Applied Robotics™
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EPSILON E160
TOOL CHANGE SYSTEM

95626, Rev 00

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REVISION

Revision	Date	Author	Description
00	3/30/2016	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
0201-P17N	RING, RETAINING EXTERNAL
85943-P1021	O-RING, .801 ID X .070 75 VITON (P)
1104-C30A	SUBASSY, CAM ACTUATOR
0107-C52N	CAM, HIGH LOCK
1507-P79N	DOWEL, M10 X 45 (HARD STL) M6
49621	DOWEL, M12 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 E160 Tool Changer provides a strong and reliable method for a manipulator to quickly change between different tools/end-effectors. With APPLIED ROBOTICS' patented six-sided design, the E160 Tool Changer offers the maximum flexibility for any application.

The E160 Tool Changer contains two major components:

Robot Adaptor (ER160 & ERS160) – Mounts directly to a robot flange utilizing a 160mm ISO 9409-1 pattern without the need for adaptor plates (Figure 3-1).

Tool Adaptor (ETS160) – Mounts directly to a tooling plate utilizing a 160mm 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.

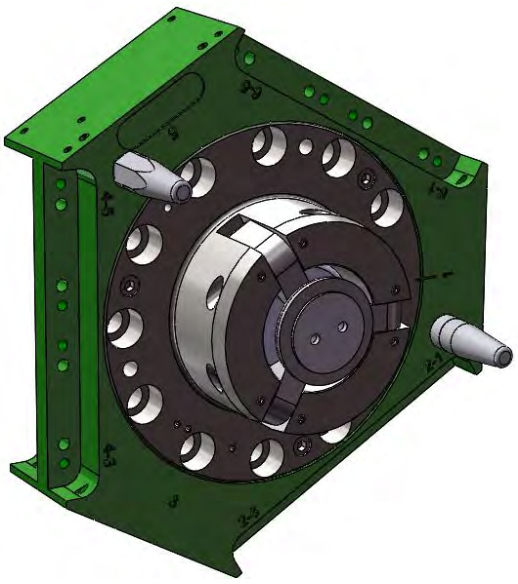


Figure 3-1. ER160/ERS160 Robot Adaptor

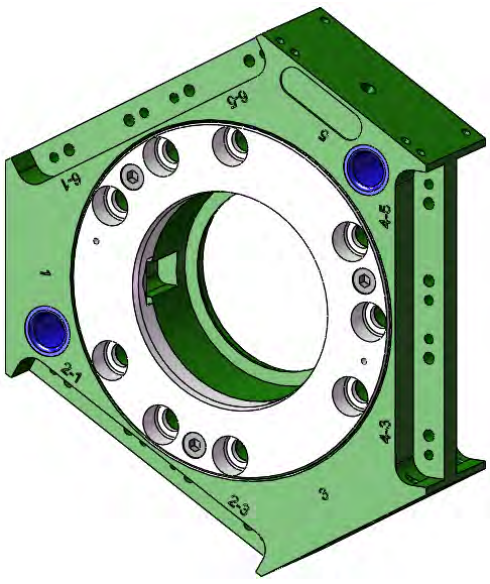
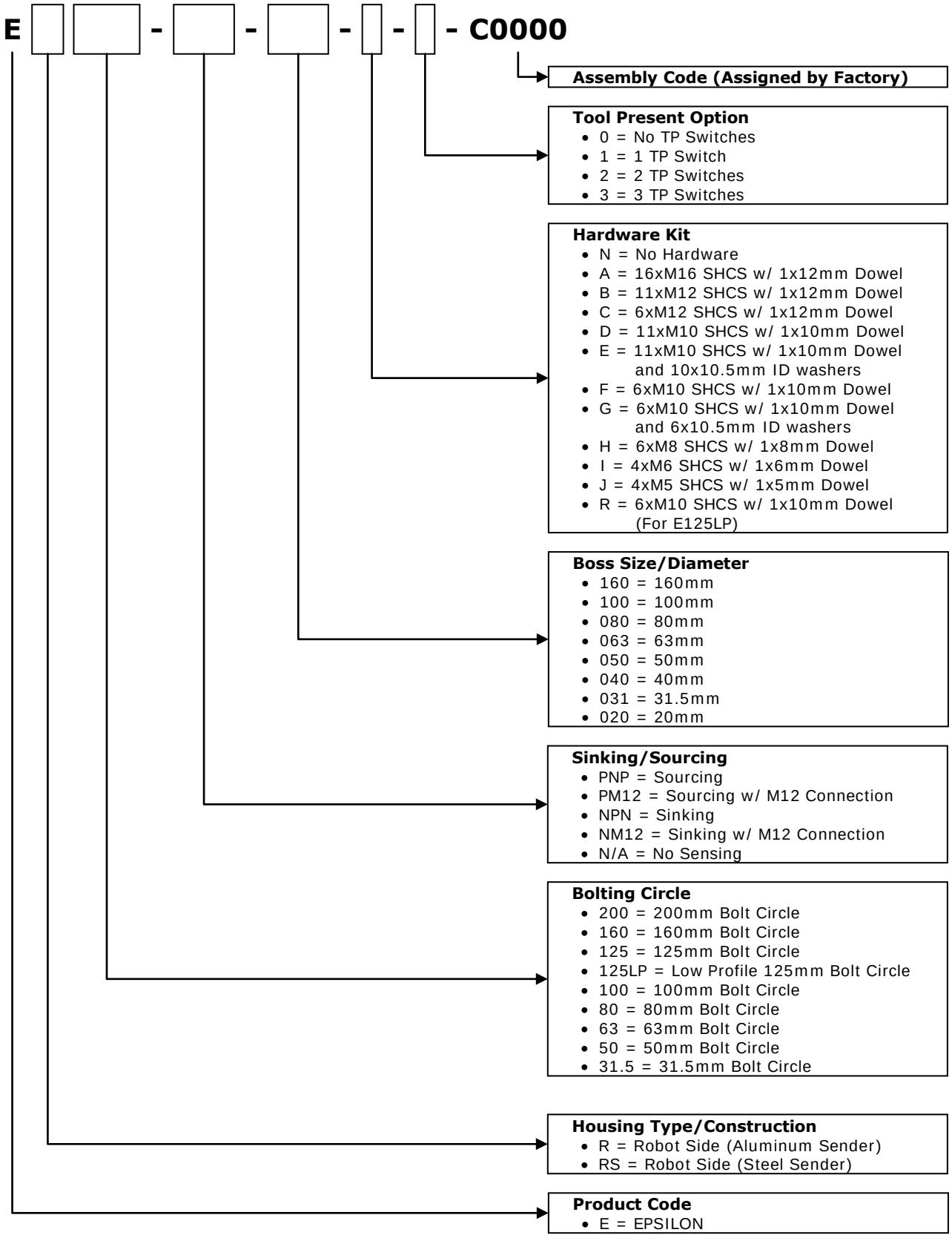
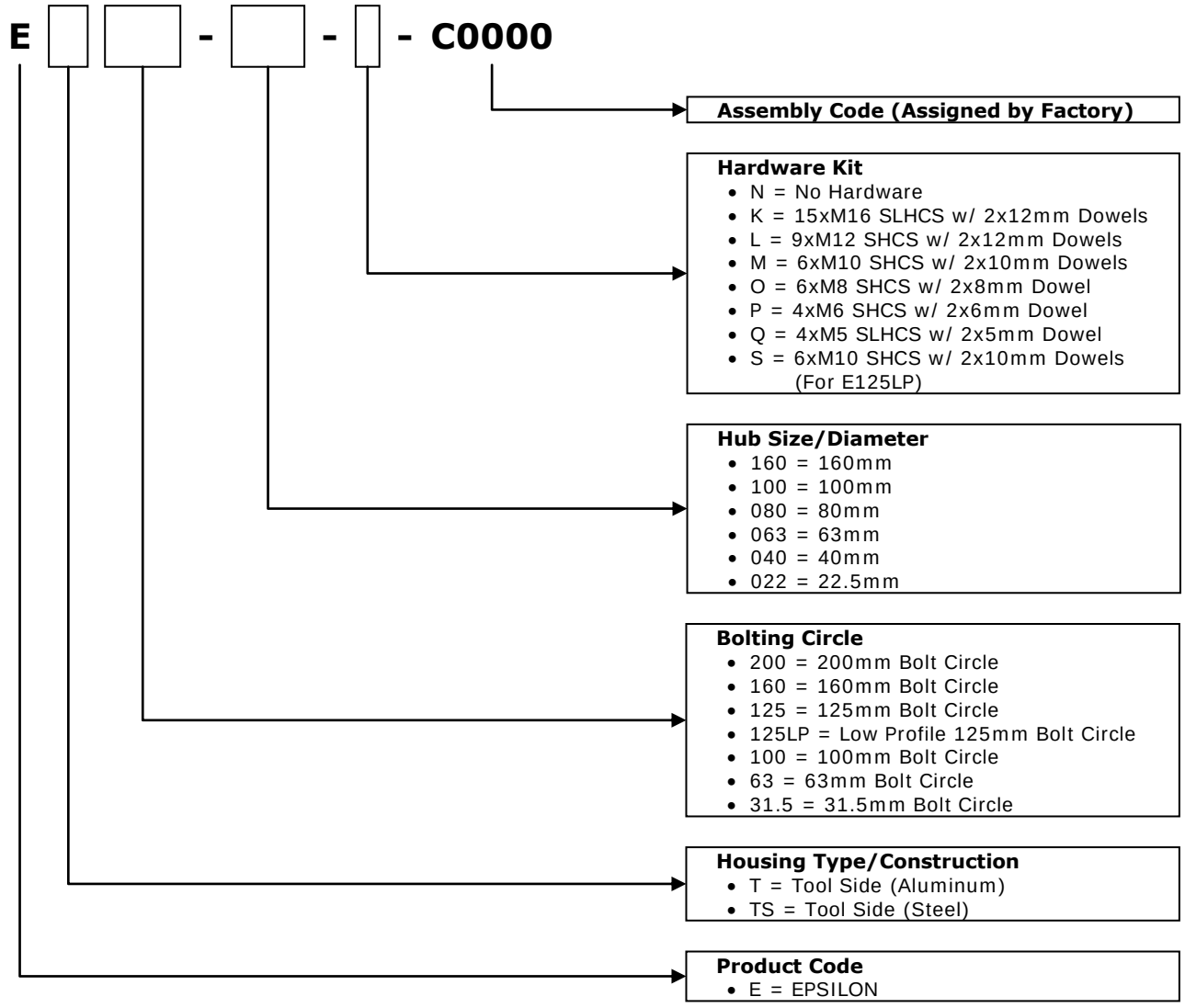


Figure 3-2. ETS160 Tool Adaptor

3.1 ROBOT ADAPTOR



3.2 TOOL ADAPTOR



4 TECHNICAL SPECIFICATIONS

4.1 E160 (HIGH STRENGTH ALUMINUM)

Table 4.1-1. E160 (High Strength Aluminum) Technical Specifications

Specification		Metric	English
Payload		525 Kg	1,155 lbs
Maximum Operating Moment (Mx, My)		4,300 Nm	38,060 in-lbs
Maximum E-Stop Moment (Mx, My)		8,195 Nm	72,530 in-lbs
Maximum Operating Torque (Mz)		4,800 Nm	42,480 in-lbs
Maximum E-Stop Torque (Mz)		5,945 Nm	52,615 in-lbs
Maximum Tensile Force (F_T)		37,120 N	8,345 lbs
Maximum Compressive Force (F_C)		160,003 N	35,970 lbs
Width x Length		242.9 mm x 280.5 mm	9.56 in x 11.04 in
Height (Robot and Tool Coupled)		120 mm	4.72 in
Mass / Weight	Robot (Al)	7.58 Kg	16.68 lbs
	Tool (Stl)	6.31 Kg	13.88 lbs
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		22 – 28 Vdc	22 – 28 Vdc

4.2 ES160 (STEEL)

Table 4.2-1. ES160 (Steel) Technical Specifications

Specification		Metric	English
Payload		800 Kg	1,760 lbs
Maximum Operating Moment (Mx, My)		5,649 Nm	50,000 in-lbs
Maximum E-Stop Moment (Mx, My)		10,999 Nm	97,350 in-lbs
Maximum Operating Torque (Mz)		5,280 Nm	46,730 in-lbs
Maximum E-Stop Torque (Mz)		6,690 Nm	59,210 in-lbs
Maximum Tensile Force (F_T)		49,486 N	11,125 lbs
Maximum Compressive Force (F_C)		160,003 N	35,970 lbs
Width x Length		242.9 mm x 280.5 mm	9.56 in x 11.04 in
Height (Robot and Tool Coupled)		120 mm	4.72 in
Mass / Weight	Robot (Stl)	11.72 Kg	25.78 lbs
	Tool (Stl)	6.31 Kg	13.88 lbs
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		22 – 28 Vdc	22 – 28 Vdc

5 INSTALLATION

5.1 ROBOT ADAPTOR INSTALLATION

The E160 Robot Adaptor is designed to mount directly to interfaces utilizing an ISO 160mm bolt pattern (ISO 9409-1). The E160 Robot Adaptor can mount to manipulator interfaces utilizing either M10 or M12 hardware. Using M10 hardware requires the use of a 10.5mm ID x 19mm OD x 3mm thick washer underneath the head of the screw. For size, locations, and tolerance information on the E160 Robot Adaptor mounting patterns, see APPLIED ROBOTICS drawing number 1500-D10A (ER160) or 1500-D69A (ERS160).

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 E160 Robot Adaptor Using M12 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) M12 locating dowel. Alternatively, the Robot Adaptor can be located using one (1) M12 locating dowel and one (1) M12/M13 stepped locating dowel (Figure 5.1-1).
2. Insert and tighten the M12 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.

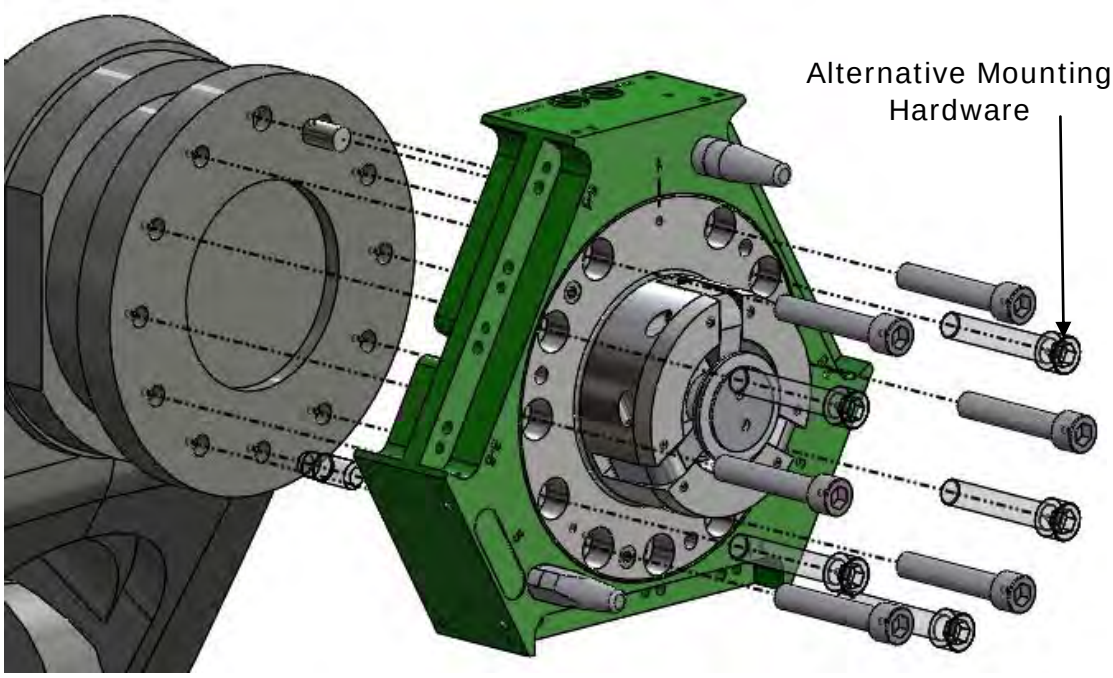


Figure 5.1-1. E160 Robot Adaptor Installation w/ M12 Hardware

⚠ 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.

