

EPSILON E31.5

TOOL CHANGE SYSTEM

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648 Saratoga Road
Glenville, NY 12302 USA
Phone: +1 518 384 1000
Fax: +1 518 384 1200
www.appliedrobotics.com

REVISION

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00	03/31/2016	SC	Initial Release
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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
1507-C65N	PISTON, ROBOT
0104-C18N	CAM, ROBOT
48318	PIVOT PIN, ROBOT
1507-C76N	RING, CAM RETAINER

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). For the purposes of this warranty, APPLIED ROBOTICS defines the lifetime as 8 years or 8,000,000 total cycles completed with regularly scheduled maintenance as per Section 8 of this manual.

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 Side.



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 E31.5 Tool Changer provides a strong and reliable method for a manipulator to quickly change between different tools/end-effectors. With Applied Robotics, Inc. modular design, the E31.5 Tool Changer offers the maximum flexibility for any application.

The E31.5 Tool Changer contains two major components:

Robot Side (ER31.5) – Mounts directly to a robot flange utilizing a 31.5mm ISO 9409-1 pattern without the need for adaptor plates (Figure 3-1).

Tool Side (ET31.5) – Mounts directly to a tooling plate utilizing a 31.5mm ISO 9409-1 pattern (Figure 3-2).

The Robot Side and Tool Side 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. As the locking mechanism actuates, the Tool Side is physically connected and disconnected along with any utilities contained in the attached modules.

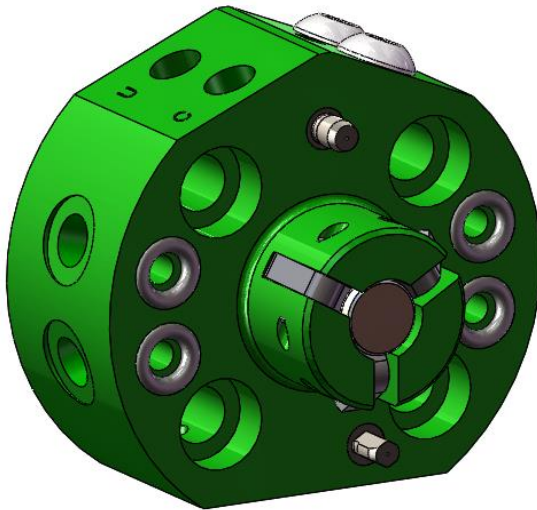


Figure 3-1. ER31.5 Robot Side

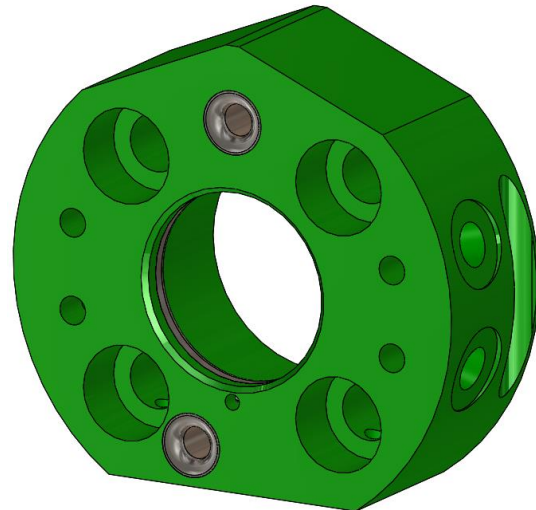
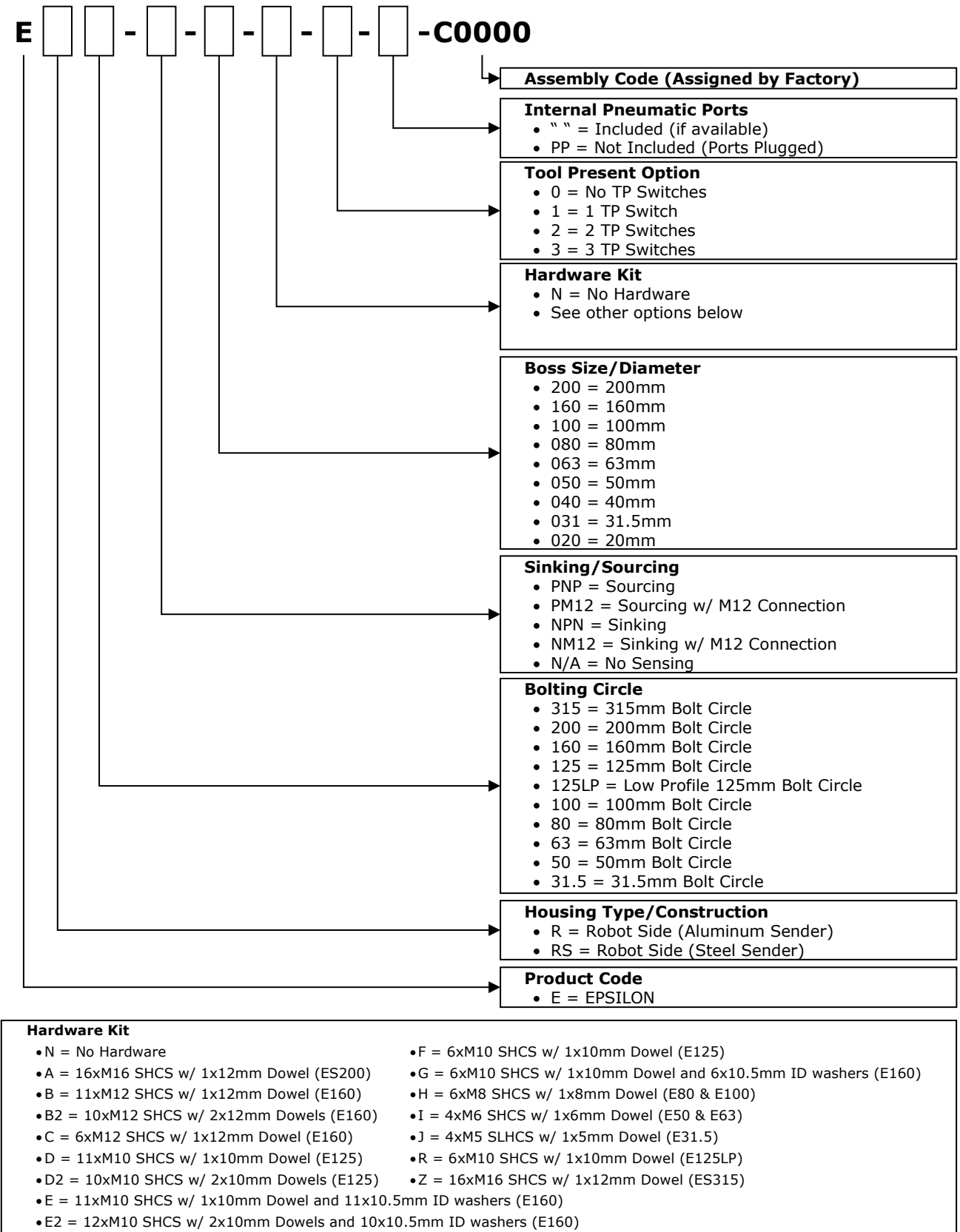
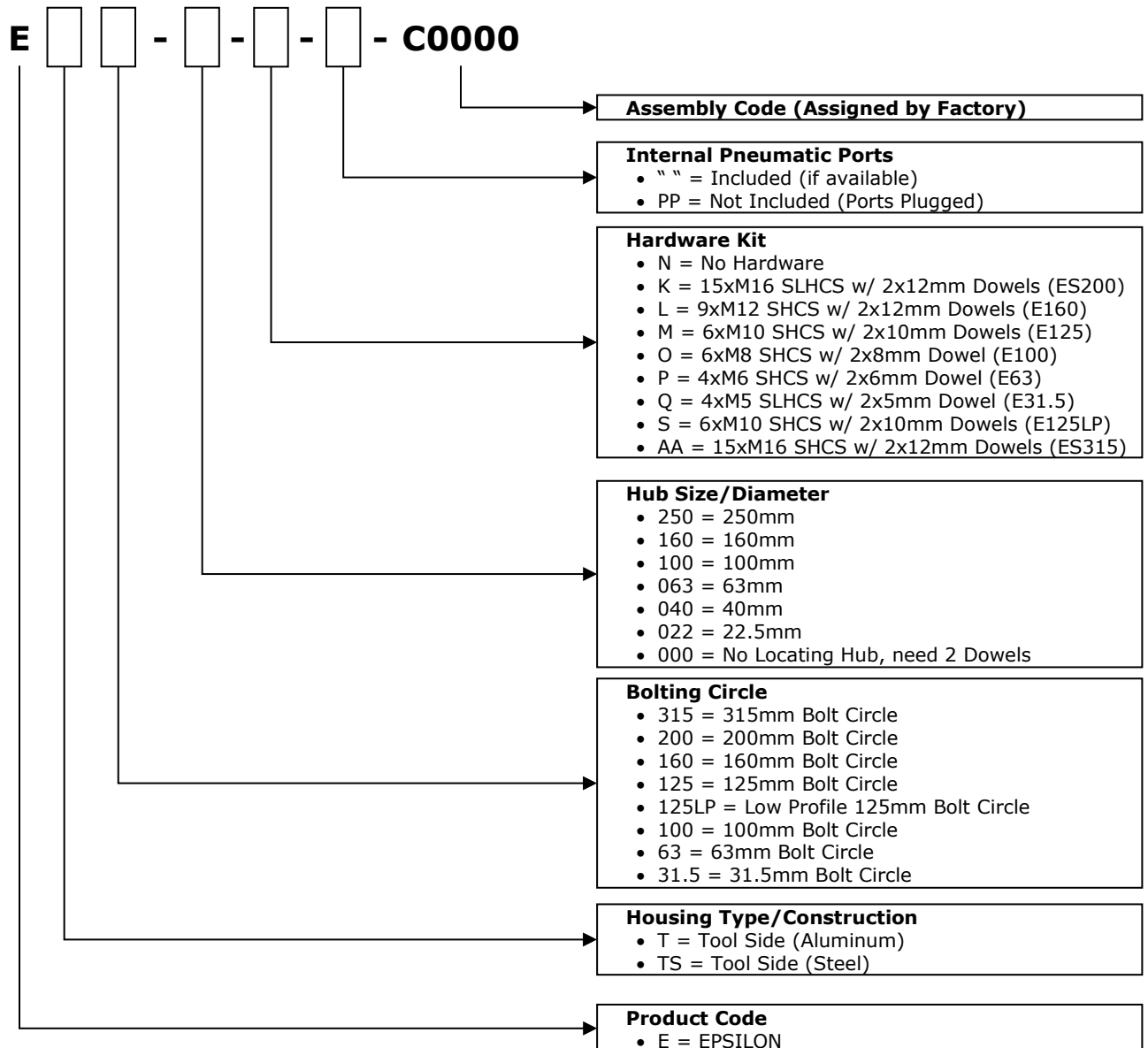


