Applied Robotics™
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EPSILON E125LP
TOOL CHANGE SYSTEM

95624, Rev 00

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REVISION

Revision	Date	Author	Description
00	3/31/2016	SC	Initial Release

CONTENTS

1 LIFETIME GUARANTEE

APPLIED ROBOTICS extends a lifetime guarantee to the components that make up the operating cam locking mechanism of the Epsilon Tool Changer. The following components are covered under APPLIED ROBOTICS Lifetime Guarantee.

PART NUMBER	DESCRIPTION
0104-C62N	SHAFT, CAM ACTUATOR
0104-B63N	WASHER, UNCOUPLE
0104-B64N	WASHER, COUPLE
0107-C47N	CAM, HIGH LOCK
0104-B59N	DOWEL, MODIFIED CAM
49382	DOWEL, M10 X 40 (HARD STL) M6

APPLIED ROBOTICS warrants the Epsilon Tool Changer cam locking mechanism for the lifetime of the product against manufacturer's defects in materials and workmanship. Additionally, APPLIED ROBOTICS warrants the cam locking mechanism against wear that results in the Epsilon Tool Changer to lose repeatability and precision during the docking sequence of operation (Section 8.1.3).

CONDITIONS OF THE WARRANTY:
Products shall have been subject to only normal use and service as instructed in this manual and shall not have been misused, neglected, altered, improperly set up or otherwise damaged; and, there shall be no evidence of tampering or deliberate misuse or destruction.

Defects to APPLIED ROBOTICS products will be determined solely by APPLIED ROBOTICS and not by any representative or distributor of or for APPLIED ROBOTICS. Upon determination of a defect, APPLIED ROBOTICS sole obligation will be to provide replacement material for the defective part(s). APPLIED ROBOTICS is not liable or responsible for costs borne from lost production or labor related costs for repairing the defective part(s).

Any claim against APPLIED ROBOTICS for defects in material or workmanship must be in writing. APPLIED ROBOTICS must authorize the return of any allegedly defective part before it is returned. The party making the claim must prepay all shipping and transportation costs. APPLIED ROBOTICS will not accept charges for parts purchased unless the conditions of the warranty have been satisfied.

No APPLIED ROBOTICS representative or distributor is authorized to assume for APPLIED ROBOTICS any other obligations or liabilities in connection with the product, or alter the terms of this warranty in any way.

APPLIED ROBOTICS shall not be liable for damages, including special, incidental or consequential damages arising out of or in connection with the performance of an APPLIED ROBOTICS product or its use by the owner.

2 PRECAUTIONS

READ MANUAL
Do not start, operate or service machine until you read and understand operator's manual. Failure to do so could result in serious injury.

HAND CRUSH NOTICE
Indicates the possibility for a crush force between components during coupling of the Robot and Tool Adaptor.

⚠ DANGER — Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING — Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION — Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE — Indicates a situation which, if not avoided, could result in equipment damage and voiding the manufacturer's equipment warranty.

IGNORING INFORMATION ABOUT POTENTIAL HAZARDS CAN LEAD TO SERIOUS HARM TO PERSONNEL AND/OR DAMAGE TO THE EQUIPMENT, AND MAY RESULT IN THE NULLIFICATION OF THE MANUFACTURER'S EQUIPMENT WARRANTY.

HEED ALL PRECAUTION NOTICES

3 SYSTEM DESCRIPTION

The Epsilon E125LP (Low Profile) Tool Changer provides a strong and reliable method for a manipulator to quickly change between different tools/end-effectors. With Applied Robotics, Inc. six-sided design, the E125LP Tool Changer offers the maximum flexibility for any application.

The E125LP Tool Changer contains two major components:

Robot Adaptor (ER125LP) – Mounts directly to a robot flange utilizing a 125mm ISO 9409-1 pattern without the need for adaptor plates (Figure 3-1).

Tool Adaptor (ET125LP) – Mounts directly to a tooling plate utilizing a 125mm ISO 9409-1 pattern (Figure 3-2).

The Robot Adaptor and Tool Adaptor lock together by means of a double-acting, pneumatically-driven cam locking mechanism. The three (3) cam self-centering locking mechanism allows for reliable and repeatable operation throughout the life of the tool changer with a unique wear compensating design. Each cam also contains a mechanical locking feature which prevents the Robot Adaptor and Tool Adaptor from separating/disconnecting in the event of power and/or air pressure loss. As the locking mechanism actuates, the Tool Adaptor is physically connected and disconnected along with any utilities contained in the attached modules.

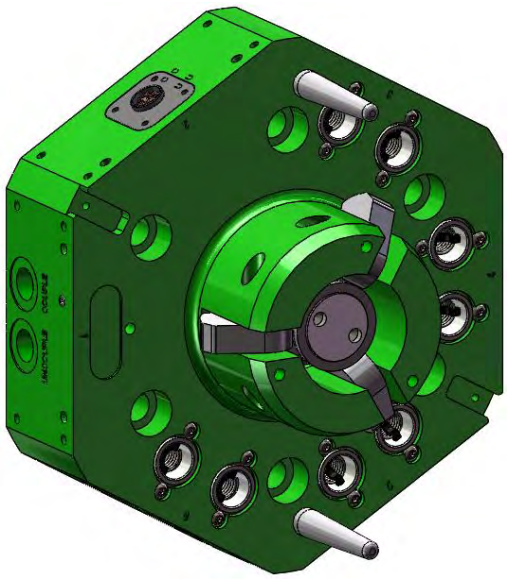


Figure 3-1. ER125LP Robot Adaptor

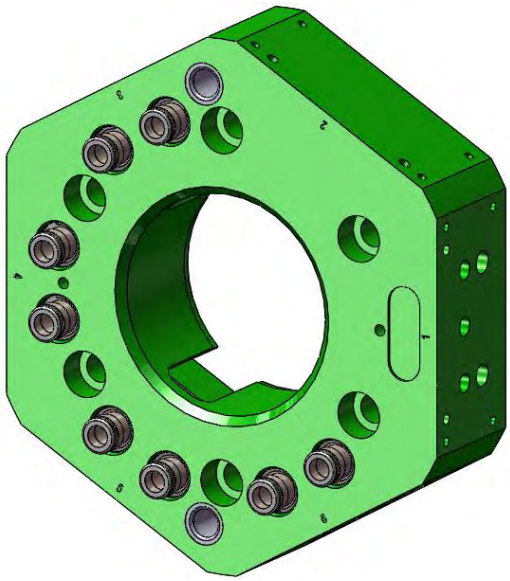
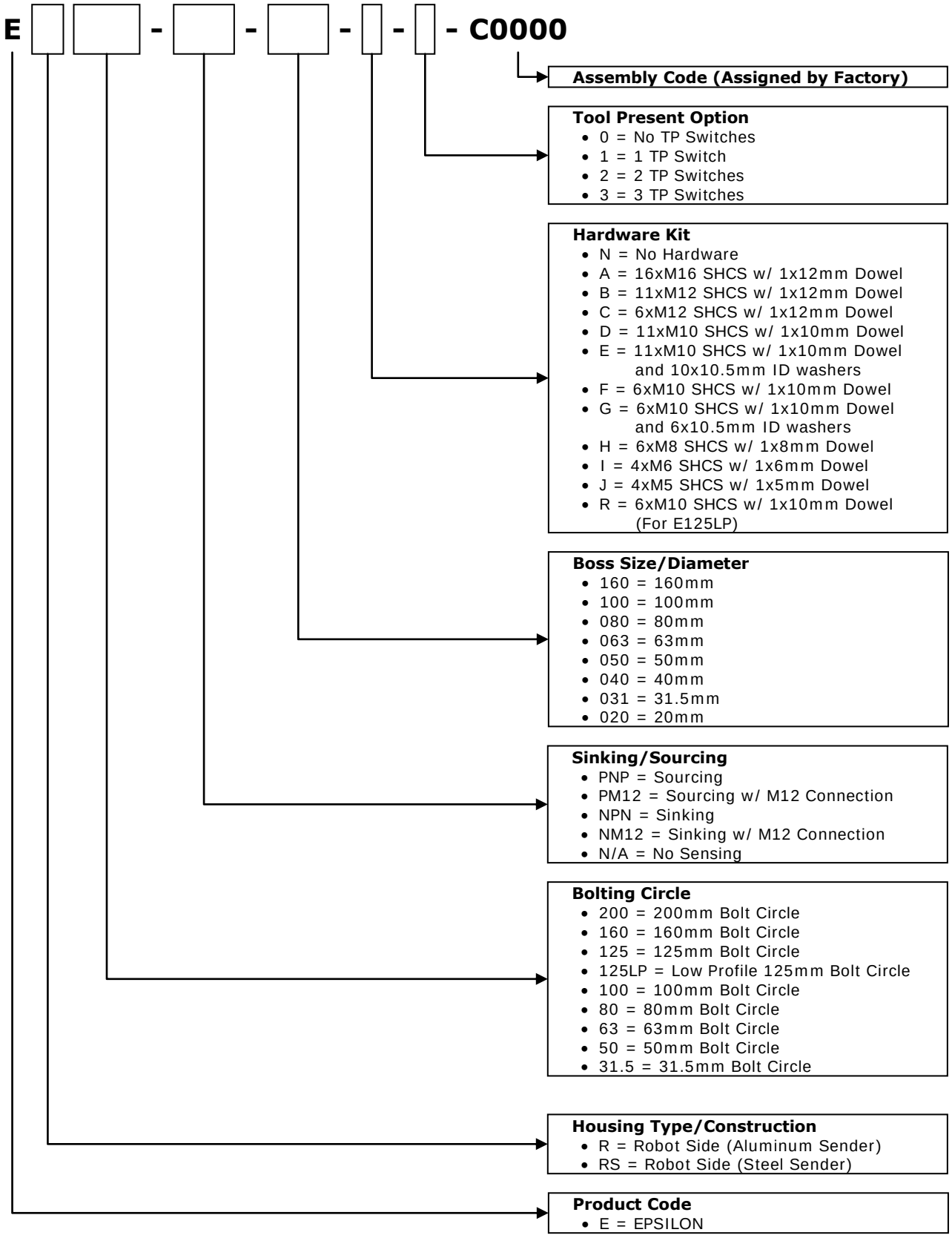
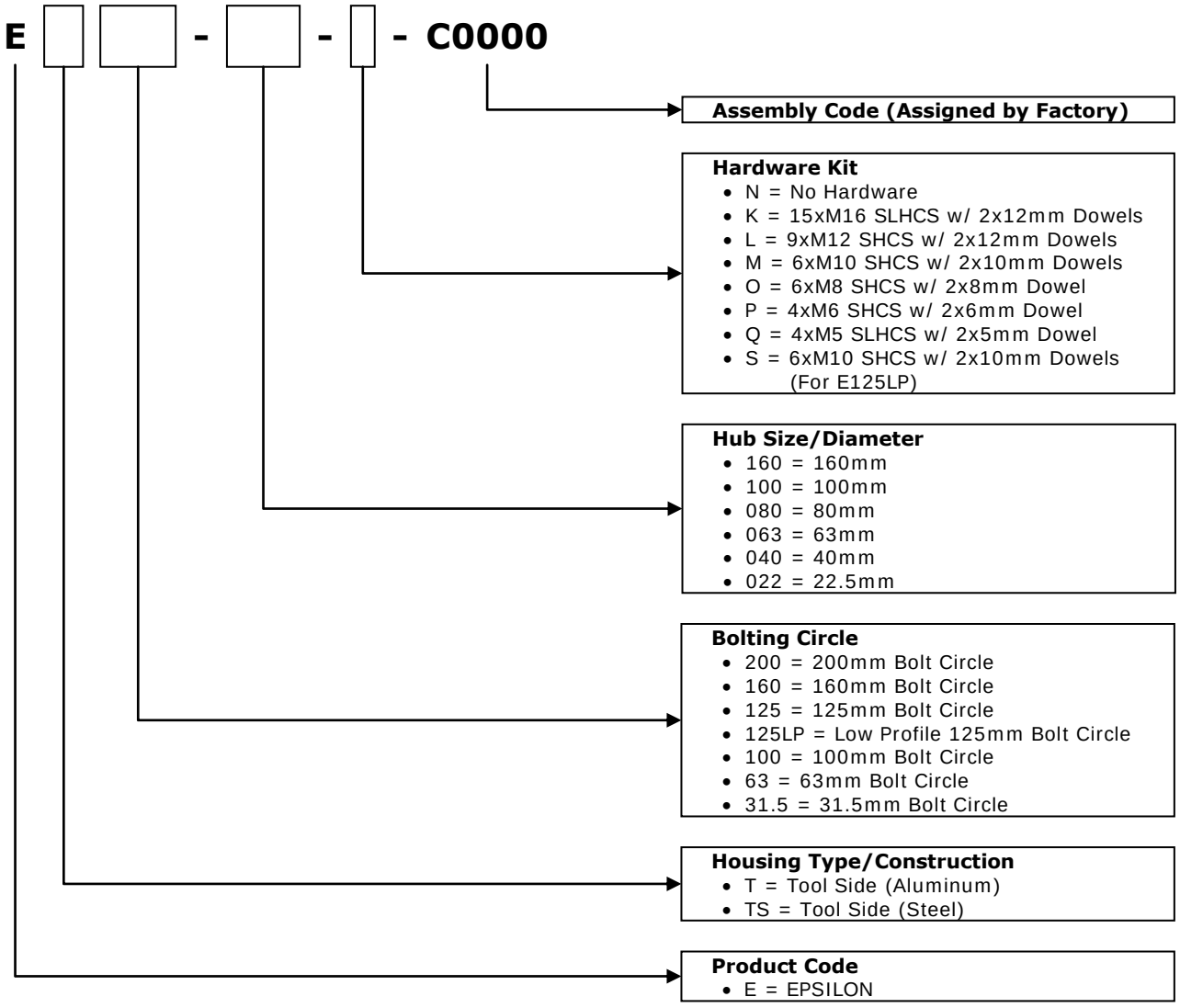


Figure 3-2. ET125LP Tool Adaptor

3.1 ROBOT ADAPTOR



3.2 TOOL ADAPTOR



4 TECHNICAL SPECIFICATIONS

Table 4-1. E125LP Technical Specifications

Specification		Metric	English
Payload		225 Kg	495 lb
Maximum Operating Moment (Mx, My)		1,737 Nm	15,370 in-lb
Maximum E-Stop Moment (Mx, My)		2,875 Nm	25,450 in-lb
Maximum Operating Torque (Mz)		2,020 Nm	17,875 in-lb
Maximum E-Stop Torque (Mz)		3,953 Nm	34,985 in-lb
Maximum Tensile Force (F_T)		15,750 N	3,540 lb
Maximum Compressive Force (F_C)		49,370 N	11,100 lb
Diameter		190 mm	7.48 in
Height (Robot and Tool Coupled)		94 mm	3.70 in
Mass / Weight	Robot	3.11 Kg	6.84 lb
	Tool	2.32 Kg	5.10 lb
Positional Repeatability X, Y & Z axis		+/- 0.02 mm	+/- 0.0008 in
Operating Temperature		5 - 60 °C	40 - 140 °F
Supply Pressure		5 – 7 bar	72 - 101 psi
Couple/Uncouple Voltage		10 – 30 Vdc	10 – 30 Vdc
User Pneumatic Pressure Range		0 – 7 bar	0 – 101 psi
User Pneumatic Flow (CFM)		**Contact Applications Engineering**	

5 INSTALLATION

5.1 ROBOT ADAPTOR INSTALLATION

The E125LP Robot Adaptor is designed to mount directly to interfaces utilizing an ISO 125mm bolt pattern (ISO 9409-1). The E125LP Robot Adaptor can mount to manipulator interfaces utilizing M10 hardware. For size, locations, and tolerance information on the E125LP Robot Adaptor mounting patterns, see APPLIED ROBOTICS drawing number 1600-D02A.

