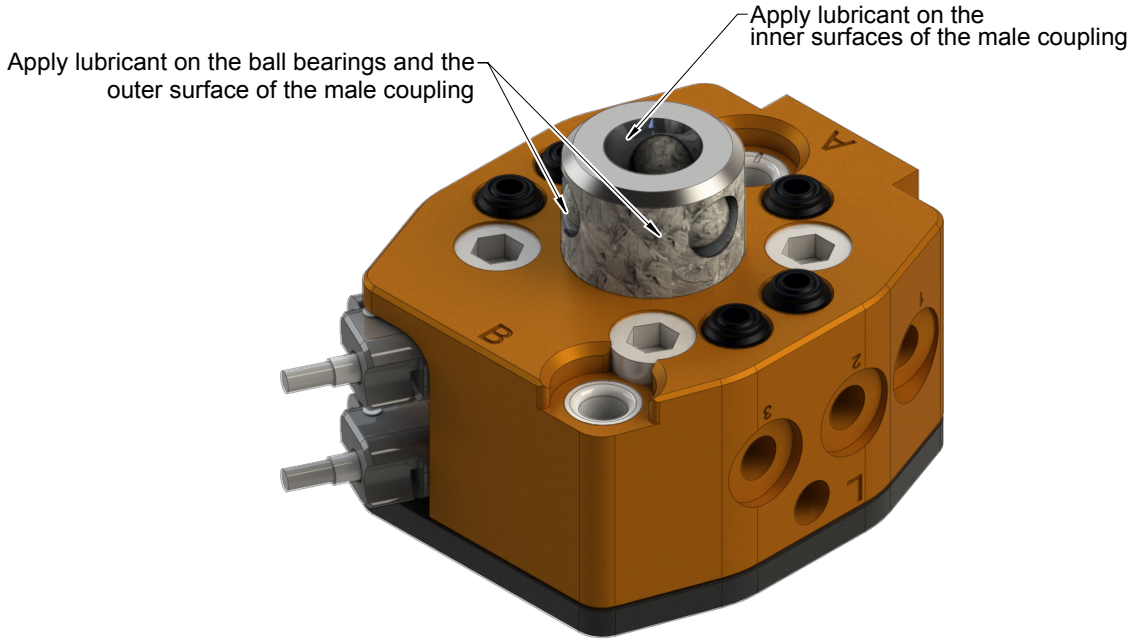
6. Check each ball bearing to make sure it moves freely in the male coupling. Additional cleaning may be necessary to free up any ball bearings that are sticking in place.

Figure 4.3—Check Ball Bearing Movement



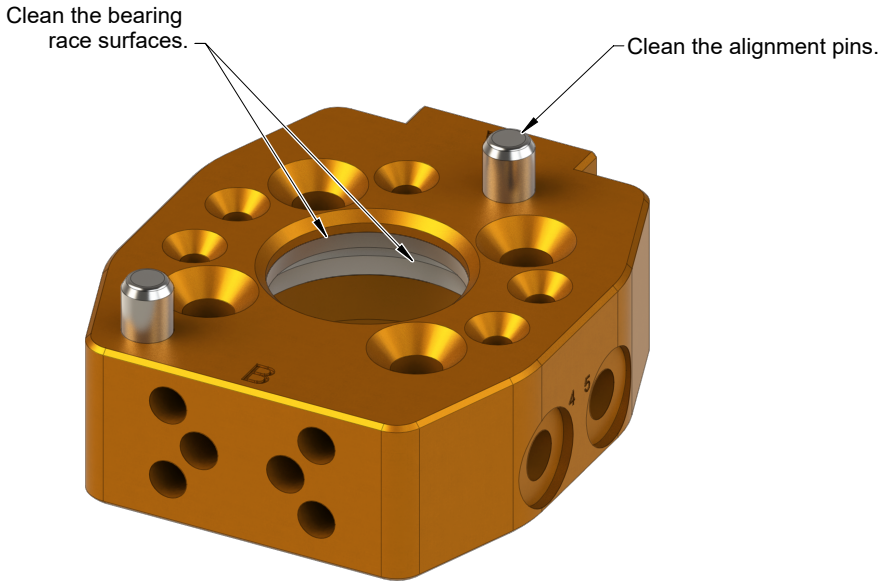
7. Apply a liberal coating of lubricant to the ball bearings and the male coupling (inside and out).