Figure 3-2. ET31.5 Tool Side

3.1 ROBOT SIDE



3.2 TOOL SIDE



Note: If " " (blank) is chosen, remove "-" (dash) if that is the only input between dashes.

4 TECHNICAL SPECIFICATIONS

Table 4-1. E31.5 Technical Specifications

Specification		Metric	English
Payload		10 kg	22 lb
Maximum Operating Moment (M _x , M _y)		52 Nm	465 in-lb
Maximum E-Stop Moment (M _x , M _y)		79 Nm	700 in-lb
Maximum Operating Torque (M _z)		30 Nm	265 in-lb
Maximum E-Stop Torque (M _z)		60 Nm	530 in-lb
Maximum Tensile Force (F _T)		934 N	210 lb
Maximum Compressive Force (F _C)		4,159 N	935 lb
Diameter		46 mm	1.81 in
Height (Robot and Tool Coupled)		36 mm	1.42 in
Mass / Weight *	Robot	0.09 kg	0.20 lb
	Tool	0.04 kg	0.09 lb
Rotational Repeatability		± .04°	
Operating Temperature		5 °C to 60 °C	40 °F to 140 °F
Supply Pressure		5 bar to 7 bar	72 psi to 101 psi
Couple/Uncouple Voltage (Optional)		10 VDC to 30 VDC	
Noise Emission		≤ 70 dB(A) in any direction	
Transportation and Storage Humidity		Up to 50%, Maximum Temperature 70 °C (158 °F)	
Transportation and Storage Temperature		-25 °C to 70 °C	-13 °F to 158 °F
User Pneumatic Pressure Range		0 bar to 7 bar	0 psi to 101 psi
User Pneumatic Flow		179 NLPM	6.9 SCFM

* Weight may vary depending on specific configuration.

5 INSTALLATION

5.1 ROBOT SIDE INSTALLATION

The E31.5 Robot Side is designed to mount directly to interfaces utilizing an ISO 31.5mm bolt pattern (ISO 9409-1). The E31.5 Robot Side can mount to manipulator interfaces utilizing M5 hardware. For size, locations, and tolerance information on the E31.5 Robot Side mounting patterns, see Informational Documents (Section 11).

NOTICE

TOOL CHANGER PAYLOAD & MOMENT RATINGS BASED ON USING A MINIMUM OF 4xM5 SCREWS TO MOUNT THE ROBOT SIDE TO THE MANIPULATOR INTERFACE.

Installing the E31.5 Robot Side Using M5 Hardware:**NOTICE**

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

1. Locate the Robot Side to the manipulator mounting flange utilizing the locating boss and one (1) M5 locating dowel (Figure 5.1-1).
2. Insert and tighten the M5 low head socket head cap screws (minimum Property Class 10.9) provided with the Robot Side 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.

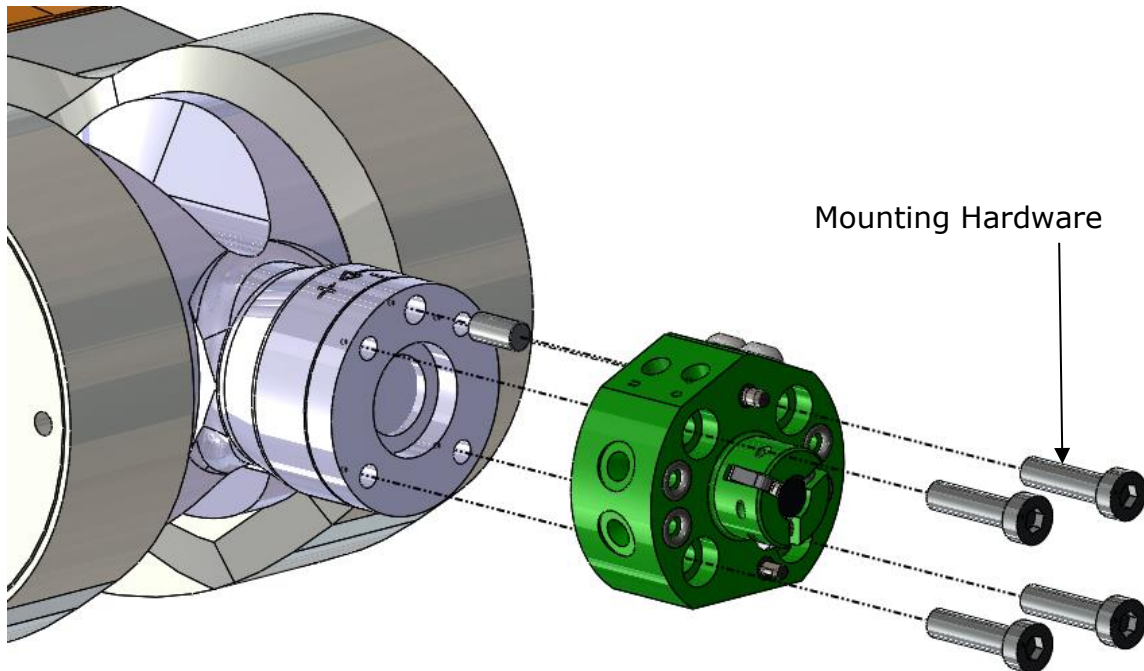


Figure 5.1-1. E31.5 Robot Side Installation w/ M5 Hardware

**WARNING**

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

5.2 TOOL SIDE INSTALLATION

The E31.5 is designed to mount directly to customer tooling utilizing an ISO 9409-1 bolt pattern. The Tool Side can be mounted from the top down using M6 hardware on the ISO 31.5mm bolt circle. For size, locations, and tolerance information on the E31.5 Tool Side mounting patterns, see Informational Documents (Section 11).

NOTICE

TOOL CHANGER PAYLOAD & MOMENT RATINGS BASED ON USING 4xM5 SCREWS TO MOUNT THE TOOL SIDE TO THE TOOLING INTERFACE.

If a locating boss/pilot is used on the tool plate to locate the tool to the Tool Side, then the boss cannot protrude into the tool changer greater than 3mm to allow for clearance of the latching mechanism (Figure 5.2-1).

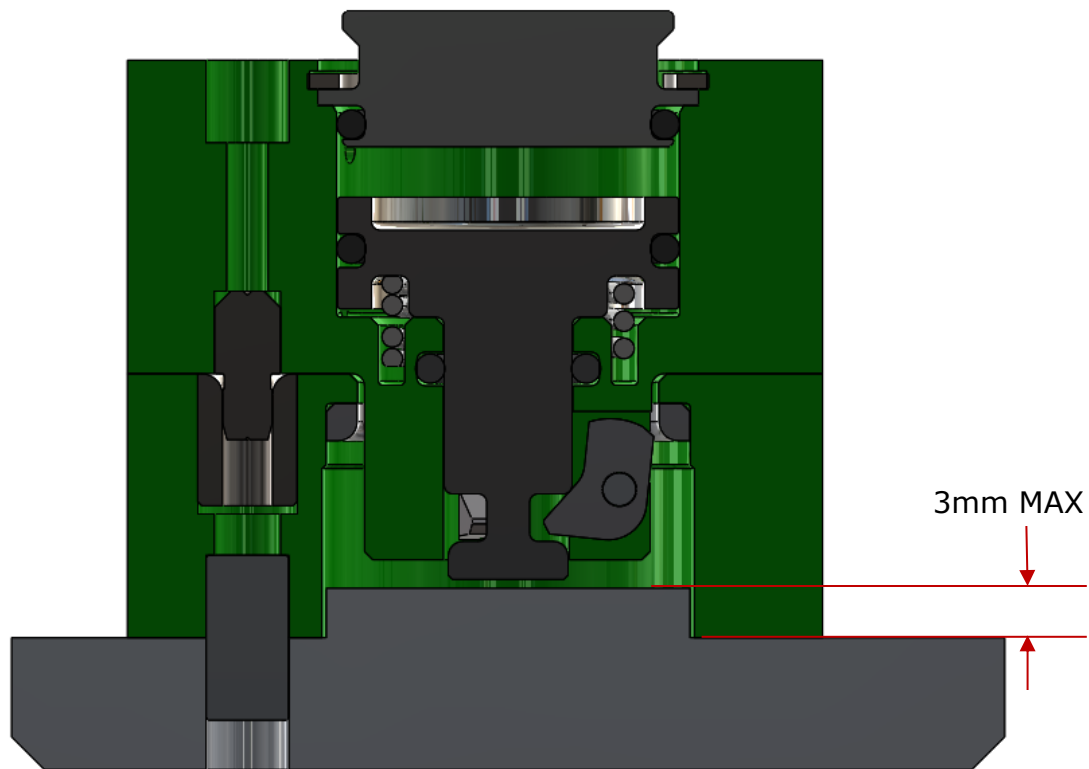


Figure 5.2-1. ET31.5 Tool Side and Tool Plate Installation (w/ Pilot)

Installing the ET31.5 Tool Side from the Top Down:**NOTICE**

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

1. Locate the Tool Side to the tool plate utilizing either the locating hub and one (1) M5 locating dowel, or two (2) M5 locating dowels (Figure 5.2-2).
2. Insert and tighten M5 low head socket head cap screws (minimum Property Class 10.9) through the Tool Side 31.5mm 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.