NOTICE

TOOL CHANGER PAYLOAD & MOMENT RATINGS BASED ON USING A MINIMUM OF 6xM10 SCREWS TO MOUNT THE ROBOT ADAPTOR TO THE MANIPULATOR INTERFACE.

Installing the E125LP Robot Adaptor Using M10 Hardware:

NOTICE

ENSURE THAT THE MATING SURFACES OF THE ROBOT ADAPTOR AND ROBOT FLANGE ARE FLUSH (PLANAR) WHEN FASTENING THE SCREWS.

1. Locate the Robot Adaptor to the manipulator mounting flange utilizing the locating boss and one (1) M10 locating dowel (Figure 5.1-1).
2. Insert and tighten the M10 socket head cap screws (minimum Property Class 10.9) provided with the Robot Adaptor Assembly. Torque the screws to the robot manufacturer's specification.

NOTICE

TIGHTEN FACEPLATE MOUNTING SCREWS TO ROBOT MANUFACTURER'S SPECIFICATIONS. IF USING LOCTITE, USE LOCTITE 242 OR EQUIVALENT.

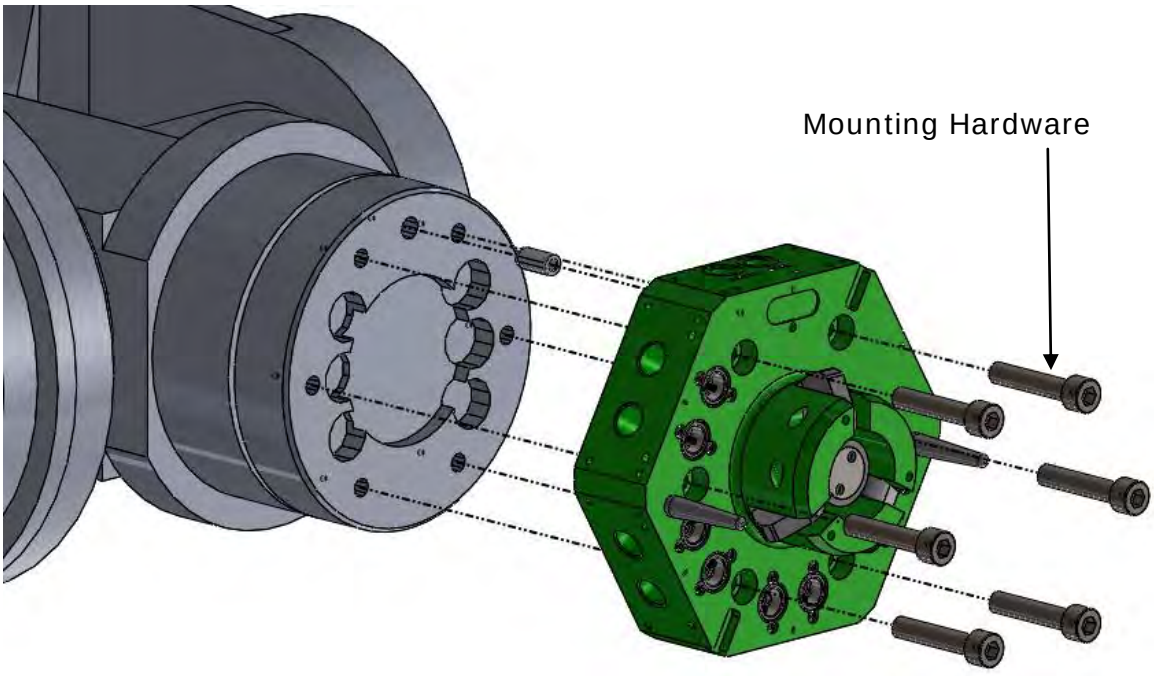


Figure 5.1-1. E125LP Robot Adaptor Installation w/ M10 Hardware

⚠ WARNING

DO NOT EXCEED THE MAXIMUM OPERATING OR E-STOP MOMENT OF THE TOOL CHANGER WHEN USING A ROBOT ADAPTOR PLATE TO ADAPT TO OTHER BOLTING PATTERNS.

5.2 TOOL ADAPTOR INSTALLATION

The E125LP Tool Adaptor is designed to mount directly to customer tooling utilizing an ISO 9409-1 bolt pattern. The Tool Adaptor can be mounted from the top down using M10 hardware on the ISO 125mm bolt circle. For size, locations, and tolerance information on the Tool Adaptor mounting patterns, see APPLIED ROBOTICS drawing number 1600-D09A.

NOTICE

TOOL CHANGER PAYLOAD & MOMENT RATINGS BASED ON USING 6xM10 SCREWS TO MOUNT THE TOOL ADAPTOR TO THE TOOLING INTERFACE.

Installing the ET125LP Tool Adaptor From the Top Down:

NOTICE

ENSURE THAT THE MATING SURFACES OF THE TOOL ADAPTOR AND TOOL PLATE ARE FLUSH (PLANAR) WHEN FASTENING THE SCREWS.

1. Locate the Tool Adaptor to the tool plate utilizing two (2) M10 locating dowels (Figure 5.2-1). Note that the ET125LP Tool Adaptor does not contain an option to use a locating hub for mounting to a tool plate.
2. Insert and tighten M10 socket head cap screws (minimum Property Class 10.9) through the Tool Adaptor 125mm bolt circle. Applied Robotics recommends the use of steel threads in the tool plate and appropriate thread engagement and torque values.

NOTICE

TIGHTEN MOUNTING SCREWS TO THE APPROPRIATE SPECIFICATION DEPENDING ON THE END EFFECTOR USED. IF USING LOCTITE, USE LOCTITE 242 OR EQUIVALENT.

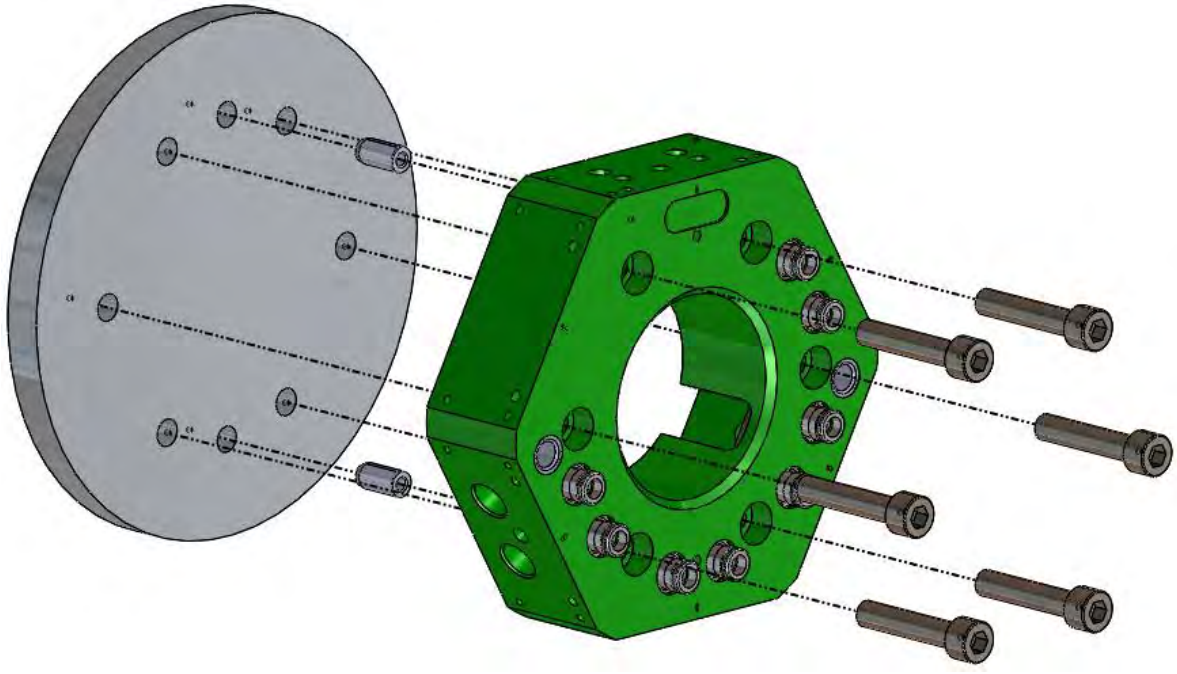


Figure 5.2-1. ET125LP Tool Adaptor Installation (Bolt Top Down)

5.3 CONNECTING THE AIR SUPPLY

The pneumatic supply for the Epsilon Tool Changer can be supplied via directly ported air fittings supplied by the customer (Figure 5.3-1).

⚠ WARNING

PNEUMATIC PRESSURE SHOULD NEVER BE SUPPLIED TO THE EPSILON TOOL CHANGE SYSTEM UNLESS THE POSITION OF THE VALVE SUPPLYING THE AIR IS KNOWN AND HAS BEEN CONFIRMED. FAILURE TO DO SO CAN RESULT IN SERIOUS INJURY OR DEATH FROM A DROPPED TOOL.

⚠ WARNING

THE ROBOT SHOULD NEVER BE RUN WITHOUT AIR PRESSURE BEING SUPPLIED TO THE TOOL CHANGER. PRESSURE TO THE TOOL CHANGER MUST BE AT LEAST 5 BAR (72 PSIG) FOR PROPER OPERATION.

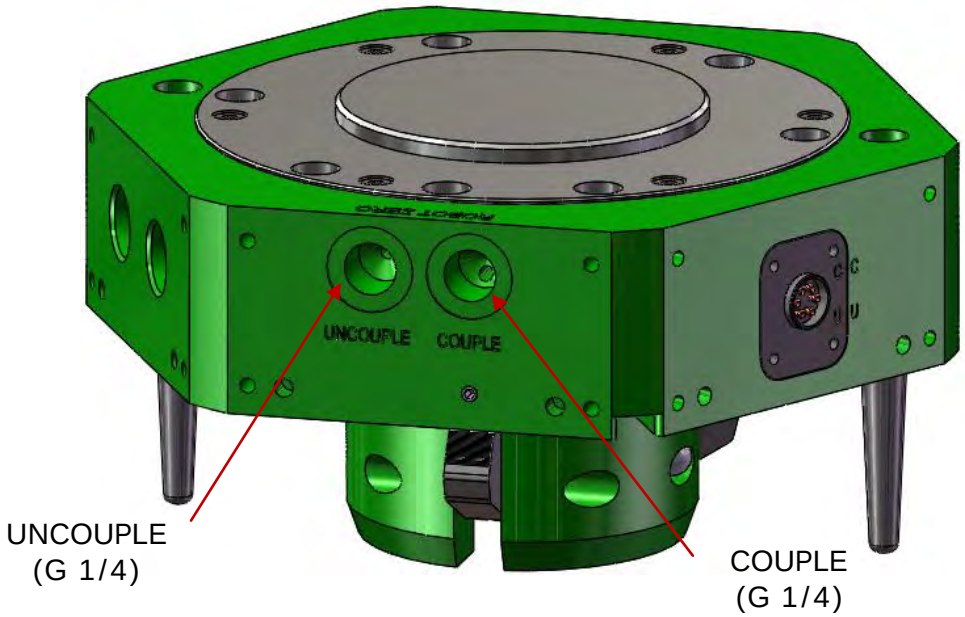


Figure 5.3-1. E125LP Robot Adaptor Air Supply Ports

Both the couple and uncouple actuation port lines must be installed in order for the Epsilon Tool Change System to function properly. To control air to the different ports, a single solenoid, spring-return, 4-way valve or a double solenoid, 4-way valve can be used.

⚠ WARNING

IF A SINGLE SOLENOID, SPRING-RETURN, 4-WAY PNEUMATIC VALVE IS USED, THE FOLLOWING MUST BE UNDERSTOOD AND ADHERED TO:

- IN THE DE-ENERGIZED STATE, THE VALVE MUST PROVIDE AIR TO THE COUPLE PORT ONLY.

