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B. Tool Changer

QC-22 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 (2) 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-22 Series of Tool Changers, refer to: *QC-22 Series.*

Table 1.1—QC-22 Tool Changer Models and Features

Payload	Flats	Plate	Pneumatic Ports	Part No.	Sensors
55 lbs	(1) Flats - (1) Flat for K series modules and J16 mounting pattern	Master	(6) 3/8 NPT Pass through ports (2) M5 x 0.8 Lock/Unlock air ports	9120-022M-000-000-S0	Dummy Plugs
				9120-022M-000-000-SM 9120-022M-000-000-SV	PNP
				9120-022M-000-000-SP	NPN
		Tool	(6) 3/8 NPT Pass through ports	9120-022T-000-000	N/A
		Master	(6) G 3/8 Pass through ports (2) M5 X 0.8 Lock/Unlock air ports	9120-022M-000-000-S0-E [1]	Dummy Plugs
				9120-022M-000-000-SM-E [1]	PNP
				9120-022M-000-000-SP-E [1]	NPN
		Tool	(6) G 3/8 Pass through ports	9120-022T-000-000-E [1]	N/A

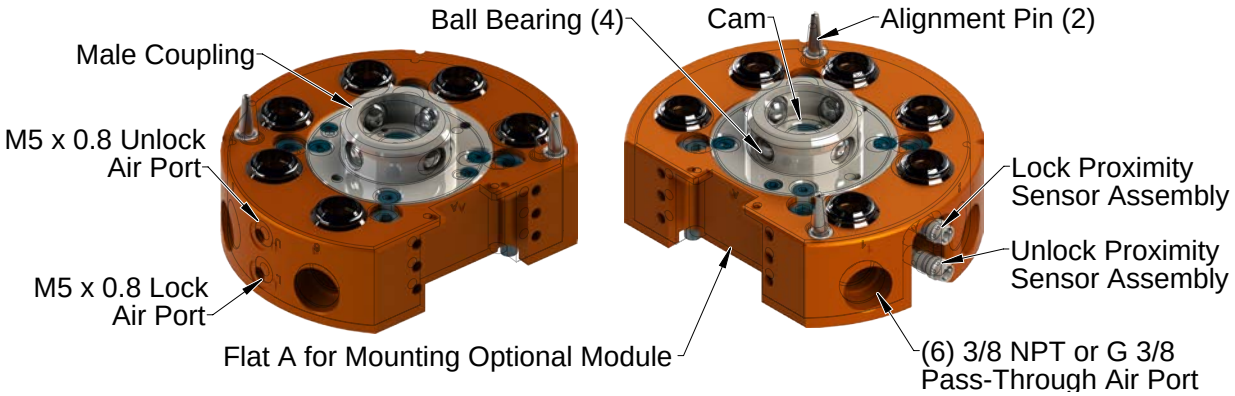
Note[1]: QC Tool Changer Master and Tool plate Assemblies with (-E) Part Numbers have black anodized body

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 Master plate has a flat for mounting optional modules. The locking mechanism consists of a cam, a male coupling, and chrome-steel ball bearings. A 73 mm BC mounting pattern is machined into the Master plate for mounting to a robot interface plate. There are (4) M6 socket head cap screws provided for mounting. Refer to *Section 8—Drawings* for mounting details. Custom robot interface plates or a hollow wrist interface plate are available for the QC-22, contact an ATI Sales Representative for availability.

M5 x 0.8 port connections supply air pressure for coupling and uncoupling the Tool Changer. The Master plate assembly has (6) 3/8 NPT (or G 3/8) pass-through air ports.

Figure 1.1— Master plate assembly (9120-022M-000-000-SM Shown)



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.

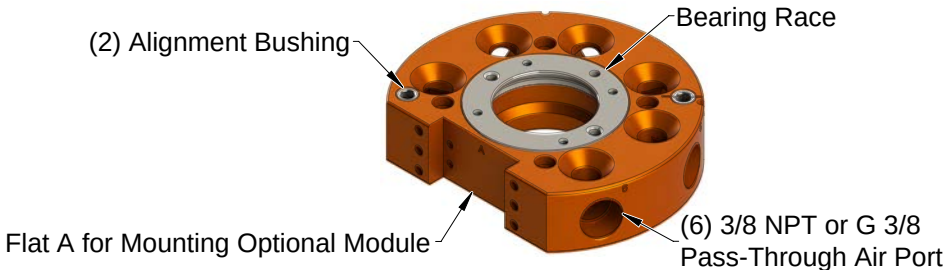
Proximity sensors in the body of the Master plate detect lock and unlock positions of the locking mechanism. The sensors provide “lock” and “unlock” position signals to the customer’s process controller. The sensors can be ordered separately.

1.2 Tool Plate Assembly

The Tool plate assembly includes an anodized aluminum body and a hardened stainless-steel bearing race. The Tool plate has a flat for mounting optional modules. The Tool plate assembly is equipped with (6) 3/8 NPT (or G 3/8) pass-through air ports.

Refer to *Section 8—Drawings* and *Section 2—Installation* for more information.

Figure 1.2—Tool Plate Assembly (9120-022FT-000-000 Shown)



1.3 Optional Modules

The QC-22 has (1) mounting flat for optional modules that support various utility pass-through, such as signal, fluid/air, and electric. For assistance in choosing the right modules for your particular application, visit our website (*QC-22 Series)* to see what is available or contact an ATI Sales Representative for optional modules compatible with the QC-22.

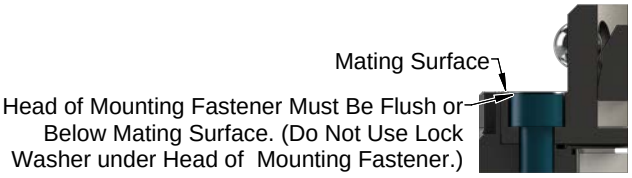
2. Installation

Tighten Tool Changer mounting fasteners to a torque value as indicated in *Table 2.1*. Fasteners must have pre-applied adhesive or be applied with removable threadlocker.

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: 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.

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: 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.

CAUTION: Thread locker applied to fasteners must not be used more than once. Fasteners might become loose and cause equipment damage. Always apply new thread locker when reusing fasteners.

Table 2.1—Fastener Size, Class, and Torque Specifications

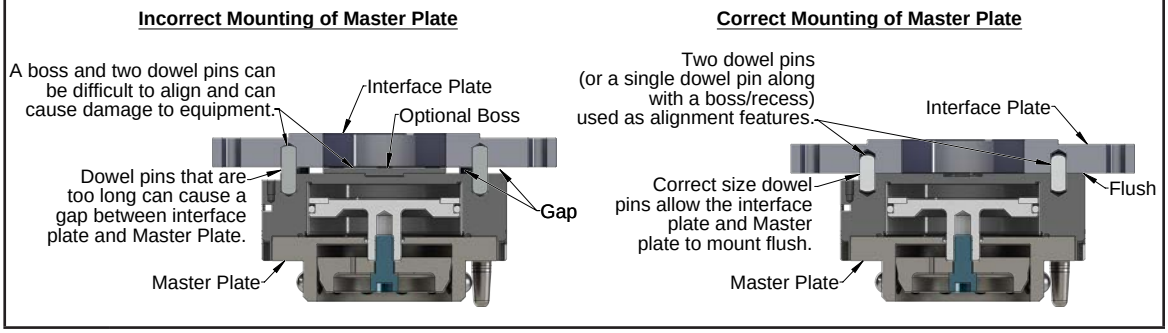
Mounting Conditions	Fastener Size and Property Class	Recommended Torque	Thread Locker
QC-22 Master plate to Robot Interface Plate.	M6 x 1.0 Class 12.9		Pre-applied Adhesive or Loctite 242
	Socket head cap	90 in-lbs (10.2 Nm)	
Tool Interface Plate to QC-22 Tool plate. The minimum thread engagement for the M6 fasteners is 9 mm [1.5X fastener Ø]. *Do not exceed maximum available thread depth of 12 mm as shown in Section 8—Drawings.*	M6 x 1.0 Class 12.9		
	Socket head cap	90 in-lbs (10.2 Nm)	
	Socket flat head cap	60 in-lbs (6.78 Nm)	
	M4 x 0.7 Class 12.9		Pre-applied Adhesive or Loctite 222
	Socket head cap	20 in-lbs (2.26 Nm)	
	Socket flat head cap	15 in-lbs (1.69 Nm)	
Optional Module or adapter plate to Master or Tool plate.	M3 x 0.5 Class 12.9		
	Socket head cap	10 in-lbs (1.13 Nm)	
	Socket flat head cap	8 in-lbs (0.9 Nm)	
	M4 x 0.7 Class 12.9		
	Socket head cap	20 in-lbs (2.26 Nm)	
	Socket flat head cap	15 in-lbs (1.69 Nm)	

2.1 Robot Interface Plate

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 (2) alignment features when securing a Master plate to an interface plate. Using more than (2) alignment features can cause damage to equipment. Use either (2) 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 (2) 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.