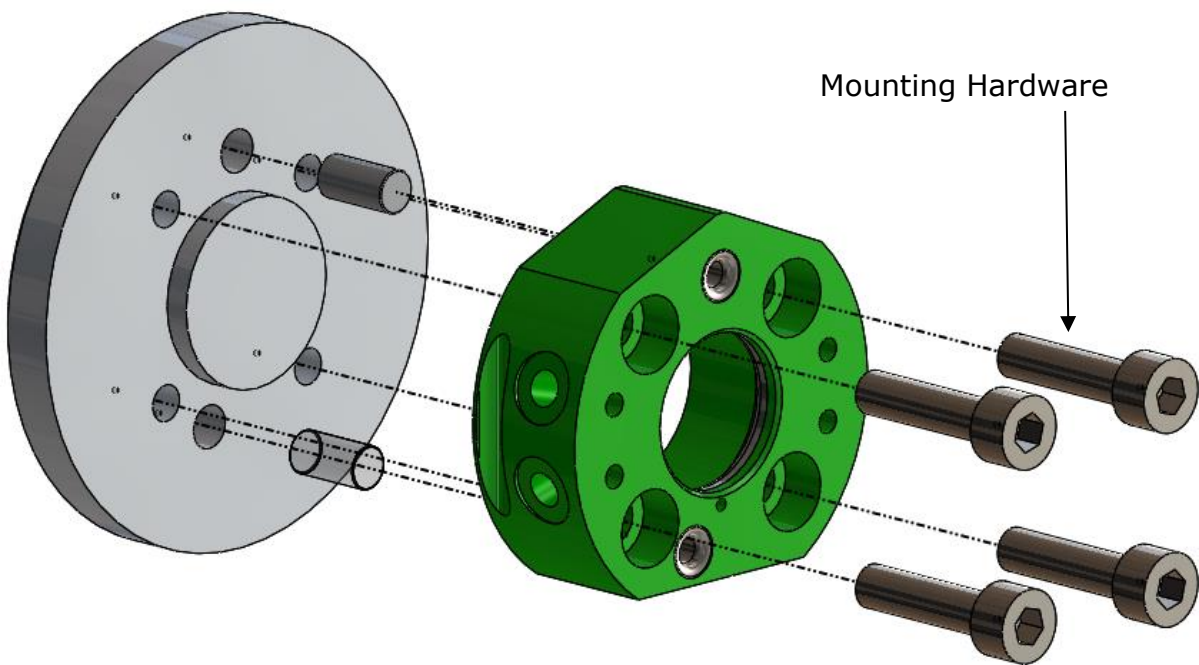


Figure 5.2-2. ET31.5 Tool Side Installation (Bolt Top Down)

**WARNING**

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

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.

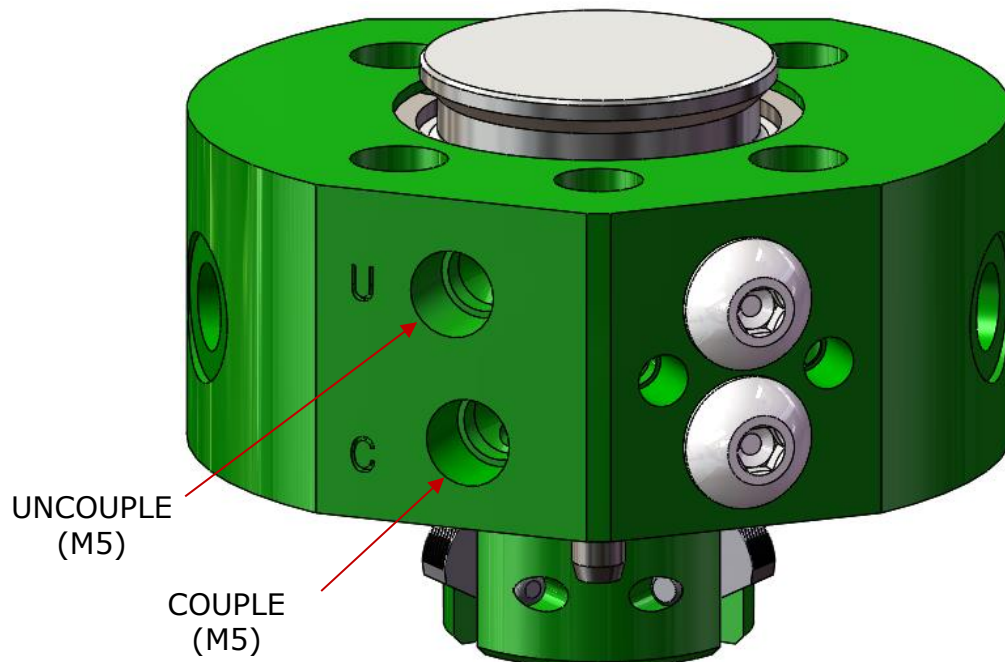


Figure 5.3-1. E31.5 Robot Side Air Supply Ports

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.

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.



WARNING

5.4 COUPLE AND UNCOUPLE SIGNALS (OPTIONAL)

Couple and uncouple signals are optional on the E31.5 Robot Side and are provided via flying lead connections (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.

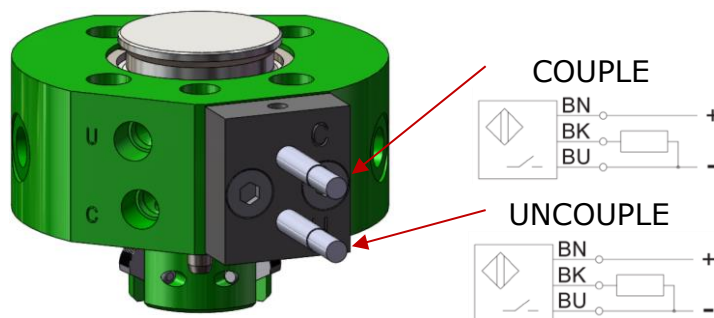


Figure 5.4-1. Couple/Uncouple Signal Interface (Optional)

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 CONNECTING USER PNEUMATIC PORTS

The E31.5 Tool Changer has 4 available user pneumatic ports to supply air through the tool changer to the specific tool being used. The tool changer must be coupled and be fitted with an O-ring seal for these ports to be operational. Air can be supplied via directly ported air fittings supplied by the customer (Figure 5.5-1).

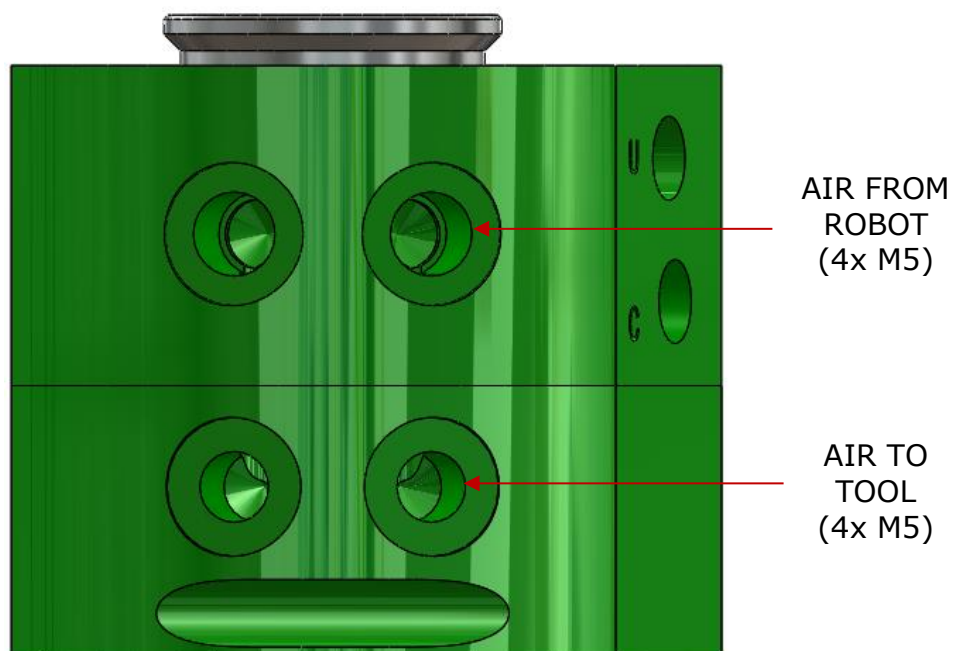


Figure 5.5-1. E31.5 User Pneumatic Ports

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 Side is clear of any obstruction and not coupled to the Tool Side.
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 (optional) 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 (optional) 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.