Installing the E160 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/M12 stepped locating dowel. Alternatively, the Robot Adaptor can be located using one (1) M10/M12 stepped locating dowel and one (1) M10/M13 stepped locating dowel (Figure 5.1-2).
2. Insert and tighten the M10 socket head cap screws (minimum Property Class 10.9) WITH 10.5mm ID x 19mm OD x 3mm thick washer 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.

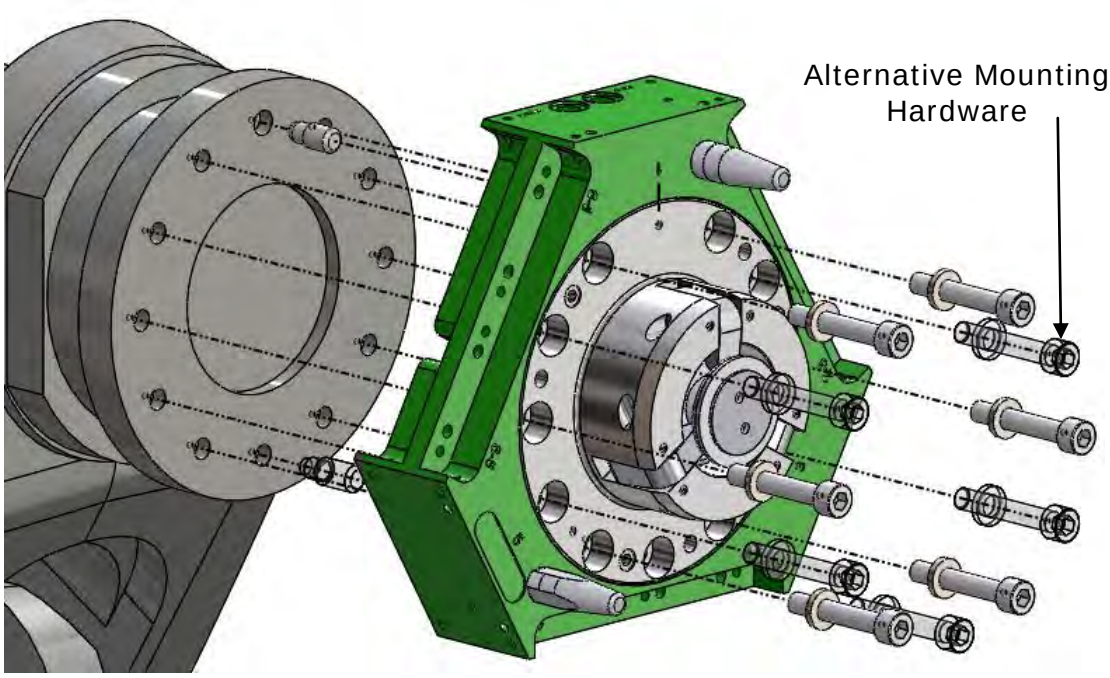


Figure 5.1-2. E160 Robot Adaptor Installation w/ M10 Hardware

⚠ 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 E160 Tool Adaptor is designed to mount directly to customer tooling utilizing an ISO 9409-1 modified bolt pattern and is compatible with both the ER160 and ERS160. The E160 Tool Adaptor can be mounted from the top down using M12 hardware on the ISO 160mm bolt circle. For size, locations, and tolerance information on the E160 Tool Adaptor mounting patterns, see APPLIED ROBOTICS drawing number 1504-D63A.

NOTICE

TOOL CHANGER PAYLOAD & MOMENT RATINGS BASED ON USING 9xM12 SCREWS TO MOUNT THE TOOL ADAPTOR TO THE TOOLING INTERFACE.

If a locating boss/pilot is used on the tool plate to locate the tool to the Tool Adaptor, then the boss cannot protrude into the tool changer greater than 8.00mm and a 60mm diameter counterbore with a minimum depth of 4mm must be made into the boss to allow for clearance of the latching mechanism (Figure 5.2-1).

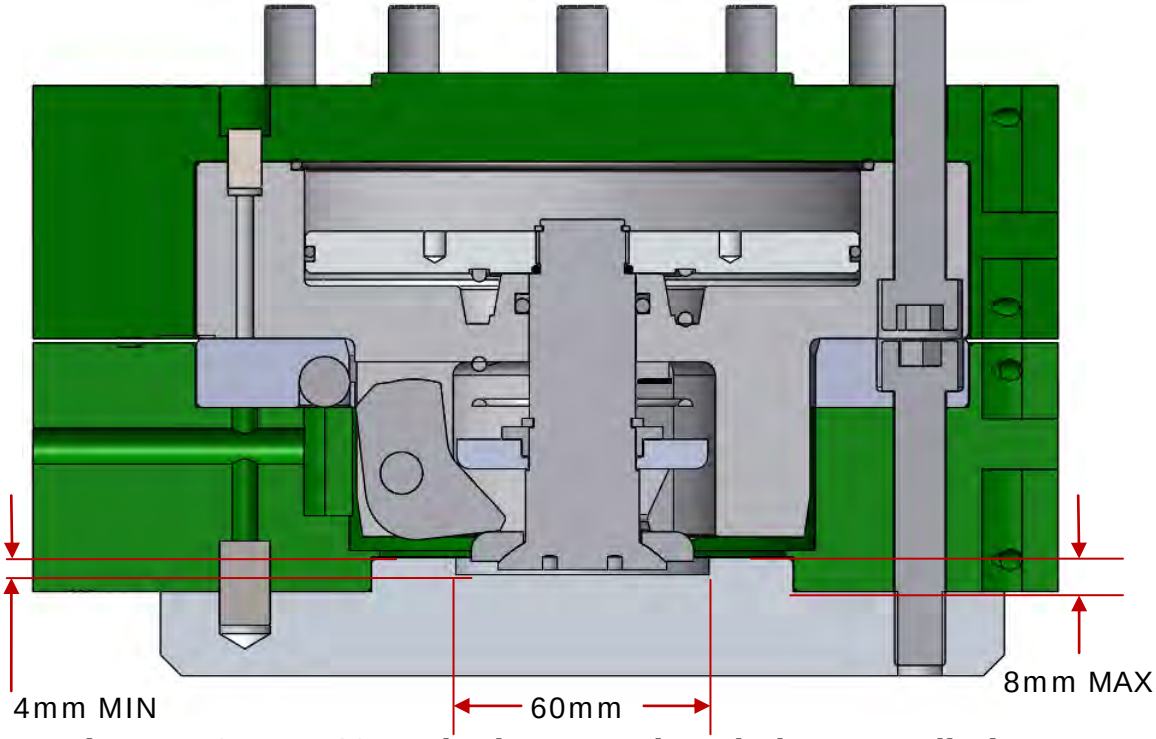


Figure 5.2-1. E160 Tool Adaptor and Tool Plate Installation

Installing the E160 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 either the locating hub and one (1) M12 locating dowel, or two (2) M12 locating dowels (Figure 5.2-2).
2. Insert and tighten M12 socket head cap screws (minimum Property Class 10.9) through the Tool Adaptor 160mm 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.

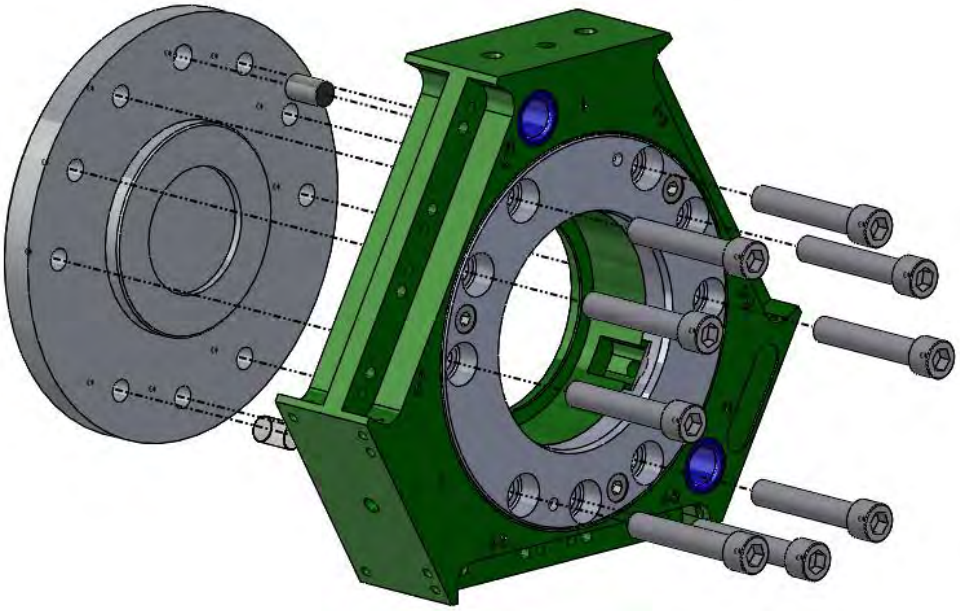


Figure 5.2-2. E160 Tool Adaptor Installation (Bolt Top Down)

5.3 CONNECTING THE AIR SUPPLY

The pneumatic supply for the Epsilon Tool Changer can be supplied via an APPLIED ROBOTICS supplied valve module (S.1-EM-R-V-PB), an APPLIED ROBOTICS supplied Safety Control Module (S-EM-R/T-E-SCM-*), or directly ported via 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.

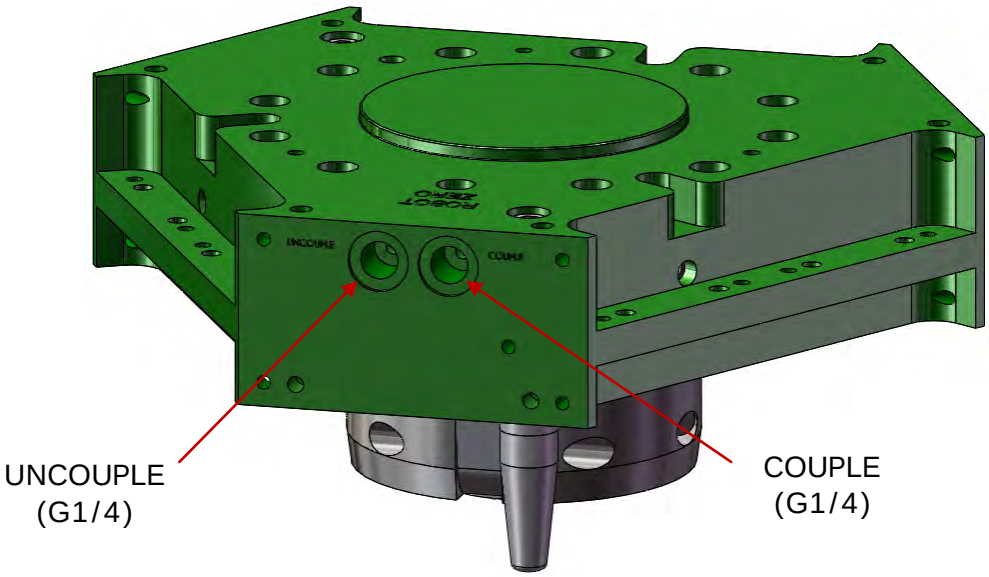


Figure 5.3-1. E160 Robot Adaptor Air Supply Ports

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 & UNCOUPLE SIGNALS

Couple and uncouple signals are provided via an electrical interface at Position 3 of the E160 Robot Adaptor (Figure 5.4-1). APPLIED ROBOTICS utilizes unidirectional differential pressure 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.

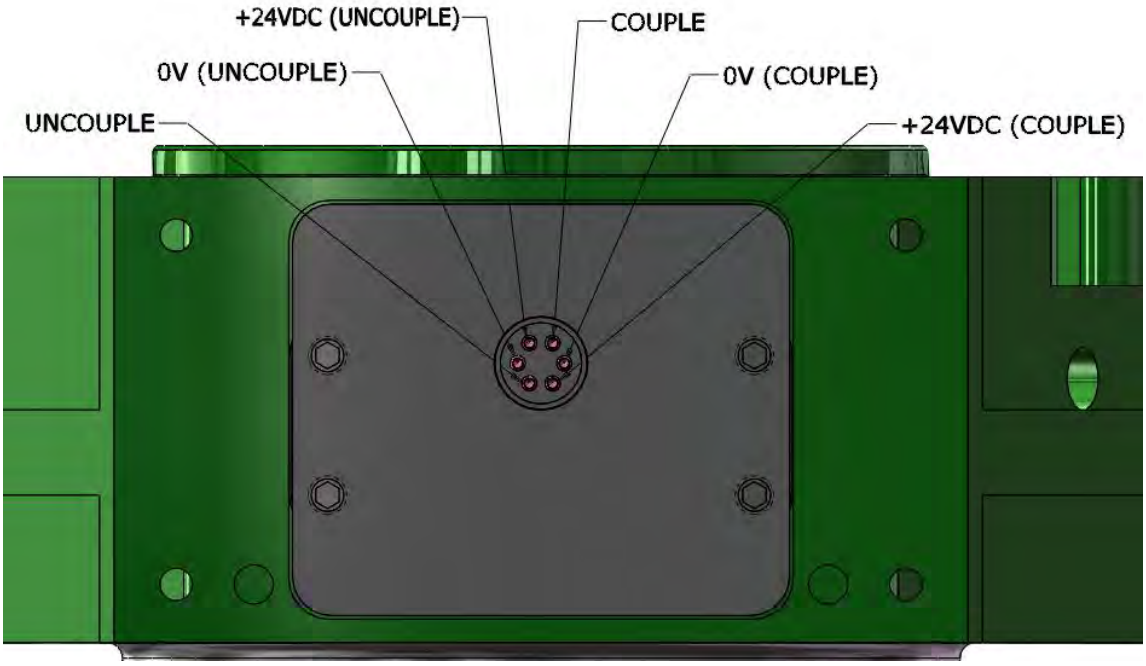


Figure 5.4-1. Couple/Uncouple Signal Interface

NOTICE

COUPLE AND UNCOUPLE SENSORS REQUIRE A MINIMUM AIR PRESSURE OF 5 BAR (72 PSIG) TO FUNCTION. ANY LOSS OF AIR SUPPLY WILL RESULT IN THE LOSS OF THE COUPLE AND UNCOUPLE SIGNALS. WITH THIS FEATURE, THE COUPLE AND UNCOUPLE SIGNALS CAN BE USED FOR INDICATION OF AIR SUPPLY TO THE TOOL CHANGER.

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 E160 Tool Changer contains built in features for Tool Present detection via proximity sensors (Figure 5.5-1). This option allows for up to three (3) Tool Present sensors to be installed and the signals to be monitored either individually or in series providing a single output signal to ensure parallelism between the Robot Adaptor and Tool Adaptor during docking.

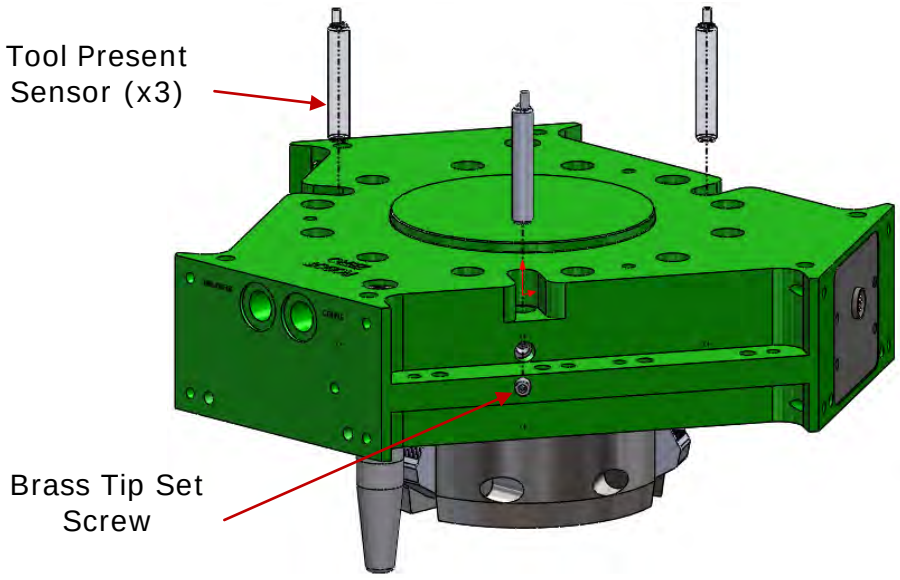


Figure 5.5-1. Tool Present Option

When the Tool Present sensors are installed, ensure that the tip of the sensor (highlighted blue) is installed flush with the Robot Adaptor interface (Figure 5.5-2) and the sensor is secured using a brass tip M6 set screw.