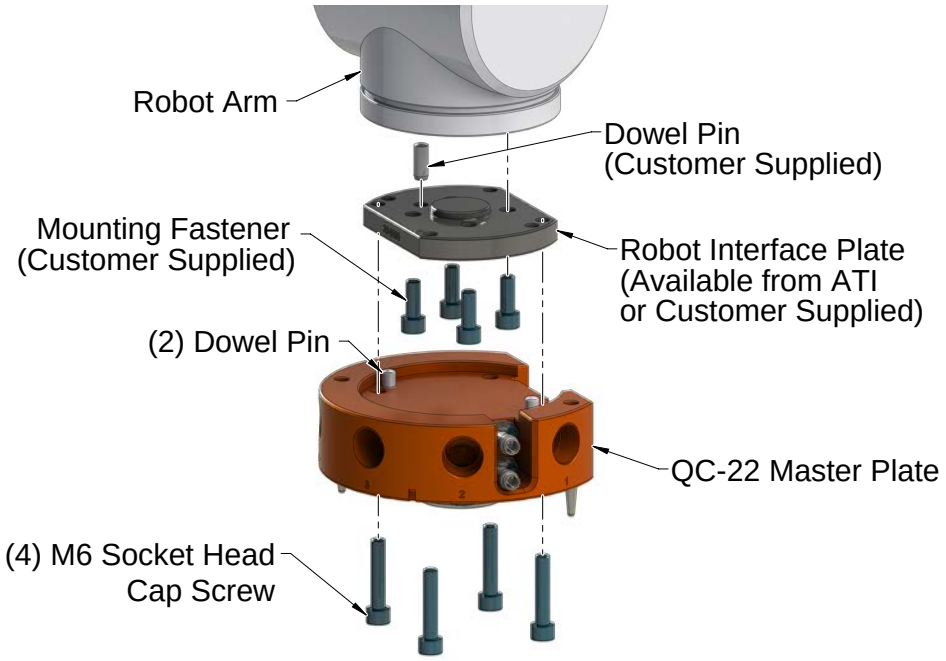
2.2 Master Plate Installation

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

Supplies required: *Clean rag, Loctite 242*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits; for example: electrical, air ,water, etc.
4. Clean the mounting surfaces.
5. Install the interface plate to the robot arm, align using the boss and dowel pin or (2) dowel pins. Secure with customer supplied fasteners.
6. Align the dowel pins to the corresponding holes in the Master plate.
7. Apply threadlocker to threads of the (4) M6 socket head cap screws (see *Table 2.1)*.
8. Secure the Master plate to the interface plate with the (4) M6 socket head cap screws using a 5 mm hex key. See *Table 2.1* for torque values.
9. Connect utilities to the appropriate modules and the pneumatic connections to the Master plate.
10. If equipped, connect the lock and unlock sensor connections.
11. Safely resume normal operation.

Figure 2.1—Typical Master Plate Installation



2.3 Master Plate Removal

Tools required: *5 mm hex key*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plate.
3. Turn off and de-energize all energized circuits; for example: electrical, air ,water, etc.
4. If equipped, disconnect the lock and unlock sensor connections.
5. Remove the (4) M6 socket head cap screws that fasten the Master plate to the interface plate using a 5 mm hex key.
6. Remove the Master Plate.

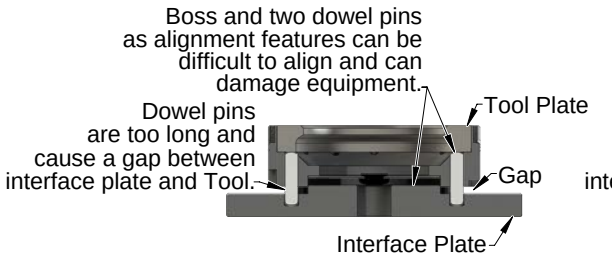
2.4 Tool Interface Plate

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).

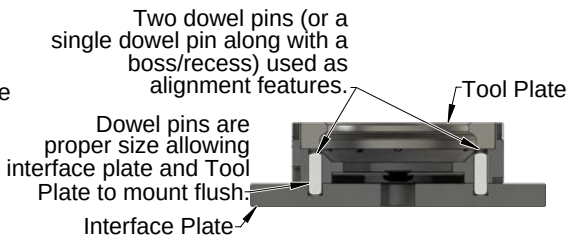
CAUTION: Do not use more than (2) alignment features when securing a Tool plate to an interface plate. Using more than (2) alignment features can cause damage to equipment. Use either (2) dowel pins or a single dowel pin, along with a boss/recess feature to align the Tool plate with the interface plate.

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 (2) 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: *5 mm or 3 mm hex key, torque wrench*

Supplies required: *Clean rag, Loctite 222 or 242*

Depending on your application, the Tool plate has (2) mounting options:

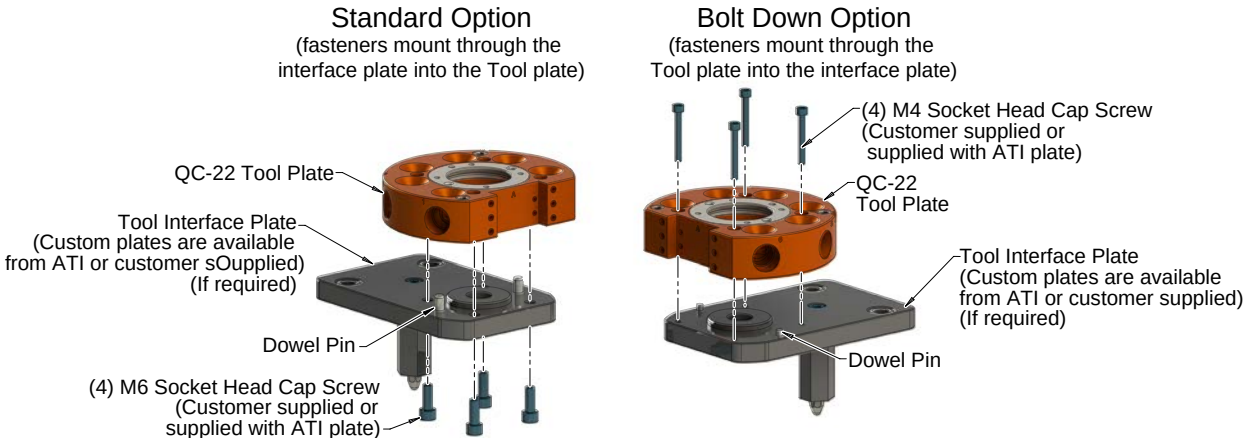
- Standard option: for fasteners mounted through the interface plate into the Tool plate. A 63 mm BC mounting pattern for direct customer tool mounting using (4) M6 tapped holes and a dowel pin. Refer to *Figure 2.2*.
- Bolt down option: for fasteners mounted through the Tool plate into the interface plate. A 76 mm BC mounting pattern for use with (4) M4 socket head cap screws and (2) possible dowel locations. Refer to *Figure 2.2*.

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, air ,water, etc.
4. Clean the mounting surfaces.
5. Apply Loctite to fasteners, see *Table 2.1* for Loctite and torque specifications.
6. If required, install the interface plate to the customer tooling. Align using the boss and dowel pin or (2) dowel pins. Secure with customer supplied fasteners.
7. Secure the Tool plate to the tool interface plate or customer tooling with customer supplied fasteners.

NOTICE: If an ATI tool interface plate is used, fasteners to mount the Tool plate to the tool interface plate may be supplied by ATI. The fasteners used to mount the tool interface plate or the Tool plate directly to the customer tooling are customer supplied.

8. Connect utilities to the module and Tool plate connections.
9. Safely resume normal operation.

Figure 2.2—Tool Plate Installation



2.6 Tool Plate Removal

Tools required: *5 mm or 3 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, air ,water, etc.
4. Remove the customer tooling from the tool interface plate or Tool plate.
5. Remove the fasteners that connect the Tool plate to the tooling or tool interface plate.
6. Remove the Tool plate.

2.7 Optional Module Installation

Optional modules are typically installed on Tool Changers by ATI prior to shipment. The steps below outline installation or removal. Tool Changers are compatible with many different types of modules. Some modules will require an adapter plate to be installed to the Tool Changer.

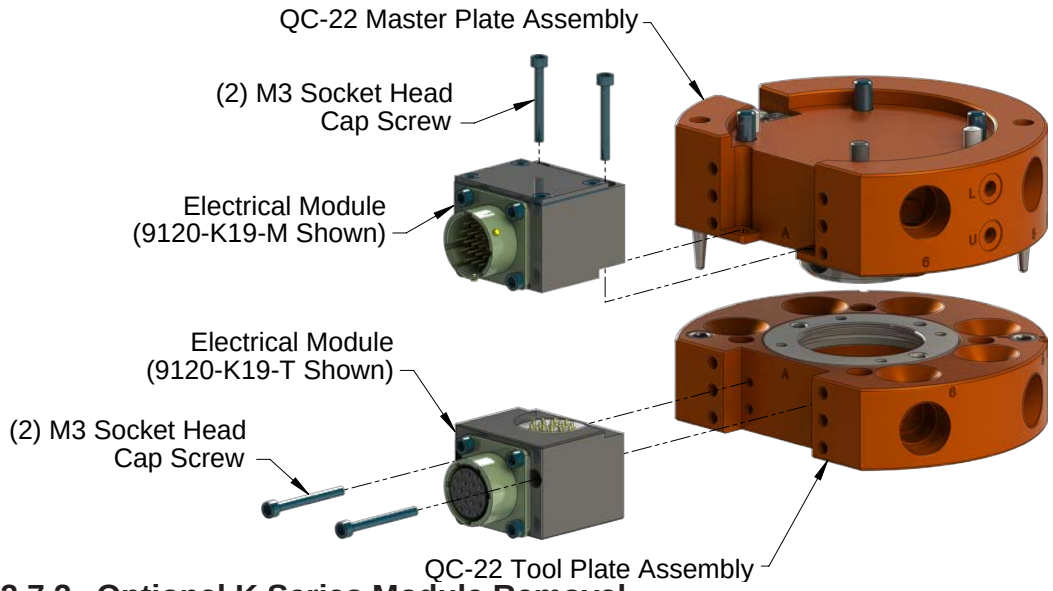
2.7.1 Optional K Series Module Installation

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

Supplies required: *Clean rag, Loctite222*

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, air ,water, etc.
4. Clean the mounting surfaces.
5. Align the optional module on flat A of the Master or Tool plate assembly.
6. Apply Loctite 222 to M3 socket head cap screws.
7. Secure the module with (2) M3 socket head cap screws using a 2.5 mm hex key. Tighten to 10 in-lbs (1.13 Nm).
8. Remove all protective caps, plugs, tape, etc from the module prior to operation.
9. Safely resume normal operation.