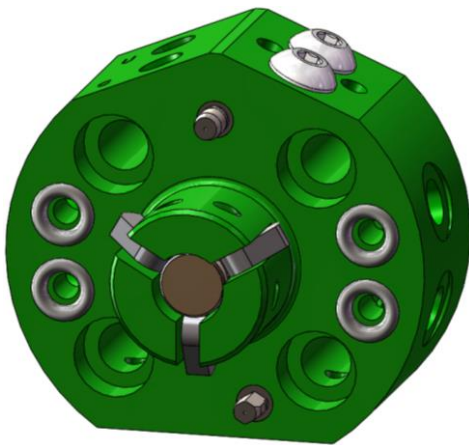


Figure 6.1-1. Robot Side Coupled (Cams Extended)

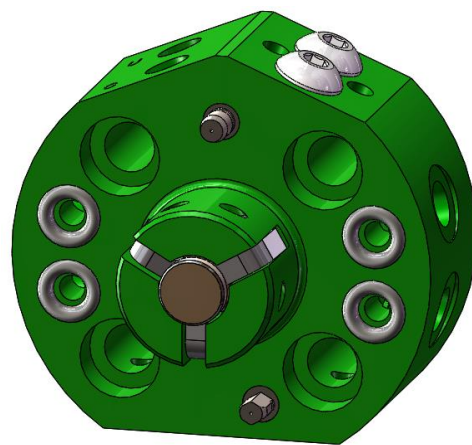


Figure 6.1-2. Robot Side Uncoupled (Cams Retracted)

6.2 PROGRAMMING THE COUPLE AND UNCOUPLE POINTS



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

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

1. Orient the Robot Side and Tool Side so that the centerline axes are aligned and the interface surfaces are parallel. Maintain approximately 15mm minimum separation between the Robot Side and Tool Side interface surfaces (Figure 6.2-1).

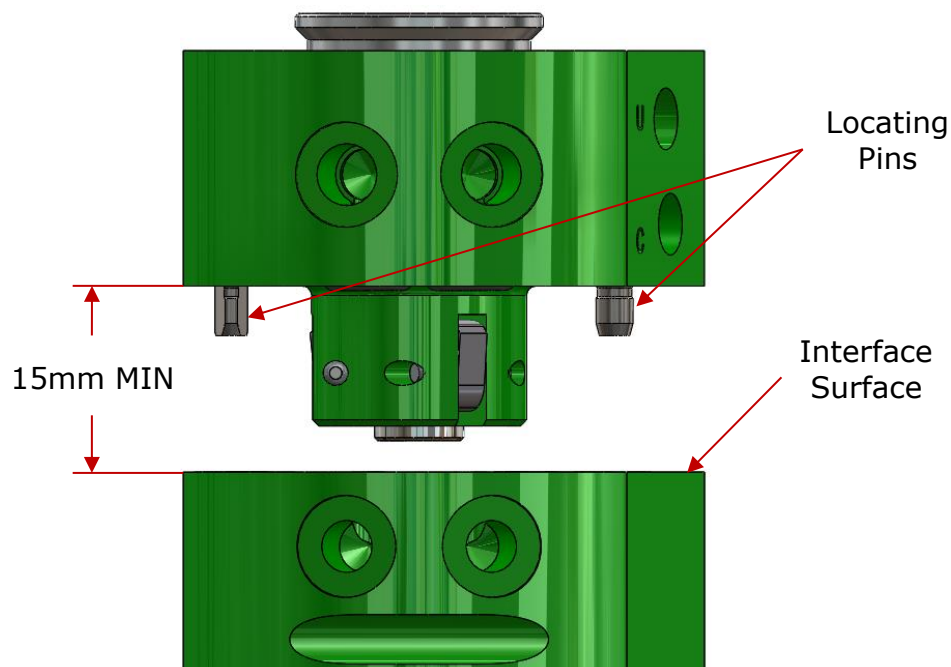


Figure 6.2-1. E31.5 Tool Changer – Docking Orientation

2. Energize the solenoid, resulting in an uncoupled (cams retracted) state.
3. Rotate the Robot Side so that the locating pins are centered on the bushings in the Tool Side.
4. Start to bring the Robot and Tool Sides 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 Side interface surface and Tool Side 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 Side and Tool Side are in contact, the outer edge of the Sides should be touching (Figure 6.2-2).

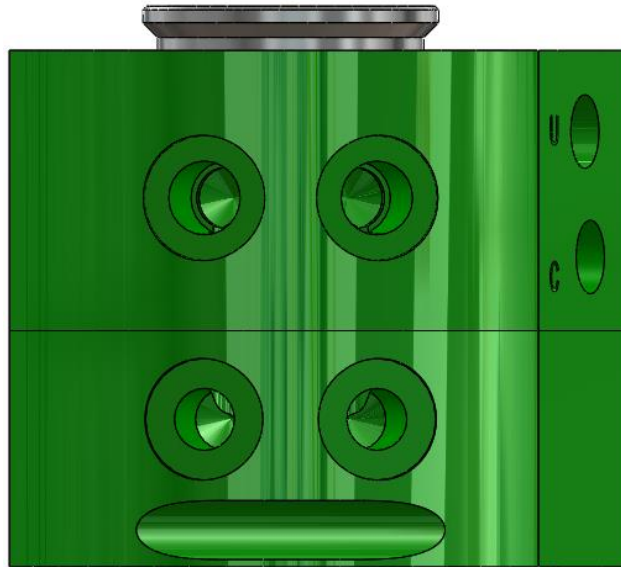


Figure 6.2-2. E31.5 Tool Changer – Docked Position

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

NOTICE

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

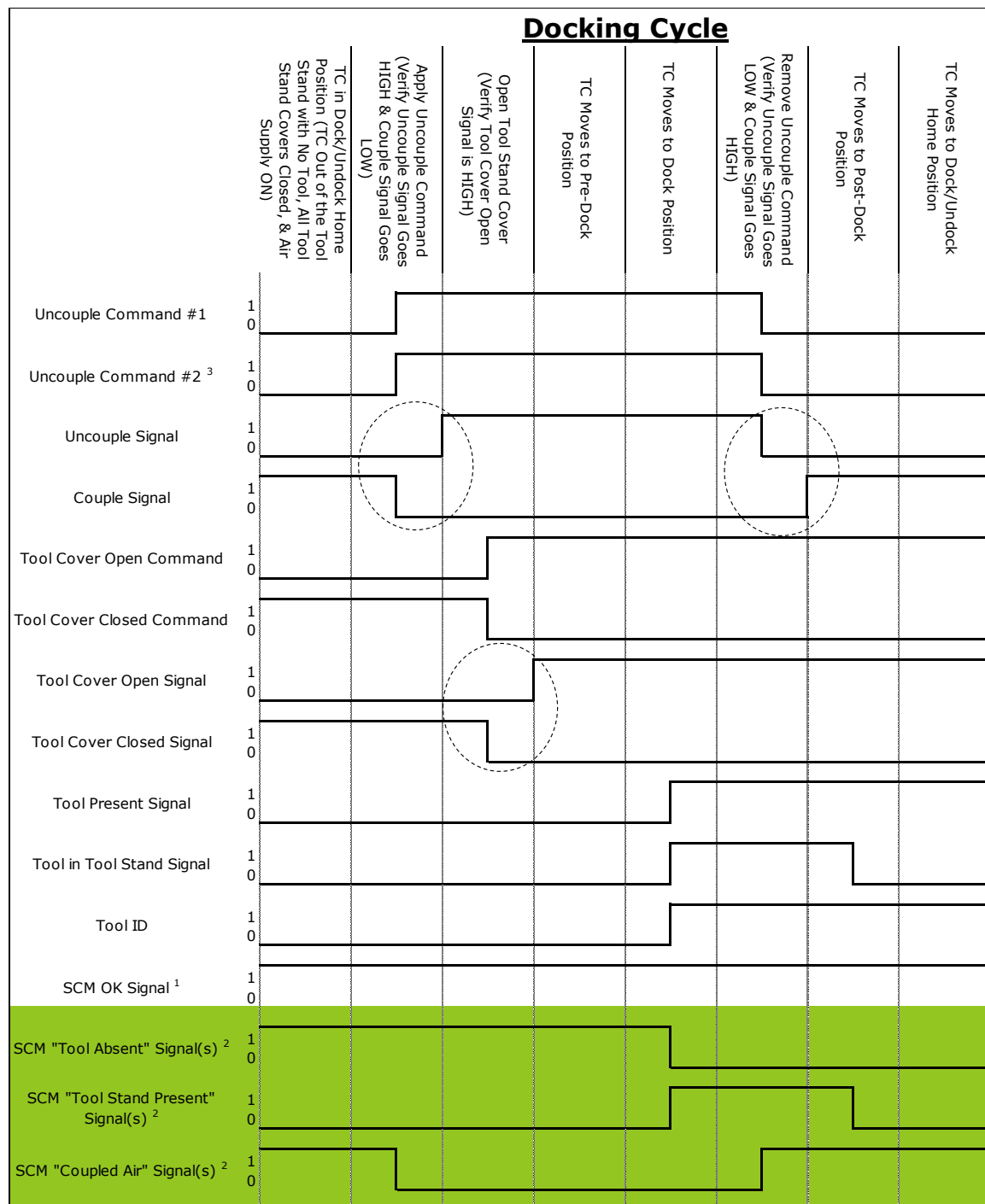
6. De-energize the solenoid that controls the air pressure to the couple port. This will couple the Robot Side with the Tool Side.
7. Cycle the cams by energizing and de-energizing the solenoid several times to verify that the Tool Side is properly connected and released from the Robot Side. If properly programmed, the Robot Side and Tool Side 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 Side. Depending on the docking station used, separate dock and undock positions may be required.
9. Repeat procedure for each Tool Side used in conjunction with the corresponding Robot Side.

