Table of Contents

B. Base Tool Changer

MC-16R—Manual Tool Changer

1. Product Overview

The Manual Tool Changer provides flexibility to robot applications by allowing the robot to change customer tooling manually. The Tool Changer consists of a Master plate and a Tool plate.

The Master plate, installed on the robot arm, locks to the Tool plate with a manually driven locking mechanism.

Robotic Tool Changers also provide a method for quick Tool change for maintenance purposes.

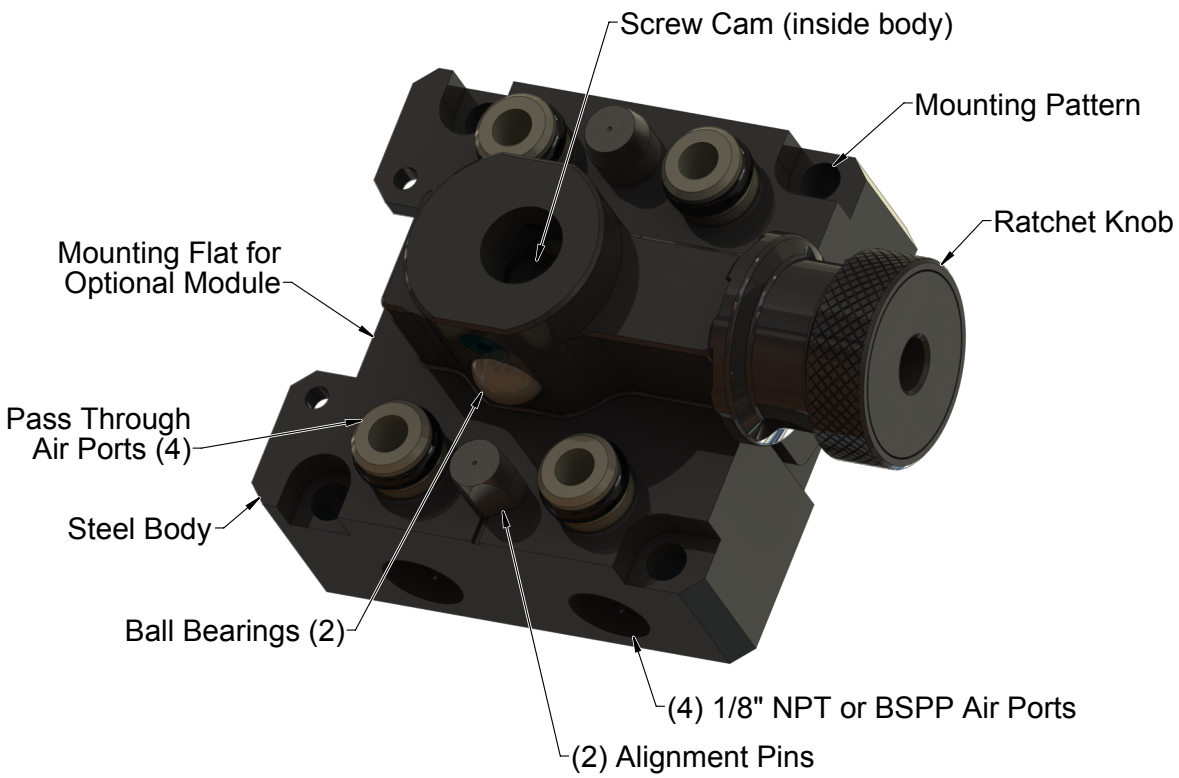
1.1 Master Plate Assembly

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

The Master plate assembly is equipped with (4) pass through air ports, 1/8” NPT or BSPP ports are provided in the body for the pneumatic connections. The body or Master plate has one flat side for mounting of optional modules. A mounting pattern is machined into the Master body.

The locking mechanism consists of a tapered cam, a set of hardened steel ball bearings, a steel threaded rod, and a spring-loaded ratchet knob release mechanism. The surfaces on the cam are tapered and contact balls as the rod is pushed in or tightened. When the Master and Tool are brought together, the user applies the tightening torque by twisting the knob. This final tightening is required to ensure the unit has full locking force applied. The ball bearings slide on the tapered surfaces of the Tool side to apply the lock. The ratchet knob locks in the closed position preventing it from coming loose during operation. Tapered pins located on the Master body mate with holes in the Tool body to ensure repeatable alignment during the coupling process. An extreme pressure grease is applied to the cam and pins to enhance performance and maximize the life of the Master assembly.

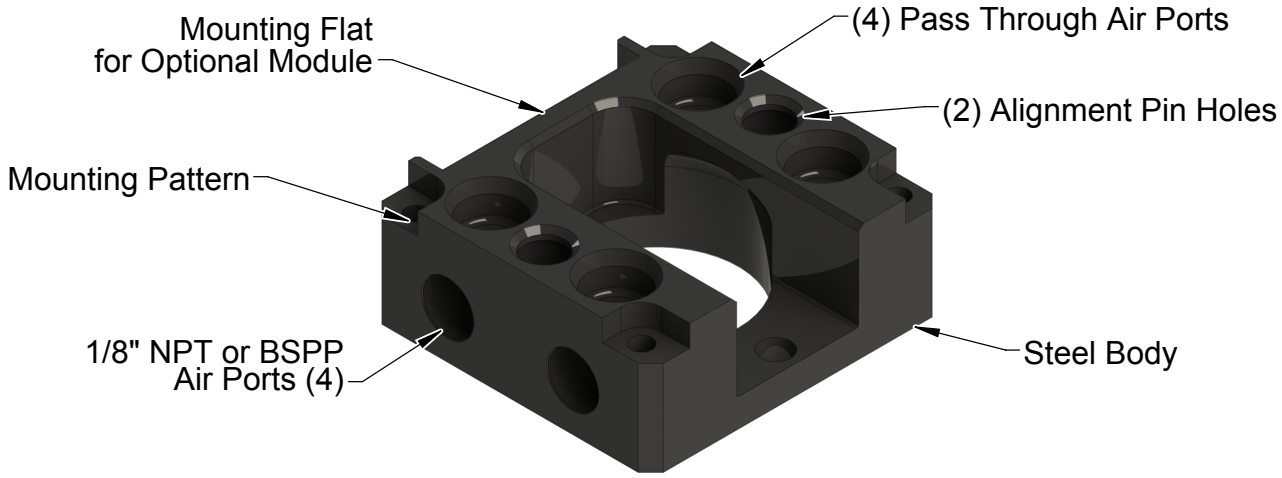
Figure 1.1—Master Plate Assembly (Shown Fully Locked)