Figure 2.3—Optional K Series Module Installation



2.7.2 Optional K Series Module Removal

Tools required: *2.5 mm hex key*

1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits; for example: electrical, air ,water, etc.
4. Disconnect any cables, air line, etc. Note: To access the module on the Master, you might need to remove the Master plate. Refer to *Section 2.3—Master Plate Removal*.
5. Remove the (2) M3 socket head cap screws that secure the module to the Tool changer using a 2.5 mm hex key.
6. Remove the module from the Master or Tool plate.

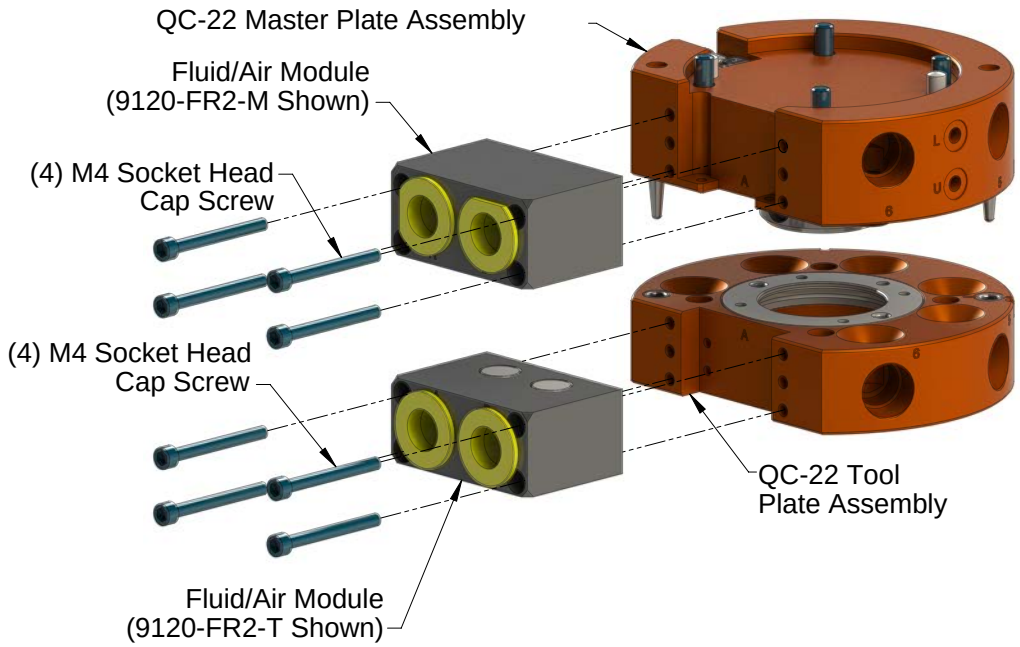
2.7.3 Optional Module Installation

Tools required: *3 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 plates.
3. Turn off and de-energize all energized circuits; for example: electrical, air ,water, etc.
4. Clean the mounting surfaces.
5. Align the optional module on the Master or Tool plate as shown in *Figure 2.4*.
6. If not using fasteners with pre-applied adhesive, apply Loctite 222 to the (4) M4 socket head cap screws.
7. Secure the module with (4) M4 socket head cap screws using a 3 mm hex key. Refer to *Table 2.1* for proper torque for your specific mounting fasteners.
8. Remove all protective caps, plugs, tape, etc from the module prior to operation.
9. Connect any cables, air lines, etc.
10. Safely resume normal operation.

Figure 2.4—Optional Module Installation



2.7.4 Optional Module Removal

Tools required: *3 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, air ,water, etc.
4. Clean the mounting surfaces.
5. Disconnect any cables, air line, etc.
6. Supporting the module, remove the (4) M4 socket head cap screws using a 3 mm hex key.
7. Remove the module from the Master or Tool plate.

2.8 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.

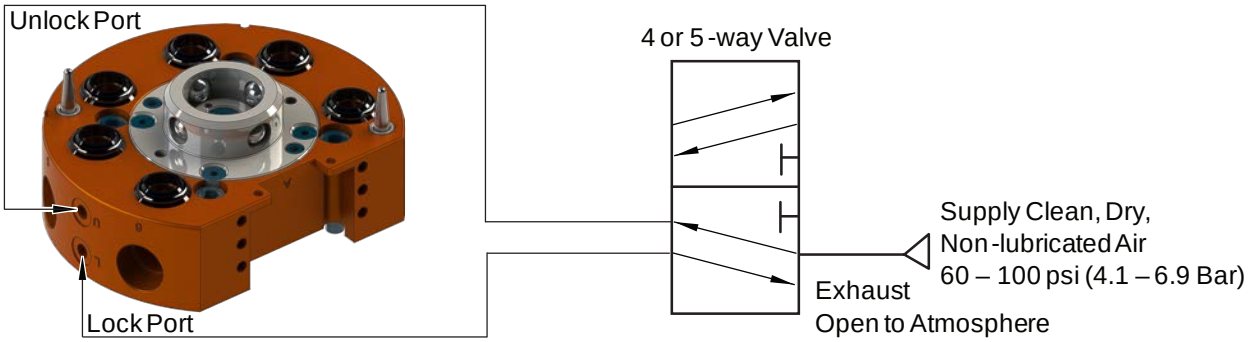
CAUTION: Do not use the Tool Changer in a fail-safe condition. Damage to the locking mechanism can occur. Re-establish air pressure and ensure the Tool Changer is in a secure lock position before returning to normal operations.

2.8.1 Valve Requirements and Connections for the Locking Mechanism

It is required that a customer supplied 2-position 4-way or 5-way valve be used to actuate the locking mechanism in the Master plate. It is imperative that when air is supplied to the lock or unlock port on the Master plate, that the opposite port be vented to atmosphere (i.e., 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 proper shuttling of the valve and prevent coupling/uncoupling from occurring.

CAUTION: The locking mechanism will not function properly when connected to a single 3-way valve as this type of valve is incapable of venting trapped air pressure from within the Tool Changer. This could result in damage to the product, attached tooling, or personnel. Connect the lock and unlock supply air to a 2-position 4-way or 5-way valve.

Figure 2.5—Lock and Unlock Pneumatic Connections



2.9 Electrical Connections

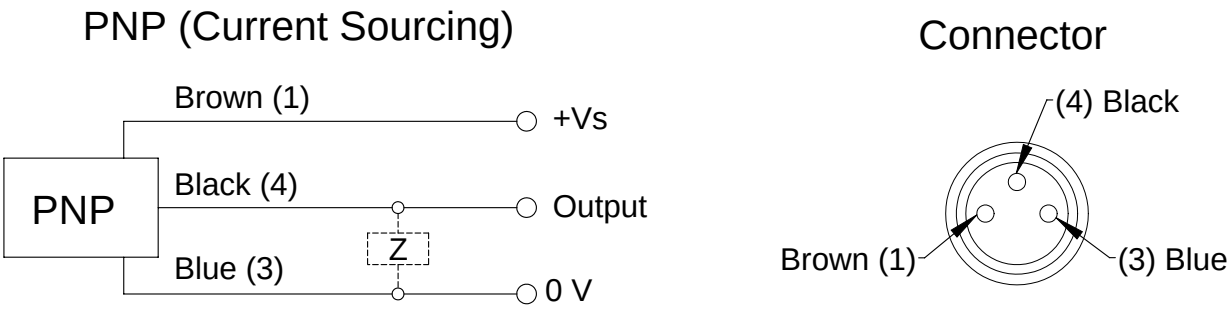
The Tool Changer is available with integrated lock/unlock sensors. If sensors are not used, plugs will be provided to seal the locking mechanism.

2.9.1 PNP Type Lock and Unlock Sensors

These sensors are used on 9120-022M-000-000-SM and 9120-022M-000-000-SM-E.

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

Figure 2.6—PNP Type Lock, Unlock and RTL Sensors

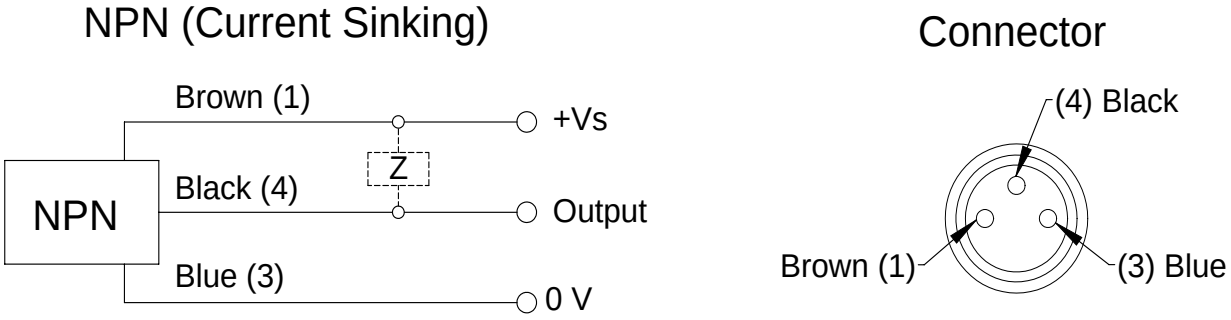


2.9.2 NPN Type Lock and Unlock Sensors

These sensors are used on 9120-022M-000-000-SP and 9120-022M-000-000-SP-E.