Figure 4.4—Apply Lubricant to Locking Mechanism



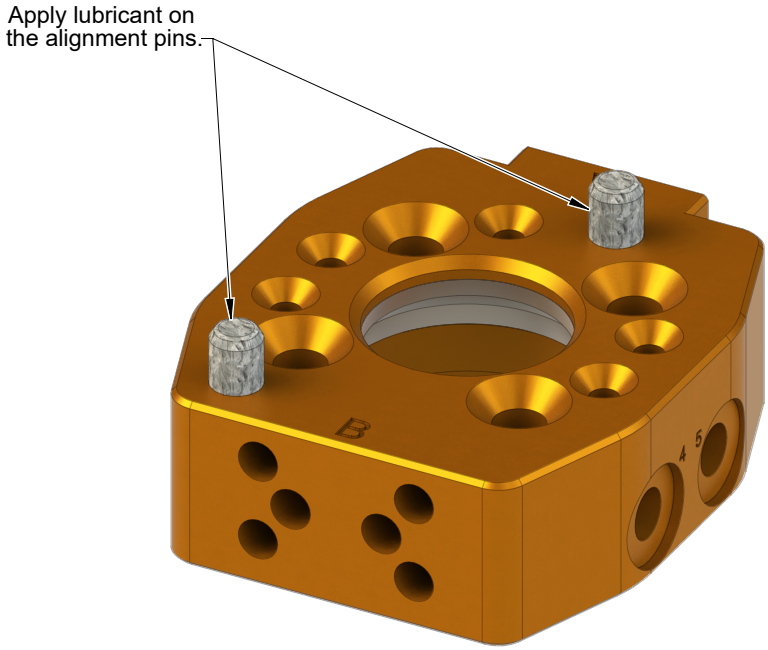
8. Use a clean rag to thoroughly remove any lubricant and debris from the Tool plate bearing race and alignment pins.

Figure 4.5—Clean the Tool Plate



9. Apply a liberal coating of lubricant to the alignment pins.

Figure 4.6—Apply Lubricant to the Alignment Pins



10. Safely resume normal operation.

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.

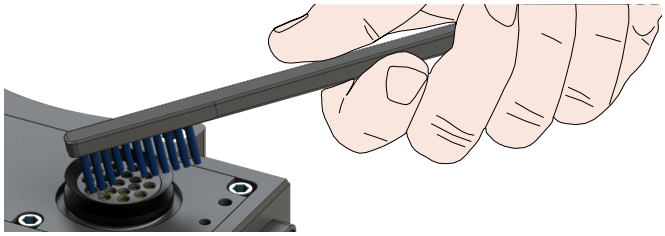
Figure 4.7—Inspect Master and Tool Pin Blocks



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).

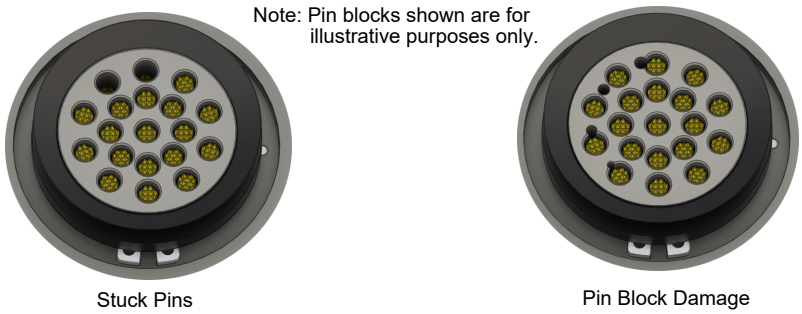
NOTICE: Do not use an abrasive media and/or cleaners or solvents to clean the contact pins. Using abrasive media and/or cleaners or solvents will cause damage to the contact surface or cause pins to stick. Clean contact surfaces with a vacuum or non-abrasive media such as a nylon brush (ATI part number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

Figure 4.8—Clean Pin Blocks with a Nylon Brush



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

Figure 4.9—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

Troubleshooting and service information is provided in the following section to help diagnose conditions and repair the Tool Changer or control 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 (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.