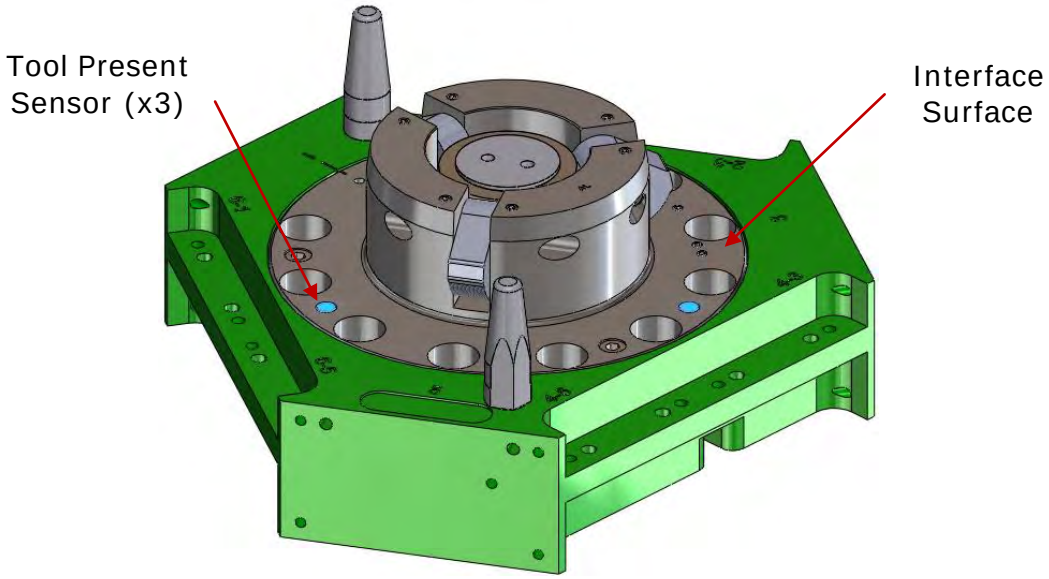


Figure 5.5-2. Tool Present Sensor Installation

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 and/or APPLIED ROBOTICS' Safety Control Module, 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.

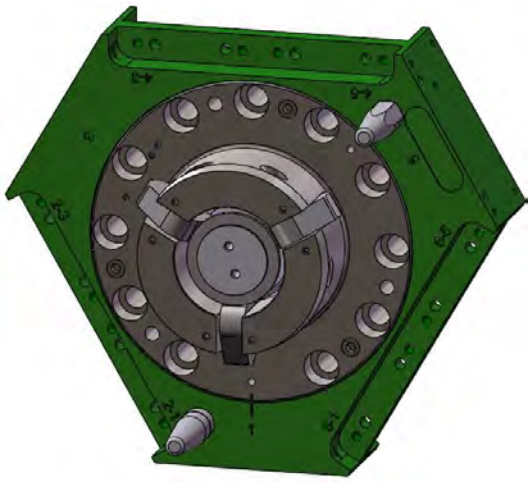


Figure 6.1-1. Robot Adaptor Coupled (Cams Extended)

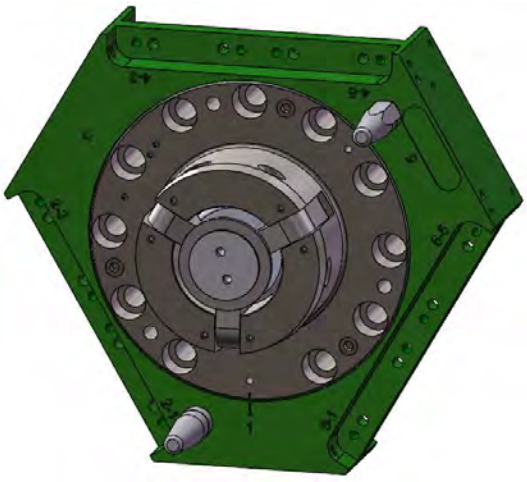


Figure 6.1-2. Robot Adaptor Uncoupled (Cams Retracted)

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 55mm minimum separation between the Robot Adaptor and Tool Adaptor interface surfaces (Figure 6.2-1). Note that the interface surfaces lie inboard of the outer perimeter of the Robot and Tool Adaptor.

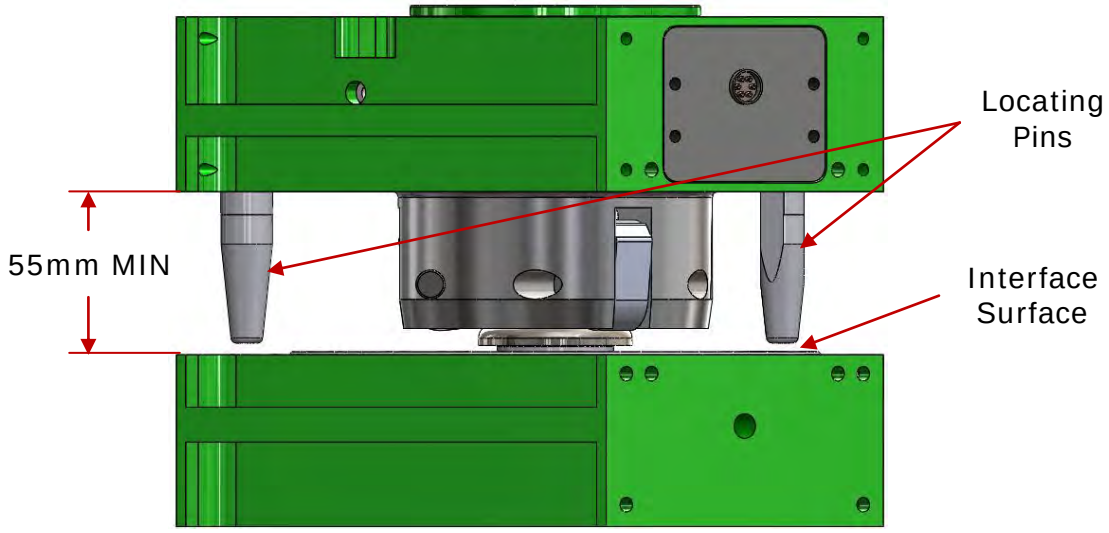


Figure 6.2-1. E160 Tool Changer – Docking Orientation

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, there is a small gap along the outer edge of the Adaptors (Figure 6.2-2).

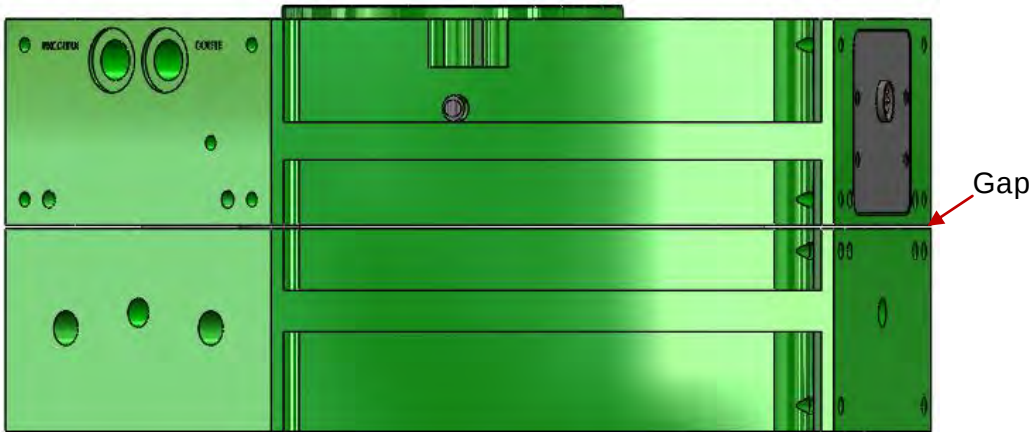


Figure 6.2-2. E160 Tool Changer – Docked Position

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, APPLIED ROBOTICS Tool Stand Monitoring(TSM) circuit, or APPLIED ROBOTICS Safety Control Module (S-EM-R/T-E-SCM-*) that mounts to the Robot and Tool Adaptors. For further information, consult the manual for your particular system or contact APPLIED ROBOTICS Applications Engineering.

6.3.1 Mechanical Lock Design Feature

The E160 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 E160 Robot Adaptor piston chamber returns the cams to the extended position (coupled) when air supply to the Tool Changer is lost.

The E160 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.

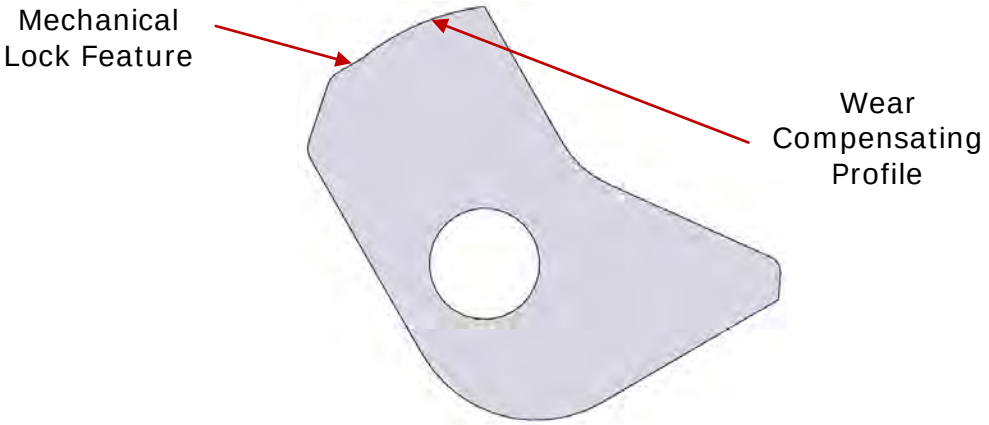


Figure 6.3.1-1. E160 Cam Mechanical Lock Feature

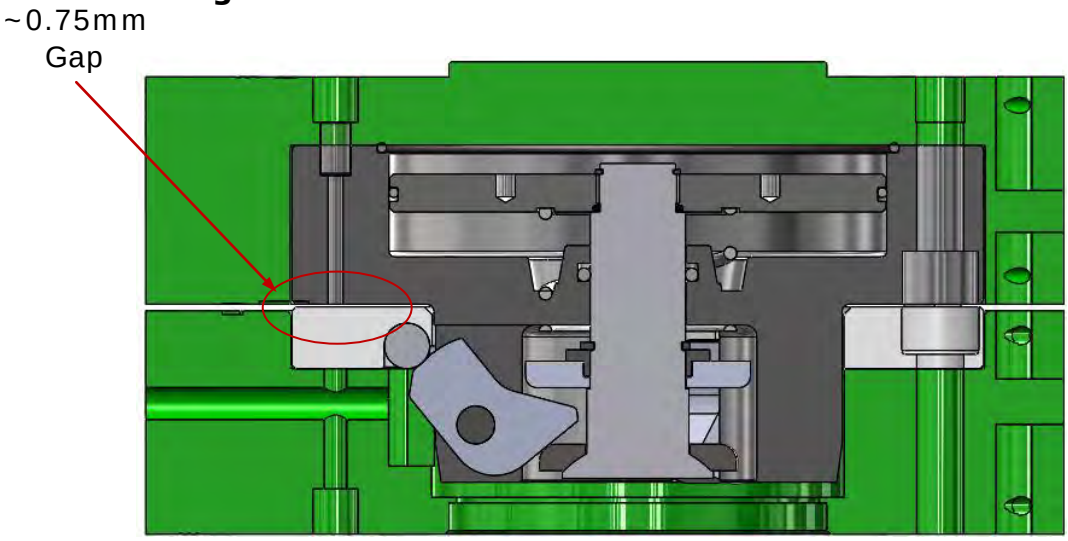


Figure 6.3.1-2. E160 Robot & Tool Adaptor – Loss of Air Mechanical Lock

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. Two (2) Uncouple Commands are required if using APPLIED ROBOTICS' Safety Control Module. 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
   - SCM OK (Safety Signal) ..... HIGH
   - 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
   - SCM OK (Safety 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**

3. Move to "Pre-Dock" position (Approximately 55mm 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
SCM OK (Safety 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

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**
SCM OK (Safety 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
SCM OK (Safety 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**
SCM OK (Safety 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

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
SCM OK (Safety 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

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
SCM OK (Safety 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

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**
SCM OK (Safety 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
SCM OK (Safety 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**
SCM OK (Safety 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

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
SCM OK (Safety Signal) ..... HIGH
Tool Cover Open Signal..... **LOW**
Tool Cover Closed Signal ..... **HIGH**

OUTPUTS:

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

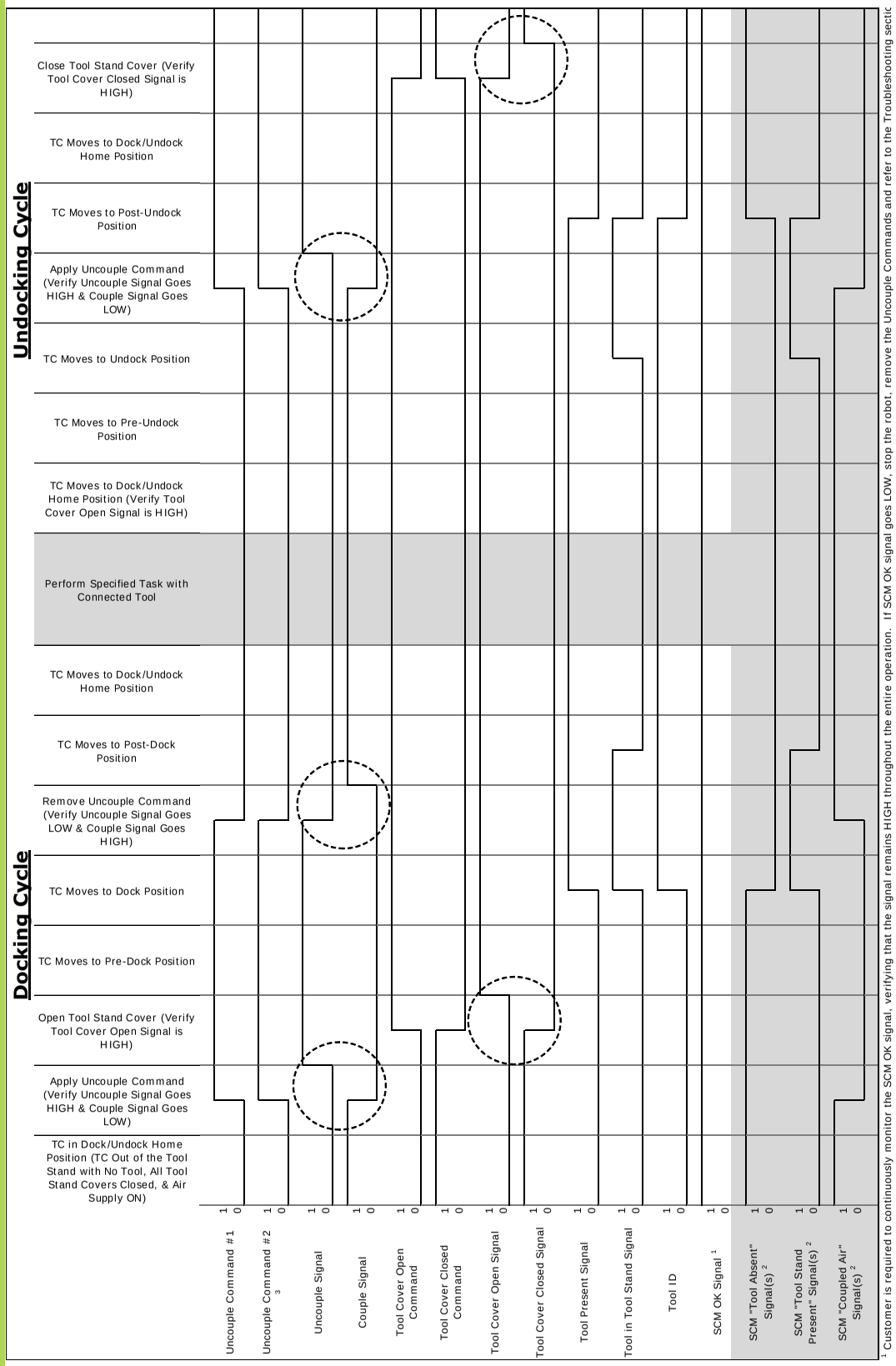


Figure 6.4-1. Sequence of Operations Diagram

[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 sectic
[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.