1.2 Tool Plate

The hardened steel body of the Tool plate has one flat side for the mounting of optional modules. The Tool plate is equipped with (4) pass through air ports, 1/8” NPT or BSPP ports are provided in the body for the pneumatic connections. A mounting pattern is machined into the Tool body.

Figure 1.2—Tool Plate



1.3 Optional Modules

There is (1) flat available for the mounting of the optional modules for support of various utility pass through, such as electrical signals.

For assistance in choosing the right modules for your particular application, visit our website to see what is available or contact an ATI Sales Representative directly.

For installation of optional modules refer to *Section 2.7—Optional Module Installation*.

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 in *Table 2.1*. **Furthermore, removable (purple) Loctite 222 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 (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.

Table 2.1—Fastener Size, Class, and Torque Specifications

Mounting conditions	Fastener Size & Property Class	Recommended Torque
Master plate to interface plate (6061-T6 aluminum) Minimum thread engagement of 6 mm (0.24") [1.5X fastener Ø]	M4 Class 12.9	12 in-lbs. (1.4 N-m)
Master plate to Robot (steel; USS ≥ 90KSI) Minimum thread engagement of 6 mm (0.24") [1.5X fastener Ø]	M4 Class 12.9	25 in-lbs. (2.8 N-m)
Interface plate to Master plate (steel) M5 threads into body Minimum thread engagement of 7.5 mm (0.30") [1.5X fastener Ø]	M5 Class 12.9	25 in-lbs. (2.8 N-m)
Tool plate to interface plate (6061-T6 aluminum) Minimum thread engagement of 9 mm (0.35") [1.5X fastener Ø]	M4 Class 12.9	12 in-lbs. (1.4 N-m)
Tool plate to interface plate (steel; USS ≥ 90KSI) Minimum thread engagement of 9 mm (0.35") [1.5X fastener Ø]	M4 Class 12.9	25 in-lbs. (2.8 N-m)
IP to Tool plate (steel) M5 threads into body Minimum thread engagement of 7.5 mm (0.30") [1.5X fastener Ø]	M5 Class 12.9	25 in-lbs. (2.8 N-m)

2.1 Master Interface

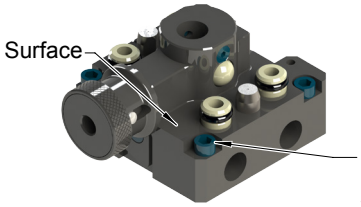
The Master plate is attached to the robot or interface plate . The Master plate is designed with mounting features such as bolt and dowel holes. These features are used to accurately position and secure the Master plate to the robot arm or it may be necessary for an interface plate to be utilized to adapt the Master plate to a specific robot arm. Custom interface plates are available from ATI upon request (Refer to *Section 8—Drawings* of this manual for technical information on mounting features.)

If the customer chooses to design and build a interface plate, the following should be considered:

- The interface plate should be designed to include bolt holes for mounting and dowel pins for accurate positioning on the robot and Master plate (Refer to robot manual.) (The dowel feature is important to prevent rotation.)
- The thickness of the interface plate must be great enough to provide the necessary thread engagement for the mounting bolts.
- Mounting bolts should not be too long, such that a gap is formed at the interface.
- The interface plate must be properly designed to provide rigid mounting to the Master plate.

2.2 Master Plate Installation

WARNING: Do not use lock washer under the head of the mounting fasteners or allow the mounting fasteners to protrude above the surfaces of the Master and Tool plates. Allowing fasteners to protrude above the 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. Make sure the mounting fasteners are flush or below the surfaces of the Master and Tool plates.



Tools required: *3 mm hex key, torque wrench*

Supplies required: *Clean rag, Loctite® 222*

1. Wipe down the mounting surfaces with a clean rag.
2. Align the dowel pins to the corresponding holes in the Master plate and secure the Master plate to the robot arm, or interface plate with customer supplied fasteners.
3. Apply Loctite 222 to threads (see *Table 2.1* for proper fasteners and torque).
4. Safely resume normal operation.