5.1 Troubleshooting

Check these conditions for all symptoms prior to troubleshooting:

- Proper pneumatic and electrical connections to the Tool Changer
- Air supplied at a minimum of 60 psi (4.1 Bar)
- No air or vacuum can be trapped in a de-energized lock or unlock port (pressure must be vented to atmosphere)

Table 5.1—QC-7 Troubleshooting

Symptom	Cause	Resolution
Tool Changer cannot lock and/ or unlock (or the lock sensor does not indicate Tool Changer is locked).	Debris caught between the Master and Tool plates.	Clean debris from between the Master and Tool plates. Verify mounting fasteners are secure and does not protrude above the mating surfaces.
	Insufficient or no air pressure supply to the lock or unlock ports.	Verified proper air pressure and pneumatic valve is supplied. Refer to *Section 2.8—Lock and Unlock Pneumatic and Valve Requirements*.
	Air pressure trapped in de-energized lock or unlock ports.	Air pressure must be vented to the atmosphere properly, refer to *Section 2.8—Lock and Unlock Pneumatic and Valve Requirements*.
	Pneumatic connections loose or damaged.	Inspect hose connection for tightness and leaks. If leaking or loose secure hose connection. Inspect hoses for interferences, abrasions, cuts, and leaks. Replace as required.
	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 and Tool plates 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 and Tool plate closer together prior to attempting to lock.
	The male coupling in the Master plate was struck and became dislodged, during coupling.	Contact ATI for assistance.

Table 5.1—QC-7 Troubleshooting		
Symptom	**Cause**	**Resolution**
Insufficient air supply to tooling or an air leak.	The rubber bushings are damaged.	Inspect the rubber bushings for damage. Replace the damaged bushings. Refer to *Section 5.2.2—Rubber Bushing Inspection and Replacement*.
Unit is locked but the lock signal does not read ON.	Lock sensor/cable is damaged.	Replace the lock sensor sub-assembly as necessary. Refer to *Section 5.2.1—Proximity Sensor Replacement*.
Unit is unlocked but the unlock signal does not read ON.	Unlock sensor/cable is damaged.	Replace the unlock sensor sub-assembly as necessary. Refer to *Section 5.2.1—Proximity Sensor Replacement*.
Units Equipped with Electrical/Servo/Control/Signal Modules		
Loss of Communication.	Debris in and around contact pins. Contact pin worn or damaged.	Clean the contact pins. Refer to *Section 4.3—Pin Block Inspection and Cleaning*.
	Cable connections loose or cables damaged.	Check that the cable connections are secure, and cables are not damaged.

5.2 Service Procedures

The following service procedures provide instructions for inspection, adjustment, test, or replacement of components.

5.2.1 Proximity Sensor Replacement

NOTICE: If customers wish to not install sensors, a blank plate option is available (refer to *Section 6.1—Master Plate Assembly Serviceable Parts*).

Parts required: *Refer to Section 6.1—Master Plate Assembly Serviceable Parts.*

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

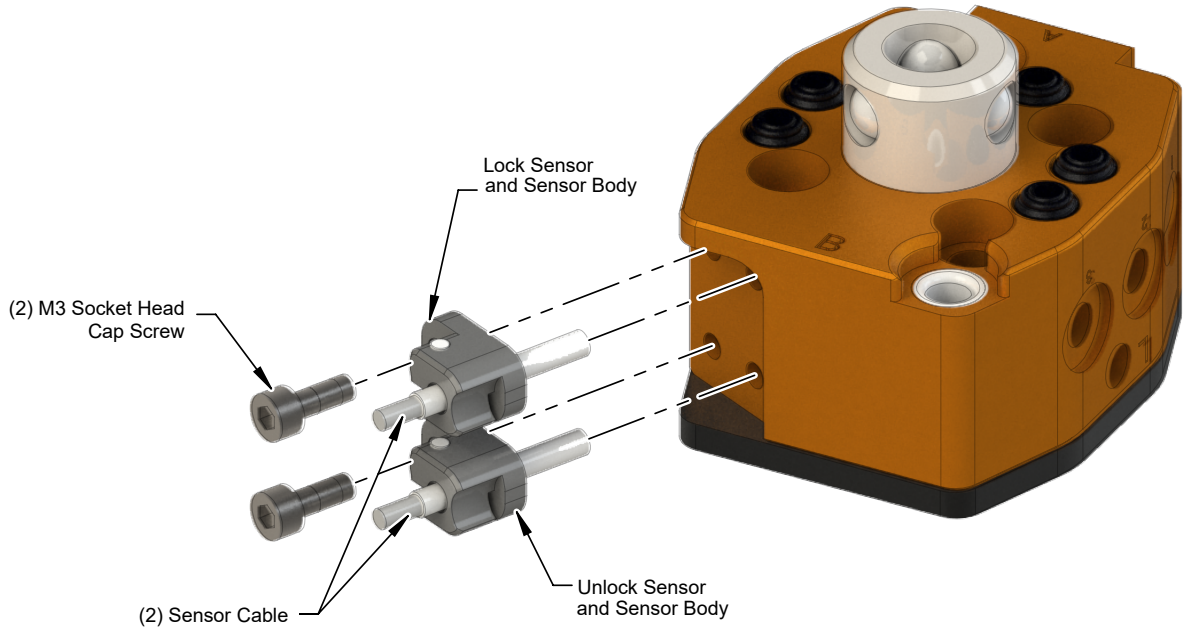
1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. De-energize all energized circuits (e.g. electrical, air, water, etc.).
4. Disconnect any cables, air lines, etc. if required.
5. Using a 2.5 mm hex key, loosen the M3 socket head cap screw securing the sensor body to the Master plate and remove the sensor.
6. Ensure the o-ring around the sensor barrel is removed with the old sensor.
7. Discard the old sensor.