⚠ WARNING

IF A DOUBLE SOLENOID, 4-WAY PNEUMATIC VALVE IS USED, THE FOLLOWING MUST BE UNDERSTOOD AND ADHERED TO:

- THE VALVE WILL REMAIN IN ITS PRESENT POSITION UNTIL EITHER THE ALTERNATE SOLENOID IS ENERGIZED OR BY MANUALLY PRESSING THE ALTERNATE SOLENOID OVERRIDE BUTTON (IF APPLICABLE).
- TO CHANGE THE STATE OF THE VALVE, ONE SIDE OF THE SOLENOID MUST BE ENERGIZED AND THE OTHER SIDE DE-ENERGIZED. IF BOTH SIDES ARE ENERGIZED (OR DE-ENERGIZED), THE VALVE WILL NOT CHANGE STATES.
- THE VALVE MUST BE PILOT ACTUATED SO THAT THE POSITION OF THE VALVE WILL NOT CHANGE UNLESS THERE IS AIR SUPPLIED TO THE VALVE.

5.4 COUPLE AND UNCOUPLE SIGNALS

Couple and uncouple signals are provided via an electrical interface at Position 2 of the E125LP Robot Adaptor (Figure 5.4-1). APPLIED ROBOTICS utilizes proximity switches to provide indication of piston limit positions (couple and uncouple). Switches are preset at the factory and do not require any adjustment for the lifetime of the tool changer.

⚠ CAUTION

COUPLE AND UNCOUPLE SENSOR SIGNALS SHOULD BE CONTINUALLY MONITORED TO VERIFY THAT THE TOOL CHANGER IS IN THE PROPER STATE BEFORE COMMANDING THE ROBOT TO MOVE.

Should the switches need to be replaced, see Section 10.1.2.

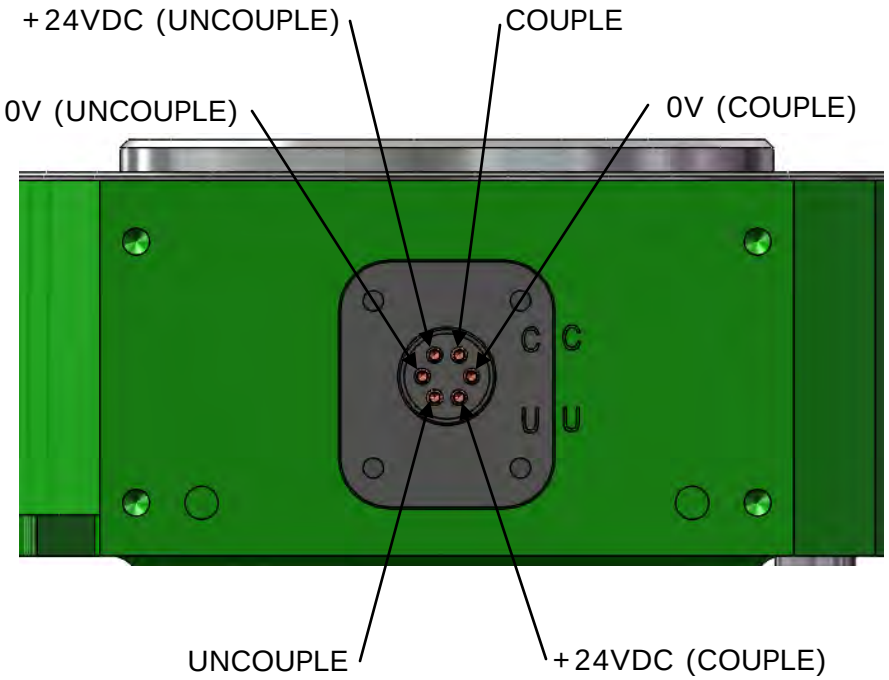


Figure 5.4-1. Couple/Uncouple Signal Interface

NOTICE

MAKING CONNECTIONS WHILE UNDER POWER COULD RESULT IN DAMAGE TO THE EQUIPMENT. TO AVOID DAMAGING EQUIPMENT, ENSURE THAT ALL CABLES ARE CONNECTED BEFORE SUPPLYING POWER TO THE EQUIPMENT.

5.5 TOOL PRESENT SIGNAL (OPTIONAL)

The E125LP Tool Changer contains a built in feature for Tool Present detection via a proximity sensor(s) (Figure 5.5-1). This option provides direct detection of the Tool Adaptor and the signal can be directly monitored by the robot controller.

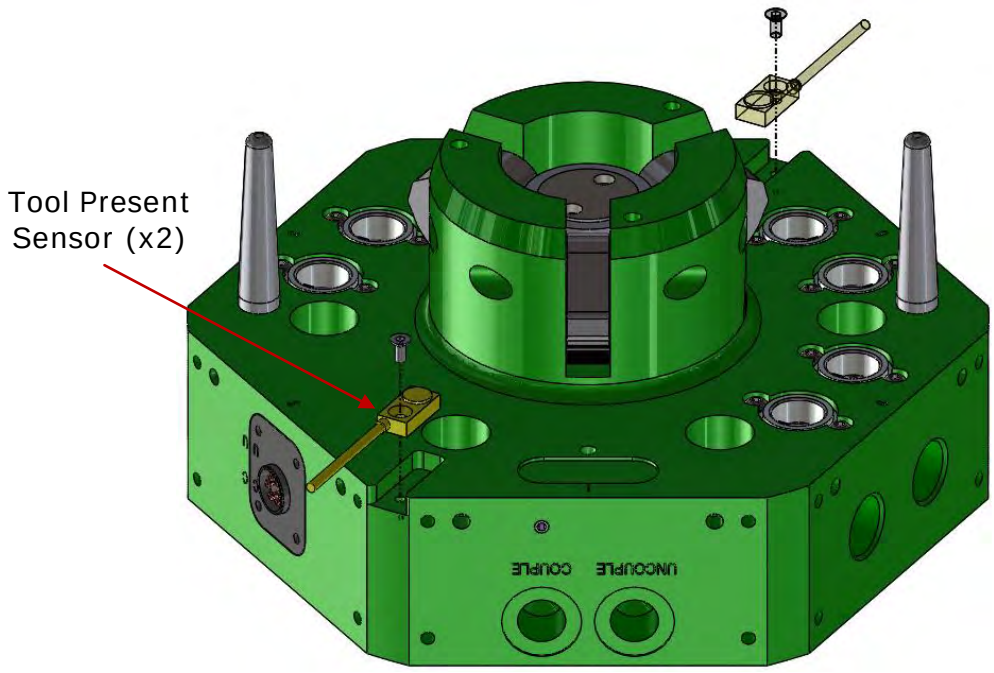


Figure 5.5-1. Tool Present Option

When the Tool Present sensors are installed, ensure that the tip of the sensor (highlighted blue) does not protrude past the Robot Adaptor interface (Figure 5.5-2).

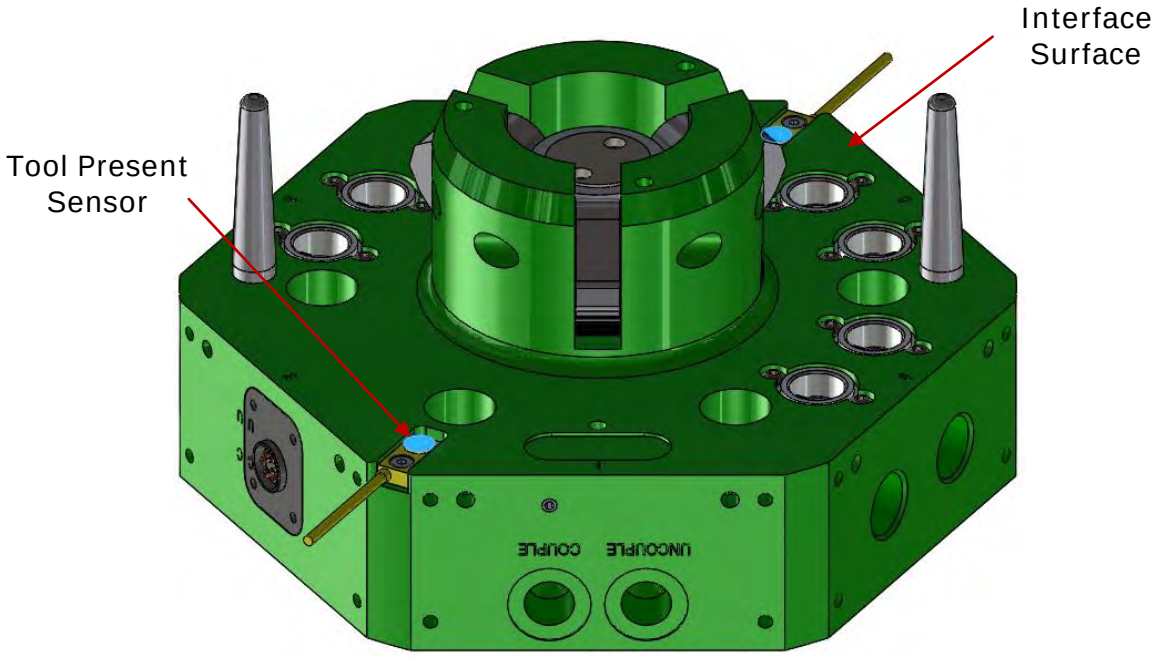


Figure 5.5-2. Tool Present Sensor Installation

5.6 CONNECTING USER PNEUMATIC PORTS

The E125LP Tool Changer has eight (8) available user pneumatic ports to supply air through the tool changer to the specific tool being used. The robot side ports can be checked if a poppet valve is installed. For the ports to be operational, the tool changer must be coupled and be fitted with a valve fitting assembly (0002-B04A). Air can be supplied via directly ported air fittings supplied by the customer (Figure 5.6-1).

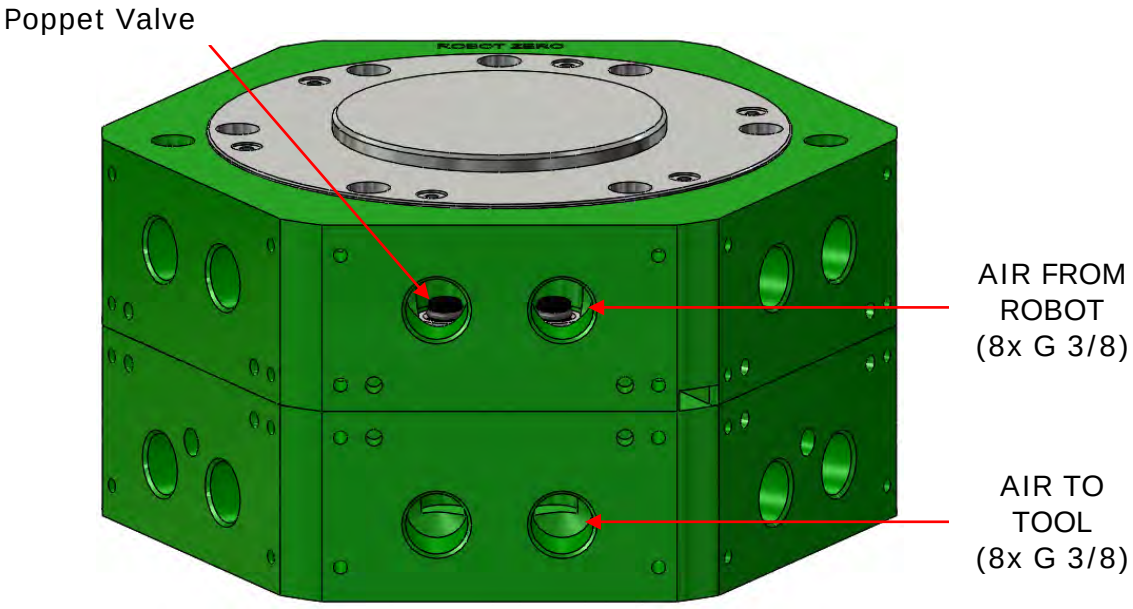


Figure 5.6-1. E125LP User Pneumatic Ports

6 GUIDE TO OPERATION

6.1 INITIAL TEST

Once the air supply has been plumbed to the couple and uncouple ports, control power is connected to the air supply valve, and the couple and uncouple position sensors are in communication with the robot controller/PLC, perform the following steps to verify the proper operation of the Epsilon Tool Changer.

⚠ CAUTION

DURING TESTING, KEEP YOUR FINGERS CLEAR OF THE MECHANICAL COUPLING MECHANISM AND THE COUPLING INTERFACE SURFACES. KEEP OUT OF THE ROBOT WORK ENVELOPE WHEN DRIVE POWER IS ON.

1. Verify that the Robot Adaptor is clear of any obstruction and not coupled to the Tool Adaptor.
2. Turn on supply air to the control valve and verify that the cams move to the extended position (Figure 6.1-1). If using a single solenoid, spring return, 4-way valve, this will verify that it is plumbed correctly.
3. Supply control power to the solenoid valve and supply the signal from the controller/PLC to move the valve to the uncoupled (solenoid energized) position. The cams should retract to the uncoupled position (Figure 6.1-2) and the input from the uncoupled sensor should be received by the robot controller/PLC.
4. Change the state of the solenoid valve by turning off the uncouple signal (solenoid de-energized). The cams should extend back to the couple position and the uncouple sensor signal should turn OFF (LOW) and the couple sensor signal should turn ON (HIGH) at the robot controller/PLC.
5. Repeat steps 3 and 4 several times. The cam action should be smooth and quick.