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.

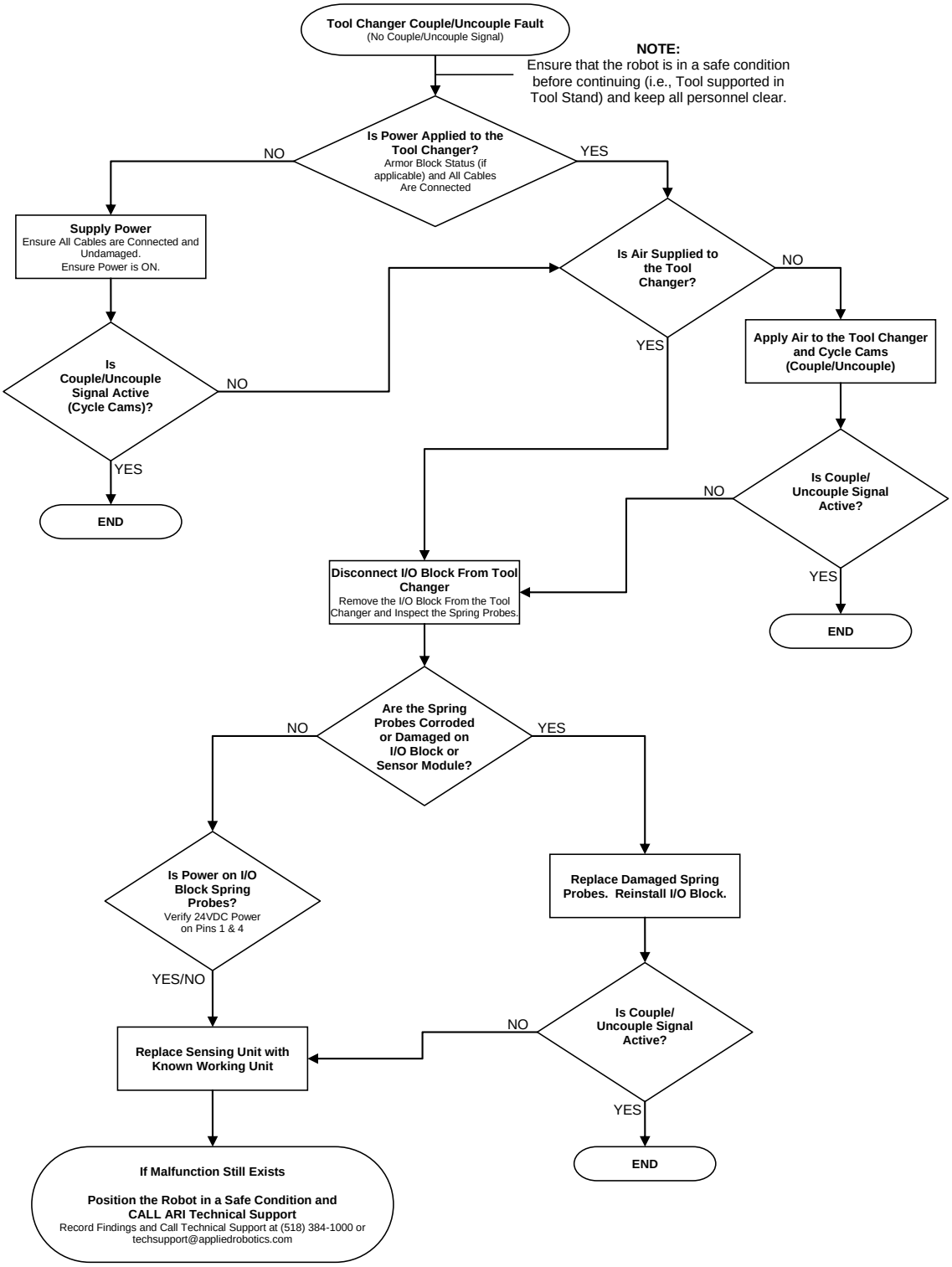
7.2 TROUBLESHOOTING GUIDE

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 sender 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
	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 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 E160 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 E160 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 8mm OD x 60mm long shaft followed by a M10x40mm long socket head cap screw in the hole located in the middle of the short sides (Positions 1, 3, or 5) of the Tool Adaptor Housing as shown in Figure 7.4-1. This requires any tool side modules on Positions 1, 3, or 5 to be removed.
5. Drive the M10 screws 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 E160 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 E160 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/washer, as shown in Figure 8.1.1.1-1 and Figure 8.1.1.1-2 with the surfaces highlighted blue.

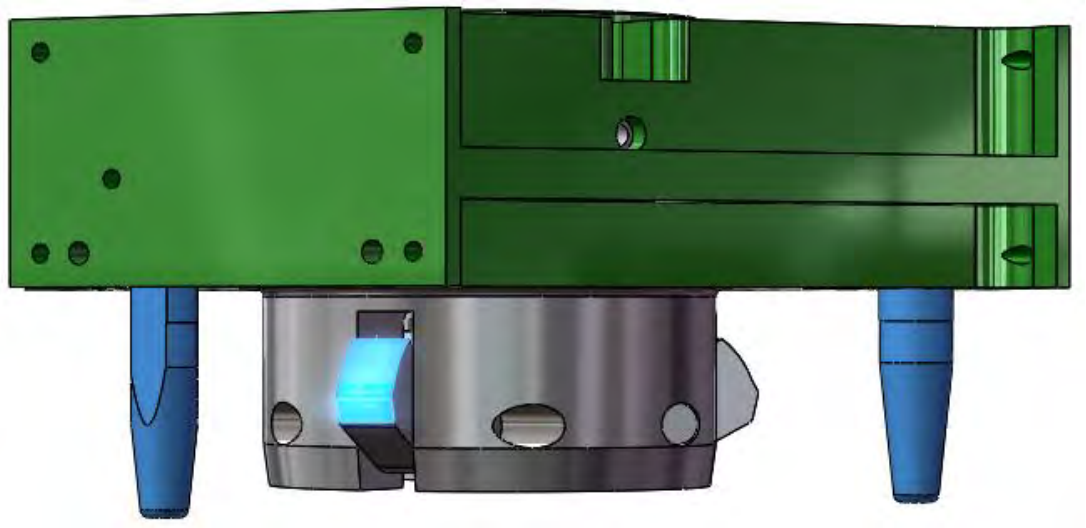


Figure 8.1.1.1-1. E160 Robot Adaptor Lubrication – Locating Pins & Cams

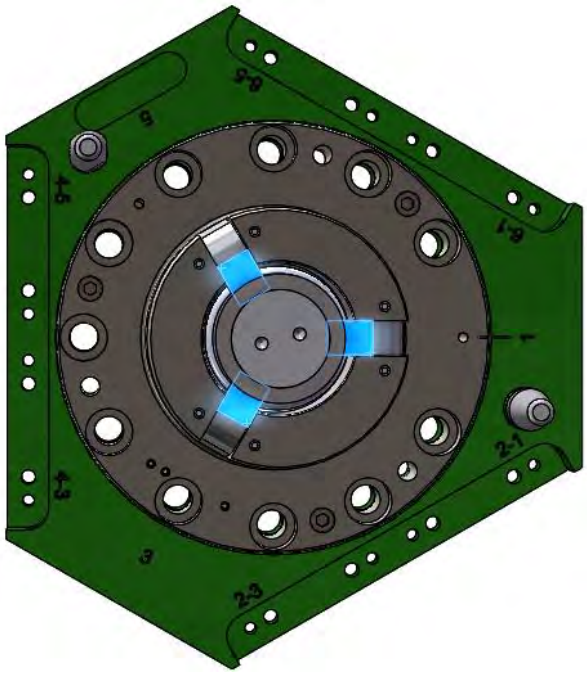


Figure 8.1.1.1-2. E160 Robot Adaptor Lubrication – Cams & Washer

8.1.1.2 Tool Adaptor

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.

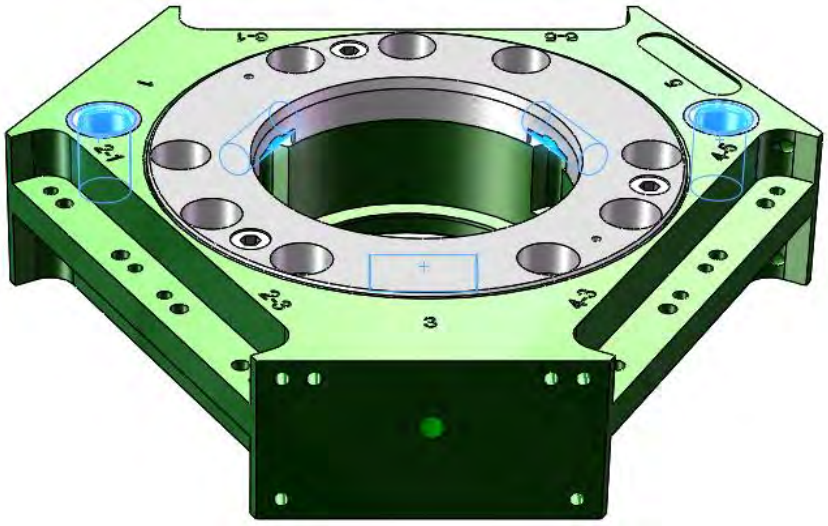


Figure 8.1.1.2-1. E160 Tool Adaptor Lubrication

8.1.2 Visual Checks

Periodic visual checks of the E160 Tool Changer provides 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.

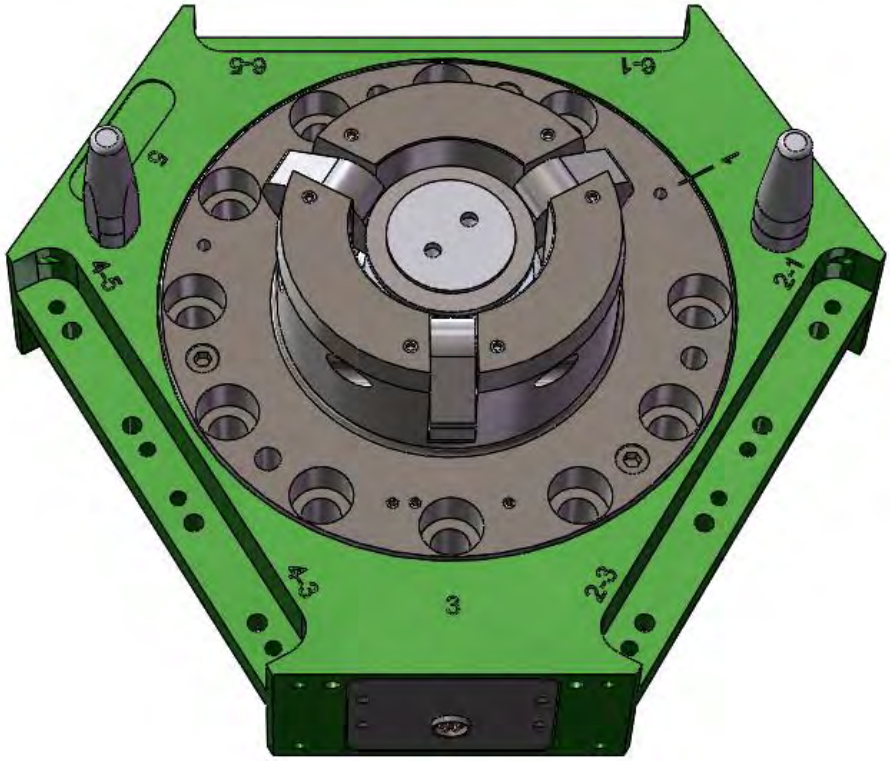


Figure 8.1.2.1-1. E160 Robot Adaptor Visual Inspection

[3] If excessive wear is found on the locating/alignment pins, latching cams (Section 8.1.3), 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.

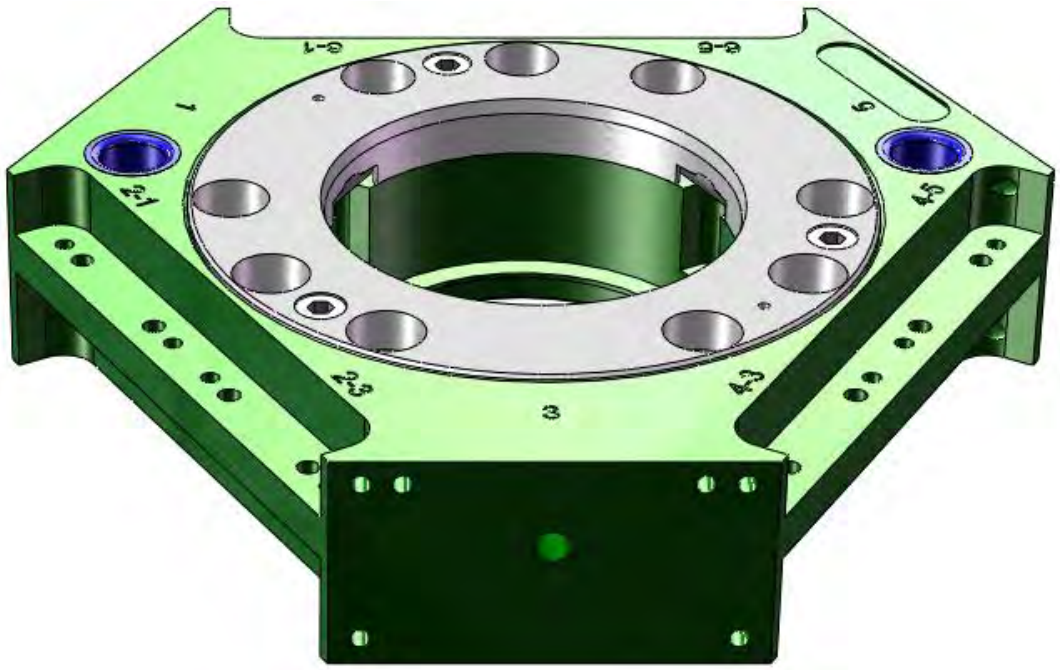


Figure 8.1.2.2-1. E160 Tool Adaptor Visual Inspection

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 (Section 8.1.3), 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.