CAUTION: Sensors are preset at ATI. To ensure that the sensors are detecting correctly, purchase replacement sensors from ATI.

8. Read the label on the sensors to identify the lock sensor from the unlock sensor.

Figure 5.1—Proximity Sensor Replacement



CAUTION: Be careful not to over tighten set screw. Over tightening set screw can cause damage to the proximity sensor.

9. Using a 2.5 mm hex key, secure the new sensor body to the Master plate with the socket set screw. Tighten to 8 in-lb (0.90 Nm).
10. Connect to the M8 end cable connector of the sensor.
11. Confirm the operation of the replaced sensor:
    a. Provide Lock or Unlock air to the Tool Changer.
    b. Verify the corresponding sensor signal is ON and the sensor LED is illuminated.
12. Safely resume normal operation

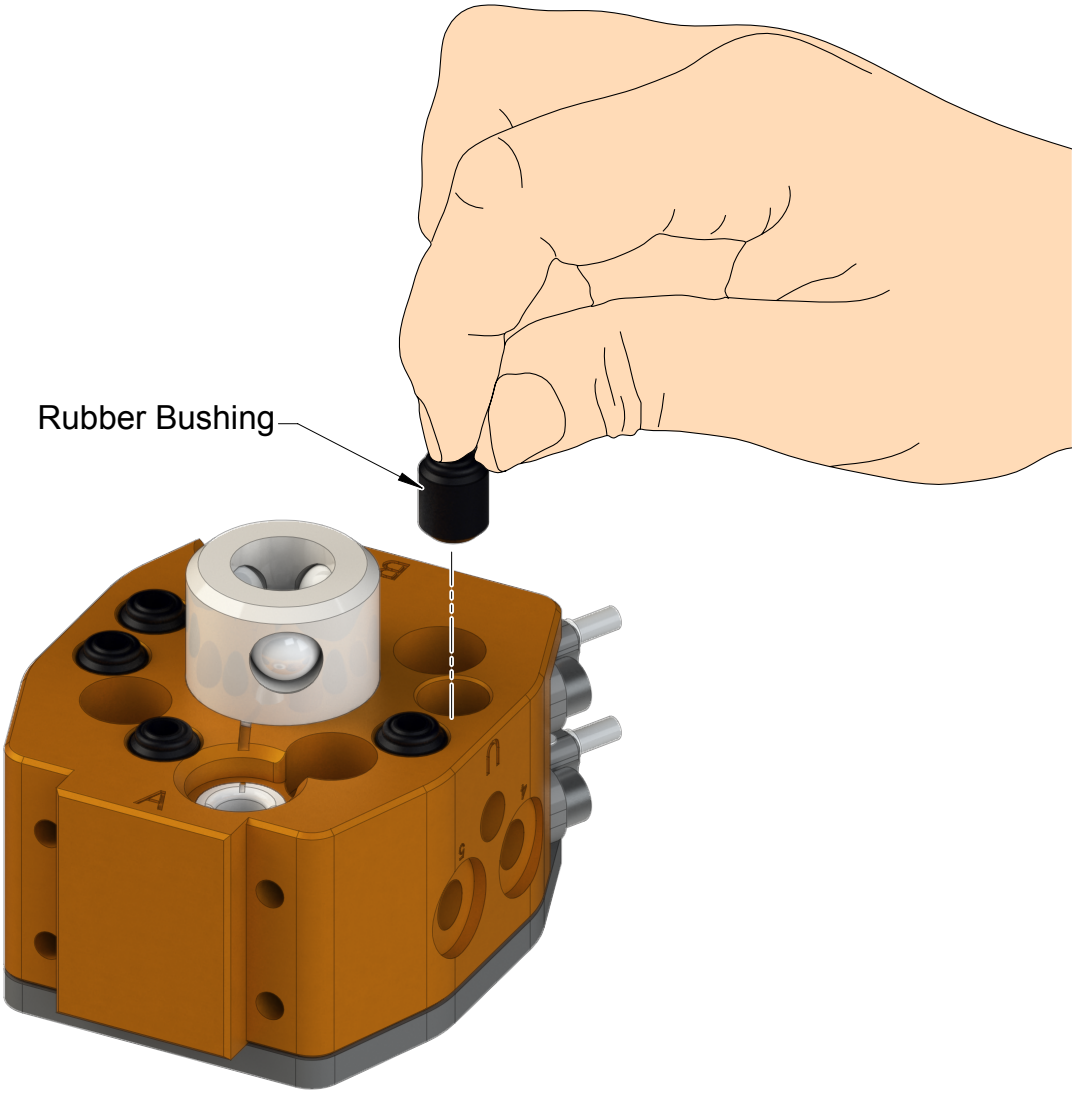
5.2.2 Rubber Bushing Inspection and Replacement