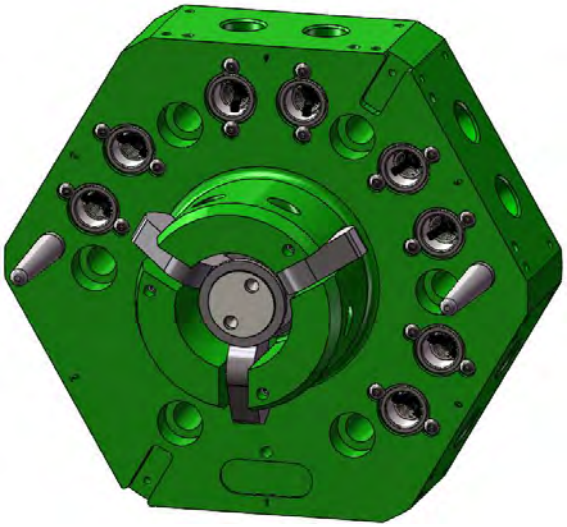


Figure 6.1-1. Robot Adaptor Coupled (Cams Extended)

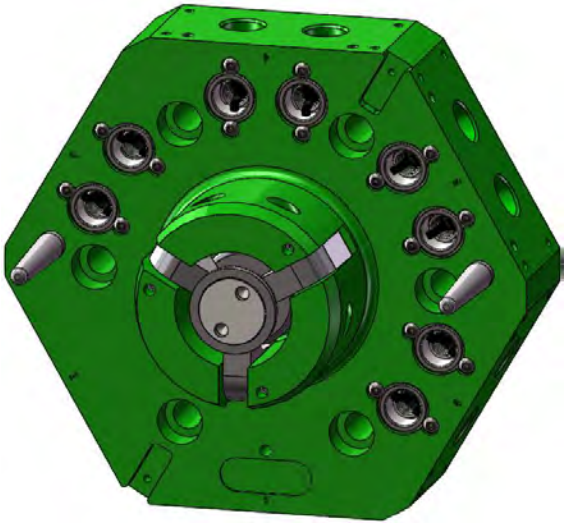


Figure 6.1-2. Robot Adaptor Uncoupled (Cams Retracted)

6.2 PROGRAMMING THE COUPLE AND UNCOUPLE POINTS

⚠ WARNING

THE ROBOT SHOULD NEVER BE RUN WITHOUT A MINIMUM AIR PRESSURE OF 5 BAR (72 PSIG) BEING SUPPLIED TO THE ROBOT ADAPTOR.

When programming the "dock" and "undock" points of each tooling, the following steps should be taken:

1. Orient the Robot Adaptor and Tool Adaptor so that the centerline axes are aligned and the interface surfaces are parallel. Maintain approximately 60mm minimum separation between the Robot Adaptor and Tool Adaptor interface surfaces (Figure 6.2-1).

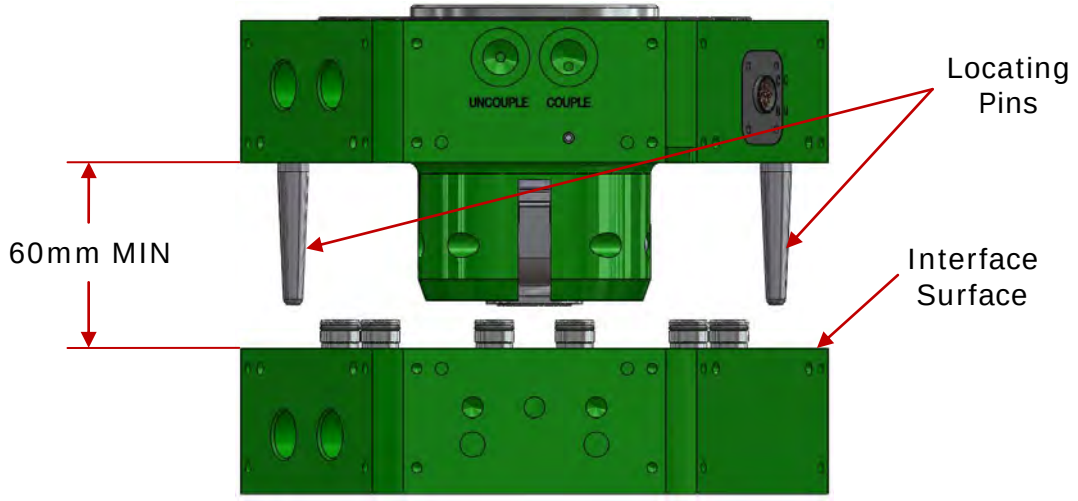


Figure 6.2-1. E125LP Tool Changer – Docking Orientation

2. Energize the solenoid, resulting in an uncoupled (cams retracted) state.
3. Rotate the Robot Adaptor so that the locating pins are centered on the bushings in the Tool Adaptor.
4. Start to bring the Robot and Tool Adaptors together while visually checking the alignment of the locating pins and bushings. Make lateral adjustments as necessary to center the locating pins to the bushings. Exact alignment is not required; however limit the amount of interference between the locating pins and bushings while docking. Interference between the locating pins and bushings while docking increases wear and decreases the life of the locating pins.
5. Stop the motion when the distance between the Robot Adaptor interface surface and Tool Adaptor interface surface are touching or as close as can reasonably be achieved. At this time, any electrical or fluid connections will be made through the use of available side modules. Note that when the interface surfaces of the Robot Adaptor and Tool Adaptor are in contact, the outer edge of the Adaptors should be touching (Figure 6.2-2).

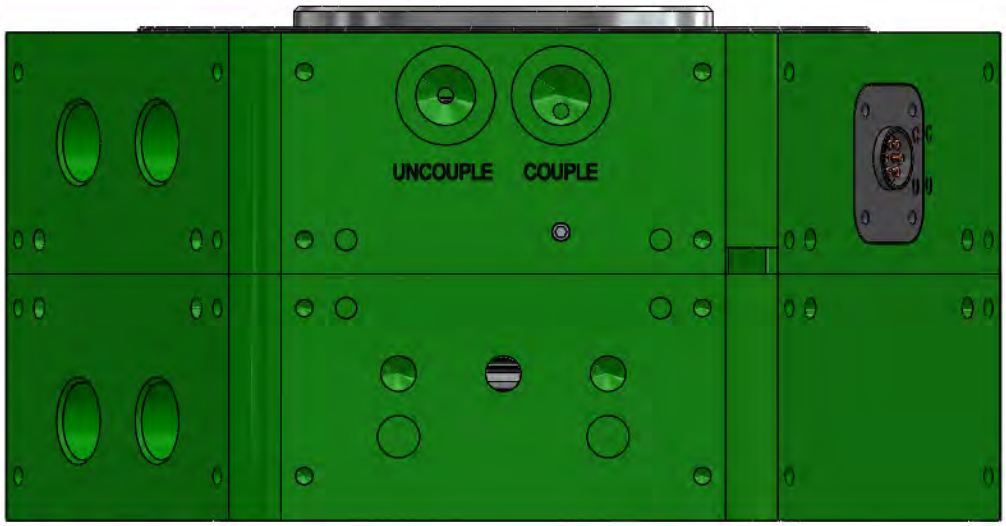


Figure 6.2-2. E125LP Tool Changer – Docked Position

NOTICE

MINIMIZING THE DISTANCE BETWEEN THE ROBOT ADAPTOR AND TOOL ADAPTOR INTERFACE SURFACES WHEN PROGRAMMING THE DOCK AND UNDOCK POINTS WILL ENSURE OPTIMUM PERFORMANCE OF THE TOOL CHANGER OVER ITS OPERATIONAL LIFE SPAN.

SEPARATION BETWEEN THE ROBOT ADAPTOR AND TOOL ADAPTOR INTERFACE SURFACES, GREATER THAN 1mm DURING DOCKING OR UNDOCKING WILL RESULT IN ADDITIONAL WEAR TO THE TOOL CHANGER AND REDUCE THE OVERALL LIFE EXPECTANCY.

6. De-energize the solenoid that controls the air pressure to the couple port. This will couple the Robot Adaptor with the Tool Adaptor.
7. Cycle the cams by energizing and de-energizing the solenoid several times to verify that the Tool Adaptor is properly connected and released from the Robot Adaptor. If properly programmed, the Robot Adaptor and Tool Adaptor should not move when the cams are coupled (extended) and uncoupled (retracted).
8. Record the position from Step 5 as the "dock" and "undock" coordinates for the Tool Adaptor. Depending on the docking station used, separate dock and undock positions may be required.
9. Repeat procedure for each Tool Adaptor used in conjunction with the corresponding Robot Adaptor.

6.3 TOOL DROP PREVENTION

Preventing accidental uncoupling of the Tool Changer is of utmost importance when setting up your Epsilon Tool Changer for operation. Various system options are available to ensure that the Tool Changer cams can only be moved into the Uncouple position when it is safe to do so (i.e., when the Tool Adaptor is not coupled to the Robot Adaptor OR when the tool is safely positioned in a docking station).

Unintentional tool drops can be prevented by using a programmable safety controller or an APPLIED ROBOTICS Tool Stand Monitoring (TSM) circuit. For further information, consult the manual for your particular system or contact APPLIED ROBOTICS Applications Engineering.

6.3.1 Mechanical Lock Design Feature

The E125LP Tool Changer is equipped with a mechanical locking feature (Figure 6.3.1-1) that prevents the cams from retracting when supply air pressure is lost. The mechanical locking feature is a "flat" cut into the profile of the cam and when air pressure is lost, the Tool Adaptor will separate from the Robot Adaptor slightly (~0.75mm) until the pickup dowel on the Tool Adaptor locks into this

feature (Figure 6.3.1-2). When the pickup dowel is locked into this feature, the Tool Changer is unable to separate. The spring in the E125LP Robot Adaptor piston chamber returns the cams to the extended position (coupled) when air supply to the Tool Changer is lost.

The E125LP cam also contains a unique wear compensating profile with a progressive design, allowing for the mechanism to remain effective for the life of the Tool Changer.

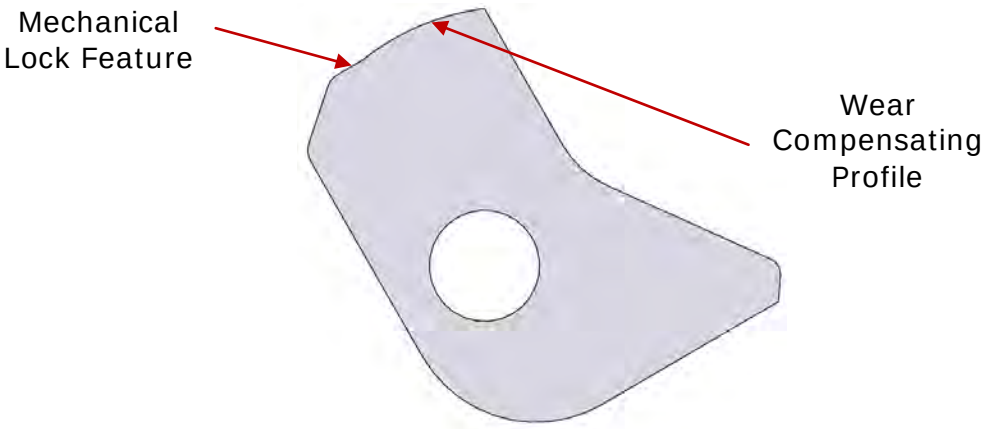


Figure 6.3.1-1. E125LP Cam Mechanical Lock Feature

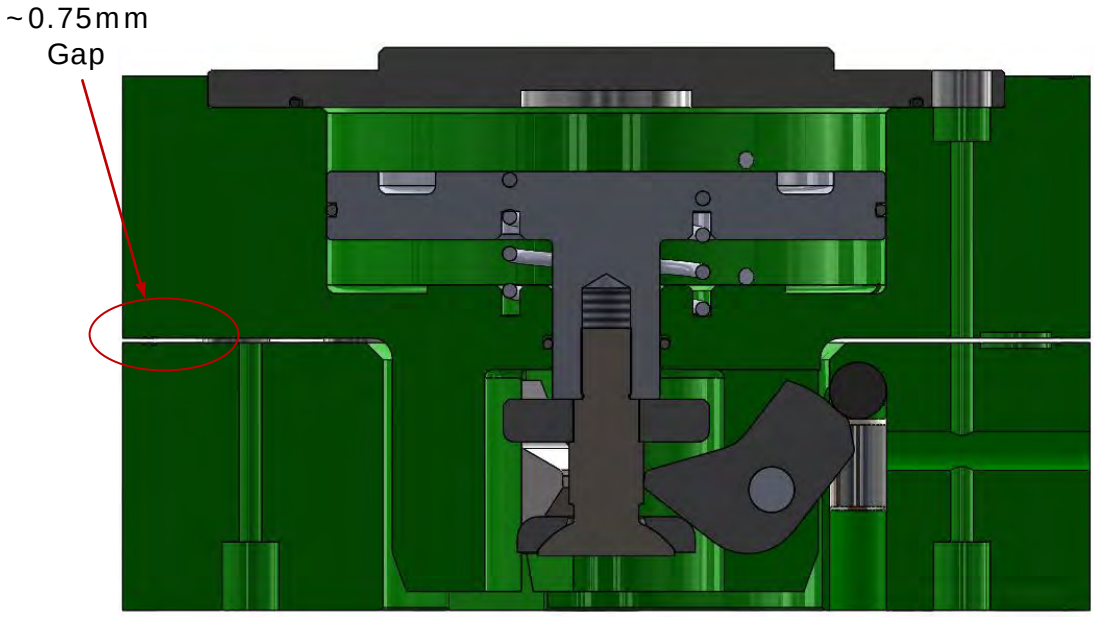


Figure 6.3.1-2. E125LP Robot & Tool Adaptor – Loss of Air Mechanical Lock

6.4 RECOMMENDED SEQUENCE OF OPERATION

NOTICE

THE EPSILON TOOL CHANGER SYSTEM SHOULD NEVER BE UNCOUPLED UNLESS THE ATTACHED TOOL IS FULLY SUPPORTED IN A DOCKING STATION/TOOL STAND.

The following is a standard sequence of operation for a Robot, Tool Changer, and Tool combination. See Figure 6.4-1 for a graphical representation of this sequence. Note that the **BOLD** indicates a change in status and not all signals may be applicable to your application.

1. The Tool Changer is in the uncoupled state (cams retracted) and in the "Home" position (Tool Changer out of the tool stand with NO tool, all tool stand covers are closed, and air supply is ON).