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

Figure 2.7—NPN Type Lock, Unlock and RTL Sensors



3. Operation

The Master locking mechanism is pneumatically driven to couple and uncouple with the bearing race on the Tool plate. The Master plate utilizes air ports to provide lock and unlock pressure to the locking mechanism.

CAUTION: Do not use the Tool Changer with air pressure below 60 psi. Safe, reliable operation of the tool changer is dependent on a continuous supply of compressed air at a pressure of 60 to 100 psi. Robot motion should be halted if the air supply pressure is below 60 psi.

CAUTION: The air supply should be clean, dry, and non-lubricated. Air supply must be filtered at minimum to 40 micron. Connection lines must be properly strain relieved.

NOTICE: All Tool Changers are initially lubricated using MobilGrease® XHP222 Special grease. 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 Locking Mechanism and Alignment Pins*). Tubes of lubricant for this purpose are shipped with every Tool Changer. Note: MobilGrease XHP222 Special is a NLGI #2 lithium complex grease with molybdenum disulfide.

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

Lock-up should occur with the Master plate in the No-Touch™ locking zone (see *Table 3.1*) but not touching the Tool plate. As locking occurs, the Master plate should draw the Tool plate into the locked position.

Figure 3.1— Offset Definitions

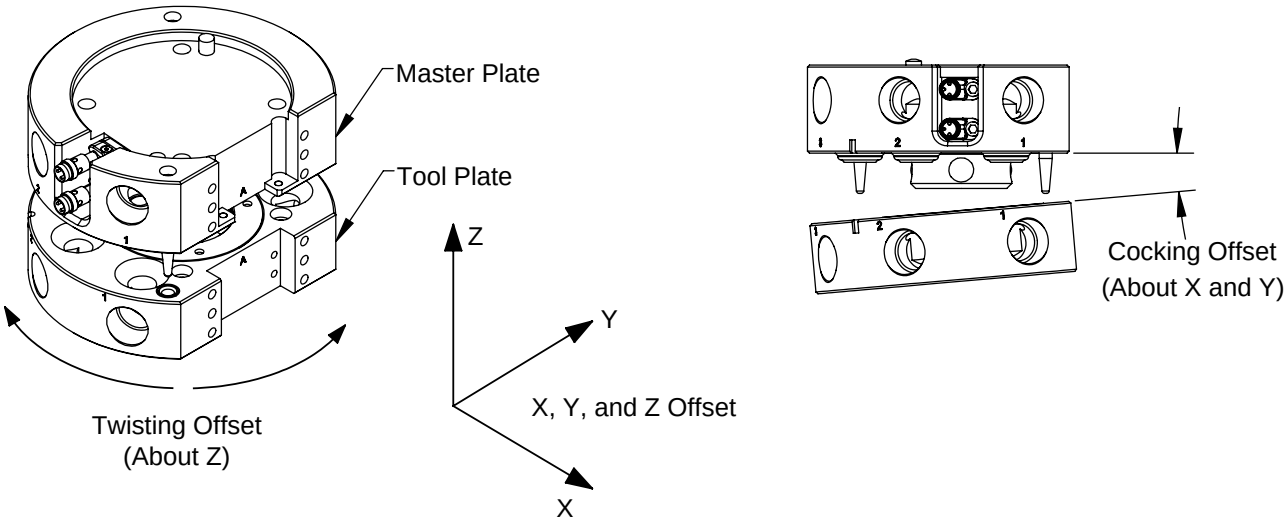


Table 3.1—Maximum Recommended Offsets Prior to Coupling				
Model	No-Touch™ Zone Z Offset (Max)x	X and Y Offset (Max)[2]	Cocking Offset (Max) (degrees)	Twisting Offset (Max) (degrees)
QC-22	+2 mm (0.08”)	±1 mm (0.039”)	±0.8	±2

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 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.

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. 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

The following section contains preventative maintenance procedures, periodic inspection recommendations, and cleaning instructions for the Tool Changer and optional modules.

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 customer tooling, 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 customer tooling and tool stand.

4.1 Preventive Maintenance

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

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

- ☐ Inspect fasteners for proper torque, interferences, and wear. Tighten and correct as required. Refer to *Section 2.2—Master Plate Installation.*

Ball Bearings/Alignment Pins/Bushings/Bearing Race

- ☐ Inspect for wear and lubrication. MobilGrease XHP222 Special a NLGI #2 lithium complex grease with molybdenum disulfide additive is suggested for locking mechanism and alignment pin lubrication. Over time, lubricants can become contaminated with debris. Therefore, it is recommended to thoroughly clean the existing grease and replace with new as needed. See *Section 4.2—Cleaning and Lubrication of the Locking Mechanism and Alignment Pins*.
- ☐ Inspect for excessive alignment pin/bushing wear, may be an indication of the 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 2.8—Pneumatic Requirements.*
- ☐ Inspect for wear on the ball bearings/bearing race, may be an indication of the excessive loading.

Hoses

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

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.*
- ☐ Inspect electrical contacts for wear or damage. Contact ATI.

Seals Pass Through Air and Optional Modules

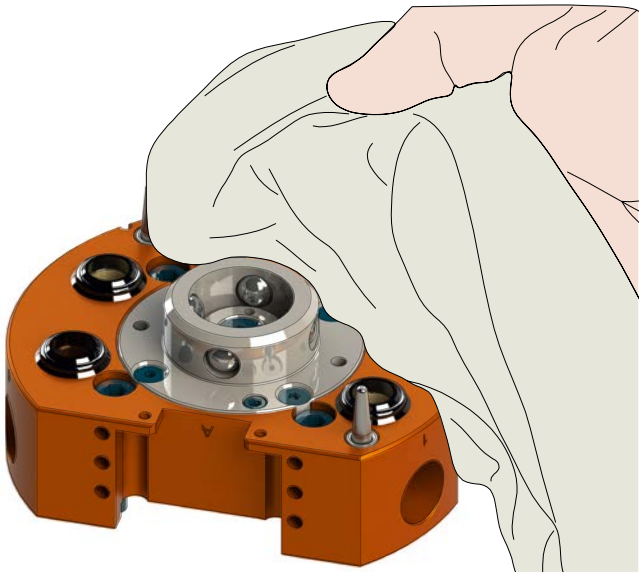
- ☐ Inspect for wear, abrasion, and cuts. Replace damaged seals or bushings as needed. Refer to *Section 5.2.4—V-ring Seal Inspection and Replacement*.

4.2 Cleaning and Lubrication of the Locking Mechanism and Alignment Pins

Supplies required: *Clean rag, MobilGrease XHP222 Special is a NLGI #2 lithium complex grease with molybdenum disulfide*

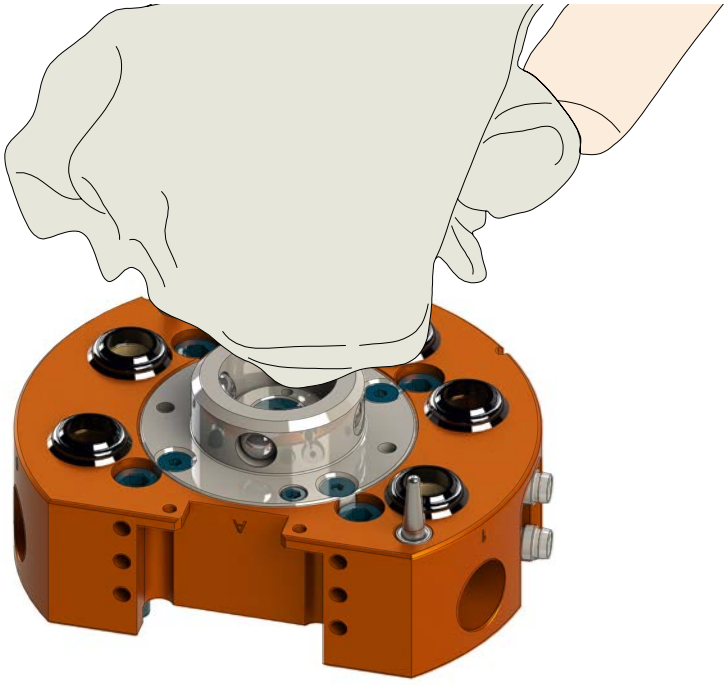
1. Place the Tool in a secure location.
2. Uncouple the Master and Tool plates.
3. Turn off and de-energize all energized circuits (e.g. electrical, air, water, etc.).
4. Use a clean rag to thoroughly remove any lubricant and debris from the ball bearings, male coupling, cam, and alignment pins.

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



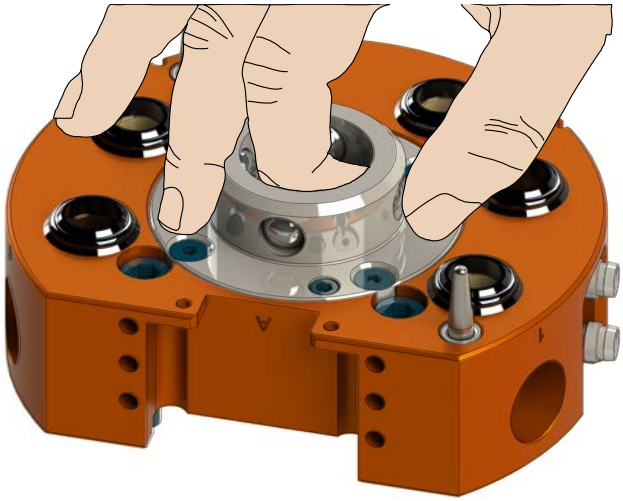
5. Use a clean rag to thoroughly remove any lubricant and debris from the inner surface of the male coupling and cam.