The rubber bushings seal the air passage from the Master plate to the Tool plate. If the bushings become cut or damaged, replace.

Parts required: *Refer to Section 6.1—Master Plate Assembly Serviceable Parts.*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. De-energize all energized circuits (e.g. electrical, air, water, etc.).
4. Remove the damaged rubber bushing by grasping with your fingers and pulling the bushing out of the body.
5. Dip the new bushing into water so that the bushing installs smoothly into the plate's bore.
6. Insert the beveled (chamfered) end of the rubber bushing into the bore, leaving ribbed end of the bushing facing outward.
7. Press the bushing in by hand until it is seated completely in the bore. If necessary, use a plastic or rubber soft-faced mallet to tap the bushings into place.
8. Safely resume normal operation.

Figure 5.2 —Rubber Bushing Replacement



5.2.3 Alignment Pin Replacement

Excessive alignment pin/bushing wear could indicate poor robot positioning during pickup/drop-off. Adjust the robot position as needed. Check the tool stand for wear and alignment problems. If necessary, replace the alignment pins.

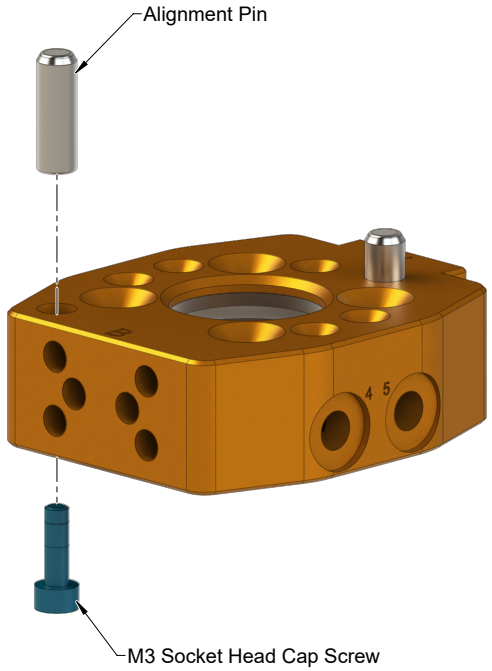
Parts required: *Refer to Section 6.2—Tool Plate Assembly Serviceable Parts.*

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

Supplies required: *MobilGrease XHP222 Special is a NLGL #2 lithium complex grease with molybdenum disulfide.*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. De-energize all energized circuits (e.g. electrical, air, water, etc.).
4. If the M3 socket head cap screw cannot be accessed from the tool side of the Tool plate, remove the Tool plate from the customer tooling; refer to *Section 2.6—Tool Plate Assembly Removal*.
5. Using a 2.5 mm hex key, remove the M3 socket head cap screw from the Tool plate.
6. Remove the alignment pin from the Tool plate. Discard the old alignment pin.
7. Insert the new alignment pin into the Tool plate.
8. Using a 2.5 mm hex key, secure the alignment pin to the Tool plate with the M3 socket head cap screw. Tighten to 12 in-lb (1.36 Nm).
9. Apply a liberal coating of MobilGrease XHP222 Special grease to the alignment pin.
10. If the customer tooling was removed in step *4*, install the Tool plate. Refer to *Section 2.5—Tool Plate Assembly Installation*.
11. Safely resume normal operation.