   INPUTS:
   - Uncouple Signal ..... HIGH
   - Couple Signal..... LOW
   - Ready to Couple Signal ..... LOW
   - Tool Present Signal..... LOW
   - Tool Stand Present Signal..... LOW
   - Tool Cover Open Signal..... LOW
   - Tool Cover Closed Signal ..... HIGH

   OUTPUTS:
   - Uncouple Command..... HIGH
   - Tool Cover Open Command ..... LOW
   - Tool Cover Close Command ..... HIGH

2. Open tool stand cover.

   INPUTS:
   - Uncouple Signal ..... HIGH
   - Couple Signal..... LOW
   - Ready to Couple Signal ..... LOW
   - Tool Present Signal..... LOW
   - Tool Stand Present Signal..... LOW
   - Tool Cover Open Signal..... **HIGH**
   - Tool Cover Closed Signal ..... **LOW**

   OUTPUTS:
   - Uncouple Command..... HIGH
   - Tool Cover Open Command ..... **HIGH**
   - Tool Cover Close Command ..... **LOW**

3. Move to "Pre-Dock" position (Approximately 60mm above the Tool Adaptor).

INPUTS:

Uncouple Signal ..... HIGH
Couple Signal..... LOW
Ready to Couple Signal ..... LOW
Tool Present Signal..... LOW
Tool Stand Present Signal..... LOW
Tool Cover Open Signal..... HIGH
Tool Cover Closed Signal ..... LOW

OUTPUTS:

Uncouple Command..... HIGH
Tool Cover Open Command ..... HIGH
Tool Cover Close Command ..... LOW

4. Move to the "Dock" position (See Section 6.2). Once Robot and Tool Adaptors are within range (~2.5mm or closer), the electrical contacts on the side modules will begin to communicate.

INPUTS:

Uncouple Signal ..... HIGH
Couple Signal..... LOW
Ready to Couple Signal ..... **HIGH**
Tool Present Signal..... **HIGH**
Tool Stand Present Signal..... **HIGH**
Tool Cover Open Signal..... HIGH
Tool Cover Closed Signal ..... LOW

OUTPUTS:

Uncouple Command..... HIGH
Tool Cover Open Command ..... HIGH
Tool Cover Close Command ..... LOW

5. Once in the "Dock" position, Couple to the tool.

INPUTS:

Uncouple Signal ..... **LOW**
Couple Signal..... **HIGH**
Ready to Couple Signal ..... HIGH
Tool Present Signal..... HIGH
Tool Stand Present Signal..... HIGH
Tool Cover Open Signal..... HIGH
Tool Cover Closed Signal ..... LOW

OUTPUTS:

Uncouple Command..... **LOW**
Tool Cover Open Command ..... HIGH
Tool Cover Close Command ..... LOW

6. Move to the "Post-Dock" position. Ensure the pins and bushings on the docking fixture are clear from one another before leaving the docking station.

INPUTS:

Uncouple Signal ..... LOW
Couple Signal..... HIGH
Ready to Couple Signal ..... HIGH
Tool Present Signal..... HIGH
Tool Stand Present Signal..... **LOW**
Tool Cover Open Signal..... HIGH
Tool Cover Closed Signal ..... LOW

OUTPUTS:

Uncouple Command..... LOW
Tool Cover Open Command ..... HIGH
Tool Cover Close Command ..... LOW

7. The Robot performs the specified task with the connected tool. Depending on the cell layout and operation being performed, the Tool Cover may need to be closed to avoid interference.

INPUTS:

Uncouple Signal ..... LOW
Couple Signal..... HIGH
Ready to Couple Signal ..... HIGH
Tool Present Signal..... HIGH
Tool Stand Present Signal..... LOW
Tool Cover Open Signal..... HIGH
Tool Cover Closed Signal ..... LOW

OUTPUTS:

Uncouple Command..... LOW
Tool Cover Open Command ..... HIGH
Tool Cover Close Command ..... LOW

8. Return to the "Post-Dock" position (alternatively could identify a "Pre-Undock" position) after completing the task.

INPUTS:

Uncouple Signal ..... LOW
Couple Signal..... HIGH
Ready to Couple Signal ..... HIGH
Tool Present Signal..... HIGH
Tool Stand Present Signal..... LOW
Tool Cover Open Signal..... HIGH
Tool Cover Closed Signal ..... LOW

OUTPUTS:

Uncouple Command..... LOW
Tool Cover Open Command ..... HIGH
Tool Cover Close Command ..... LOW

9. Move to the "Dock" position (alternatively, could identify an "Undock" position) with the tool.

INPUTS:
Uncouple Signal ..... LOW
Couple Signal..... HIGH
Ready to Couple Signal ..... HIGH
Tool Present Signal..... HIGH
Tool Stand Present Signal..... **HIGH**
Tool Cover Open Signal..... HIGH
Tool Cover Closed Signal ..... LOW

OUTPUTS:
Uncouple Command..... LOW
Tool Cover Open Command ..... HIGH
Tool Cover Close Command ..... LOW

10. Once in the "Dock"/"Undock" position and the weight is fully supported by the docking station, Uncouple the Tool Changer.

INPUTS:
Uncouple Signal ..... **HIGH**
Couple Signal..... **LOW**
Ready to Couple Signal ..... HIGH
Tool Present Signal..... HIGH
Tool Stand Present Signal..... HIGH
Tool Cover Open Signal..... HIGH
Tool Cover Closed Signal ..... LOW

OUTPUTS:
Uncouple Command..... **HIGH**
Tool Cover Open Command ..... HIGH
Tool Cover Close Command ..... LOW

11. Move to the "Pre-Dock" (alternatively, could identify a "Post-Undock" position). Once Robot and Tool Adaptors are separated by approximately 2.5mm, the electrical contacts on the side modules will lose contact and the robot side modules will lose communication with the tool side modules.

INPUTS:
Uncouple Signal ..... HIGH
Couple Signal..... LOW
Ready to Couple Signal ..... **LOW**

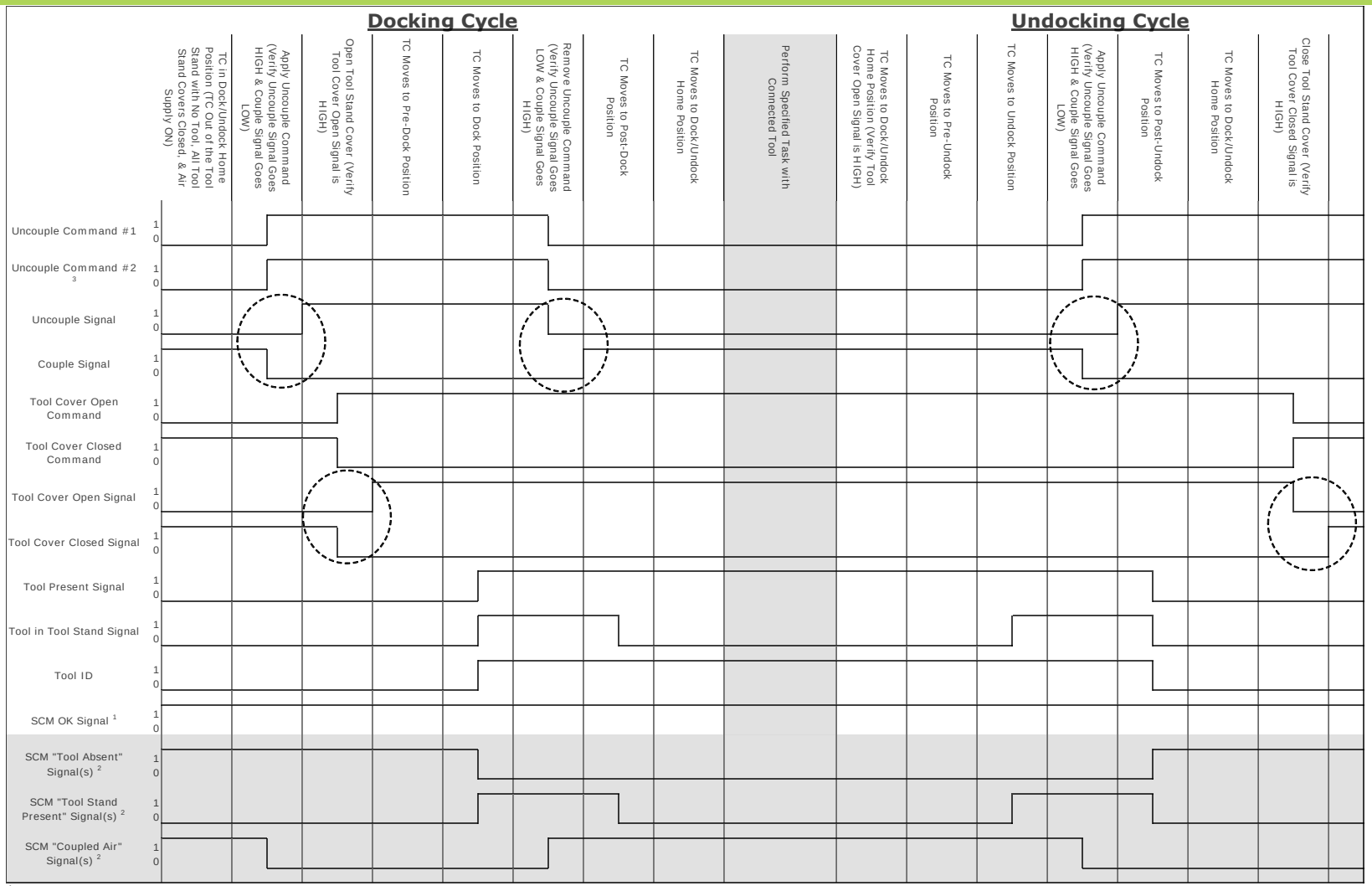
Tool Present Signal..... **LOW**
Tool Stand Present Signal..... **LOW**
Tool Cover Open Signal..... HIGH
Tool Cover Closed Signal..... LOW

OUTPUTS:
Uncouple Command..... HIGH
Tool Cover Open Command ..... HIGH
Tool Cover Close Command ..... LOW

12. Move back to the "Home" position and close the tool stand cover.

INPUTS:
Uncouple Signal ..... HIGH
Couple Signal..... LOW
Ready to Couple Signal ..... LOW
Tool Present Signal..... LOW
Tool Stand Present Signal..... LOW
Tool Cover Open Signal..... **LOW**
Tool Cover Closed Signal ..... **HIGH**

OUTPUTS:
Uncouple Command..... HIGH
Tool Cover Open Command ..... **LOW**
Tool Cover Close Command ..... **HIGH**



1 Customer is required to continuously monitor the SCM OK signal, verifying that the signal remains HIGH throughout the entire operation. If SCM OK signal goes LOW, stop the robot, remove the Uncouple Commands and refer to the Troubleshooting sectio
2 Signals (dual channel) are only available via LED's on ARI's Safety Control Module (SCM). Not available for monitoring by the robot controller.
3 Second Uncouple Command is required when using ARI's Safety Control Module (SCM) and should be applied simultaneously with the first Uncouple Command.
- Verify the status of all signals before proceeding to the next step.
- Input/Output HIGH = 1, LOW = 0
- Dotted circles indicate a intermediate state of an actuating cyclinder when neither "Open" or "Close" signal is present.

Figure 6.4-1. Sequence of Operations Diagram

7 TROUBLESHOOTING

7.1 TECHNICAL SUPPORT

If you require assistance, contact APPLIED ROBOTICS Technical Support Department at:

Phone: +1 518 384-1000
E-mail: techsupport@appliedrobotics.com.

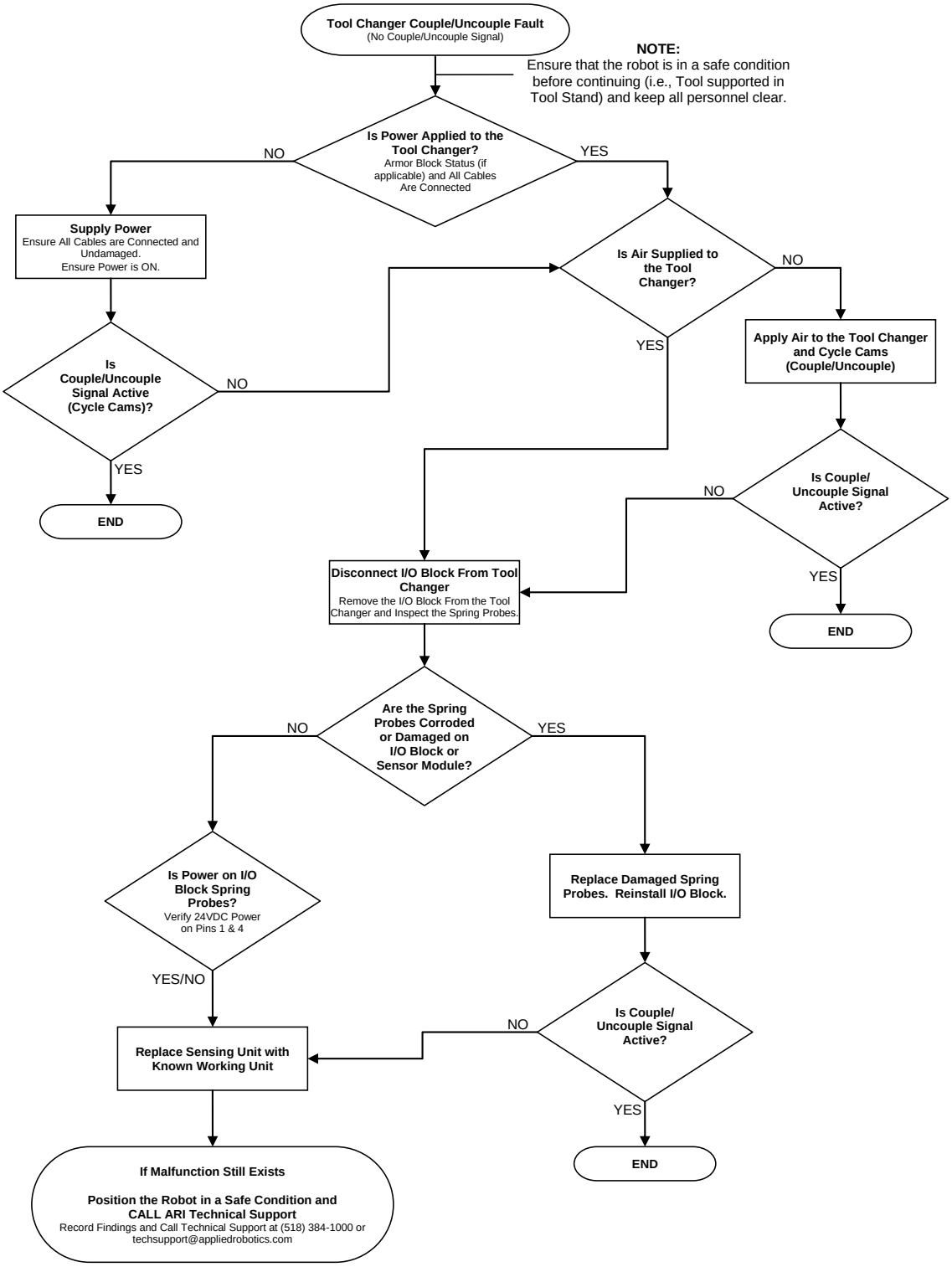
7.2 TROUBLESHOOTING GUIDE

Table 7.2-1. Troubleshooting Guide

Symptom	Possible Cause	Resolution
Tool Changer Will Not Couple	Tool Changer not within required distance for coupling (<1mm)	Adjust Robot program to move within the required distance (<1mm)
	Electrical connection to the actuation valve has been lost (only if using double-acting solenoid)	Verify all connections are in place and that valve is not damaged and operating correctly
Tool Changer Will Not Uncouple	Air supply to the Tool Changer has been lost	Verify all air connections are in place and air is being supplied to the Robot cell
	Electrical connection to the actuation valve has been lost	Verify all connections are in place and that valve is not damaged and operating correctly
	Tool is not in Tool Stand	Verify the tool is supported in the tool stand and that the Tool Stand Present signal is activated
	Spring Failure	Replace piston spring
Tool Changer Couples, But No Coupled Signal is Being Received	Coupled sensing has failed	Replace sensor puck (See Section 10.1.2)
	Cable/Connections supplying signal failed	Inspect cables/connections and replace if necessary
Tool Changer Uncouples, But No Uncoupled Signal is Being Received	Uncoupled sensing has failed	Replace sensor puck (See Section 10.1.2)
	Cable/Connections supplying signal failed	Inspect cables/connections and replace if necessary

7.3 TROUBLESHOOTING FAULT TREE

The fault tree provides guidance for troubleshooting a Tool Changer Couple/Uncouple signal fault.