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



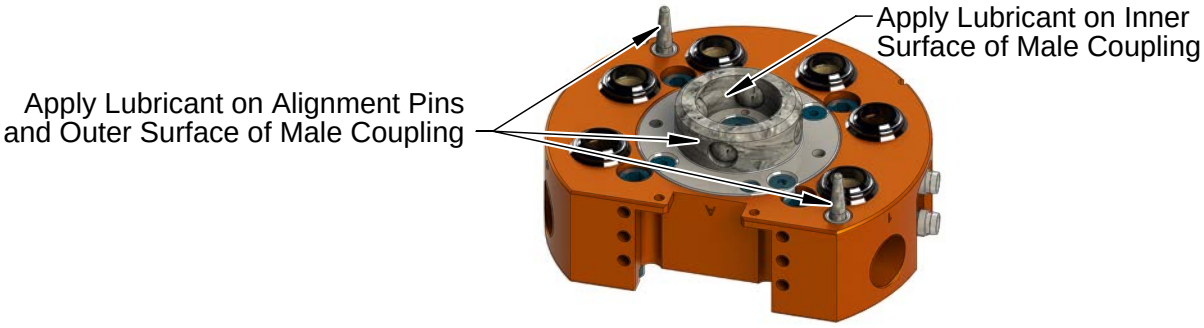
6. Check each ball bearing to make sure it moves freely in the male coupling. Additional cleaning may be necessary to free up any ball bearings that are sticking in place.

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

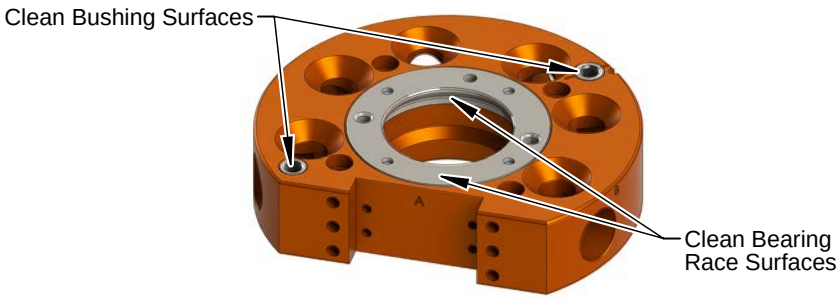


8. Use a clean rag to thoroughly remove any lubricant and debris from the Tool plate bearing race and bushings.

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



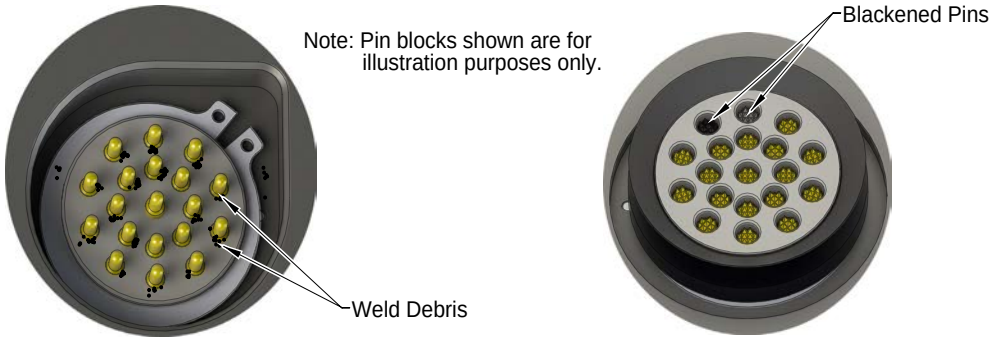
10. No application of lubrication is necessary on the Tool plate components.
11. After maintenance is complete, all circuits can be energized (e.g. electrical, air, water, etc.).

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. Turn off and de-energize all energized circuits (e.g. electrical, air, water, etc.).
3. Inspect the Master and Tool pin blocks for any debris or darkened pins.

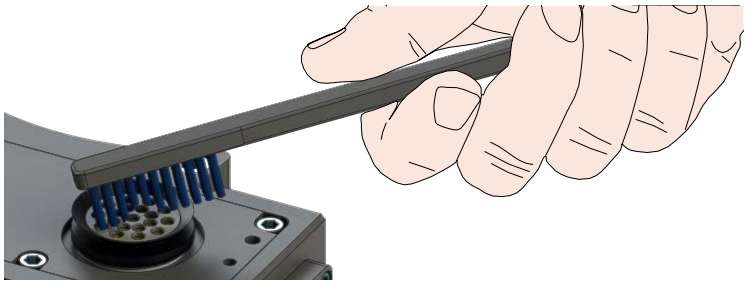
Figure 4.6—Inspect Master and Tool Pin Blocks



4. If debris or darkened pins exist, remove debris using a vacuum, and clean using a nylon brush (ATI Part Number 3690-0000064-60).

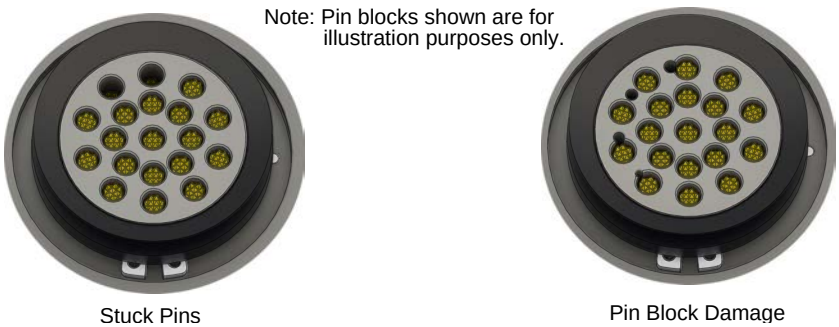
NOTICE: Do not use an abrasive media, cleaners, or solvents to clean the contact pins. Using abrasive media, cleaners, or solvents will cause erosion to the contact surface or pins to stick. Clean contact surfaces with a vacuum or non-abrasive media such as a nylon brush (ATI Part Number 3690-0000064-60)

Figure 4.7—Clean Pin Blocks with a Nylon Brush



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

Figure 4.8—Stuck Pin and Pin Block Damage



6. If stuck pins or severe pin block damage exists, contact ATI for possible pin replacement procedures or module replacement.
7. Safely resume normal operation.

5. Troubleshooting and Service Procedures

WARNING: Do not perform maintenance or repair on 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 purged and power discharged from circuits in accordance with the customer's safety practices and policies. Injury or equipment damage can occur with Tool not placed and energized circuits on. Place the Tool safely in the tool stand, turn off and discharge all energized circuits, purge all pressurized connections, verify all energized circuits are de-energized before performing maintenance or repair on 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:

Table 5.1—Troubleshooting

Symptom	Cause	Resolution
Unit unable to lock or unlock	Insufficient or no air pressure supply to lock or unlock ports.	Verify proper air pressure and pneumatic valve is supplied. Refer to *Section 2.8—Pneumatic Requirements*
	Air pressure trapped in de-energized Lock/Unlock ports.	Air pressure must be vented to the atmosphere properly, refer to *Section 2.8.1—Valve Requirements and Connections for the Locking Mechanism*
	Pneumatic connections loose or damaged.	Refer to the air/valve adapter manual for more information.
	Debris caught between the Master and Tool plates.	Clean debris from between Master and Tool plates. Verify mounting fasteners is secure and does not protrude above the mating surfaces.
	The ball bearings and/or cam are not moving freely in the male coupling.	Clean and lubricate as needed to restore smooth operation (see *Section 4.2—Cleaning and Lubrication of the Locking Mechanism and Alignment Pins.*
	The Master plate and Tool plate are not within the specified No-Touch zone when attempting to lock.	Check that the Tool is properly seated in the tool stand. Refer to *Section 3.5—Tool Storage Considerations.* Re-teach the robot to bring the Master plate and Tool plate closer together prior to attempting to lock. Refer to *Section 3—Operation.*
Unit is locked but Lock signal does not read "on" (true).	Lock sensor/cable is damaged.	Inspect sensor cable for damage, verify cable continuity, replace if necessary. Replace the lock sensor assembly as necessary. Refer to *Section 5.2.1—Lock and Unlock Sensor Replacement.*
Unit is unlocked but unlock signal does not read "on" (true).	Unlock sensor/cable is damaged.	Inspect sensor cable for damage, verify cable continuity, replace if necessary. Replace the unlock sensor assembly as necessary. Refer to *Section 5.2.1—Lock and Unlock Sensor Replacement.*
Insufficient air supply to tooling or air leaking from between Master and Tool plates	Rubber Bushings damaged	Inspect Rubber Bushings for damage, replace damaged bushings. Refer to *Section 5.2.2—Rubber Bushing Replacement.*
Units Equipped with Electrical Modules		
Loss of Communication	Contamination in electrical contacts	Inspect and clean contacts pins, refer to *Section 4.3—Pin Block Inspection and Cleaning*
		Inspect V-ring seal for damage, replace damaged seal. Refer to *Section 5.2.4—V-ring Seal Inspection and Replacement.*