6.3 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 8.1.1-1 and Figure 8.1.1-2 for a graphical representation of this sequence.



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 section of the SCM User Guide.

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.

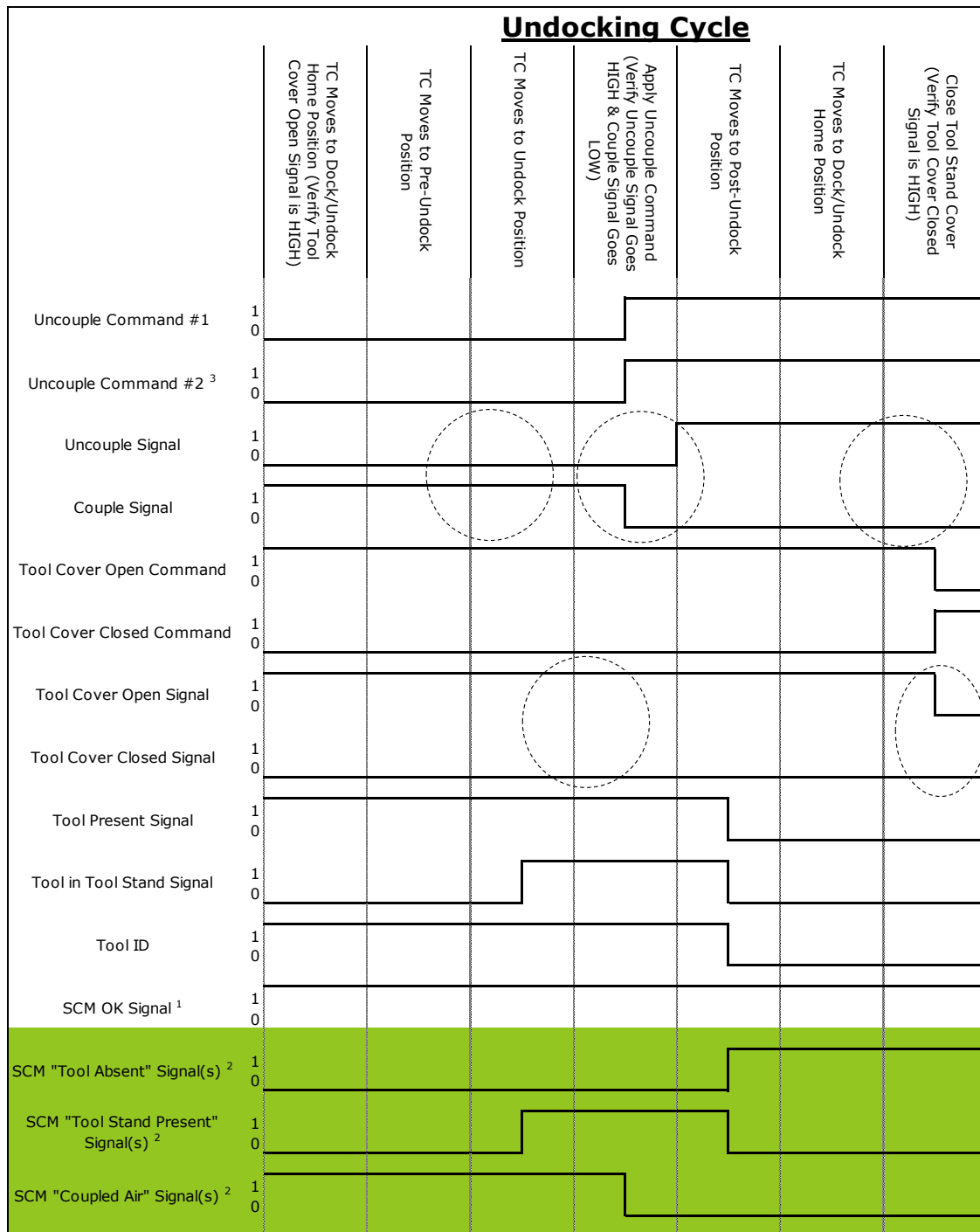
³ Second Uncouple Command is required when using ARI's Safety Control Module (SCM) and should be applied simultaneously with the first Uncouple Command.

- 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 cylinder when neither "Open" or "Close" signal is present.

Figure 8.1.1-1. Sequence of Operations Diagram – Docking Cycle



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 section of the SCM User Guide.

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 cylinder when neither "Open" or "Close" signal is present.

Figure 8.1.1-2. Sequence of Operations Diagram – Undocking Cycle

7 TROUBLESHOOTING

7.1 TROUBLESHOOTING GUIDE

Table 7.1-1. 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 (optional) has failed	Replace sensor puck (See Section 10.1.2)
	Cable/Connections supplying signal failed	Inspect cables/connections and replace if necessary
	Air supply to the Tool Changer has been lost (Coupled via the sender spring)	Verify all air connections are in place and air is being supplied to the Robot cell
Tool Changer Uncouples, But No Uncoupled Signal is Being Received	Uncoupled sensing (optional) has failed	Replace sensor puck (See Section 10.1.2)
	Cable/Connections supplying signal failed	Inspect cables/connections and replace if necessary

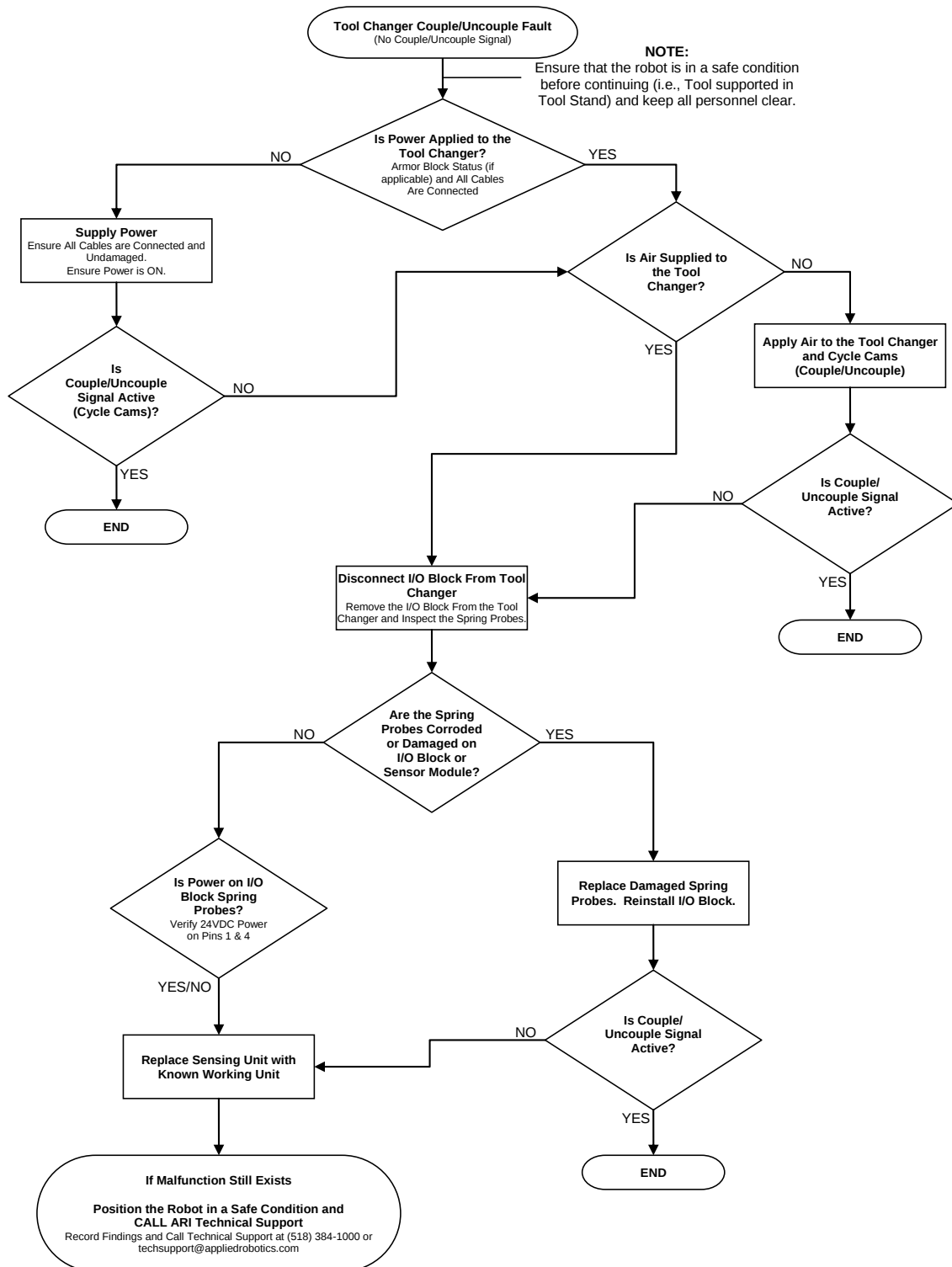
7.2 TECHNICAL SUPPORT

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

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

7.3 TROUBLESHOOTING FAULT TREE

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



7.4 MANUAL UNCOUPLE

A feature has been designed into the E31.5 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 E31.5 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 1.5mm Allen wrench (alternatively, a 1.5mm punch may be used) as shown in Figure 7.4-1. This requires any tool side modules to be removed.
5. While pushing the cams back with the Allen wrench, pull down on the Tool Side to separate the tool from the Robot Side.