7.4 MANUAL UNCOUPLE

A feature has been designed into the E125LP Tool Changer that allows the system to be manually uncoupled in the event that damage occurs that prevents the system from uncoupling under normal means.

⚠ WARNING

ENSURE THAT THE ATTACHED TOOLING IS SAFELY SUPPORTED, PREFERABLY IN ITS TOOL STAND.

The following steps must be followed to ensure that the E125LP Tool Changer is manually uncoupled in a safe manner:

1. Ensure that the attached tooling is safely supported, preferably in its tool stand, so that no damage or personal injury occurs when the tool is released.
2. Ensure that all unnecessary personnel are clear of the tooling before going further in this procedure.
3. Shut off the air supply to the actuating cylinder. The cylinder must not be pressurized for this operation to be performed successfully.
4. Insert a 6mm OD x 20mm long shaft followed by a M8x40mm long socket head cap screw in the hole as shown in Figure 7.4-1. This requires any tool side modules to be removed.
5. Drive the M8 screw in until the cams are fully retracted. This action will allow the tool changer to uncouple.

NOTICE

WHEN AIR SUPPLY IS OFF, THE COUPLE/UNCOUPLE SIGNALS WILL BE LOST DUE TO THE LACK OF AIR. ONLY MOVE THE ROBOT AFTER THE CAMS HAVE BEEN FULLY RETRACTED.

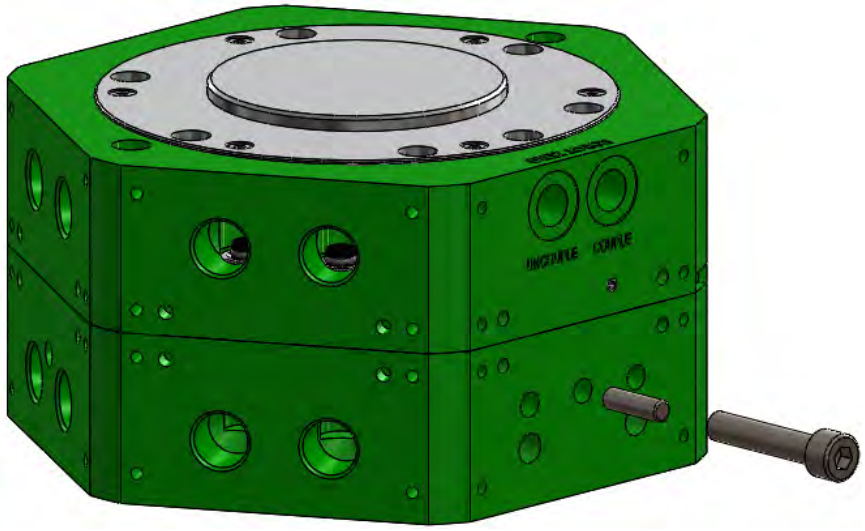


Figure 7.4-1. Manual Uncouple Feature

8 MAINTENANCE

NOTICE

FAILURE TO FOLLOW THE MAINTENANCE SCHEDULE DESCRIBED IN THIS SECTION COULD ALTER OR VOID THE WARRANTY PROVIDED BY APPLIED ROBOTICS, INC.

The following table provides a schedule for preventive maintenance to be performed for the Epsilon Tool Changer.

Table 8-1. Preventive Maintenance Schedule

	Frequency of Maintenance				
	Every 2 Weeks	250,000 Cycles	500,000 Cycles	750,000 Cycles	1,000,000 Cycles
Robot Adaptor	Visual Checks (Section 7.1.2.1)	Lubrication (Section 7.1.1.1) & Visual Checks (Section 7.1.2.1)			Lubrication (Section 7.1.1.1) & Visual Checks (Section 7.1.2.1) & Replace Locating Pins if Worn or Damaged & Inspect Piston Spring Functionality and Replace if Necessary[1]
Tool Adaptor	Visual Checks (Section 7.1.2.2)	Lubrication (Section 7.1.1.2) & Visual Checks (Section 7.1.2.2)			Lubrication (Section 7.1.1.2) & Visual Checks (Section 7.1.2.2) & Replace Locating Bushings if Worn or Damaged

	Frequency of Maintenance				
	Every 2 Weeks	1,250,000 Cycles	1,500,000 Cycles	1,750,000 Cycles	2,000,000 Cycles[2]
Robot Adaptor	Visual Checks (Section 7.1.2.1)	Lubrication (Section 7.1.1.1) & Visual Checks (Section 7.1.2.1)			Lubrication (Section 7.1.1.1) & Visual Checks (Section 7.1.2.1) & Inspect the Following Parts for Wear or Damage and Replace if Necessary; Locating Pins, Piston Head, Piston O-Ring, Cam Shaft, Cams. & Inspect Piston Spring Functionality and Replace if Necessary
Tool Adaptor	Visual Checks (Section 7.1.2.2)	Lubrication (Section 7.1.1.2) & Visual Checks (Section 7.1.2.2)			Lubrication (Section 7.1.1.2) & Visual Checks (Section 7.1.2.2) & Replace Cam Pickup Dowels if Worn or Damaged & Replace Locating Bushings if Worn or Damaged

[1] To test Piston Spring functionality, retract the cams (Figure 6.1-2) using air pressure, then completely vent off all air and ensure that the cams return to the extended position (Figure 6.1-1).
[2] Continue Lubrication and Visual Checks every 250,000 Cycles. Continue inspecting for wear or damaged components every 500,000 cycles.

8.1 PREVENTIVE MAINTENANCE

8.1.1 Lubrication

Proper lubrication of wear components is essential to maintaining the performance and prolonging the operational life of the E125LP Tool Changer. Failure to apply proper lubrication could result in increased wear and shorten the life expectancy of the Tool Changer. The following lubricants are approved for use on the E125LP Tool Changer.

Table 8.1.1-1. Approved Lubricants

Lubricant	ARI Part #	Manufacturer	Manufacturer's Part #
Lube-A-Cyl	51120	Parker	0766130000
White Lithium Grease	91504-P1037	Century Lubricants	ST-80
Staburags NBU 30 Grease	0903-P11N	Klüber	NBU 30
White EP Bearing Grease	96503-P1018	Dow Corning	White EP Bearing Grease

8.1.1.1 Robot Adaptor

1. Clean the latching cams, locating/alignment pins, and driver/washer to ensure all existing grease, dirt, and debris is removed.
2. Apply a liberal coating of white lithium grease to the contact surfaces on the three (3) latching cams, the cylindrical surfaces of the locating/alignment pins, and the contact surfaces between the latching cams and driver, as shown in Figure 8.1.1.1-1 and Figure 8.1.1.1-2 with the surfaces highlighted blue.

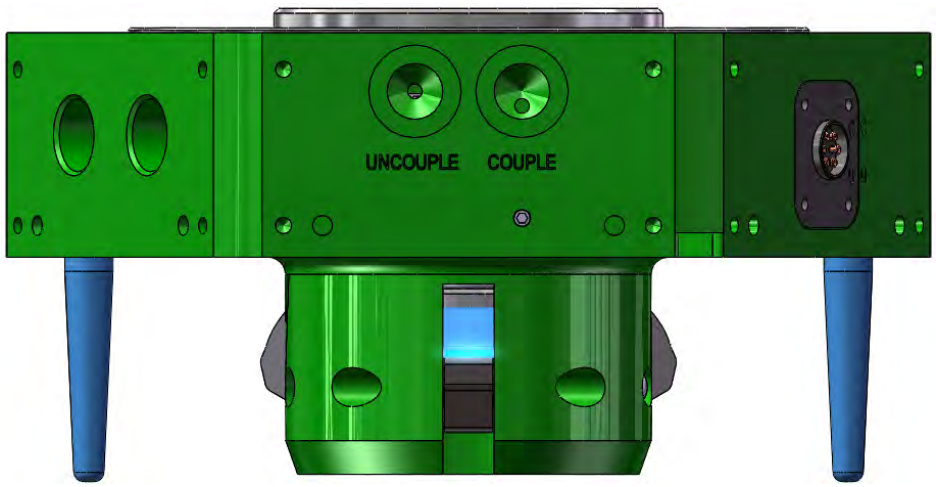


Figure 8.1.1.1-1. E125LP Robot Adaptor Lubrication – Locating Pins & Cams

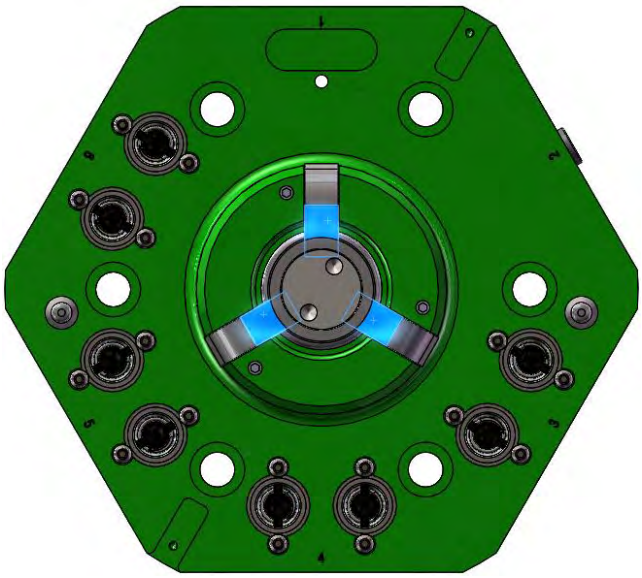


Figure 8.1.1.1-2. E125LP Robot Adaptor Lubrication – Cams & Washer

8.1.1.2 Tool Adapter

1. Clean the inner surface of the tool housing, the locating/alignment bushings, and the latching surfaces to ensure all existing grease, dirt, and debris is removed.
2. Apply a liberal coating of white lithium grease to the latching surfaces and to the inner surface of the locating/alignment bushings, as shown in Figure 8.1.1.2-1 with the surfaces highlighted blue.
3. Apply a thin coating of Lub-A-Cyl to the o-ring surfaces on the valve fittings as shown in Figure 8.1.1.2-1 with the surfaces highlighted red.

Figure 8.1.1.2-1. ET100 Tool Adaptor Lubrication

8.1.2 Visual Checks

Periodic visual checks of the E125LP Tool Changer provide early detection of breakage or wearing components.

8.1.2.1 Robot Adaptor

1. The latching cams and locating/alignment pins should be inspected for proper lubrication as defined in Section 8.1.1.1.
2. Inspect the latching cams and locating/alignment pins for rust, breakage, or wear[3].
3. Inspect the Robot Adaptor mating surface for raised material[4] or dings that could prevent proper mating to the Tool Adaptor.
4. Uncouple the Robot Adaptor from the Tool Adaptor and cycle the coupling mechanism several times to verify the latching cams are operating smoothly. The cycling of the coupling mechanism will also ensure that the operating cylinder remains properly lubricated.
5. Inspect the poppet valves for damage and depress them to check for smooth operation.

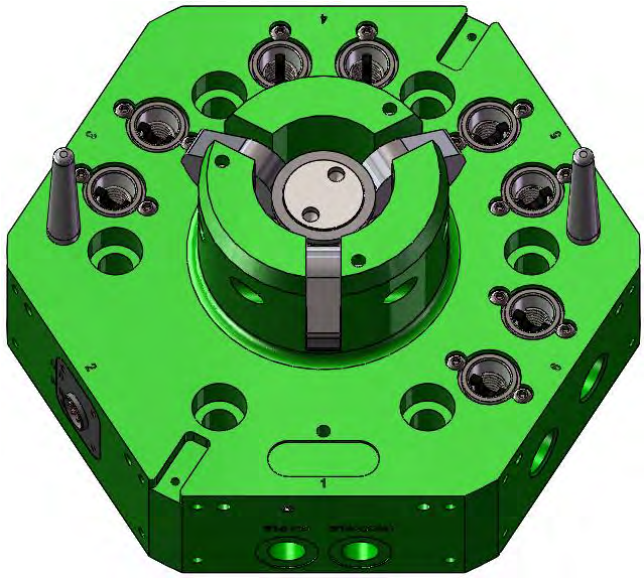


Figure 8.1.2.1-1. E125LP Robot Adaptor Visual Inspection

[3] If excessive wear is found on the locating/alignment pins, latching cams, or Robot Adaptor mating surface, review the docking and undocking sequence of the robot program and adjust if necessary.
[4] All raised material should be filed smooth.