5.2 Service Procedures

5.2.1 Lock and Unlock Sensor Replacement

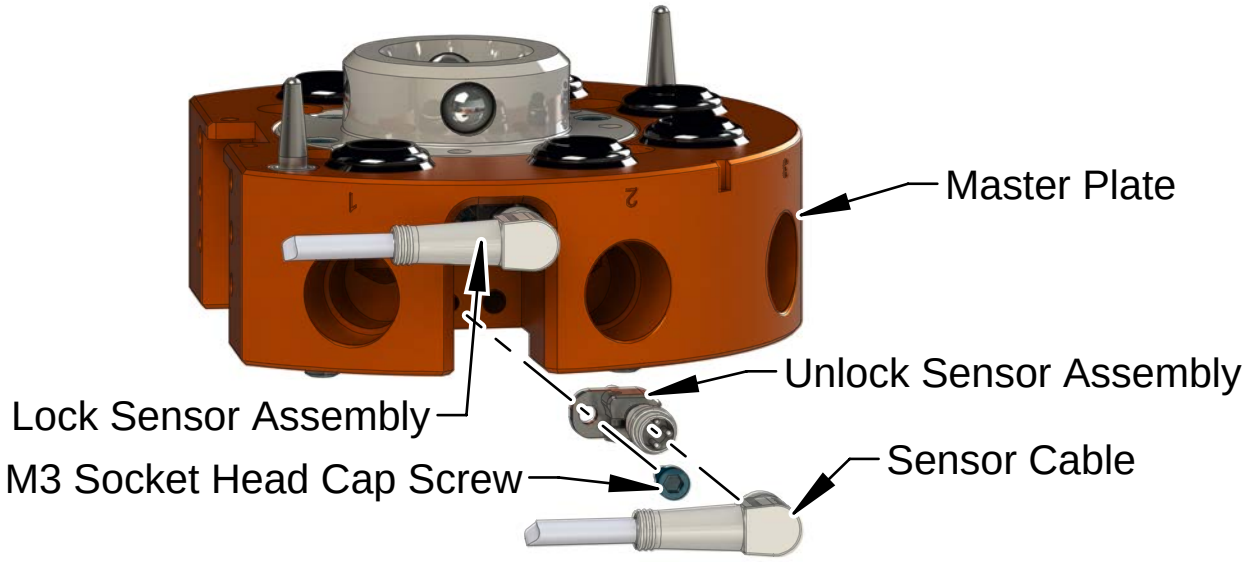
Parts required: *Refer to Section 6.1—QC-22 Master plates Serviceable Parts*

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. Turn off and de-energize all energized circuits; for example: electrical, air ,water, etc.
4. Disconnect the lock and/or unlock sensor cable connectors from the lock and/or unlock sensor assembly.
5. Remove the M3 socket head cap screw that secure the lock and/or unlock sensor assembly to the Tool Changer body using a 2.5 mm hex key (refer to *Figure 5.1*).
6. Pull the sensor assembly straight out from the Tool Changer body. Discard the removed sensor.

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

Figure 5.1— Lock and Unlock Sensor Assembly Replacement



7. Insert the new lock and/or unlock sensor into the Tool Changer body as shown in *Figure 5.1*. Make sure the O-ring is in place and seated properly on the back side of the sensor assembly.
8. Secure the sensor assembly using the M3 socket flat head screw using a 2.5 mm hex key. Tighten to 12 in-lbs (1.4 Nm).
9. Connect the lock and/or unlock sensor cable connector to the proper sensor.
10. To confirm the operation of the unlock sensor, unlock the Tool Changer and check to see that the LED in the unlock sensor body is on. To confirm the operation of the lock sensor, lock the Tool Changer and then check to see that the LED in the Lock sensor body is on.
11. Safely resume normal operation.

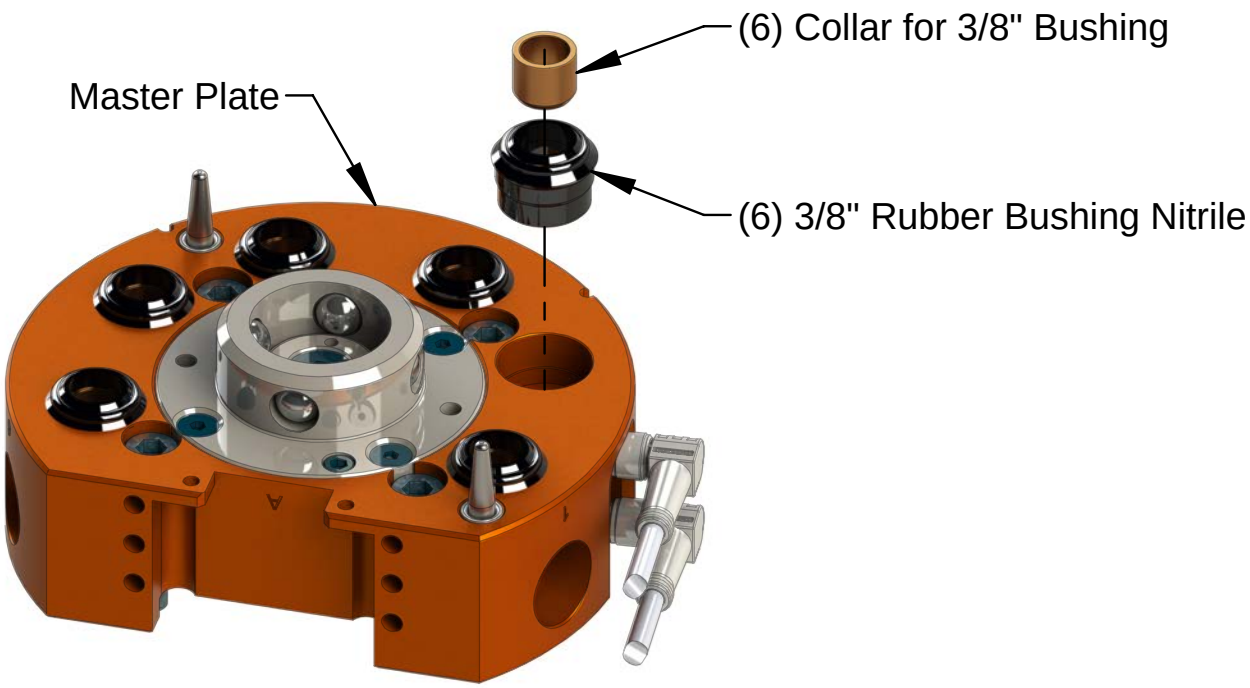
5.2.2 Rubber Bushing Replacement

Parts required: *Refer to Section 6.1—QC-22 Master plates Serviceable Parts*

Tools required: *needle nose pliers*

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, air ,water, etc.
4. Using needle nose pliers, grasp the collar and pull it out of the rubber bushing.
5. Remove the rubber bushing.
6. Lightly lubricate the new rubber bushing and push into the Master body (refer to *Figure 5.2)*.
7. Insert the new collar into the rubber bushing, make sure the bushing is pressed all the way in.
8. Safely resume normal operation.

Figure 5.2— Rubber Bushing Replacement



5.2.3 Alignment Pin Replacement

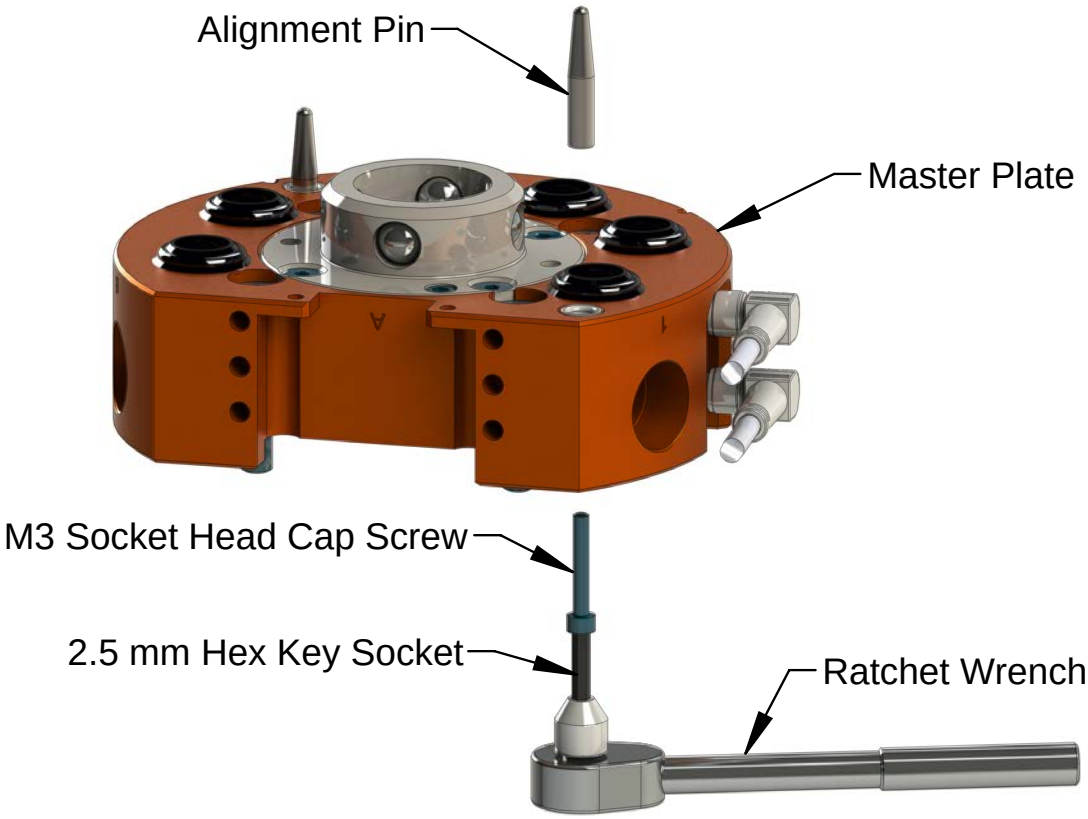
Parts required: *Refer to Section 6.1—QC-22 Master plates Serviceable Parts*

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

Supplies required: *Loctite primer 7649, Loctite 222, MobilGrease XHP222 Special is a NLGI #2 lithium complex grease with molybdenum disulfide*

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, air ,water, etc.
4. If the M3 socket head cap screw cannot be accessed from the robot side of the Master plate, remove the Master plate from the robot, refer to *Section 2.3—Master Plate Removal.*
5. Unscrew the M3 socket head cap screw from the robot side of the Master plate using a 2.5 mm hex key.
6. Remove the alignment pin from the tool side of the Master plate. Discard the old alignment pin.
7. Apply Loctite primer 7649 to the threads in the new alignment pin.
8. Insert the new alignment pin into the master body.
9. Apply Loctite 222 to the threads of the M3 socket head cap screw.
10. Secure the alignment pin to the Master plate with the M3 socket head cap screw using a 2.5 mm hex key. Tighten to 12 in-lbs (1.4 Nm).
11. If the Master plate was removed in setp *4*, install on the robot. Refer to *Section 2.2—Master Plate Installation.*
12. Safely resume normal operation.