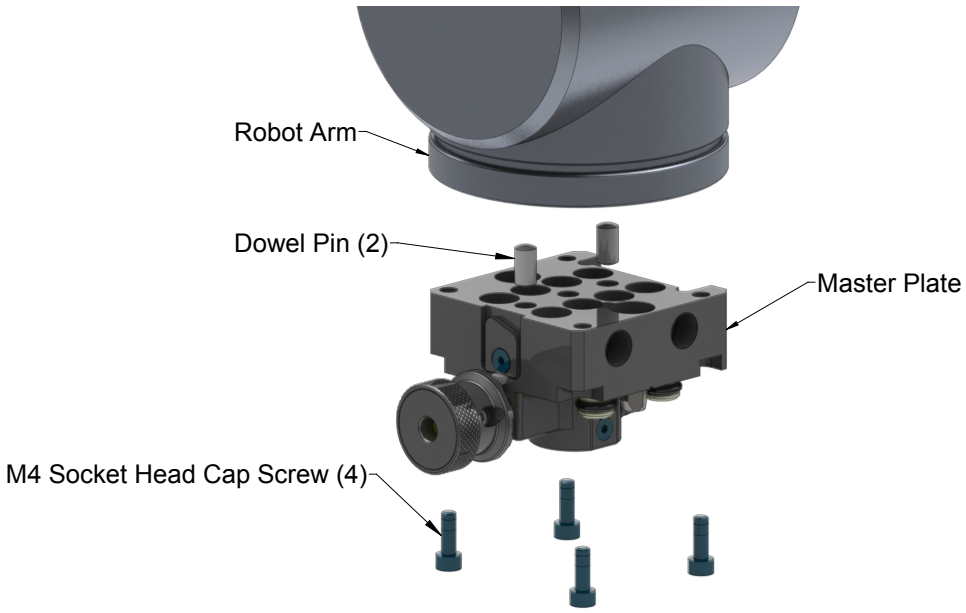
2.3 Master Plate Removal

WARNING: Do not perform removal unless the Master is safely supported. Injury or equipment damage can occur with Master not supported. Support the Master safely before performing removal.

Tools required: *3 mm hex key*

1. Support the Tool side of the Tool Changer safely and uncouple the Tool Changer to allow clear access to the Master and Tool plates.
2. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
3. Remove the (4) M4 socket head cap screws connecting the Master plate to the robot arm, or interface plate

Figure 2.1—Typical Master Plate Installation



2.4 Tool Interface

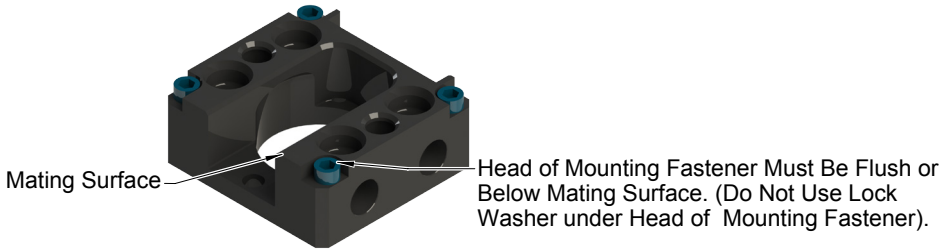
The Tool plate is attached to customer's tooling. The Tool plate is designed with mounting features such as dowel pin holes and bolt holes. These features are used to accurately position and secure the customer's tooling. A tool interface plate may be utilized to adapt the Tool plate to customer's tooling that is not compatible with the Tool plate mounting features. Custom tool interface plates can be supplied by ATI to meet customer's requirements (see *Figure 2.2*) (Refer to the application drawing).

If the customer chooses to design and build a tool interface plate, the following should be considered:

- The tool interface plate should be designed to include dowel pin holes and bolt holes for mounting and a boss that mates with Tool plate recess for accurate positioning (The dowel features are important to prevent rotation.)
- The thickness of the interface plate must be great enough to provide the necessary thread engagement for the mounting bolts. Fasteners should be chosen to 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.

2.5 Tool Plate Installation

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



Tools required: *3 mm hex key, torque wrench*

Supplies required: *Clean rag, Loctite 222*

4. Wipe down the mounting surfaces with a clean rag.
5. If required, install the tool interface plate to the customer tooling, align using the boss or dowel pins and secure with customer supplied fasteners.
6. Align the dowel pins to the holes in the Tool plate and secure the Tool plate to the tool interface plate or customer tooling with customer supplied fasteners. Apply Loctite 222 to threads (see *Table 2.1*).
7. Safely resume normal operation.

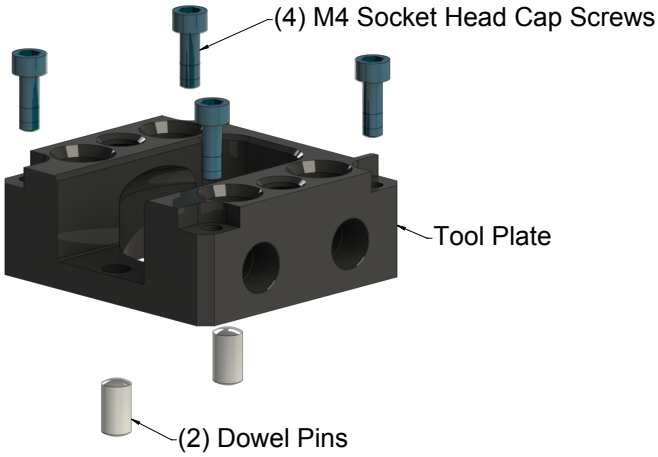
2.6 Tool Plate Removal

WARNING: Do not perform removal unless the Tool and tooling is safely supported. Injury or equipment damage can occur with Tool and tooling not supported. Support the Tool and tooling safely before performing removal.

Tools required: *3 mm hex key*

1. Support the Tool side of the Tool Changer safely and uncouple the Tool Changer to allow clear access to the Master and Tool plates.
2. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
3. Remove the (4) M4 socket head cap screws connecting the Tool plate to the tooling or tool interface plate.

Figure 2.2—Standard Tool Plate Installation



2.7 Optional Module Installation

The optional modules are typically installed by ATI prior to shipment. The following procedure outlining the field installation and removal of optional modules.