8.1.2.2 Tool Adaptor

1. The locating/alignment bushings and the latching surfaces should be inspected for proper lubrication as defined in Section 8.1.1.2.
2. Inspect the latching surfaces and locating/alignment bushings for rust, breakage, or wear[5].
3. Inspect the Tool Adaptor mating surface for raised material[6] or dings that could prevent proper mating to the Robot Adaptor.
4. Inspect the air valve fittings for damaged o-rings.

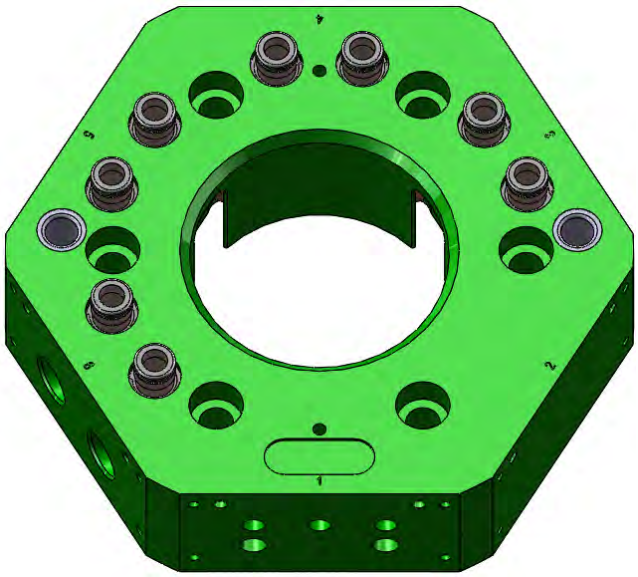


Figure 8.1.2.2-1. ET100 Tool Adaptor Visual Inspection

8.1.3 Checking Wear of the Cam Locking Mechanism

In the unlikely event that the Epsilon Tool Changer begins to demonstrate signs of wear in the cam locking mechanism, causing the connection between the Robot Adaptor and Tool Adaptor to lose repeatability and precision, the following can be used to check the wear of the locking mechanism.

1. Remove the Robot Adaptor from the Robot/Manipulator.
2. Remove the Tool Adaptor from the Tool.
3. With the adaptors positioned on a workbench, inspect the mating surfaces of the Robot (Figure 8.1.3-1) and Tool (Figure 8.1.3-2) Adaptor for any raised material. If any raised material is found, file it smooth before proceeding.

[5] If excessive wear is found on the locating/alignment bushings, latching surfaces, or Tool Adaptor mating surface, review the docking and undocking sequence of the robot program and adjust if necessary.
[6] All raised material should be filed smooth.

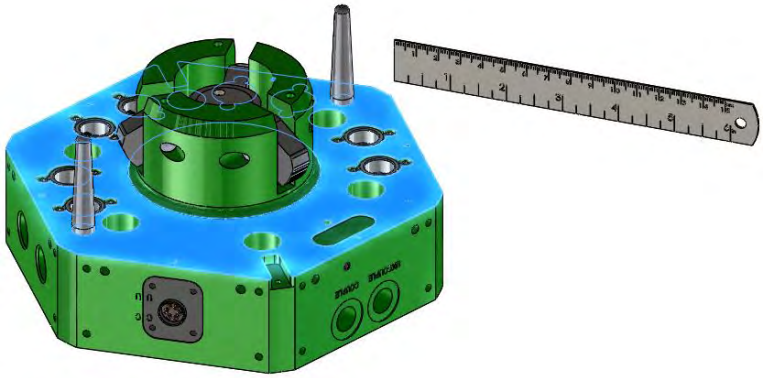


Figure 8.1.3-1. Robot Adaptor – Raised Material Inspection

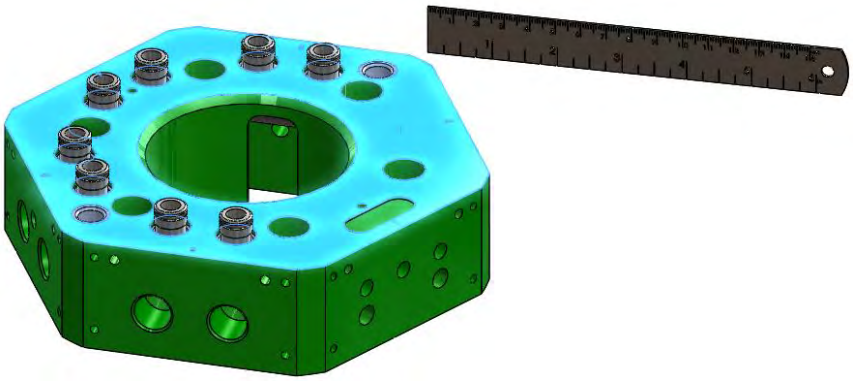


Figure 8.1.3-2. Tool Adaptor – Raised Material Inspection

4. Connect the couple and uncouple actuation port lines (Figure 5.3-1) so that the locking mechanism can be manually actuated.
5. With the cams retracted (Figure 6.1-2), position the Robot Adaptor and Tool Adaptor so that they can be coupled together.
6. Place a 0.05mm piece of shim stock at the locations shown in Figure 8.1.3-3, one location at a time.
7. Actuate the cams to couple the Robot Adaptor to the Tool Adaptor (Figure 6.1-1).
8. With a slight tug, check if the piece of shim stock is securely clamped between the Robot Adaptor and Tool Adaptor interface surfaces.
9. Uncouple the Robot Adaptor from the Tool Adaptor.
10. Repeat steps 6 through 9 for each location shown in Figure 8.1.3-3.

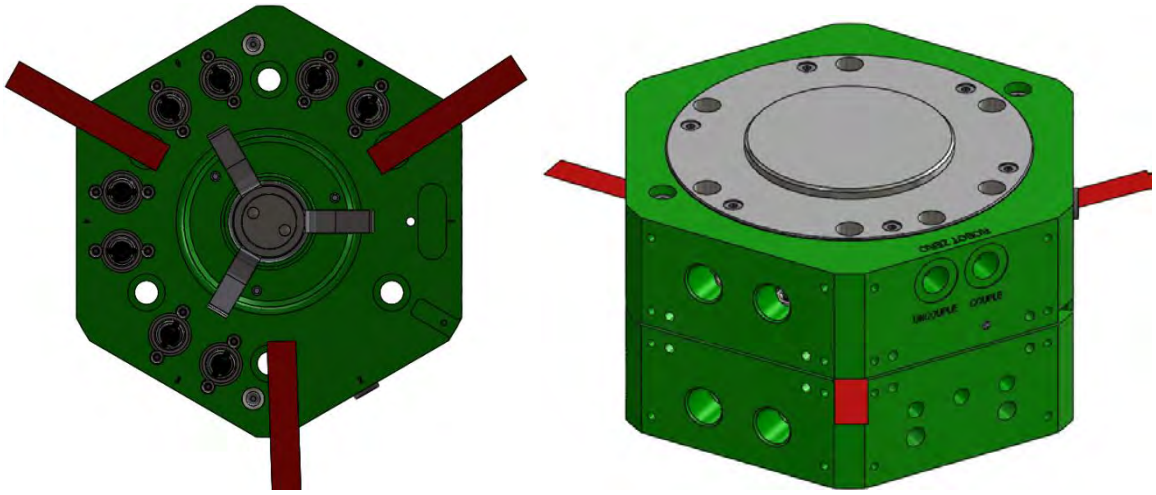


Figure 8.1.3-3. Shim Test of the Cam Locking Mechanism

If the piece of shim stock is able to be pulled free from the coupling interface while the cams are actuated (Figure 6.1-1), record the serial number of the Robot Adaptor and Tool Adaptor and contact APPLIED ROBOTICS Technical Support Department at (518) 384-1000 or techsupport@appliedrobotics.com

9 SPARE PARTS

The spare parts listed below are recommended to be maintained in stock for the life of the Tool Changer. These quantities are based on a single unit. If higher quantities are purchased, please contact the Technical Support Department at (518) 384-1000 or techsupport@appliedrobotics.com to determine the quantity of spares recommended for the size of your installation.

Table 9-1. Robot Adaptor Spare Parts

ROBOT ADAPTOR		
Description	**Part Number**	**Quantity**
PIN, LOCATING MXC160	0104-B71N	2
SUBASSY, PNP MODULE ER125LP	1600-D06A	1
SUBASSY, AIR CHECK O3.1	99502-C1059A	8

Table 9-2. Tool Adaptor Spare Parts

TOOL ADAPTOR		
Description	**Part Number**	**Quantity**
DOWEL, M10 X 40 (HARD STL) m6	49382	3
BUSHING, 15MM X 10MM I.D.	49431	2
FITTING, PNEUMATIC O3	0002-B04A	8

10 SPARE PARTS REPLACEMENT

The following procedures explain the correct method for removing and replacing the recommended spare parts listed in Section 9 of this manual.

10.1 ROBOT ADAPTOR

10.1.1 Locating/Alignment Pins

1. Remove the Robot Adaptor from the Robot/Manipulator.
2. Remove the M6 socket head cap screw (49185) using a 5mm allen wrench.
3. Remove round Locating Pin(s) (0104-B71N). Locating/Alignment Pins may need to be punched out.
4. Place new Locating Pin into the appropriate mounting hole (Figure 10.1.1-1).
5. Apply Loctite 242, or equivalent, to M6 socket head cap screws removed in step 2 (Clean threads before applying thread locker) and thread it into the Locating Pin from the top side of the Robot Adaptor Housing. Tighten until Locating Pins are no longer pulled into holes and do not rotate.
6. Lubricate Locating Pin per Section 8.1.1.1.

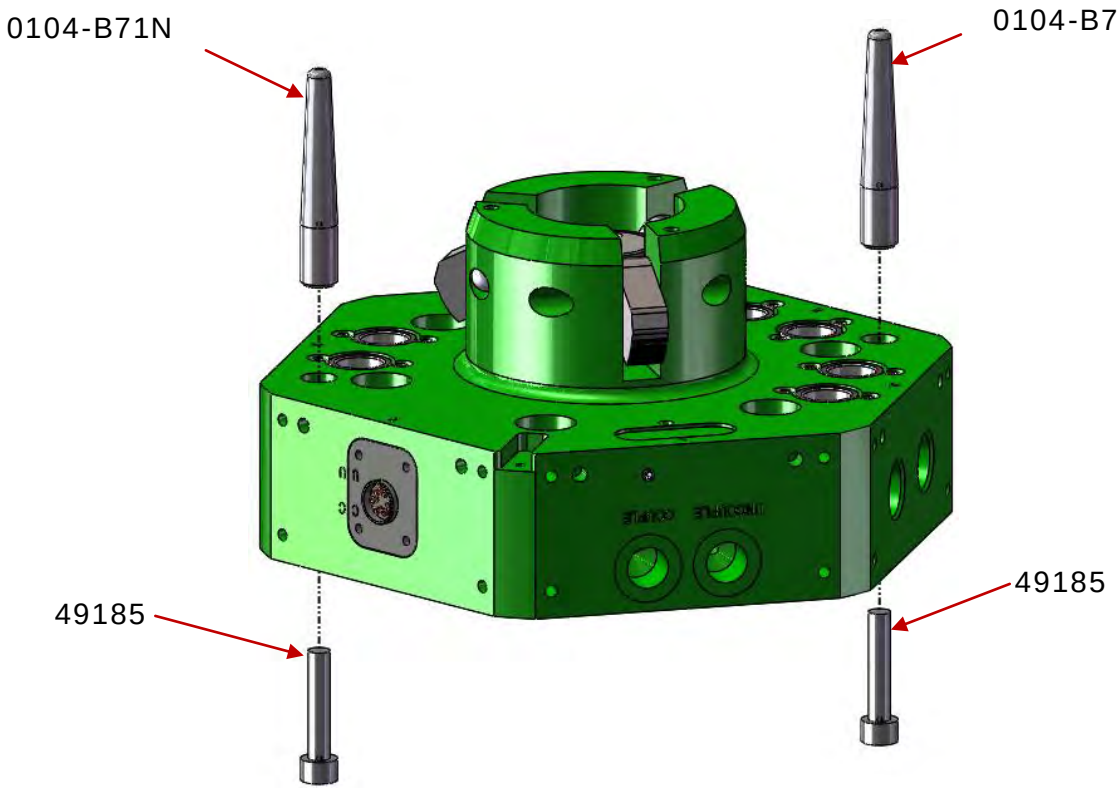


Figure 10.1.1-1. Locating/Alignment Pin Replacement

10.1.2 Couple/Uncouple Sensing Module

1. Remove the module (1600-D06A).
2. Loosen the captivated socket head cap screws holding the Sensing Module using a 2.5mm allen wrench.
3. Remove the Sensing Module and either discard or send to APPLIED ROBOTICS for repair.
4. Replace unit with another Sensing Module.
5. Ensure that the cavity in the Robot Adaptor Housing holding the Sensing Module is free of all foreign objects.
6. Ensure that the two (2) o-rings (97501-P1084) for the proximity sensors, supplied with the Sensing Module, are properly positioned.
7. Apply Loctite 242, or equivalent, to the threads of the captivated socket head cap screws before installing.
8. Install the new Sensing Module using the captivated socket head cap screws.
9. Prior to coupling the Tool Changer, cycle the actuating cylinder for the Robot Adaptor several times to ensure that the sensors are working properly and the correct inputs are being received by the robot controller.