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.

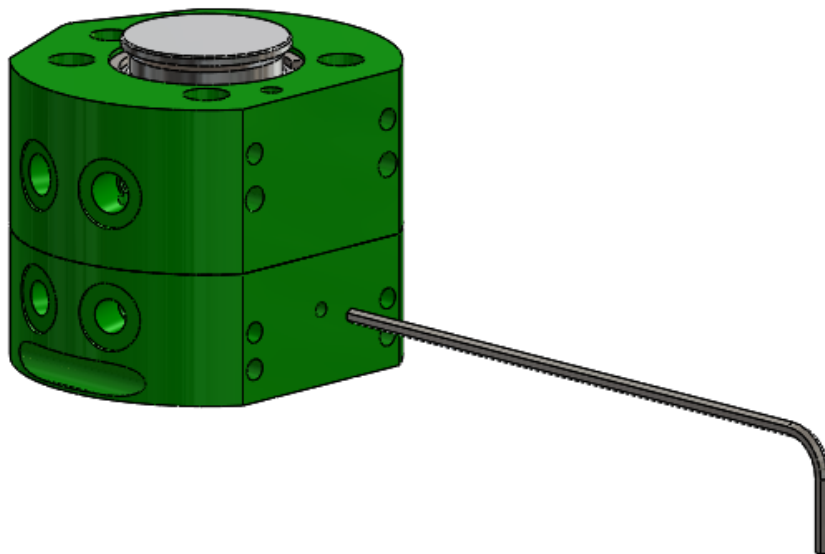


Figure 7.4-1. Manual Uncouple Feature

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 Side	Visual Checks (Section 8.1.2.1)	Lubrication (Section 8.1.1.1) & Visual Checks (Section 8.1.2.1)			Lubrication (Section 8.1.1.1) & Visual Checks (Section 8.1.2.1) & Replace Locating Pins if Worn or Damaged & Inspect Piston Spring Functionality and Replace if Necessary ¹
Tool Side	Visual Checks (Section 8.1.2.2)	Lubrication (Section 8.1.1.2) & Visual Checks (Section 8.1.2.2)			Lubrication (Section 8.1.1.2) & Visual Checks (Section 8.1.2.2) & 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 Side	Visual Checks (Section 8.1.2.1)	Lubrication (Section 8.1.1.1) & Visual Checks (Section 8.1.2.1)			Lubrication (Section 8.1.1.1) & Visual Checks (Section 8.1.2.1) & Inspect Piston Spring Functionality and Replace if Necessary & Inspect Dock and Undock Positions to Ensure Proper Alignment with Each Tool Side
Tool Side	Visual Checks (Section 8.1.2.2)	Lubrication (Section 8.1.1.2) & Visual Checks (Section 8.1.2.2)			Lubrication (Section 8.1.1.2) & Visual Checks (Section 8.1.2.2) & 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 E31.5 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 E31.5 Tool Change System.

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 Side

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 between the three (3) latching cams and driver, as shown in Figure 8.1.1.1-1 with the surfaces highlighted blue.

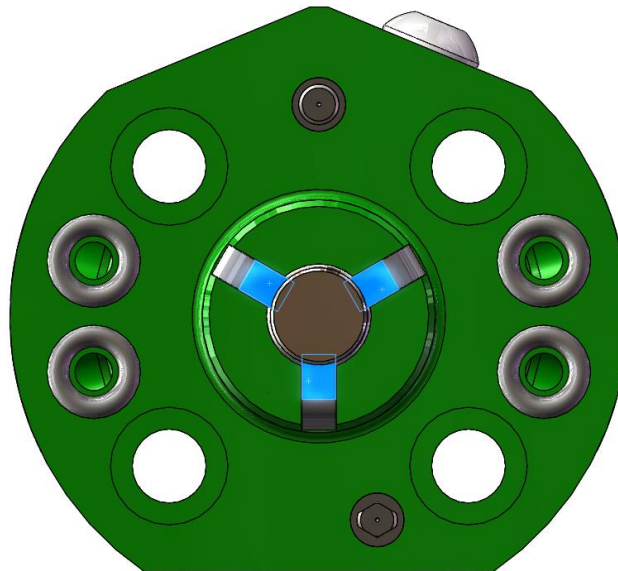


Figure 8.1.1.1-1. E31.5 Robot Side Lubrication – Cams & Driver

8.1.1.2 Tool Side

1. Clean the inner surface of the tool ring, 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.

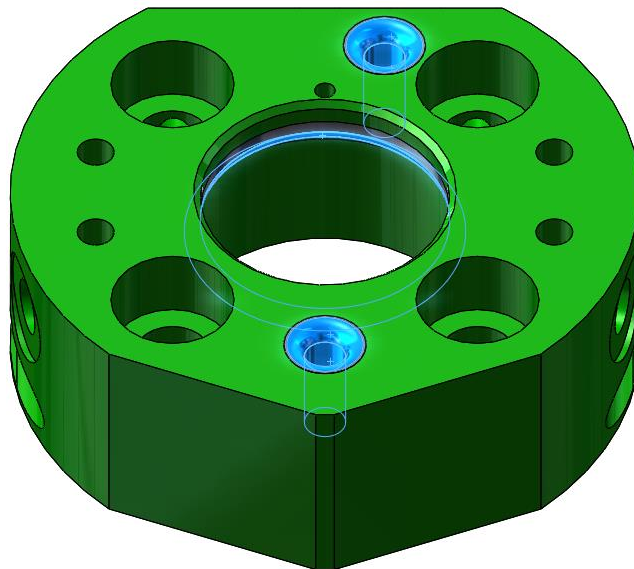


Figure 8.1.1.2-1. ET31.5 Tool Side Lubrication

8.1.2 Visual Checks

Periodic visual checks of the E31.5 Tool Changer provide early detection of breakage or wearing components.

8.1.2.1 Robot Side

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 wear³.
3. Inspect the Robot Side mating surface for raised material⁴ or dings that could prevent proper mating to the Tool Side.
4. Uncouple the Robot Side from the Tool Side 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.

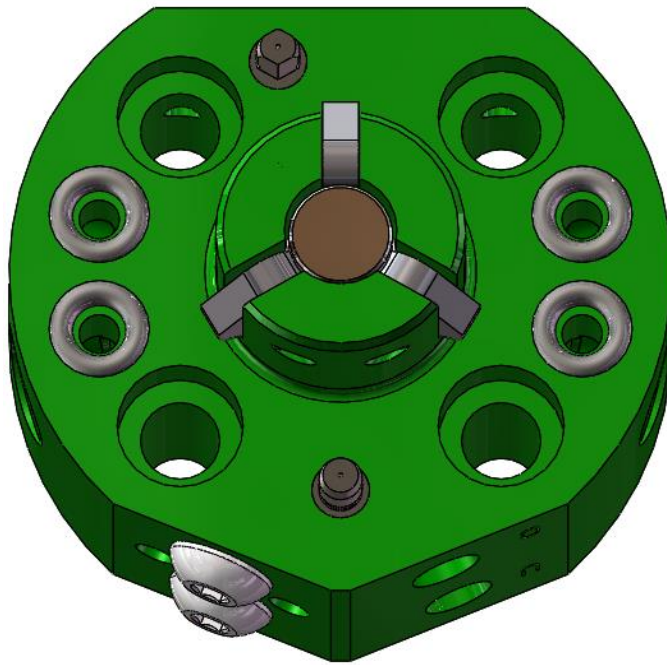


Figure 8.1.2.1-1. E31.5 Robot Side Visual Inspection

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 Side

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 wear⁵.
3. Inspect the Tool Side mating surface for raised material⁶ or dings that could prevent proper mating to the Robot Side.

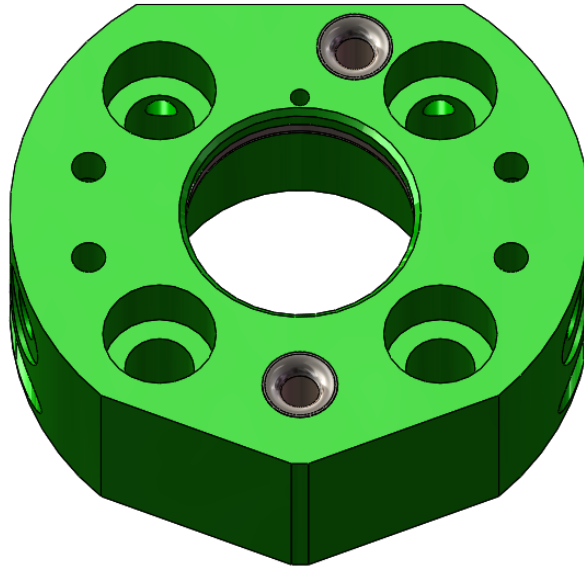


Figure 8.1.2.2-1. ET31.5 Tool Side Visual Inspection

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 Side and Tool Side to lose repeatability and precision, the following can be used to check the wear of the locking mechanism.

1. Remove the Robot Side from the Robot/Manipulator.
2. Remove the Tool Side from the Tool.
3. Remove the face seals from the Robot Side.
4. With the Sides positioned on a workbench, inspect the mating surfaces of the Robot (Figure 8.1.3-1) and Tool (Figure 8.1.3-2) Side 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.