Figure 5.3—Alignment Pin Replacement

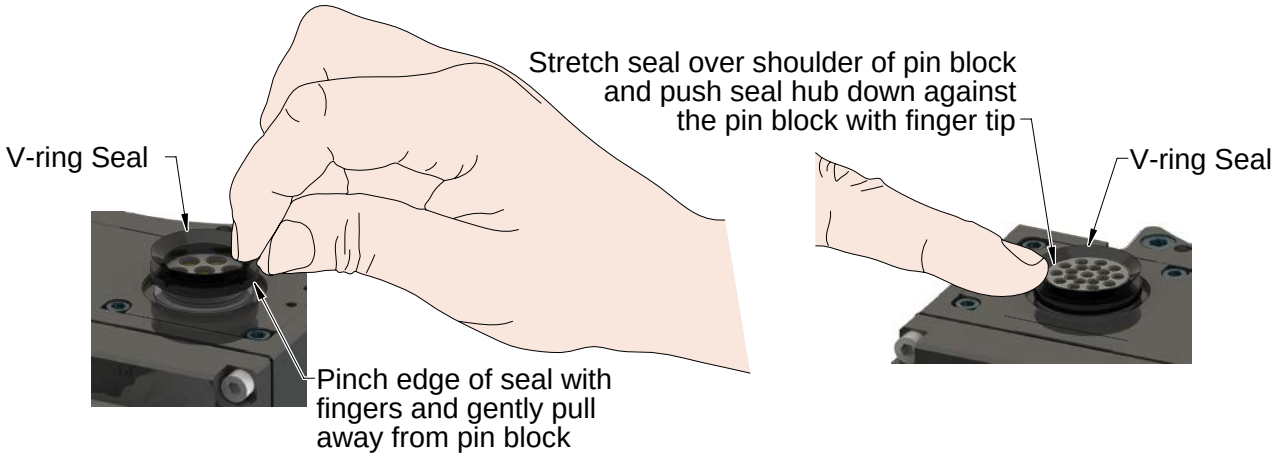


5.2.4 V-ring Seal Inspection and Replacement

The seal protects the electrical connection between the Master and Tool module. If the seal becomes worn or damaged it needs to 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, air ,water, etc.
4. To remove the existing seal, pinch edge of seal with fingers and gently pull the seal away from the pin block on the Master.
5. Pull the seal off the pin block.
6. To install a new seal, stretch the new seal over the shoulder of the pin block.
7. Push the seal's hub down against the pin block using finger tip.
8. Safely resume normal operation.

Figure 5.4—V-ring Seal Replacement



6. Serviceable Parts

6.1 QC-22 Master plates Serviceable Parts

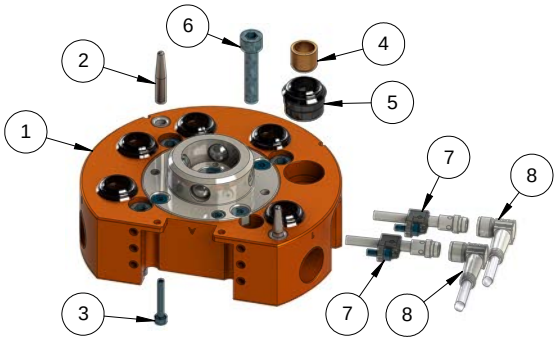


Table 5.2—QC-22 Master plate			
Item No.	**Qty**	**Part Number**	**Description**
1	1	9120-022M-000-000 9120-022M-000-000-E	QC-22 Master Base Assembly, No Options QC-22 Master Base Assembly, Euro No Options[1]
2	2	3700-20-5863	Long 5 mm Alignment Pin
3	2	3500-1058020-15A	M3 x 20 mm socket head cap screws Blue Dyed Magni-565, ND Microspheres
4	6	3700-20-2000	Collar for 3/8” Bushing
5	6	4010-0000010-01	3/8” Rubber Bushing. Nitrile
6	4	3500-1066030-11	M6 x 30 mm socket head cap screws Black Oxide
9120-022M-000-000-S0(-E)[1]			
7	2	9005-20-2378	Sensor Carrier Assembly, Single Screw, Dummy Sensor,4 mm Dowel
9120-022M-000-000-SM-(E) [1], 9120-022M-000-000-ST-(E) [1, 2]			
7	2	9005-20-2345	Sensor Carrier Assembly, Single Screw, 4 mm PNP, 0 Degree Orientation
8	2	8590-9909999-63	Sensor Cable 90 Degree Connector 6M lg
9120-022AM-000-000-SP-(E) [1], 9120-022M-000-000-SU-(E) [1, 2]			
7	2	9005-20-2394	Sensor Carrier Assembly, Single Screw, 4 mm NPN, 0 Degree Orientation
8	2	8590-9909999-63	Sensor Cable 90 Degree Connector 6M lg
9120-022M-000-000-SV			
7	2	9005-20-2406	Sensor Carrier Assembly, Single Screw, NAMUR 4 mm PNP

Notes:
1. QC-22 models with (-E) Part Numbers are Euro products with black anodized bodies.
2. QC-22 models (-ST and (-SU) include the sensor cables.

6.2 QC-22 Tool plate Serviceable Parts

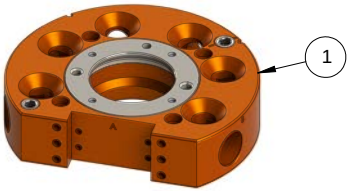


Table 5.3—QC-22 Tool plate			
Item No.	**Qty**	**Part Number**	**Description**
1	1	9120-022T-000-000 9120-022T-000-000-E[1]	QC-22 Tool Base Assembly QC-22 Tool Base Assembly, Euro

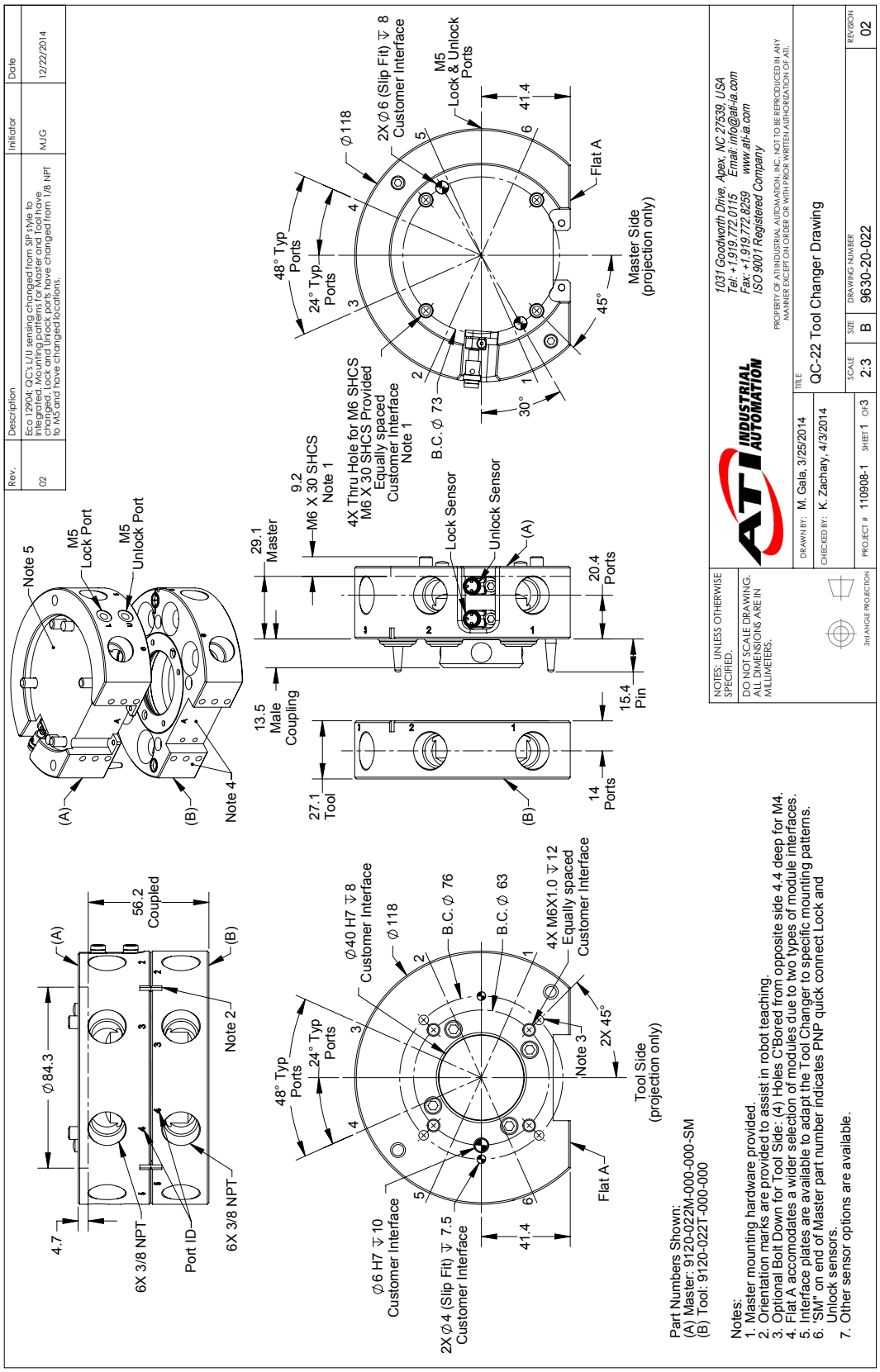
Note:
1. QC-22 models with -E Part Numbers are Euro products, they have black anodized bodies.