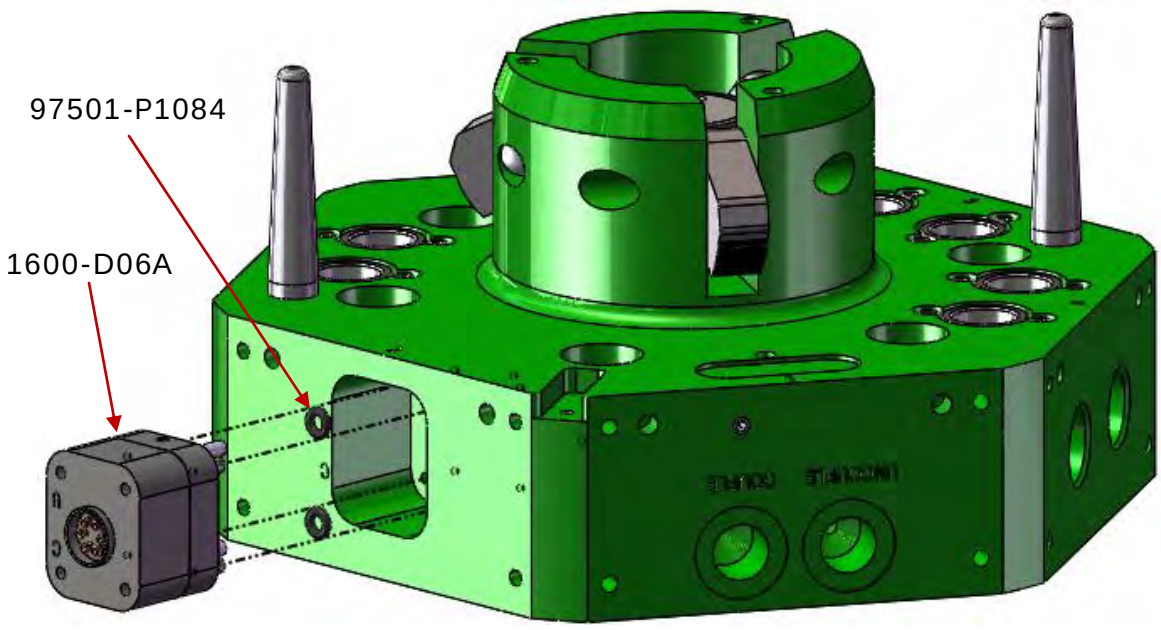


Figure 10.1.2-1. Couple/Uncouple Sensing Module Replacement

NOTICE

MAKING CONNECTIONS WHILE UNDER POWER COULD RESULT IN DAMAGE TO THE EQUIPMENT. TO AVOID DAMAGING EQUIPMENT, ENSURE THAT ALL CABLES ARE CONNECTED BEFORE SUPPLYING POWER TO THE EQUIPMENT.

10.1.3 Poppet Valves

1. Remove the M3 button head socket cap screws (88503-P1084) that hold the Fitting (99502-C1059A) in the housing, using a 2mm allen wrench.
2. Remove Fitting (99502-C1059A) and discard.
3. Apply a thin layer of Lub-A-Cyl to all o-rings.
4. Press the new Fitting into the port hole and re-install the M3 screws removed in step 1. Apply Loctite 242, or equivalent, to M3 socket head cap screws removed in step 2 (Clean threads before applying thread locker) and tighten.

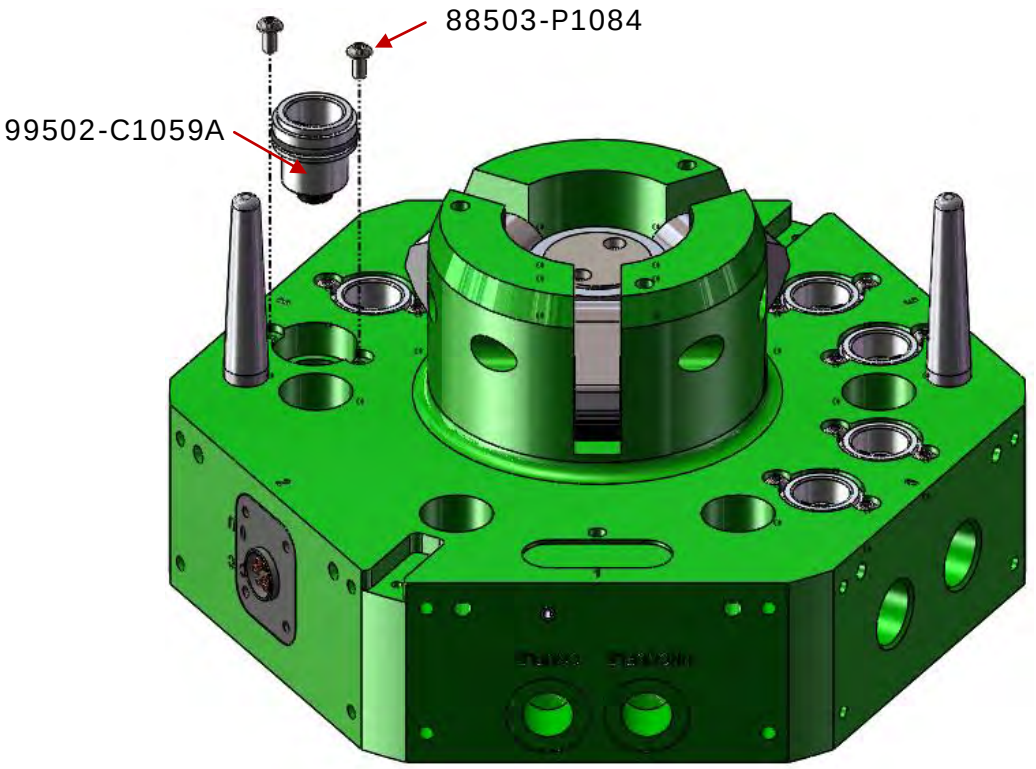


Figure 10.1.3-1. Poppet Valve Removal

10.2 TOOL ADAPTOR

10.2.1 Latching Dowels

1. Remove the Tool Adaptor from the Tool.
2. Remove the M12 socket head set screws (47001) using a 6mm allen wrench.
3. Remove the Latching Dowels (49382) from the Tool Adaptor.
4. Place new Latching Dowels into the grooves of the Tool Adaptor. Ensure that the dowels are fully seated in the grooves.
5. Install the first set of M12 set screws removed in step 2 until they are just NOT touching the Latching Dowels.
6. Apply Loctite 242, or equivalent, to the second set of M12 socket head set screws removed in step 2 (clean threads before applying thread locker) and screw into the Tool Adaptor Housing.
7. Lubricate Latching Dowels per Section 8.1.1.2.

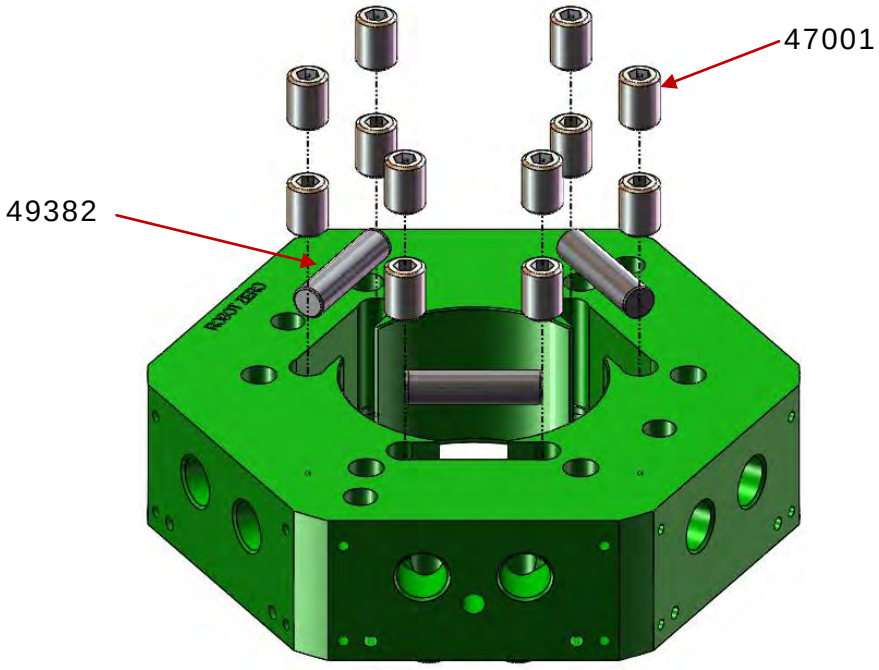


Figure 10.2.1-1. Latching Dowel Replacement

10.2.2 Locating Bushing

1. Remove the Tool Adaptor from the Tool.
2. Press out the Locating Bushings (49431) from the bottom of the Tool Adaptor Housing.
3. Press in new Locating Bushings from the top of the Tool Adaptor Housing until it is just below the Tool Adaptor Housing surface. Ensure that the rounded edge of the Locating Bushing faces the top surface of the Tool Adaptor Housing.
4. Lubricate the Locating Bushing per Section 8.1.1.2.

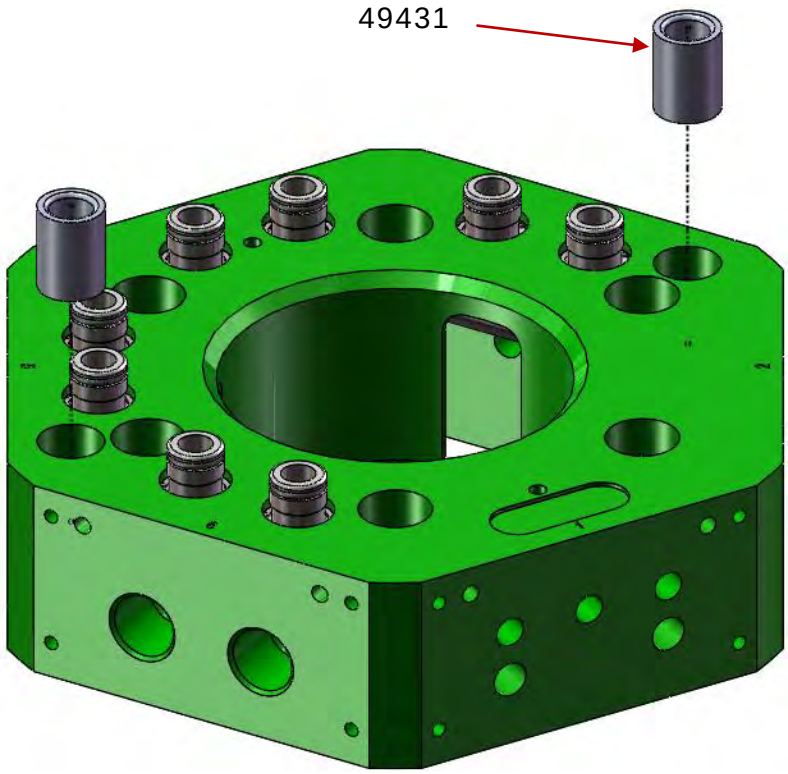


Figure 10.2.2-1. Locating Bushing Replacement

10.2.3 Air Valve Fitting

1. Remove the retaining ring (89504-P1033) and pull out the remainder of the valve fitting assembly (0002-B04A).
2. Discard old valve fitting assembly and replace with a new fitting assembly. Note that the retaining ring (89504-P1033) is included in the valve fitting assembly (0002-B04A).
3. Apply a thin layer of Lub-A-Cyl to all o-rings.
4. Push the valve fitting assembly into the valve fitting hole by hand until it bottoms out in the hole. Ensure the proper orientation of the valve fitting as shown in Figure 10.2.3-1.
5. Install the retaining ring to secure the fitting.

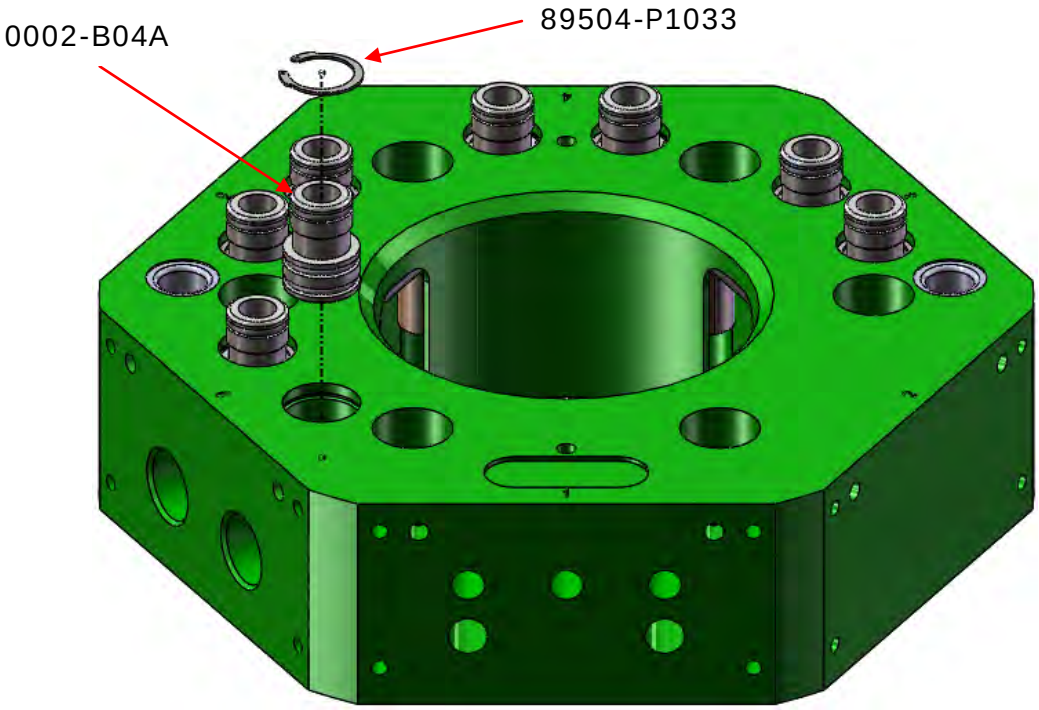


Figure 10.2.3-1. Air Valve Fitting Replacement

11 INFORMATIONAL DRAWINGS

The drawings in this section can assist with installation, use and identification of replacement parts for the Epsilon Tool Changer. Please contact **APPLIED ROBOTICS Technical Support** if you have any questions.

DRAWING NUMBER	DESCRIPTION
1600-D02A	ER125LP-PNP-080-N-0-C0000
1600-D09A	ET125LP-000-N-C0000