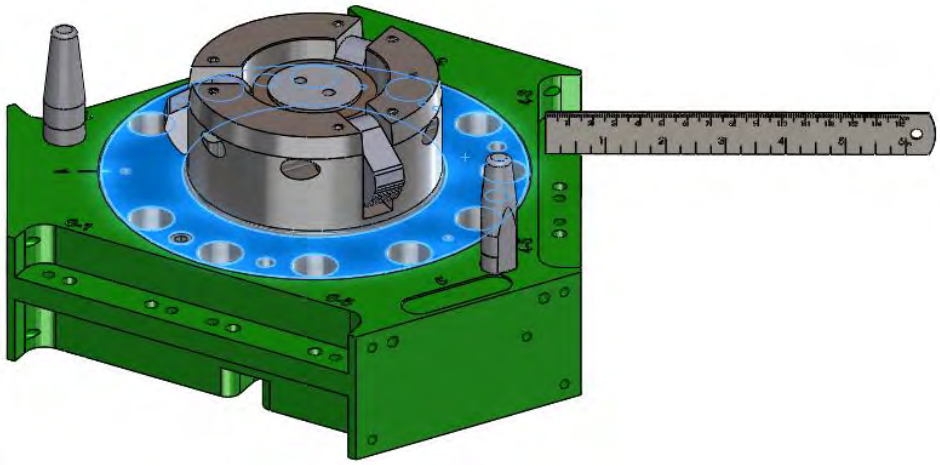


Figure 8.1.3-1. Robot Adaptor – Raised Material Inspection

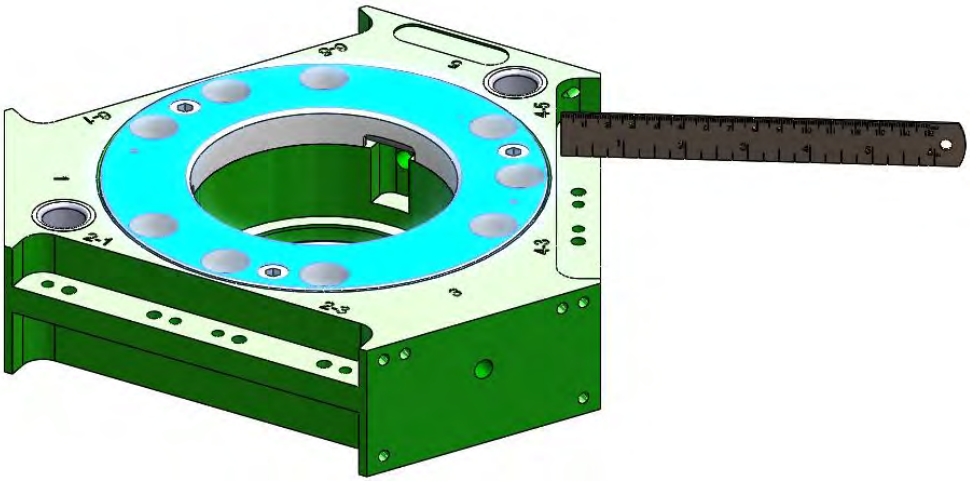


Figure 8.1.3-2. Tool Adaptor – Raised Material Inspection

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.

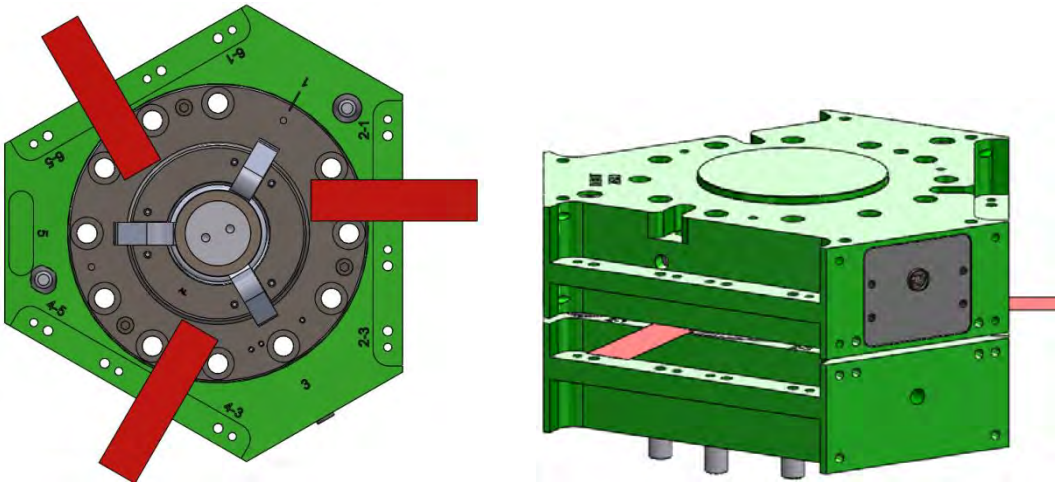


Figure 8.1.3-3. Shim Test of the Cam Locking Mechanism

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, ROUND LOCATING S3 (Round Locating Pin)	0201-B67N	1
PIN, DIAMOND LOCATING S3 (Diamond Locating Pin)	0201-B68N	1
SUBASSY, PS MODULE S3.3R	1500-D05A	1

Table 9-2. Tool Adaptor Spare Parts

TOOL ADAPTOR		
Description	**Part Number**	**Quantity**
DOWEL, M12 X 40 (HARD STL) m6	49621	3
RING, TOOL, ETS160	1504-D64N	1
BUSHING, LOCATING	0201-P86N	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 ADAPTOR

10.1.1 Locating/Alignment Pins

1. Remove the Robot Adaptor from the Robot/Manipulator.
2. Remove the M8 socket head cap screw (49045) using a 6mm allen wrench.
3. Remove round Locating Pin (0201-B67N) or Diamond Locating Pin (0201-B68N). Locating/Alignment Pins may need to be punched out.
4. Place new Locating Pin into the appropriate mounting hole. Check the orientation of the Diamond Locating Pin as shown in Figure 10.1.1-1.
5. Apply Loctite 242, or equivalent, to M8 socket head cap screw 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. Torque screws to 15 Nm (120 in-lbs).
6. Lubricate Locating Pin per Section 8.1.1.1.

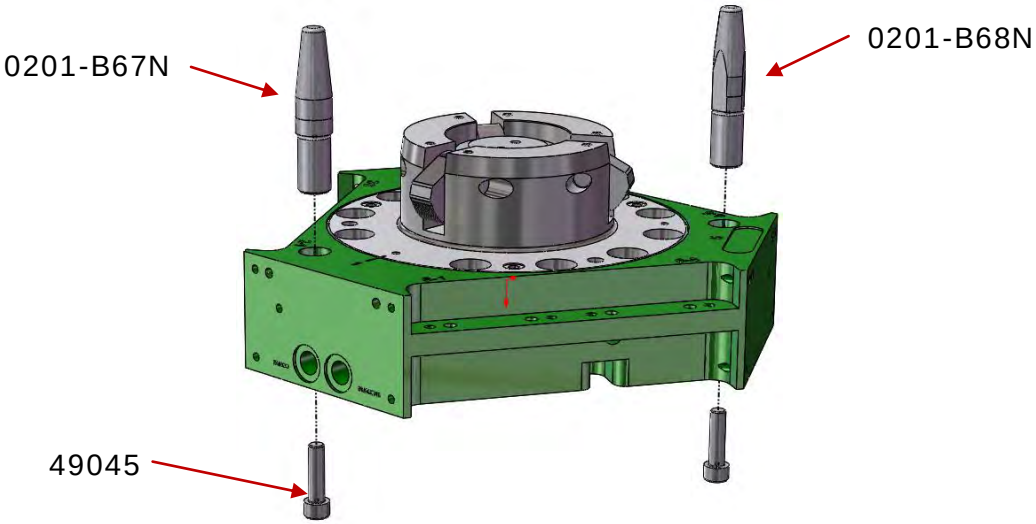


Figure 10.1.1-1. Locating/Alignment Pin Replacement

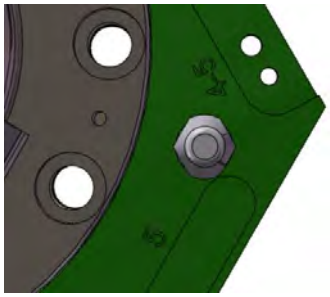


Figure 10.1.1-2. Locating/Alignment Pin Replacement

10.1.2 Couple/Uncouple Sensing Module

1. Remove the module (1500-D05A) located in Position 3.
2. Loosen the captivated socket head cap screws holding the Sensing Module using a 3mm 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. Clean the socket head cap screw threads and apply Loctite 242, or equivalent, to the threads and tighten.
6. Ensure that the cavity in the Robot Adaptor Housing holding the Sensing Module is free of all foreign objects.
7. Ensure that the four (4) o-rings (0601-P65N) for the air ports, supplied with the Sensing Module, are properly positioned.
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.

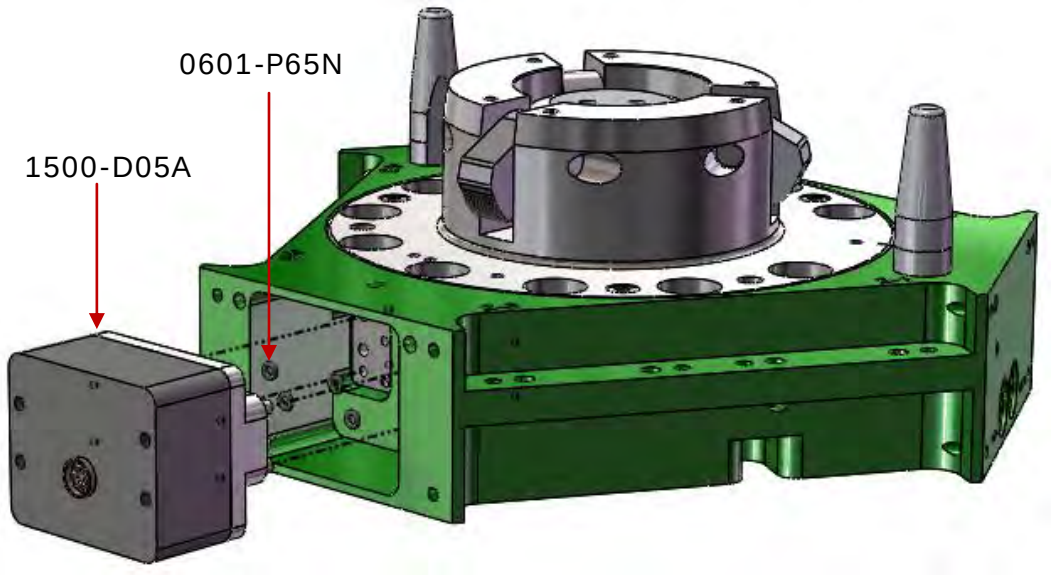


Figure 10.1.2-1. Couple/Uncouple Sensing Module Replacement

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.

10.2 TOOL ADAPTOR

10.2.1 Latching Dowel & Tool Ring

1. Remove the Tool Adaptor from the Tool.
2. Remove the M8 socket head cap screws (49043) using a 6mm allen wrench and separate the Tool Ring (1504-D64N) from the Tool Adaptor Housing.
3. Remove the Latching Dowels (49621) from the Tool Ring.
4. Place new Latching Dowels into the grooves of the Tool Ring.
5. Apply Loctite 242, or equivalent, to M8 socket head cap screws removed in step 2 (clean threads before applying thread locker) and re-install the Tool Ring into the Tool Adaptor Housing.
6. Lubricate Latching Dowels per Section 8.1.1.2.

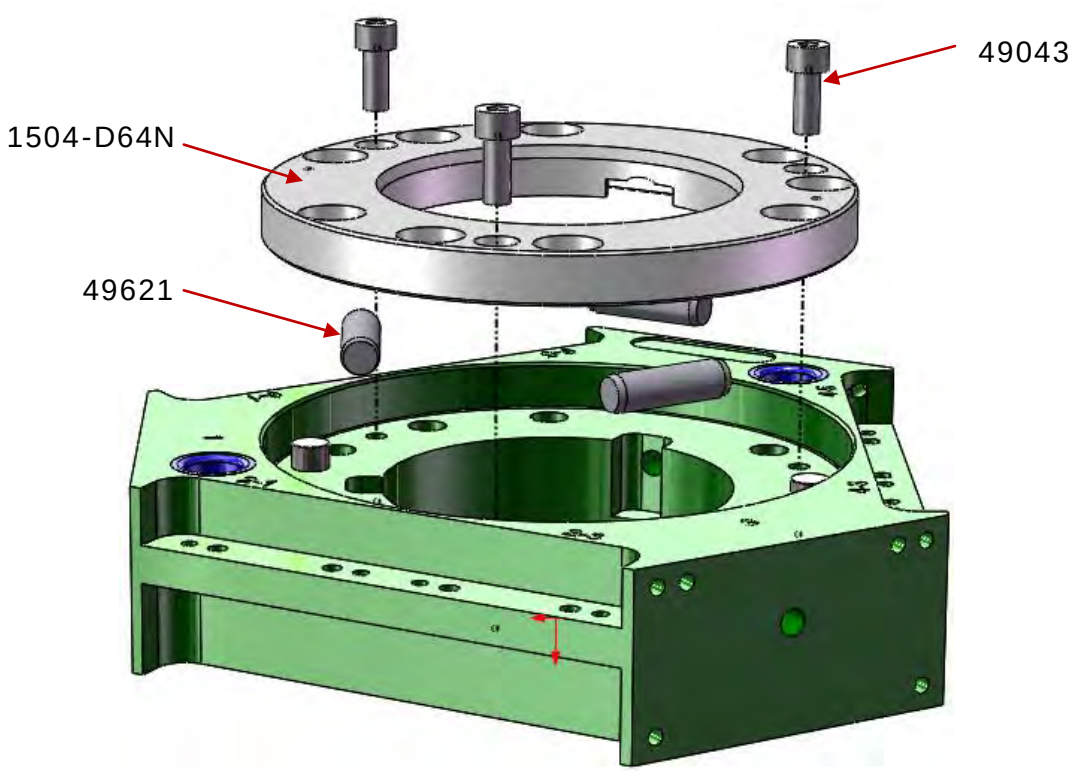


Figure 10.2.1-1. Latching Dowel & Tool Ring Replacement

10.2.2 Locating Bushing

1. Remove the Tool Adaptor from the Tool.
2. Press out the Locating Bushings (0201-P86N) 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 flush with 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.