Figure 5.3 —Alignment Pin Replacement



6. Serviceable Parts

6.1 Master Plate Assembly Serviceable Parts

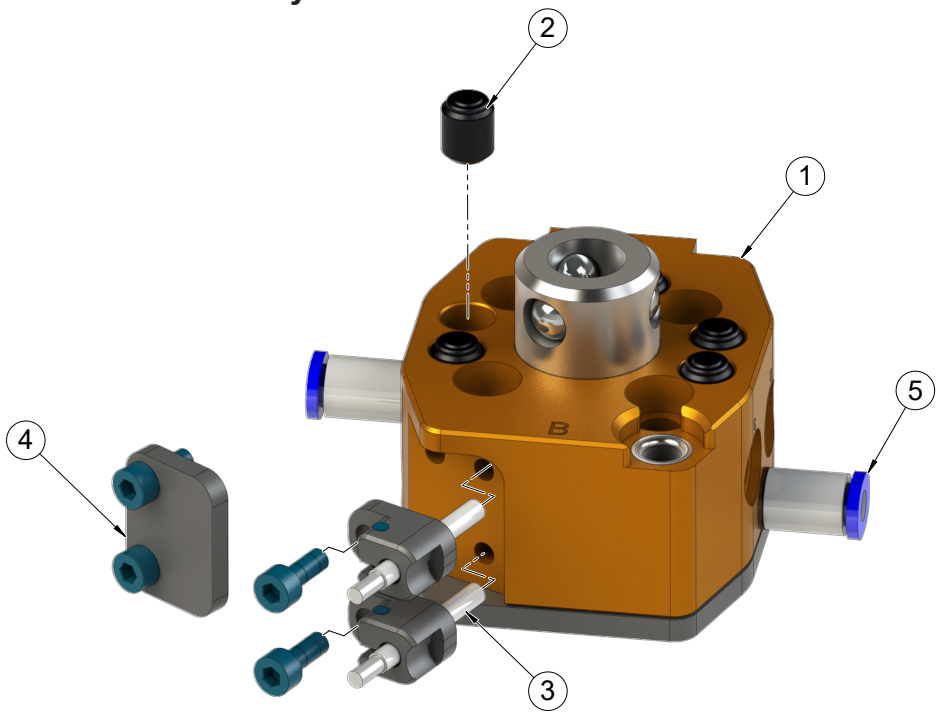


Table 6.1—QC-7 Master Assembly			
Item No.	**Qty**	**Part Number**	**Description**
1	1	9120-007***X***M-0-0-S***Y***-B[1, 2]	QC-7 Base Master Assembly, black
		9120-007***X***M-0-0-S***Y***[1, 2]	QC-7 Base Master Assembly, orange
2	5	4010-0000009-02	M5 Rubber Bushing, Nitrile, Short
3	2	9005-20-8847	Proximity sensor, PNP, 0.2 m cable with M8 straight connector
		9005-20-8860	Proximity sensor, NPN, 0.2 m cable with M8 straight connector
4	1	9005-20-9026	Cover Plate Assembly (no sensors)
5	2	3405-1220004-01	Air Fitting, Lock and Unlock

Notes:

1. The ***X*** is a placeholder for one of the following:
   - A = no boss
   - B = 12 mm boss
   - C = 20 mm boss
2. The ***Y*** is a placeholder for one of the following:
   - M = PNP sensors
   - P = NPN sensors
   - 0 = No Sensors (P/N 9005-20-9026)