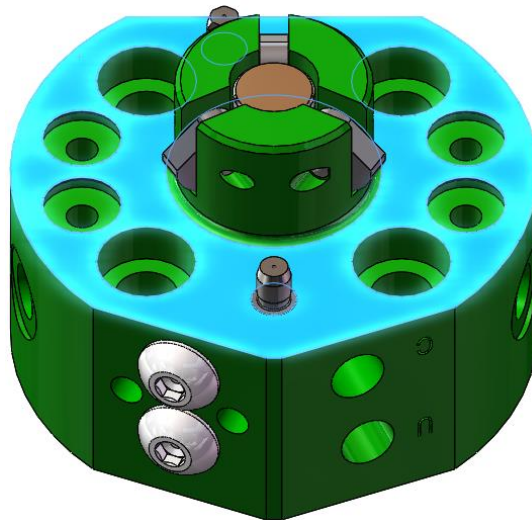


Figure 8.1.3-1. Robot Side – Raised Material Inspection

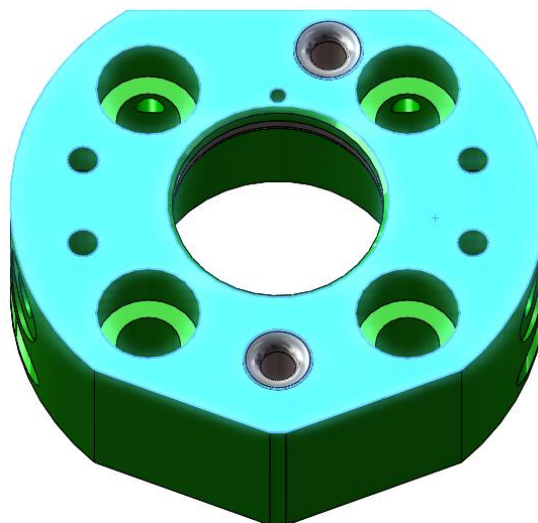


Figure 8.1.3-2. Tool Side – Raised Material Inspection

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

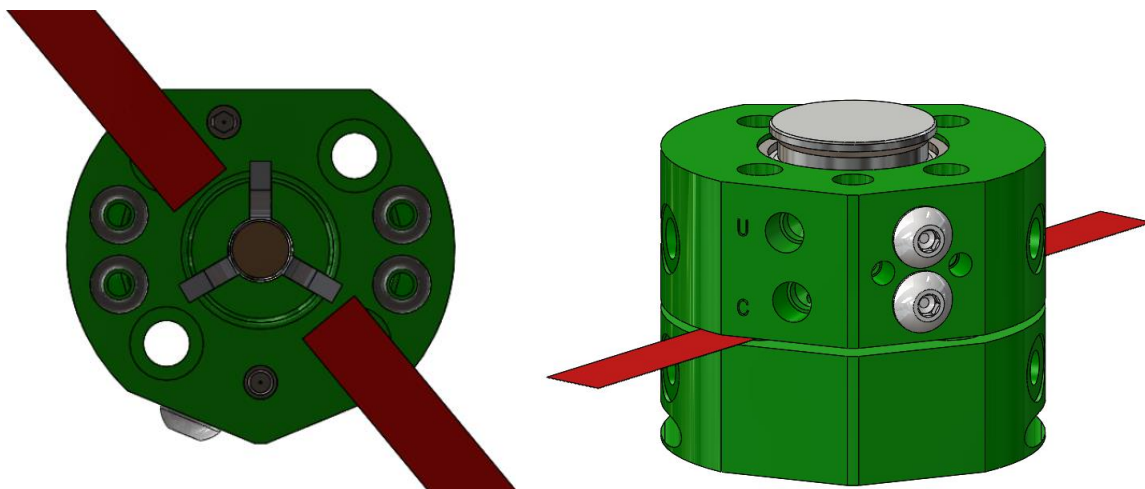


Figure 8.1.3-3. Shim Test of the Cam Locking Mechanism

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 Side and Tool Side and contact APPLIED ROBOTICS Technical Support Department at +1 518 384 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 +1 518 384 1000 or techsupport@appliedrobotics.com to determine the quantity of spares recommended for the size of your installation.

Table 9-1. Robot Side Spare Parts

ROBOT SIDE		
Description	Part Number	Quantity
PIN, ALIGNMENT, MXC5	1004-P67N	1
PIN, ALIGNMENT, DIAMOND MXC5	1004-P68N	1
SUBASSY, PNP MODULE ER31.5 (Optional)	1507-D69A	1
O-RING, .145 ID X .07 70VT	96504-P1019	4

Table 9-2. Tool Side Spare Parts

TOOL SIDE		
Description	Part Number	Quantity
BUSHING, 6MM O.D.	49429	2

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 SIDE

10.1.1 Locating/Alignment Pins

1. Remove the Robot Side from the Robot/Manipulator.
2. Using a punch, press the Locating Pin(s) out through the front face of the Robot Side Housing.
3. Apply a liquid adhesive to the Locating Pin(s) before pressing into housing.
4. Press the new Locating Pin(s) into the appropriate mounting hole (Figure 10.1.1-1) until the pin is fully seated at the bottom of the hole.
5. Lubricate Locating Pin per Section 8.1.1.1.

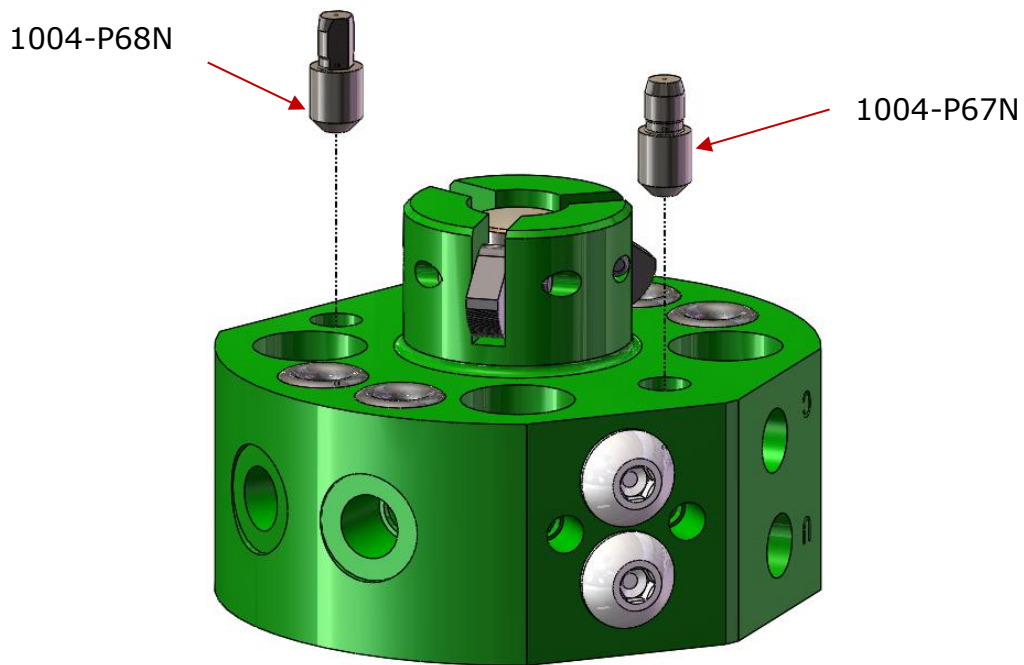


Figure 10.1.1-1. Locating/Alignment Pin Replacement

10.1.2 Couple/Uncouple Sensing Module (Optional Feature)

1. Remove the module from Side 2.
2. Loosen the M3 flat head socket cap screws holding the Sensing Module using a 2.5mm Allen wrench.
3. Remove the Sensing Module (1507-D69A) 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 Side 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 flat head socket cap screws before installing.
8. Install the new Sensing Module using the flat head socket cap screws.
9. Reinstall module removed from Side 2 in Step 1.
10. Prior to coupling the Tool Changer, cycle the actuating cylinder for the Robot Side several times to ensure that the sensors are working properly and the correct inputs are being received by the robot controller.

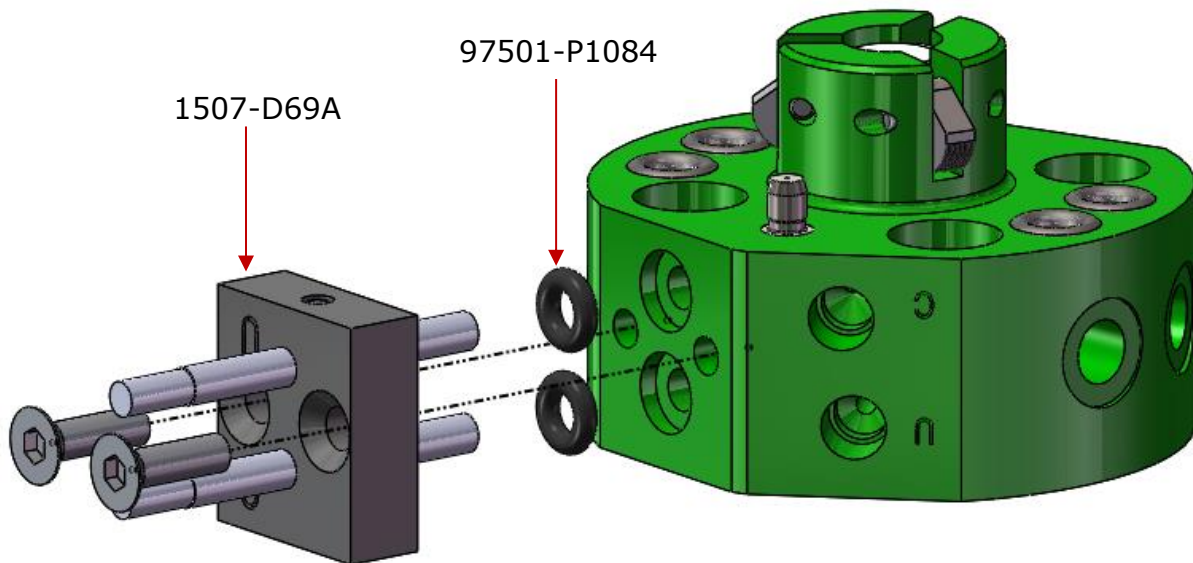


Figure 10.1.2-1. Couple/Uncouple Sensing (Optional) Module Replacement

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.