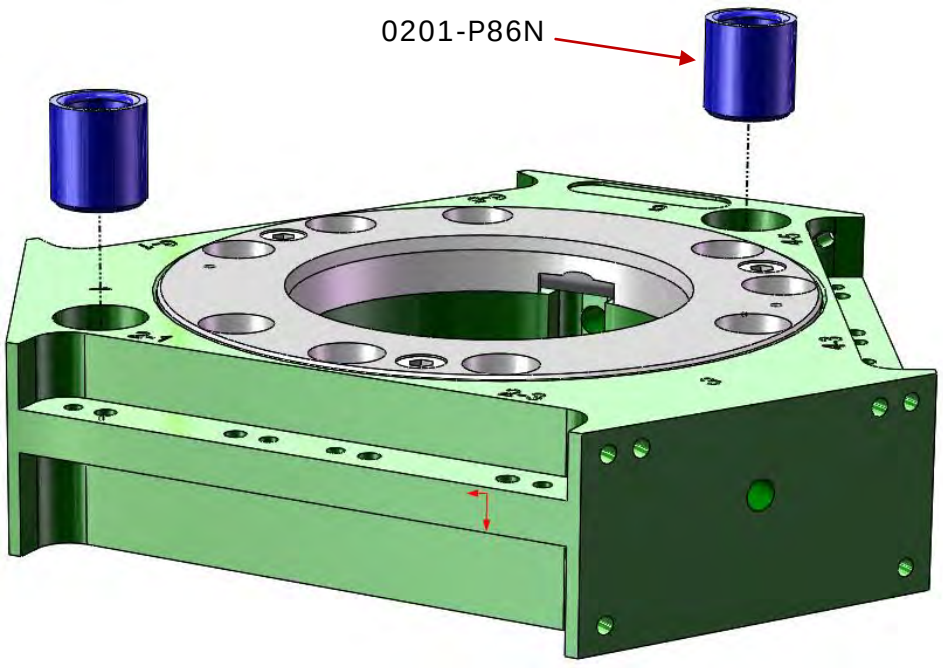


Figure 10.2.2-1. Locating Busing Replacement

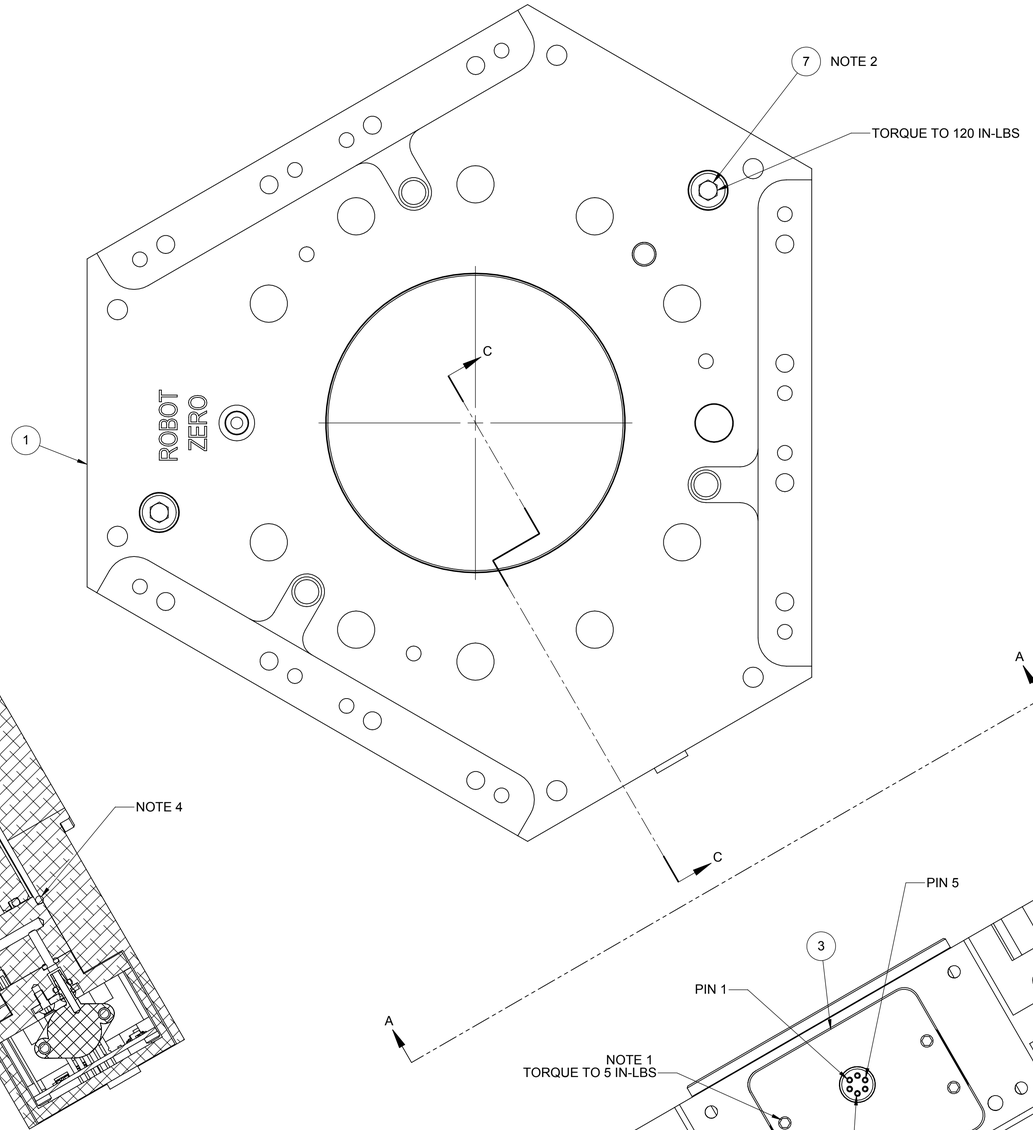
11 INFORMATIONAL DRAWINGS

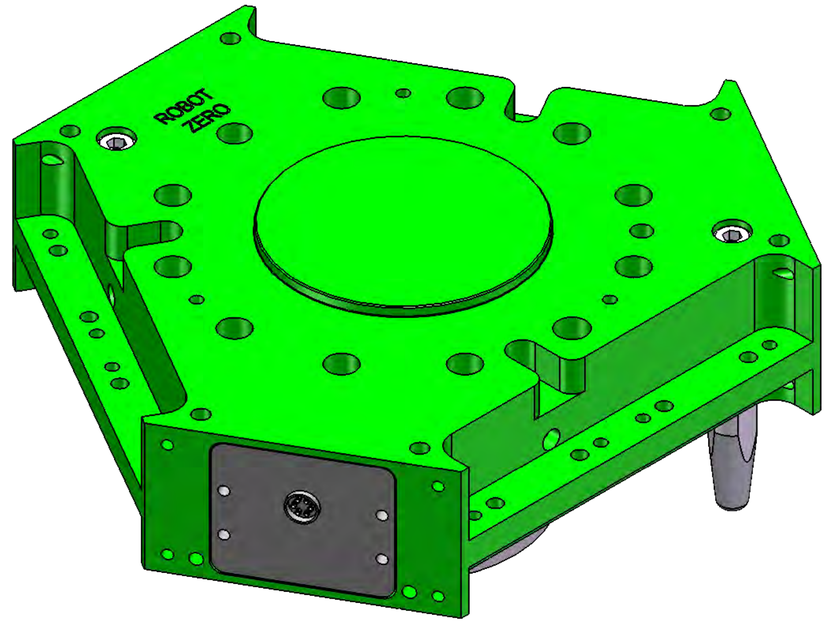
The drawings in this section can assist with installation, use and identification of replacement parts for the Epsilon Tool Changer. Please contact **APPLIED ROBOTICS Technical Support** if you have any questions.

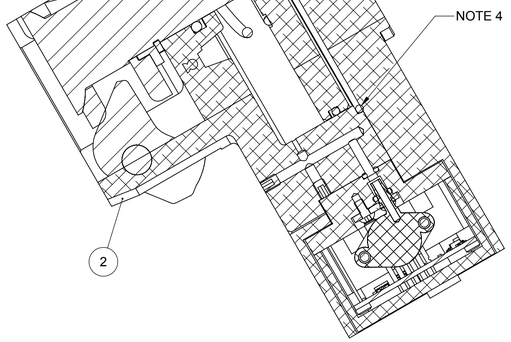
DRAWING NUMBER	DESCRIPTION
1500-D10A (Aluminum)	ER160-PNP-100-N-0-C0000
1500-D69A (Steel)	ERS160-PNP-100-N-0-C0000
1504-D63A	ETS160-100-N-C0000

SIZE	DRAWING NUMBER	REV
D	1500-D10A	01

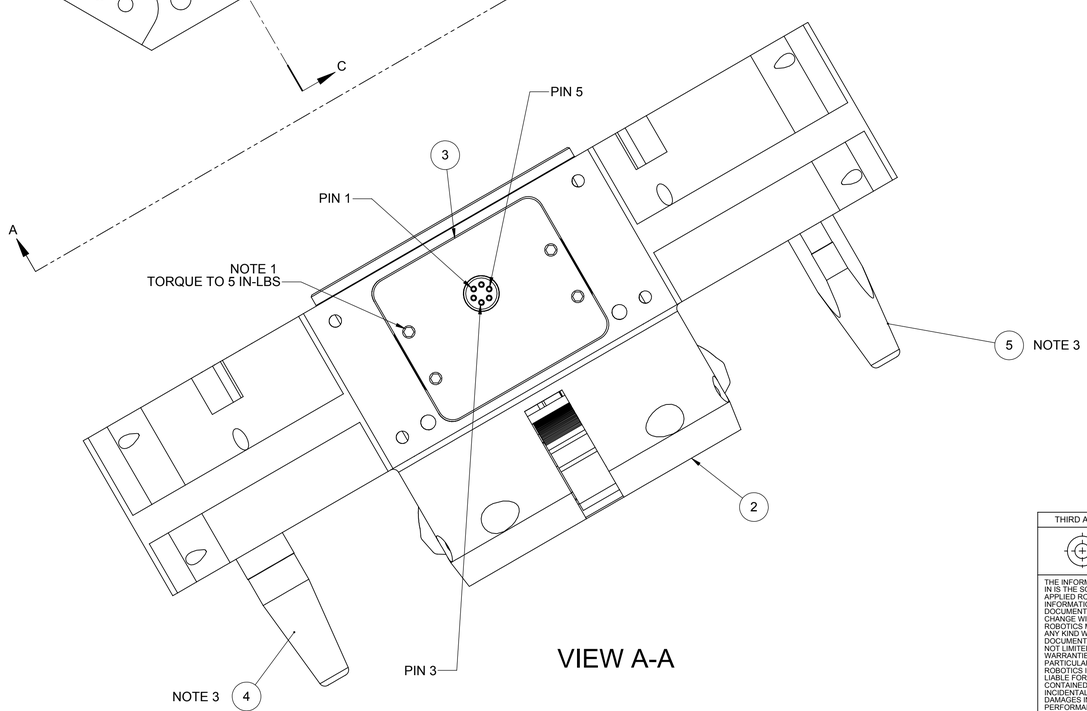
REVISIONS						
ZONE	REV	DESCRIPTION	DR	CHK	DATE	ECR/ESR NO.
	00	RELEASE FOR MANUFACTURE	JV	SC	7/24/15	JVAA-9TLLJN
	01	NAME WAS SUBASSY, ER160	TM	CM	2/9/2016	TMAA-A6YKPP







SECTION C-C



VIEW A-A

NOTES:

1. APPLY LOCTITE 222, ARI #86005-P1020.
2. APPLY LOCTITE 242, ARI #50106.
3. APPLY GREASE, ARI #91504-P1037.
4. APPLY LUBE-A-CYL, ARI #51120.
5. APPLY LABEL NP, ARI #90114L.

ITEM NO.	QTY	PART NO.	DESCRIPTION
8	2	91500-P1038	DOWEL, M8 X 14 (HD STL), M6
7	2	49045	SCR, SOC HD CAP M8 X 30 (STL)
6	1	85551-P1008	O-RING, .176 ID X .07 75 VITON
5	1	0201-B68N	PIN, DIAMOND LOCATING S3
4	1	0201-B67N	PIN, ROUND LOCATING S3
3	1	1500-D05A	SUBASSY, PS MODULE, S3.3R
2	1	1500-D12A	SUBASSY, SENDER ER160
1	1	1500-E11N	HOUSING, ROBOT ER160

THIRD ANGLE PROJECTION

DIM. AND TOLERANCING IN ACCORDANCE WITH ANSI Y14.5M-1994

METRIC

UNLESS OTHERWISE SPECIFIED:

UNTOLERANCED DIMS ARE BASIC

.25 A B C

⌖ ∅ .25 Ⓜ A B C

ALL HOLE DIAMETERS +/- 0.25

INTERNAL RADII & BROKEN EDGES TO BE .13-.38
ALL SURFACE FINISHES 1.6Ra

MAT'L:
-

SURFACE TREATMENT:
NONE

DR:	J. VALLELUNGA
CHK:	S. CASEY
ENG:	J. VALLELUNGA
MFG:	C. BEST
QC:	M. DUDNATH

3D MODEL NUMBER:
1500-D10A

SCALE: 1:1
DO NOT SCALE DRAWING

ISO 9001
REGISTERED

PRINT DATE
2/16/2016

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www.appliedrobotics.com

TITLE:

ER160-PNP-100-N-0-C0000

SIZE	DRAWING NUMBER	REV
D	1500-D10A	01

WEIGHT: 7.58 kg | RoHs COMPLIANT: - | SHT. 1 OF 2

SIZE	DRAWING NUMBER	REV
D	1500-D10A	01

REVISIONS						
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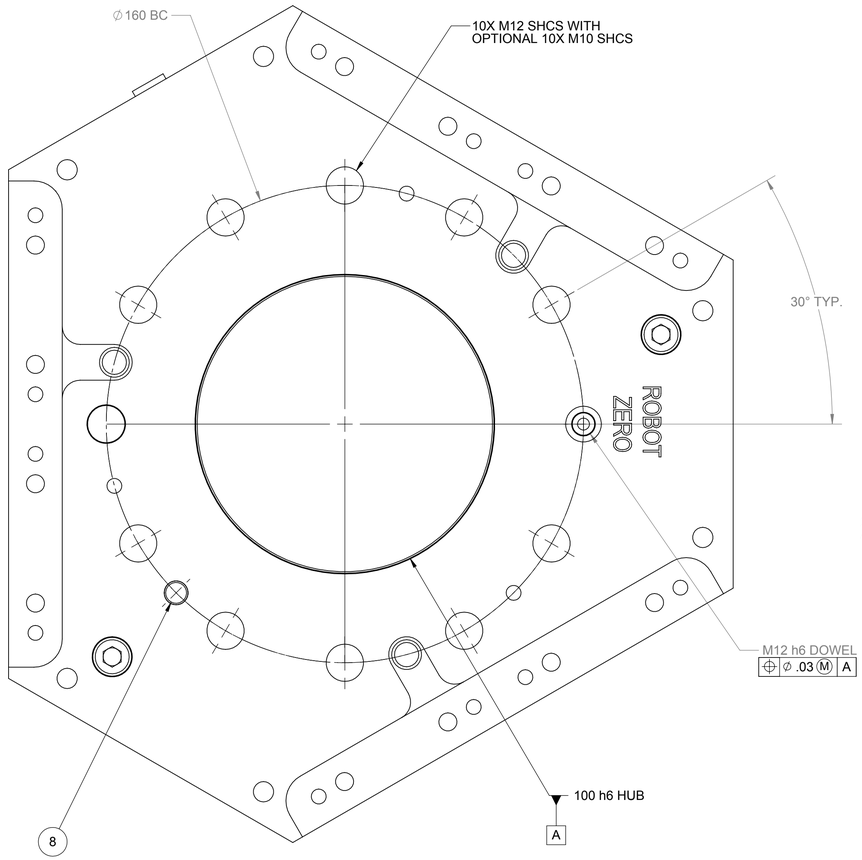
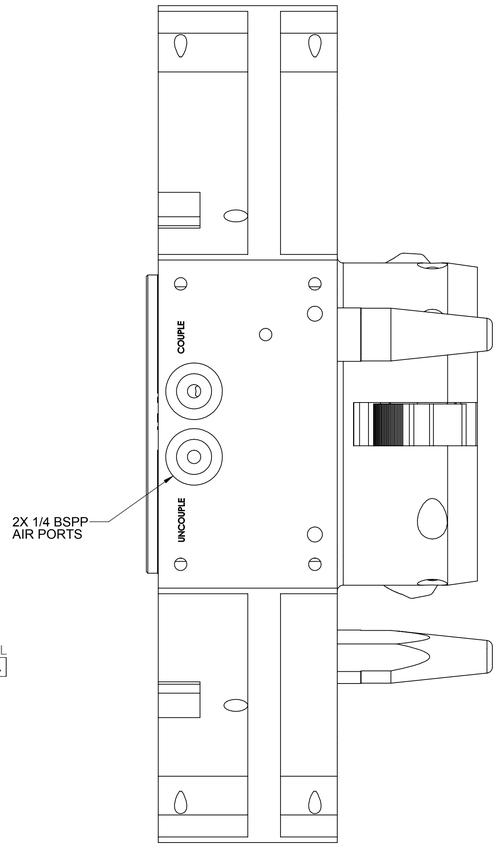
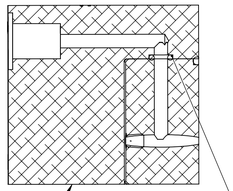
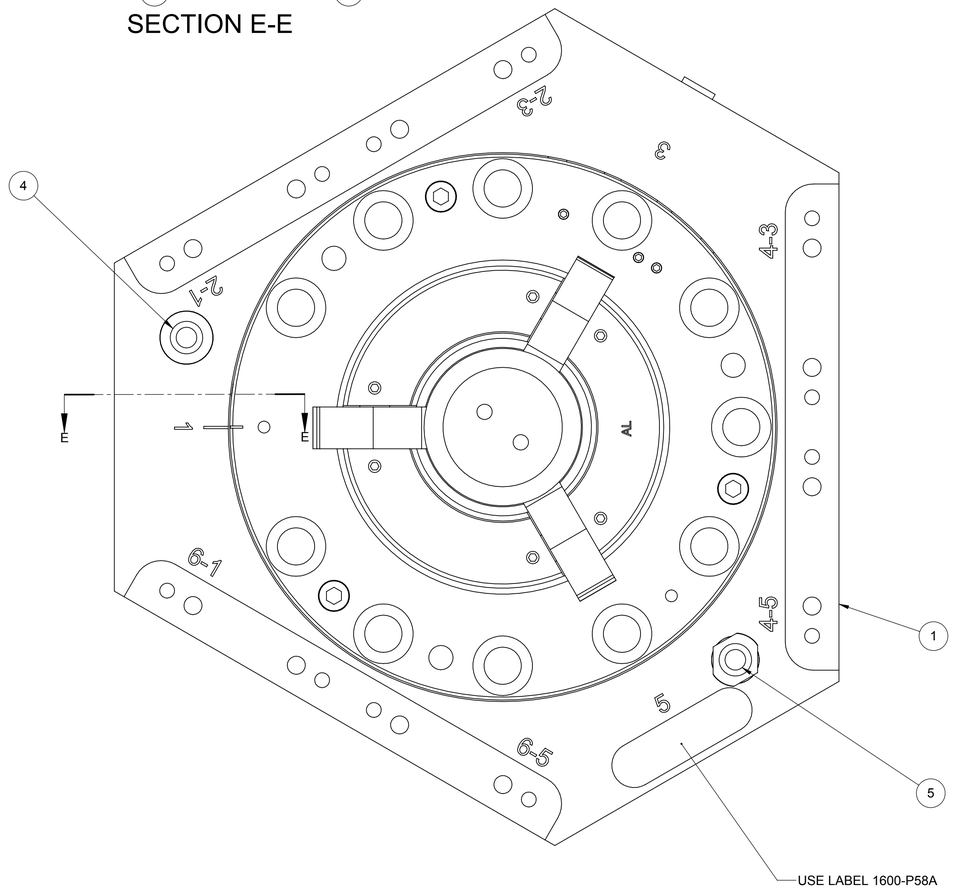
-	-	See Sheet1	-	-	-	-