6.2 Tool Plate Assembly Serviceable Parts

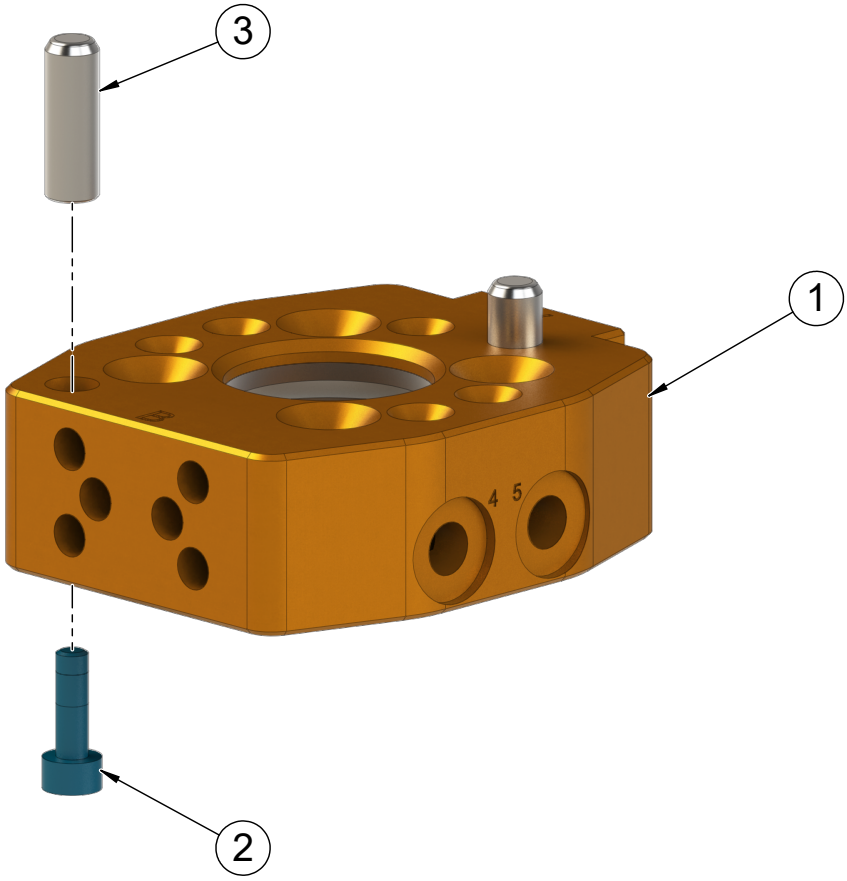


Table 6.2—QC-7 Tool Assembly			
Item No.	**Qty**	**Part Number**	**Description**
1	1	9120-007DT-0-0-B	QC-7 Base Tool Assembly, Black
		9120-007ST-0-0	QC-7 Base Tool Assembly, Orange
		9120-007ST-0-0-B	(not shown) QC-7 Base Tool Assembly, Slotted, Black
		9120-007ST-0-0	(not shown) QC-7 Base Tool Assembly, Slotted, Orange
2	2	3500-1058010-15A	M3X10 Socket Head Cap Screw, 12.9, ISO4762/DIN912, ES-ATI-007, YL M-spheres/IFI 525
3	2	3700-20-1238	Alignment Pin

7. Specifications

Table 7.1—QC-7 Specifications		
Specification	**Value**	**Description**
Recommended Max Payload	35 lbs. (16 kg)	The mass attached to the Tool Changer.
Operating Temperature Range	-20–150°F (-30–66°C)	Temperature for optimal operation.
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.
Locking Force @ 80 psi	220 lbs. (980 N)	Axial holding force
Recommended Max Moment X-Y (Mxy)	180 in-lb (20.34 Nm)	Maximum recommended working load for optimum performance of the Tool Changer
Recommended Max Torque about Z (Mz)	110 in-lb (12.43 Nm)	Maximum recommended working torque for optimum performance of the Tool Changer
Positional Repeatability	0.0004” (0.0102 mm)	Repeatability tested at rated load at one million cycles.
Weight (coupled, no access.)	0.6 lbs (0.28 kg)	Master: 0.4 lbs (0.20 kg) Tool: 0.2 lbs (0.08 kg)
Max. Recommended distance between Master and Tool Plate	0.06 in.x (1.5 mm)	No-Touch™ locking technology allows the Master and Tool Plates to lock with separation when coupling.
Pass-Through Port Quantity and Connection Size	(5) M5 or #10-32”	Fluid/Air can pass-through ports from the Master to the Tool at a maximum pressure of 100 psi (6.9 bar).
Pneumatic Lock and Unlock Port Connection Size	M5	Air port for coupling and uncoupling the Tool Changer.
Mounting/Customer Interface	Master Plate	Meets ISO 9409-1-31.5-4-M5
	Tool Plate	Refer to *Section 8—Drawings*

8. Drawings

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