2.7.1 Installing Optional Modules

Tools required: *2 mm or 2.5 mm hex key, torque wrench*

Supplies required: *Clean rag, Loctite 222*

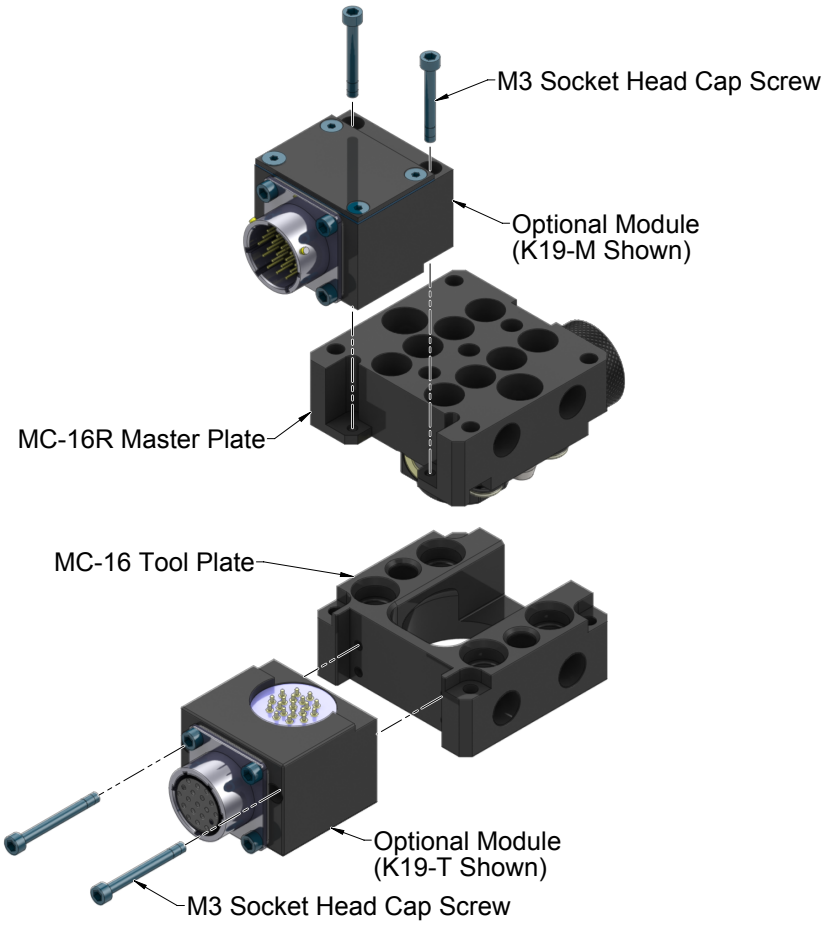
1. The Tool Changer may need to be removed. Refer to *Section 2.3—Master Plate Removal* and *Section 2.6—Tool Plate Removal.*
2. It may be necessary to clean the mounting surface on the Master or Tool plate prior to installing the module in order to remove any debris that may be present.
3. Align the module to the mounting flat as shown in *Figure 2.3*.
4. If fasteners do not have pre-applied adhesive, apply Loctite 222 to the supplied M3 socket head cap screws fasteners. Install the (2) M3 Socket Head Cap Screws securing the module to the Master or Tool plate and tighten to 10 in-lbs (1.13 Nm).

2.7.2 Removing Optional Modules

Tools required: *2 mm or 2.5 mm hex key*

1. Depending upon the service or repair being done, the customer connections up to the module may or may not need to be disconnected.
2. The Tool Changer may need to be removed. Refer to *Section 2.3—Master Plate Removal* and *Section 2.6—Tool Plate Removal.*
3. Remove the M3 socket head cap screws and lift the module from the Master or Tool plate. Refer to *Figure 2.3*.

Figure 2.3—Optional Modules



3. Operation

The Master locking mechanism is manually-driven to couple and uncouple with the Tool plate. The Master plate utilizes mechanical action from the rachet knob and cam to provide lock and unlock force to the locking mechanism.

NOTICE: All Tool Changers are initially lubricated using XHP-222 Special type of lubrication. The end user must apply additional lubricant to the locking mechanism components and alignment pins prior to start of service (See *Section 4.2—Cleaning and Lubrication of the Master and Tool Plate*). Tubes of lubricant for this purpose are shipped with every Tool Changer. Note: XHP-222 Special type of lubrication is a special grease suited for the locking mechanism and alignment pins.

3.1 Coupling Sequence

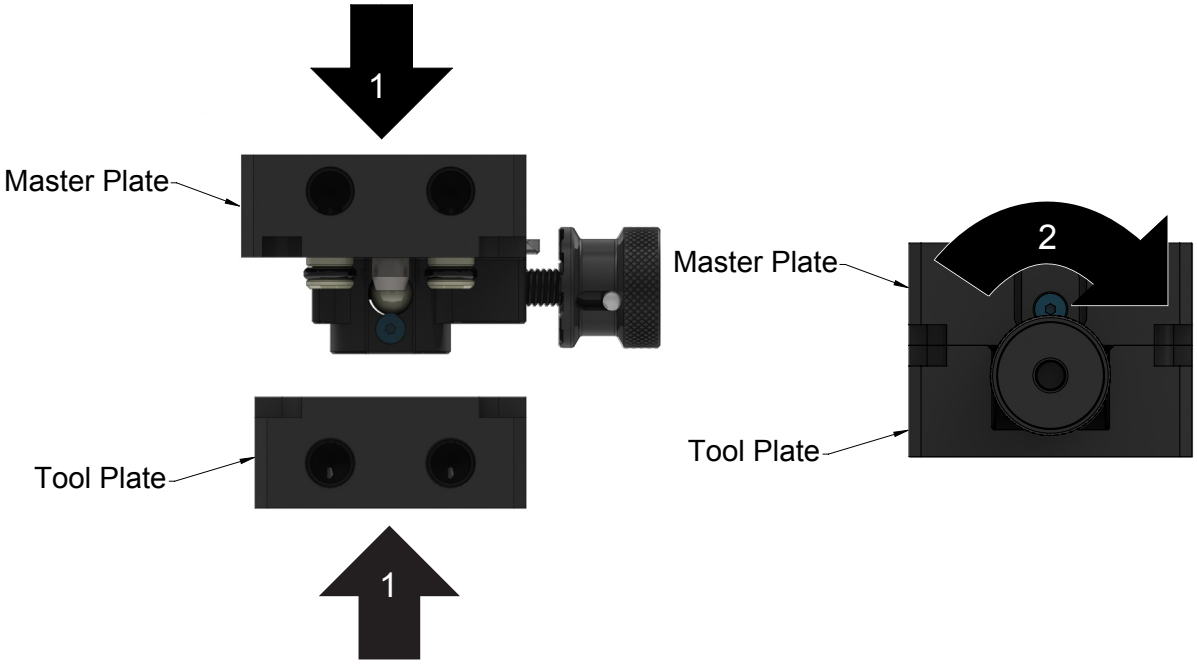
CAUTION: The locking mechanism must be in the unlock position when attempting to couple the Tool Changer. Failure to adhere to this condition may result in damage to the unit and/or the robot. Unlock the locking mechanism before attempting coupling.