10.2 TOOL SIDE

10.2.1 Locking Ring

1. Remove the Tool Side from the Tool.
2. Remove two (2) M2.5 socket head set screws (2000118P) using a 1.3 mm Allen wrench.
3. Remove the Locking Ring (1507-C76N) from the Tool Adaptor by using a pin through the pin hole to push the Locking Ring out of the Tool Side.
4. Apply Loctite 648, or equivalent, to the mating surface of the housing.
5. Insert Locking Ring into the Tool Side with the FLAT SIDE down with NO GAP between the housing and Locking Ring. A press may be needed to properly seat the Locking Ring.
6. Apply Loctite 222, or equivalent, to two (2) M2.5 socket head set screws and install them using a 1.3 mm Allen wrench.

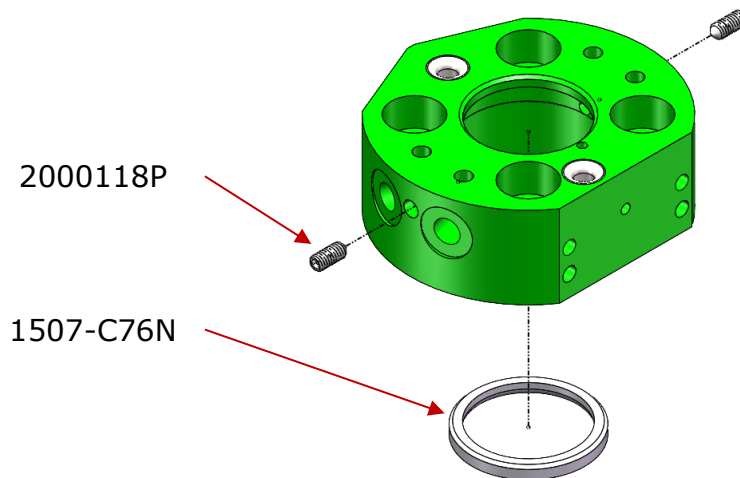


Figure 10.2.1-1. Locking Ring

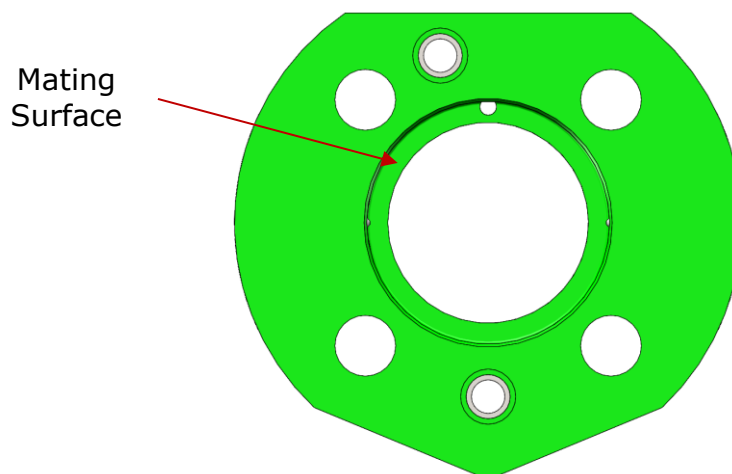


Figure 10.2.1-2. ET31.5 Mating Surface

Locking Ring (1507-C76N) hidden for clarity.

10.2.2 Locating Bushing

1. Remove the Tool Side from the Tool.
2. Press out the Locating Bushings (49429) from the bottom of the Tool Side Housing.
3. Press in new Locating Bushings from the top of the Tool Side Housing until it is just below the Tool Side Housing surface. Ensure that the rounded edge of the Locating Bushing faces the top surface of the Tool Side Housing.
4. Lubricate the Locating Bushing per Section 8.1.1.2.

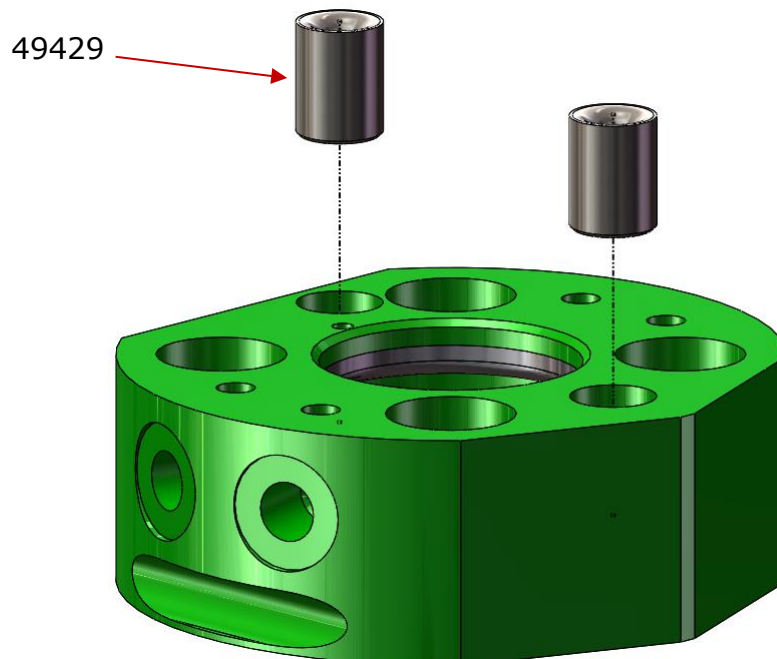


Figure 10.2.2-1. Locating Bushing Replacement

11 INFORMATIONAL DOCUMENTS

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.

DECLARATIONS	
Declaration of Incorporation for Partly Completed Machinery	

DRAWINGS	
DRAWING NUMBER	DESCRIPTION
1507-D63A	ER31.5-N/A-020-N-0-C0000
1606-D02A	ER31.5-PNP-020-N-0-C0000
1507-D67A	ET31.5-022-N-C0000

Declaration of Incorporation of Partly Completed Machinery (Annex II 1 B of EC Machinery Directive 2006/42/EC)

Description and identification of the partly completed machinery:

XChange – EPSILON Series Tool Changers & Utility Modules

Fulfills the following function:

Allows industrial robots (and other automated equipment) to automatically change their end of arm tooling under programmed control without the need of human intervention. These products are intended to be incorporated into machinery supplied by others.

The following essential requirements of EC Machinery Directive 2006/42/EC (Annex I) have been applied and fulfilled:

Section 1.1.2.	Principles of safety integration
Section 1.1.3.	Materials and products
Section 1.1.5.	Design of machinery to facilitate its handling
Section 1.2.1.	Safety and reliability of control systems
Section 1.2.6.	Failure of the power supply
Section 1.3.2	Risk of break-up during operation
Section 1.3.3.	Risks due to falling or ejected objects
Section 1.3.4.	Risks due to surfaces, edges or angles
Section 1.3.7.	Risks related to moving parts
Section 1.3.9.	Risks of uncontrolled movements
Section 1.5.1.	Risks due to electricity supply
Section 1.5.3.	Risks due to energy supply other than electricity (air pressure)
Section 1.5.8.	Risks due to noise
Section 1.5.10.	Risks due to non-ionizing radiation
Section 1.6.4.	Operator intervention
Section 1.7.1.	Information and warnings on the machinery
Section 1.7.2.	Warning of residual risks
Section 1.7.3.	Marking of machinery
Section 1.7.4.	Instructions.

The partly completed machinery has been designed and manufactured according to the following harmonized standards:

EN ISO 12100-1	Safety of machinery - Basic concepts, general principles for design Part 1: Basic terminology, methodology
EN ISO 12100-2	Safety of machinery - Basic concepts, general principles for design Part 2: technical principles

EN ISO 10218-2	Robots and robotic devices — Safety requirements for industrial robots — Part 2: Robot systems and integration
EN ISO 60204-1	Safety of machinery. Electrical equipment of machines. General requirements
EN 61000-6-2	Electromagnetic compatibility (EMC) - Generic standards. Immunity for industrial environments
EN 61000-6-4	Electromagnetic compatibility (EMC) - Generic standards. Emission standard for industrial environments
EN 61000-4-2	Electromagnetic compatibility (EMC). Testing and measurement techniques. Electrostatic discharge immunity test
EN 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use -- Part 1: General requirements

The relevant technical documentation has been compiled in accordance with Annex VII, Part B of EC Machinery Directive 2006/42/EC. We undertake, in response to a reasoned request, to supply it in electronic form to the market surveillance authorities within a reasonable period.

The party authorized to compile the technical documentation is:

Giovanni Patrini, at Effecto Group SpA

The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of the Machinery Directive.


Stefan Casey
Vice President, Engineering

APRIL 20, 2018
Date