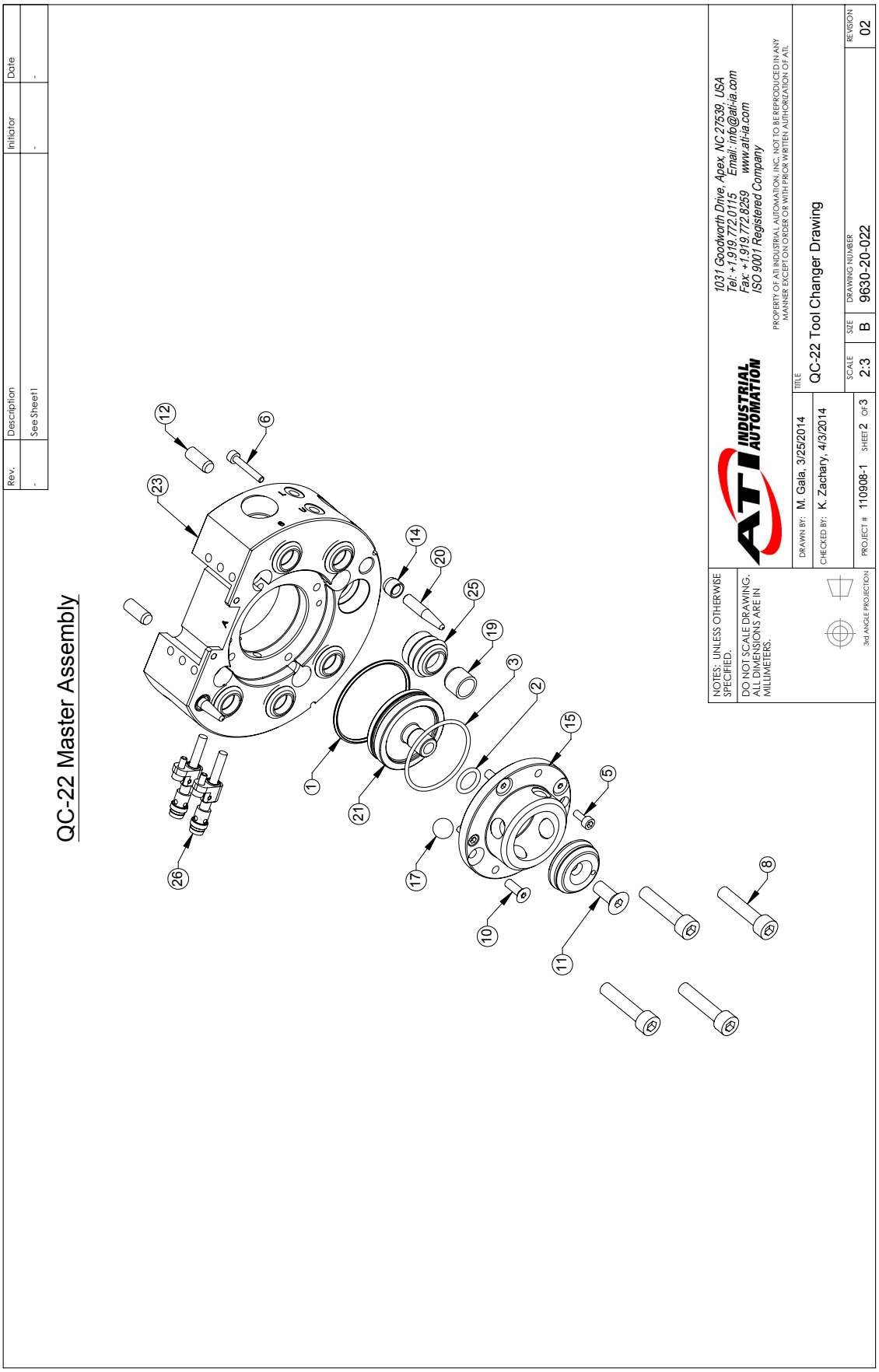
7. Specifications

Table 5.4—QC-22 Specifications		
Specification	Value	**Description**
Recommended Max Payload	55 lbs (25kg)	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	520 lbs (2,300 N)	Axial holding force
Recommended Max Moment X-Y (Mxy)	500 lbf-in 56.6 (Nm)	Maximum recommended working load for optimum performance of the Tool Changer
Recommended Max Torque about Z (Mz)	690 in-lbs 78 (Nm)	Maximum recommended working torque for optimum performance of the Tool Changer
Positional Repeatability	0.0006” (0.0152 mm)	Repeatability tested at rated load at one million cycles.
Weight (coupled, no access.)	3.12 lbs (1.42 kg)	Master 1.91 lbs (0.866 kg) / Tool 1.21 lbs (0.549 kg)
Max. Recommended distance between Master and Tool plate	0.08” (2 mm)	No-Touch™ locking technology allows the Master and Tool plates to lock with separation when coupling.
Pass through port, (Qty) Size (Cv, Min)	(6) 3/8 NPT (G 3/8)	Maximum pressure of 100psi (6.9 bar), Nitrile seals
Mounting/Customer Interface	Master plate Tool plate	73 mm BC, (4) M6 Thru Holes, (2) 6 mm Dowels(SF) 63 mm BC, (4) M6-1.0 tapped Holes, (1) 6 mm Dowel(SF) or 76 mm BC, (4) M4 Thru Holes, (2) 4 mm Dowels(SF)

8. Drawings

8.1 QC-22 Tool Changer




QC-22 Master Assembly
Rev.
Description
Initator
Date
-
See Sheet1
-
-
NOTES: UNLESS OTHERWISE SPECIFIED.
DO NOT SCALE DRAWING. ALL DIMENSIONS ARE IN MILLIMETERS.
3rd ANGLE PROJECTION
DRAWN BY: M. Gala, 3/25/2014
CHECKED BY: K. Zachary, 4/3/2014
PROJECT # 110908-1 SHEET 2 OF 3
TITLE
QC-22 Tool Changer Drawing
SCALE 2:3
SIZE B
DRAWING NUMBER 9630-20-022
REVISION 02
INDUSTRIAL AUTOMATION
1031 Goodworth Drive, Apex, NC 27539, USA
Tel: +1.919.772.0115 Email: info@ati-ia.com
Fax: +1.919.772.8259 www.ati-ia.com
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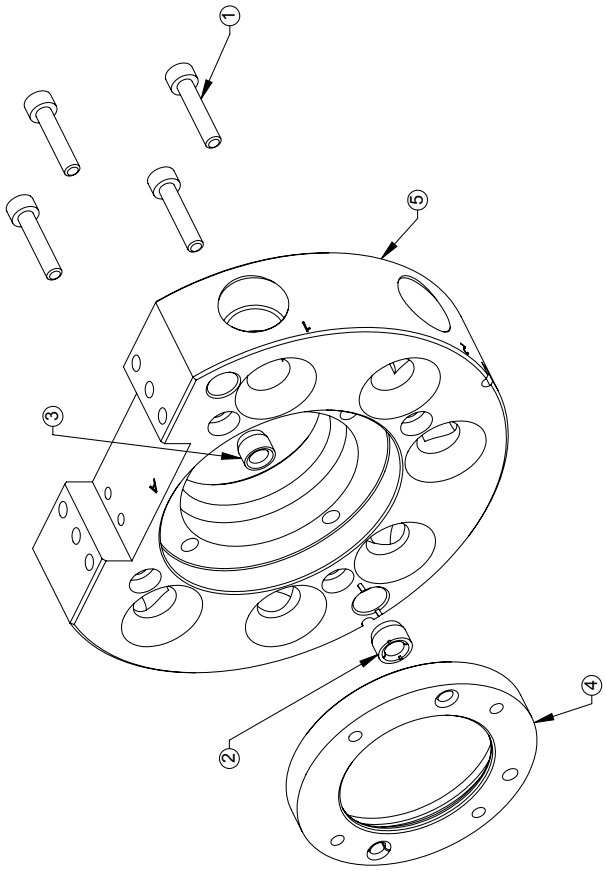
Rev.	Description	Initator	Date
-	See Sheet1	-	-

QC-22 Tool Assembly



NOTES: UNLESS OTHERWISE SPECIFIED.

DO NOT SCALE DRAWING. ALL DIMENSIONS ARE IN MILLIMETERS.

3rd ANGLE PROJECTION

DRAWN BY: M. Gala, 3/25/2014
CHECKED BY: K. Zachary, 4/3/2014
PROJECT # 110908-1 SHEET 3 OF 3

TITLE: QC-22 Tool Changer Drawing

SCALE: 1:1
SIZE: B
DRAWING NUMBER: 9630-20-022
REVISION: 02

1031 Goodworth Drive, Apex, NC 27539, USA
Tel: +1.919.772.0115 Email: info@ati-ia.com
Fax: +1.919.772.8259 www.ati-ia.com
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