Manually move the Tool plate toward the Master plate and begin to engage with the alignment features on the Master plate. Make sure that the tapered alignment pins from the Master plate enters the alignment holes on the Tool plate. The alignment pins should be relatively concentric with the alignment holes such that they do not rub against the edge.

Turn the knob clockwise toward the locked position to rotate the cam in the Master body. Be sure the Tool is engaged with the Master. There should be no gap between the Master and Tool mating surfaces at this time.

Then apply the tightening torque to the knob to provide the final clamping force. In lab testing, 25 in-lbs of tightening torque was determined to provide the optimal clamping force but anywhere between 10 in-lbs and 25 in-lbs is adequate. This tightening force range equates to the average human tightening a knob by hand. Do not use a tool or over-tighten, this can cause excessive wear on components and the product lifespan will be shortened.

Figure 3.1—Coupling Sequence



3.2 Fail-Safe Operation

CAUTION: Do not use the Tool Changer in the fail-safe condition. Do not transport the Tool Changer in the fail-safe condition. Possible damage to the locking mechanism could occur. Repair the locking mechanism before resuming operation.

The manual Tool Changer has two fail-safe features. The first feature is the ratchet knob feature. When the Master is locked, the ratchet pin is spring-loaded to bias against the knob to keep it locked. This spring prevents the knob from vibrating to the unlock position.

The second fail-safe feature is the tapered surface on the cam. As the cam is screwed in towards lock position, the ball bearings roll along the first taper. The first taper simply provides the travel necessary to move towards lock. Then the ball bearings roll past the intermediate tapered surface and onto the final tapered surface called the lock angle. This lock angle, combined with the tightening torque from the cam shaft, results in a high mechanical advantage and reliable locking force. In the event that the cam shaft is accidentally loosened, the cam may want to back out toward unlock position. If this happens, the ball bearings will contact the intermediate “fail-safe” taper on the cam profile, and become trapped. Both the ratchet knob and the fail-safe cam tapered surface act together to provide a high assurance and high level of safety.

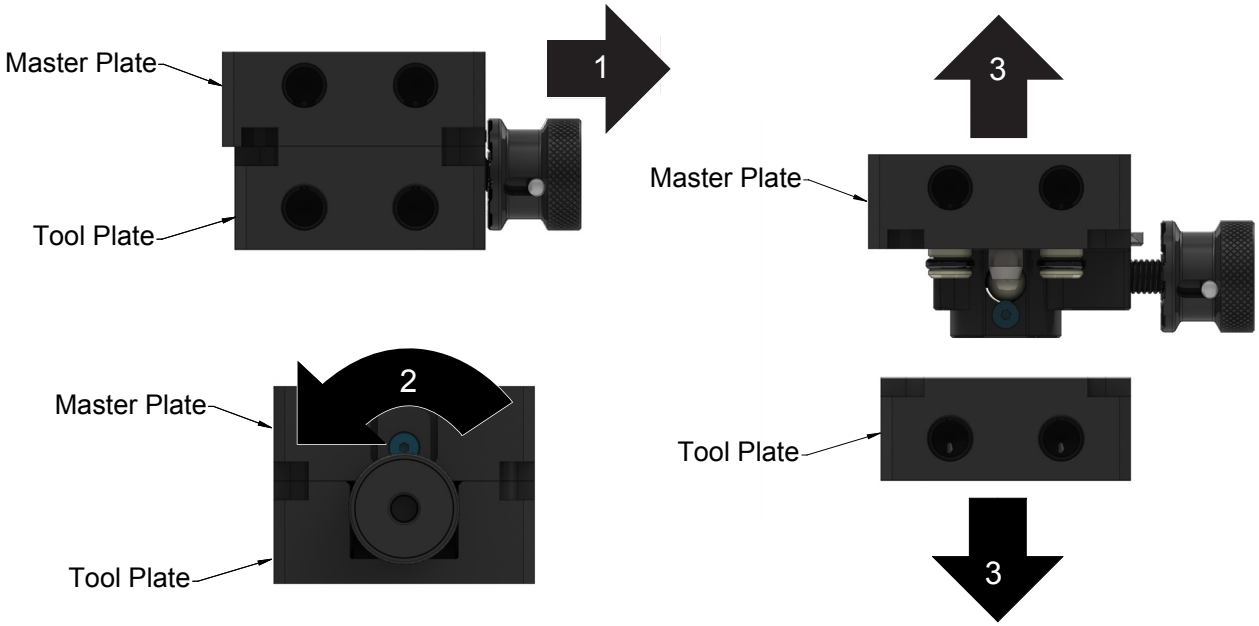
3.3 Uncoupling Sequence

CAUTION: Tool must be in a secure supported before attempting to uncouple the Tool Changer. Failure to adhere to this condition may result in damage to the Tool and/or the robot. Securely support the Tool before uncoupling Tool Changer.