SECTION E-E



USE LABEL 1600-P58A

THIRD ANGLE PROJECTION	METRIC	DR: J. VALLELUNGA	Applied Robotics™ Solutions in reach
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PRINT DATE 2/16/2016	MAT'L: -	SCALE: 1:1 DO NOT SCALE DRAWING	SIZE D · DRAWING NUMBER 1500-D10A · REV 01
DIM. AND TOLERANCING IN ACCORDANCE WITH ANSI Y14.5M-1994	SURFACE TREATMENT: NONE	ISO 9001 REGISTERED	WEIGHT: 7.58 kg · RoHs COMPLIANT: - · SHT. 2 OF 2

SIZE	DRAWING NUMBER	REV
D	1500-D69A	01

REVISIONS						
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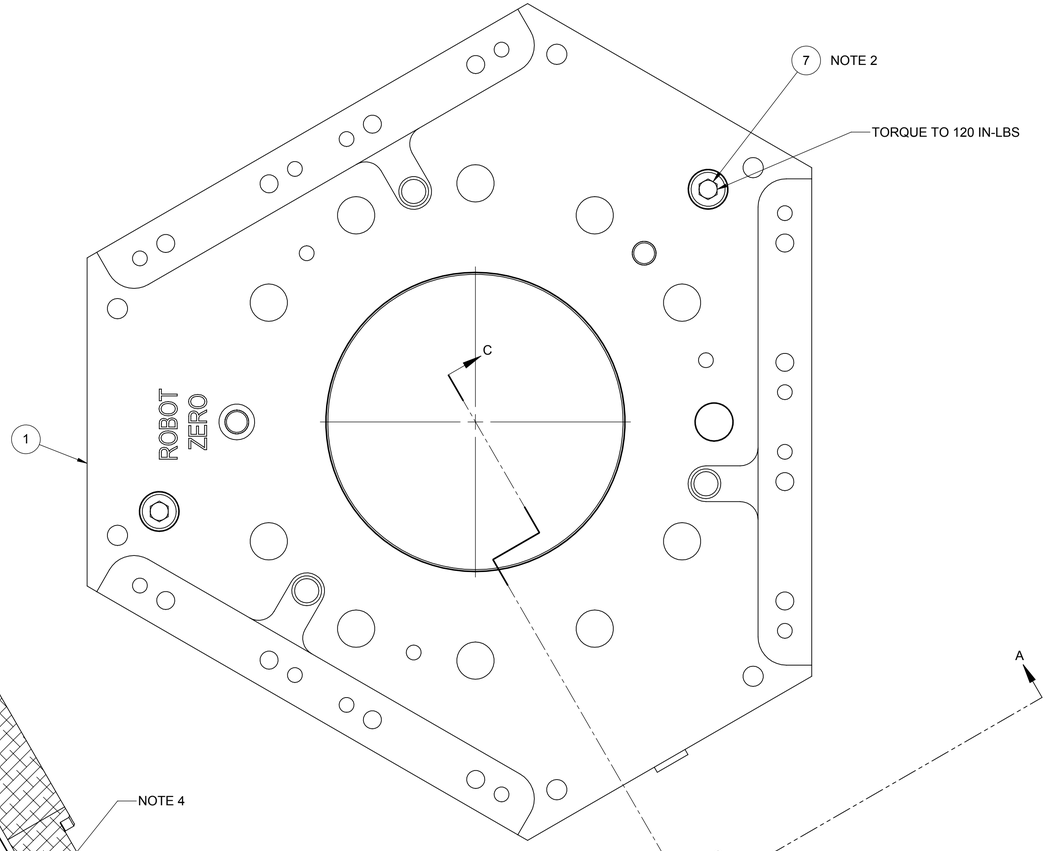
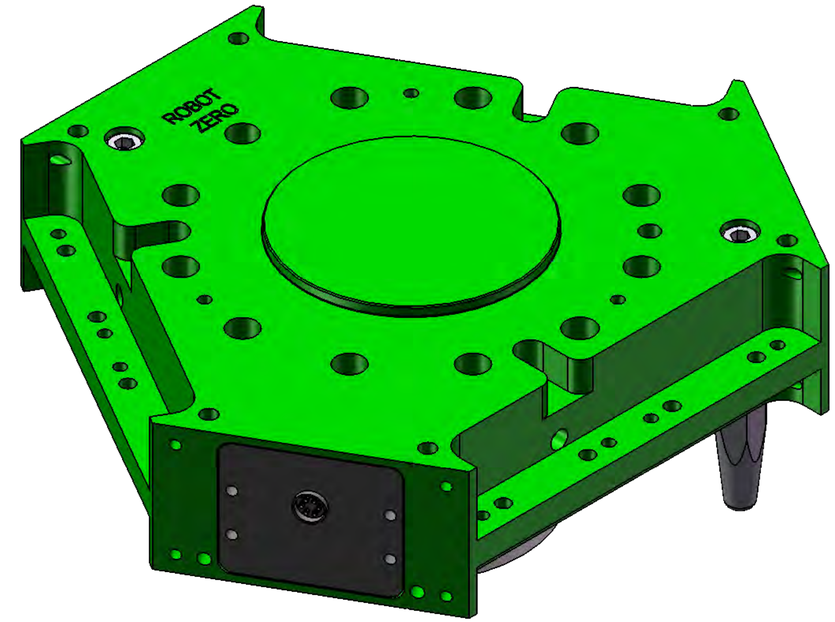
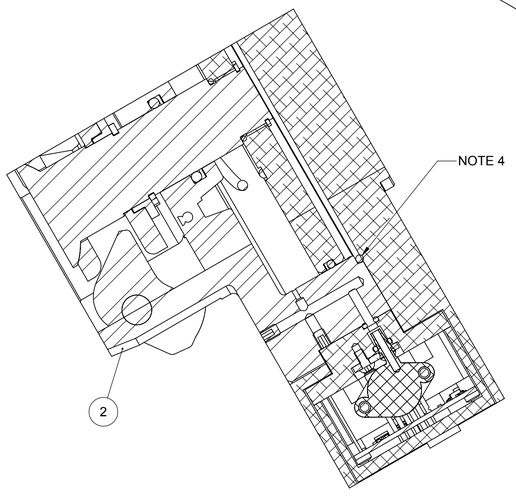
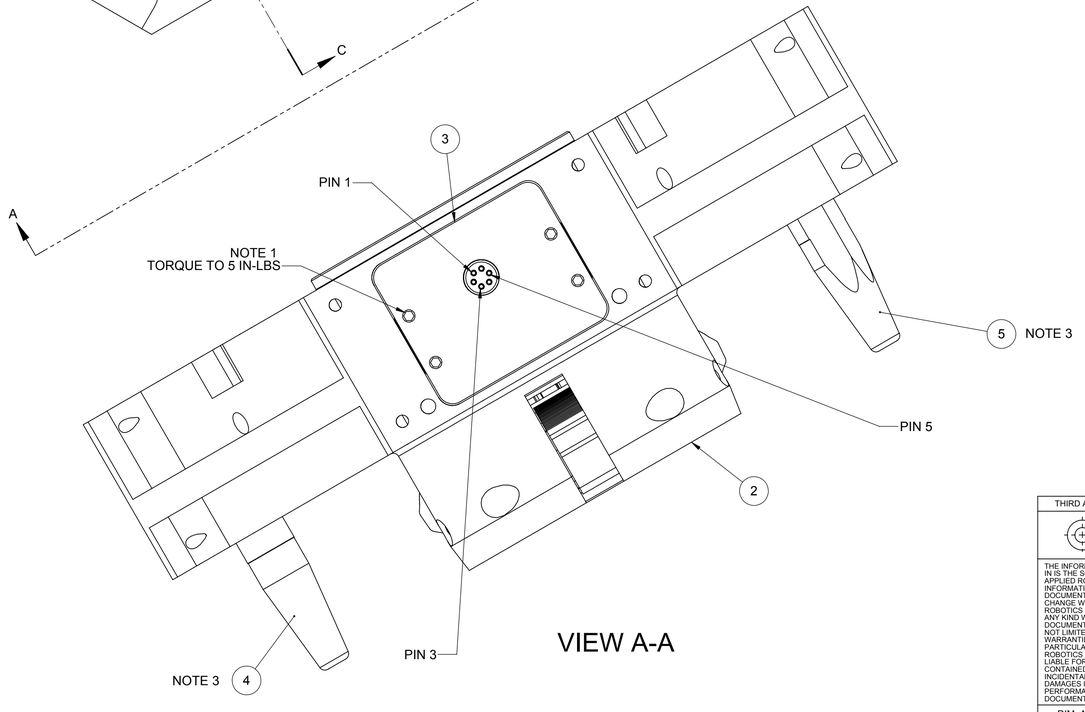
	01	NAME WAS SUBSSY, ERS160	TM	CM	2/9/2016	TMAA-A6YKPP







SECTION C-C



VIEW A-A

NOTES:

1. APPLY LOCTITE 222, ARI #86005-P1020.
2. APPLY LOCTITE 242, ARI #50106.
3. APPLY GREASE, ARI #91504-P1037.
4. APPLY LUBE-A-CYL, ARI #51120.
5. APPLY LABEL NP, ARI #90114L.

ITEM NO.	QTY	PART NO.	DESCRIPTION
8	2	91500-P1038	DOWEL, M8 X 14 (HD STL), M6
7	2	49045	SCR, SOC HD CAP M8 X 30 (STL)
6	1	85551-P1008	O-RING, .176 ID X .07 75 VITON
5	1	0201-B68N	PIN, DIAMOND LOCATING S3
4	1	0201-B67N	PIN, ROUND LOCATING S3
3	1	1500-D05A	SUBASSY, PS MODULE, S3.3R
2	1	1500-D70A	SUBASSY, SENDER ERS160
1	1	1500-E11N	HOUSING, ROBOT ER160

THIRD ANGLE PROJECTION

PRINT DATE 2/16/2016

METRIC

UNLESS OTHERWISE SPECIFIED:

UNTOLERANCED DIMS ARE BASIC

.25 A B C

⌖ ∅ .25 Ⓜ A B C

ALL HOLE DIAMETERS +/- 0.25

INTERNAL RADII & BROKEN EDGES TO BE .13-.38
ALL SURFACE FINISHES 1.6Ra

MAT'L:
-

DIM. AND TOLERANCING IN ACCORDANCE WITH ANSI Y14.5M-1994

SURFACE TREATMENT:
NONE

DR:	J. VALLELUNGA
CHK:	S. CASEY
ENG:	J. VALLELUNGA
MFG:	C. BEST
QC:	M. DUDNATH

3D MODEL NUMBER:
1500-D69A

SCALE: 1:1
DO NOT SCALE DRAWING

ISO 9001 REGISTERED

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www.appliedrobotics.com

TITLE:

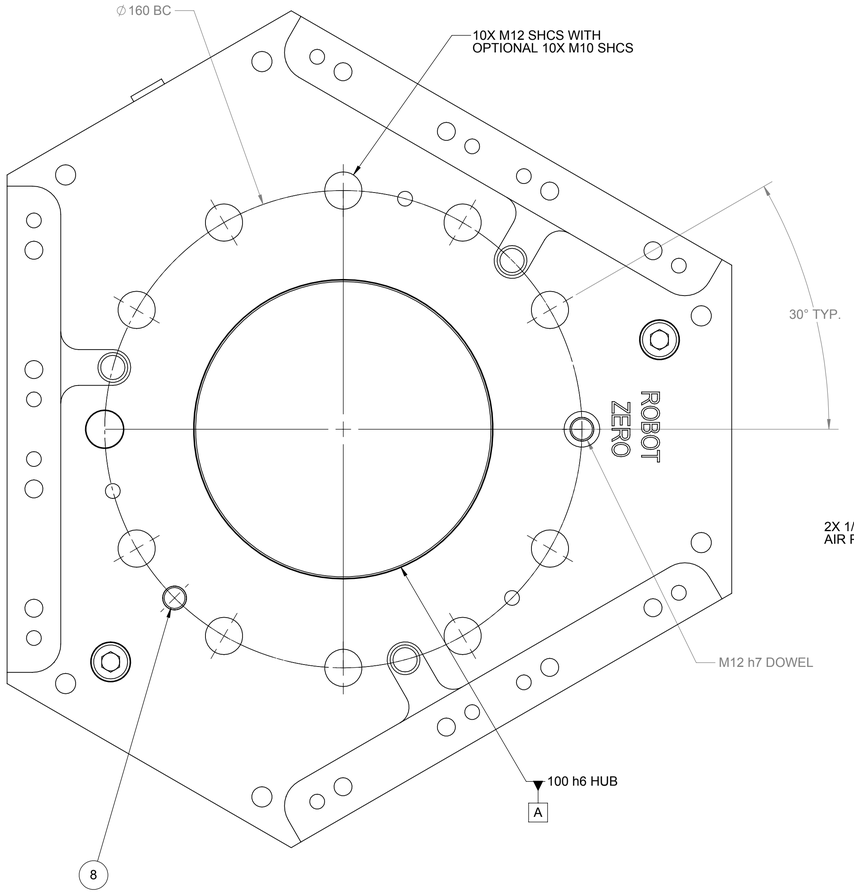
ERS160-PNP-100-N-0-C0000

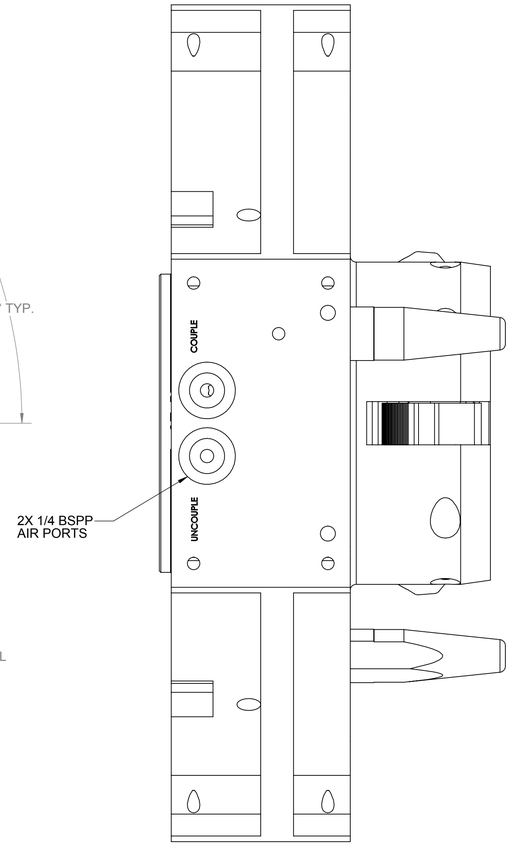
SIZE	DRAWING NUMBER	REV
D	1500-D69A	01

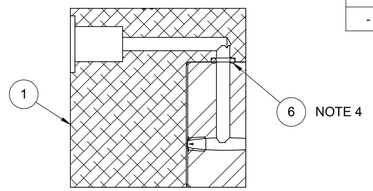
WEIGHT: 11.72 kg | RoHs COMPLIANT: - | SHT. 1 OF 2