The Tool Changer should be positioned in the same location as that when coupling took place.

The unit is equipped with a ratchet knob, pull out on the knob and unscrew counter-clockwise until the ratchet knob is passed the ratcheting device on the Tool Changer body. The unit will not fully disengage the Tool until the cam is all the way unscrewed. It is safe to remove the Master from the Tool only when the cam is in the fully unlocked position.

Figure 3.2—Uncoupling Sequence



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:
1) Placement of tool stands away from debris generators.
2) Covers incorporated into the tool stands.
3) Guards, deflectors, air curtains, and similar devices built into the EOAT and the tool stand.

4.1 Preventive Maintenance

The Tool Changer is designed to provide a long life with regular maintenance.

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

Detailed assembly drawings are provided in *Section 8—Drawings* of this manual.

Table 4.1—Preventive Maintenance Checklist

Application(s)	Inspection Schedule
General Usage Material Handling Docking Station	Monthly
Welding/Servo/Deburring, Foundry Operations (Dirty Environments)	Weekly

Checklist

Mounting Fasteners/Interface Connections

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

Balls/Alignment Pins/Holes/Bearing Race

- ☐ Inspect for wear and proper lubrication. MobilGrease XHP222 Special a NLGI #2 lithium complex grease with molybdenum disulfide additive is suggested for locking mechanism and alignment pin lubrication. Over time, lubricants can become contaminated with debris. Therefore, it is recommended to thoroughly clean the existing grease and replace with new as needed. See *Section 4.2—Cleaning and Lubrication of the Master and Tool Plate*.
- ☐ Inspect for 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. To replace worn alignment pins, refer to *Section 5.3—Alignment Pin Replacement*.
- ☐ Inspect for wear on the ball bearings/bearing race, may be an indication of excessive loading.

Electrical Contacts/Pin Block (Modules)

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

Seals

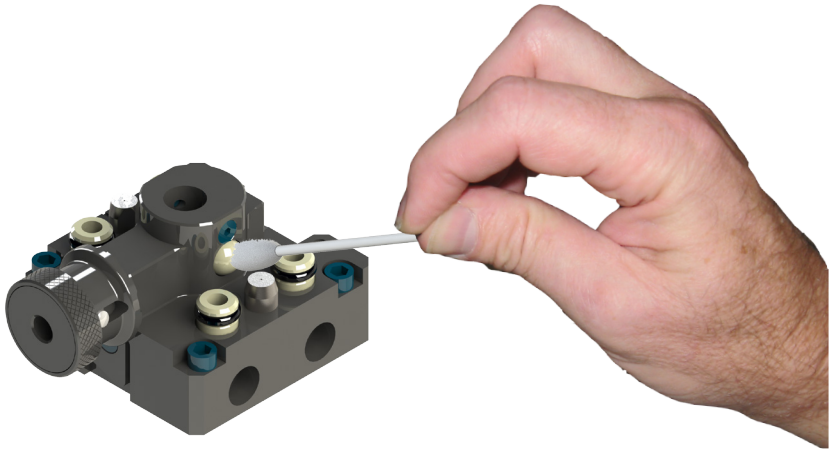
- ☐ Inspect for wear, abrasion, and cuts. Refer to *Section 5.2.1—V-ring Seal Inspection and Replacement*.

4.2 Cleaning and Lubrication of the Master and Tool Plate

Supplies required: *Cotton swabs, clean rag, XHP-222 Specail Lubricant*

1. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
2. Uncouple the Tool Changer to allow clear access to the Master and Tool plates.
3. Use a clean cotton swab to thoroughly remove the existing lubricant and debris from the ball bearings, alignment pins, and cam.

Figure 4.1—Cleaning Ball Bearings, Alignment Pin and Cam



4. Apply a light coating of XHP-222 Special lubricant to the cam, ball bearings, and the alignment pins.
5. Use a clean lint free rag to thoroughly remove the any lubricant and debris from the engagement surfaces and alignment holes in the Tool plate.
6. No application of lubrication is necessary on the Tool plate components.
7. Safely resume normal operation.

4.3 Pin Block Inspection and Cleaning

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

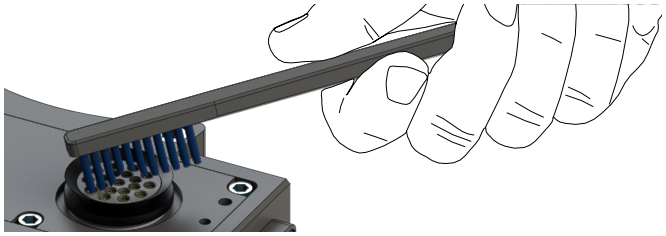
1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. Inspect the Master and Tool pin blocks for debris or darkened pins.

Figure 4.2—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).

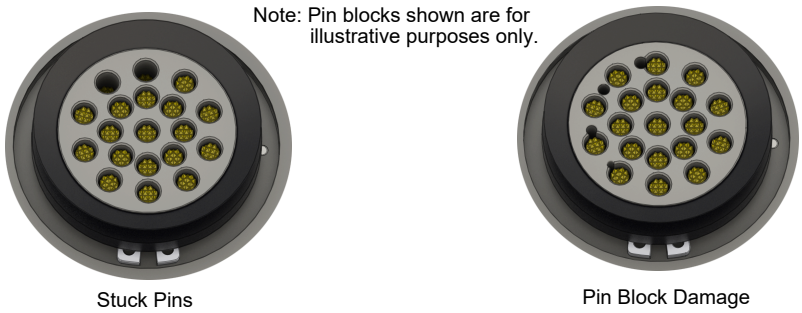
NOTICE: Do not use an abrasive media and/or cleaners or solvents to clean the contact pins. Using abrasive media and/or cleaners or solvents will cause damage to the contact surface or cause pins to stick. Clean contact surfaces with a vacuum or non-abrasive media such as a nylon brush (ATI part number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

Figure 4.3—Clean Pin Blocks with a Nylon Brush



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

Figure 4.4—Stuck Pin and Pin Block Damage



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

5. Troubleshooting and Service Procedures

The following section provides troubleshooting and service information to help diagnose conditions and repair the Tool Changer.

WARNING: Do not perform maintenance or repair(s) on the Tool Changer or modules unless the Tool is safely supported or placed in the tool stand, all energized circuits (for example: electrical, air, water, etc.) are turned off, pressurized connections are purged and power is discharged from circuits in accordance with the customer specific safety practices and policies. Injury or equipment damage can occur with the Tool not placed and energized circuits on. Place the Tool in the tool stand, turn off and discharge all energized circuits, purge all pressurized connections, and verify all circuits are de-energized before performing maintenance or repair(s) on the Tool Changer or modules.

5.1 Troubleshooting

The following table offers some diagnosis and resolution of the Tool Changer.

Table 5.1—Troubleshooting Procedures

Symptom	Cause	Resolution
Unit will not lock or unlock	The locking mechanism cam is jammed.	Clean and lubricate as needed to restore smooth operation (see *Section 4.2—Cleaning and Lubrication of the Master and Tool Plate*
	The knob is not moving.	Check for debris in the knob or cam area of the locking mechanism, and clean if necessary.
	The Master and Tool are not touching prior to lock.	Check the Tool is properly oriented in the Master.
		Verify there is no debris between the Master and Tool prior to locking.
Units Equipped with Electrical Modules		
Contamination in electrical contacts	V-ring seal damaged.	Inspect V-ring seal for damage, replace damaged seal. Refer to *Section 5.2.1—V-ring Seal Inspection and Replacement*.

5.2 Service Procedures

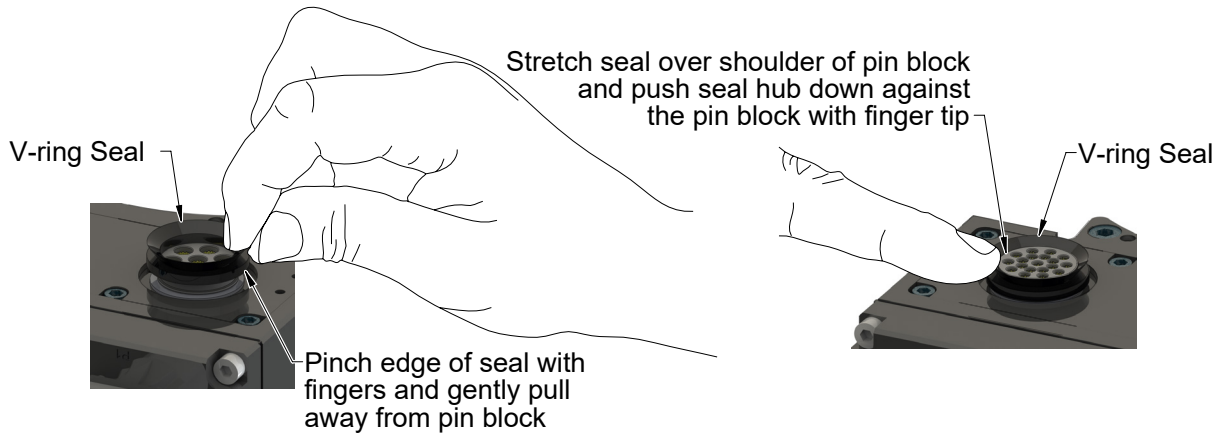
Component replacement and adjustment procedures are provided in the following section:

5.2.1 V-ring Seal Inspection and Replacement

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

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
4. To remove the existing seal, pinch the edge of the seal and pull the seal away from the pin block on the Master module.
5. To install a new seal, stretch the new seal over the shoulder of the pin block.
6. Push the seal hub down against the pin block.
7. Safely resume normal operation.

Figure 5.1—V-ring Seal Replacement



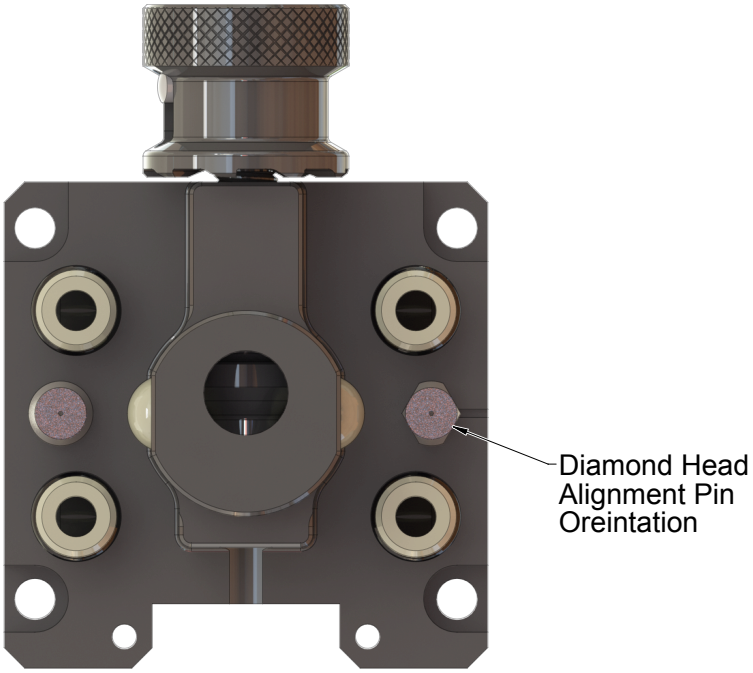
5.3 Alignment Pin Replacement

Parts required: *Refer to Section 6.1—MC-16R Master Plate Serviceable Parts.*

Tools required: *pliers*

1. Turn off and de-energize all energized circuits (for example: electrical, pneumatic, and hydraulic circuits).
2. Uncouple the Tool Changer to allow clear access to the Master and Tool plates.
3. Alignment pins can be removed via pliers or by pushing the pins out from the back of the Master housing.

Figure 5.2—Alignment Pin Replacement



4. Install the new alignment pin into the body via an arbor press. Verify the pin is fully seated into the body. The pin heads should seat fully against the Master body.
5. Also be sure the diamond head is oriented as shown.
6. After repair is complete, all circuits may be returned to normal operation.

6. Serviceable Parts

6.1 MC-16R Master Plate Serviceable Parts

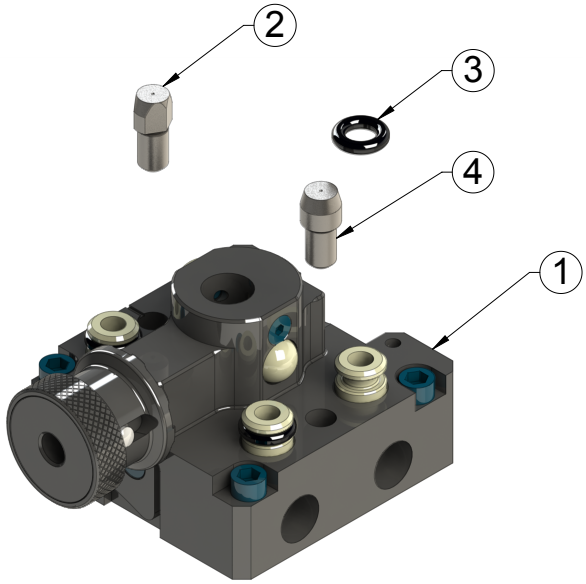


Table 6.1—MC-16R Master Plate			
Item No.	**Qty**	**Part Number**	**Description**
1	1	9122-016RM-000	MC-16R Base Master NPT, Steel Fully Threaded, Ratchet Knob
		9122-016RM-000-E	MC-16R Base Master, Steel Fully Threaded, Ratchet Knob, Euro
		9122-016RM-000-NP	MC-16R Base Master NPT, Steel Fully Threaded, Ratchet Knob, Ports Removed
2	1	3690-5800804-10	Alignment Pin, Diamond, 6 mm Dia Shank, 8 mm Dia Head, 4 mm L Head, Steel
3	4	3410-0001291-01	O-Ring AS568-108 Buna-N Shore A: 70 Black
4	1	3690-5800803-10	Alignment Pin, Round, 6 mm Dia Shank, 8 mm Dia Head, 4 mm L Head, Steel

6.2 MC-16 Tool Plate Serviceable Parts

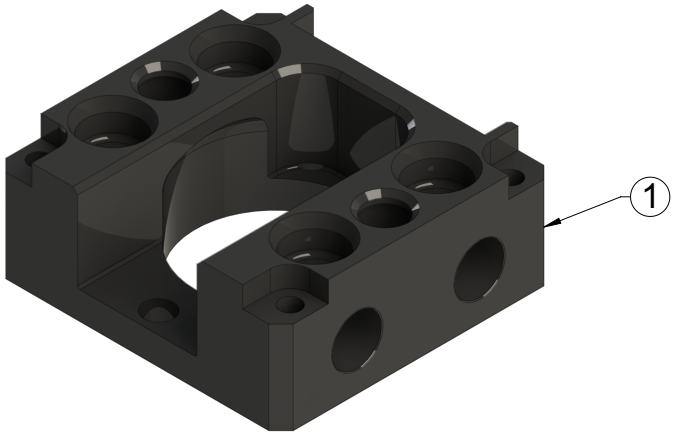


Table 6.2—MC-16 Tool Plate			
Item No.	**Qty**	**Part Number**	**Description**
1	1	9122-016T-000	MC-16 Manual Coupler Base Tool with (4) 1/8” NPT Ports
1	1	9122-016T-000-E	MC-16 Manual Coupler Base Tool with (4) G 1/8 Ports, Euro

7. Specifications

Table 7.1—Master and Tool Plate Specifications		
Recommended Max Payload	35 lbs	The mass attached to the Tool Changer.
Operating Temperature Range	-20–150°F (-30–66°C)	Optimal operating temperature range.
Recommended Max Moment X-Y (Mxy)	220 in-lbs 25 (Nm)	Maximum recommended working load for optimum performance of the Tool Changer
Recommended Static Moment Z (Mz)	400 in-lbs 45 (Nm)	Maximum recommended static load for optimum performance of the Tool Changer
Positional Repeatability	+/-.001”	Repeatability tested at rated load at 30K cycles.
Weight (coupled, no access.)	1.75 lbs (0.79 kg)	Master 1.15 lbs (0.52 kg) / Tool 0.60 lbs (0.27 kg)
Pneumatic Pass Through Ports	(4) 1/8” NPT or BSPP	Optional. Specify –NP for version with No Ports
Mounting/Customer Interface	Master plate Tool plate	Custom Rectangular Pattern See *Section 8—Drawings.* Custom Rectangular Pattern See *Section 8—Drawings.*

8. Drawings

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