SIZE	DRAWING NUMBER	REV
D	1500-D69A	01

REVISIONS						
ZONE	REV	DESCRIPTION	DR	CHK	DATE	ECR/ESR NO.
-	-	See Sheet1	-	-	-	-







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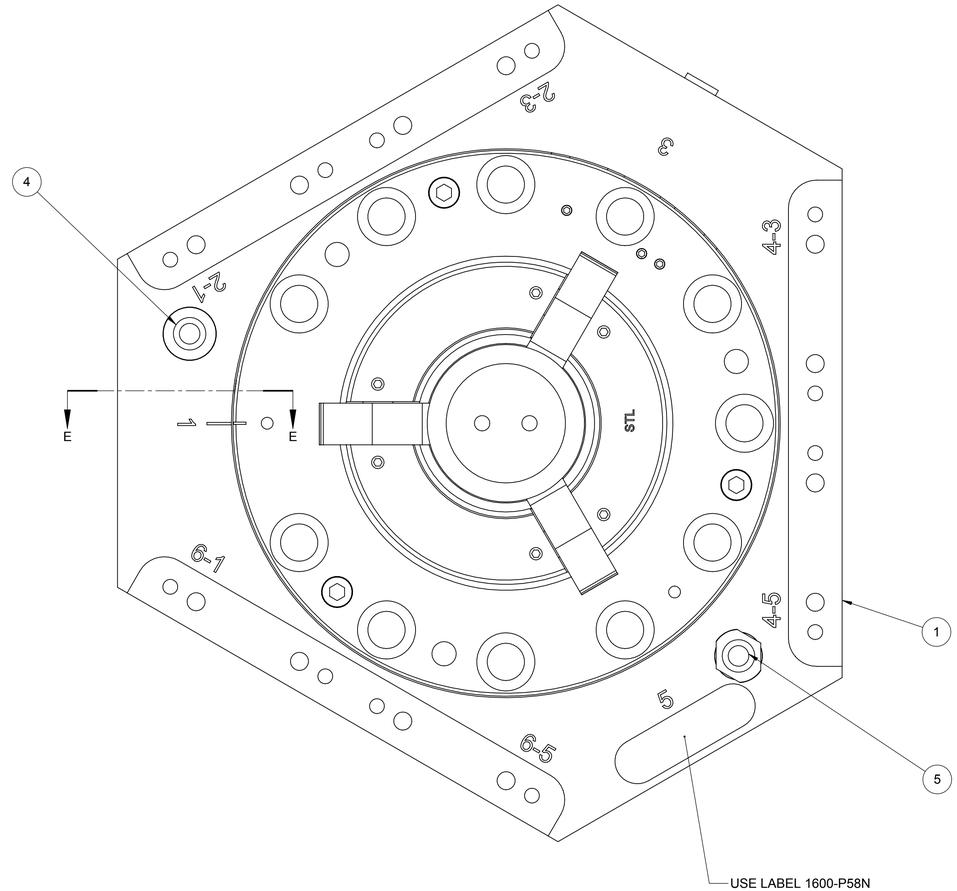

THIRD ANGLE PROJECTION	METRIC **UNLESS OTHERWISE SPECIFIED:** UNTOLERANCED DIMS ARE BASIC .25 A B C ∅ .25 M A B C ALL HOLE DIAMETERS +/- 0.25 INTERNAL RADII & BROKEN EDGES TO BE .13-.38 ALL SURFACE FINISHES 1.6Ra	DR: J. VALLELUNGA CHK: S. CASEY ENG: J. VALLELUNGA MFG: C. BEST QC: M. DUDNATH 3D MODEL NUMBER: 1500-D69A	Applied Robotics™ Solutions in reach 648 Saratoga Rd. Glenville, NY 12302 www.appliedrobotics.com
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PRINT DATE 2/16/2016	DIM. AND TOLERANCING IN ACCORDANCE WITH ANSI Y14.5M-1994	SURFACE TREATMENT: NONE	SCALE: 1:1 DO NOT SCALE DRAWING ISO 9001 REGISTERED

SIZE	DRAWING NUMBER	REV
D	1500-D69A	01

WEIGHT: 11.72 kg	RoHs COMPLIANT: -	SHT. 2 OF 2

SIZE	DRAWING NUMBER	REV
D	1504-D63A	01

REVISIONS						
ZONE	REV	DESCRIPTION	DR	CHK	DATE	ECR/ESR NO.
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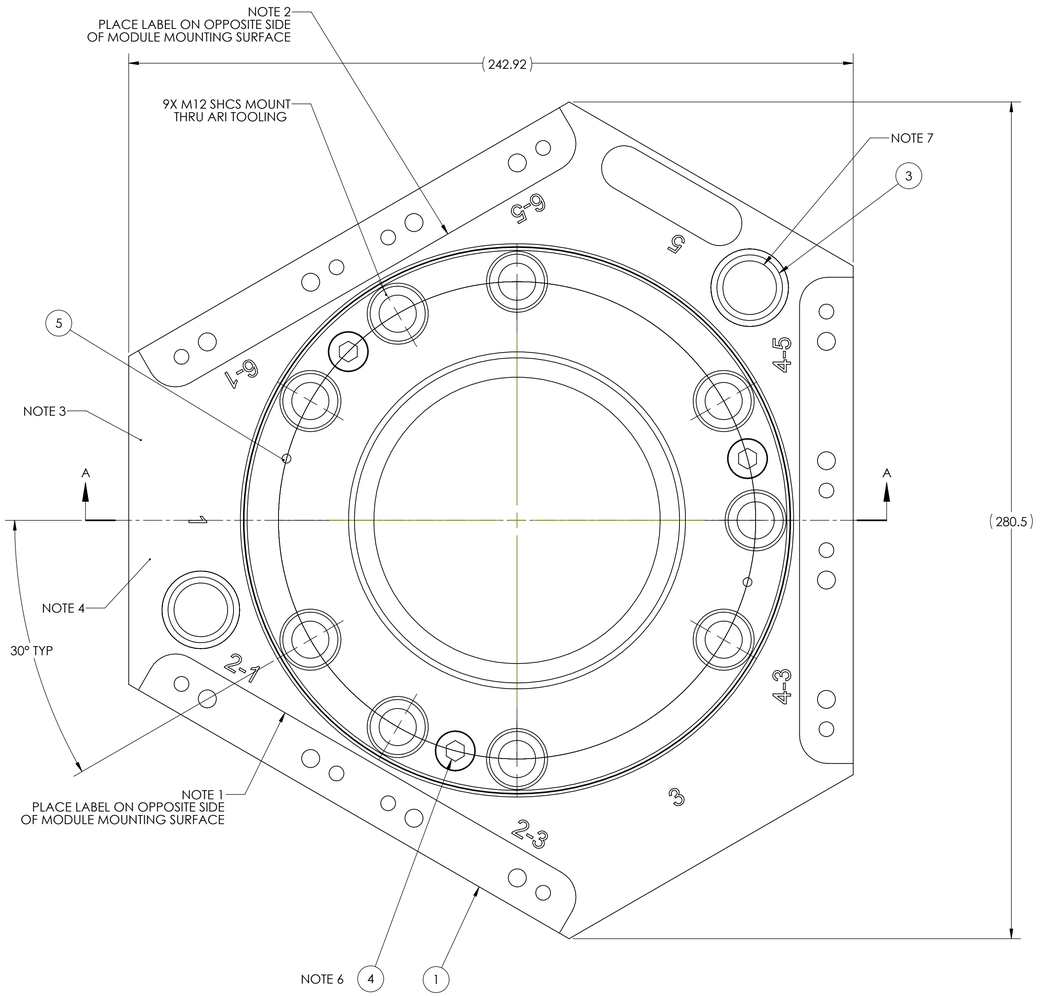
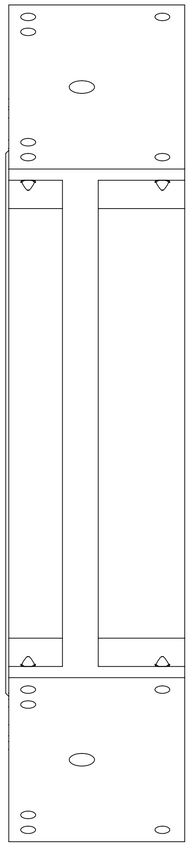
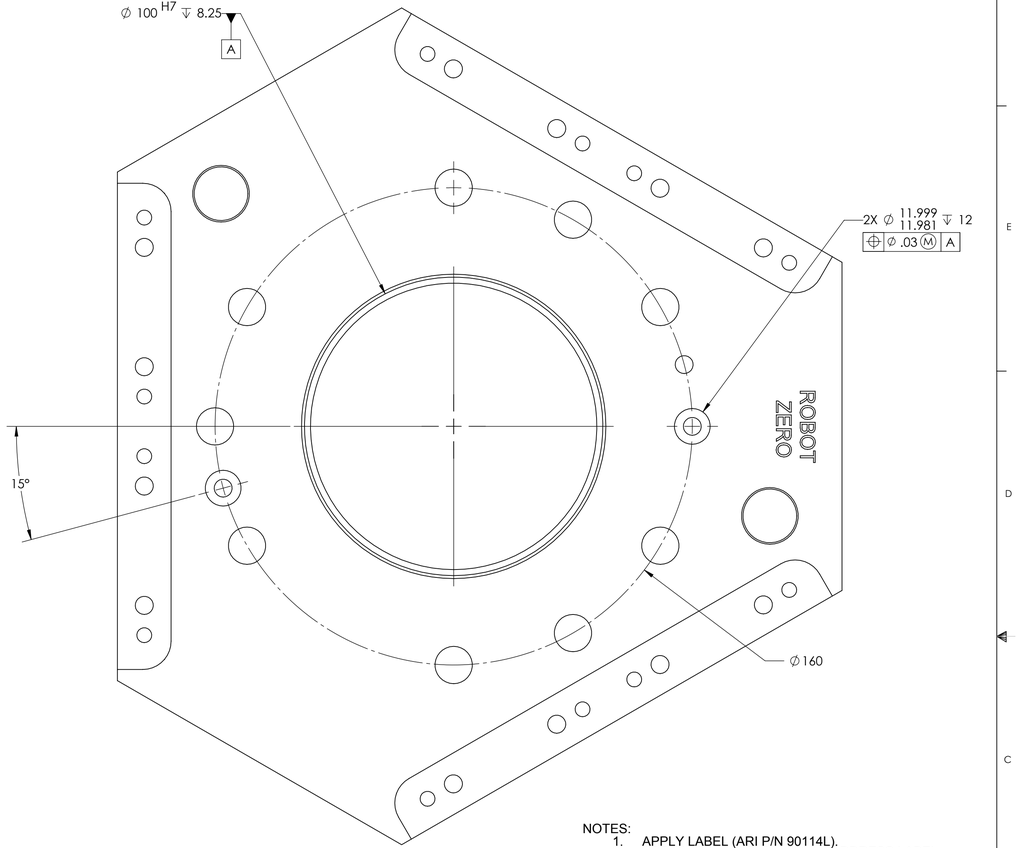
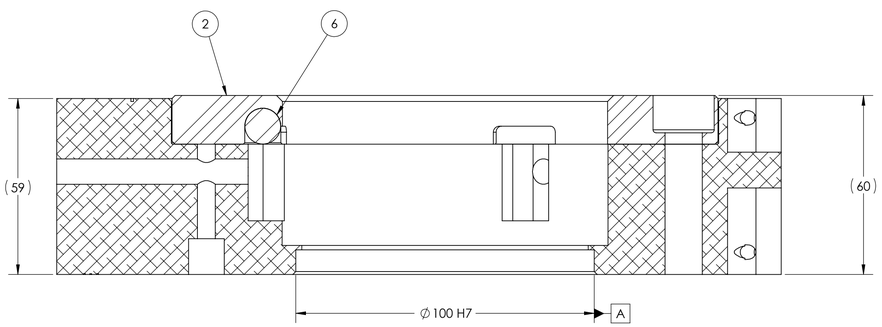
	01	REMOVED 125MM PATTERN	TM	JV	11/24/2015	TMAA-2APGMY



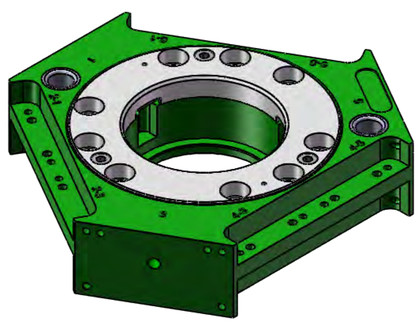




NOTES:
1. APPLY LABEL (ARI P/N 90114L).
2. APPLY LABEL (ARI P/N 90994) ADDRESS LABEL.
3. APPLY LABEL (ARI P/N 0708-P74N).
4. APPLY LABEL (ARI P/N 0708-P75N).
5. ALL ITEMS TO RECIEVE LOCTITE ARE TO BE THOROUGHLY CLEANED FROM GREASE AND OIL, USE PRIMER "N" (ARI P/N 51172) BEFORE APPLYING ANY LOCTITE THREAD LOCKERS.
6. APPLY LOCTITE 242 (ARI P/N 50106).
7. APPLY GREASE (ARI P/N 91504-P1037) TO BEARING SURFACES ON ITEMS 3 & 6.



SECTION A-A



SCREW TORQUE CHART	
SIZE	TORQUE
M5	4.5 ft-lbs (6.1 N-m)
M6	7.7 ft-lbs (10.4 N-m)
M8	19.0 ft-lbs (25.7 N-m)
M10	37.0 ft-lbs (50.1 N-m)
M12	65.0 ft-lbs (88.1 N-m)

ITEM NO.	QTY	PART NO.	DESCRIPTION
6	3	49621	DOWEL, M12 X 40 (HARD STL) M6
5	2	49538	DOWEL, M12 X 20 H6
4	3	49043	SCR, SOC HD CAP M8 X 20 (STL)
3	2	0201-P86N	BUSHING, LOCATING
2	1	1504-D64N	RING, TOOL, ETS160
1	1	1500-D15N	HOUSING, TOOL, ET160-100

THIRD ANGLE PROJECTION

PRINT DATE
4/1/2016

METRIC

UNLESS OTHERWISE SPECIFIED:

UNTOLERANCED DIMS ARE BASIC

⌓ .25 A B C

⌖ ∅ .25 Ⓜ A B C

ALL HOLE DIAMETERS +/- 0.25

INTERNAL RADII & BROKEN EDGES TO BE .13-.38
ALL SURFACE FINISHES 1.6Ra

MAT'L:
-

SURFACE TREATMENT:
-

DIM. AND TOLERANCING IN ACCORDANCE WITH ANSI Y14.5M-1994

DR: J. VALLELUNGA
CHK: S. CASEY
ENG: J. VALLELUNGA
MFG: C. BEST
QC: M. DUDNATH

3D MODEL NUMBER:
1504-D63A

SCALE: 1:1
DO NOT SCALE DRAWING

ISO 9001
REGISTERED

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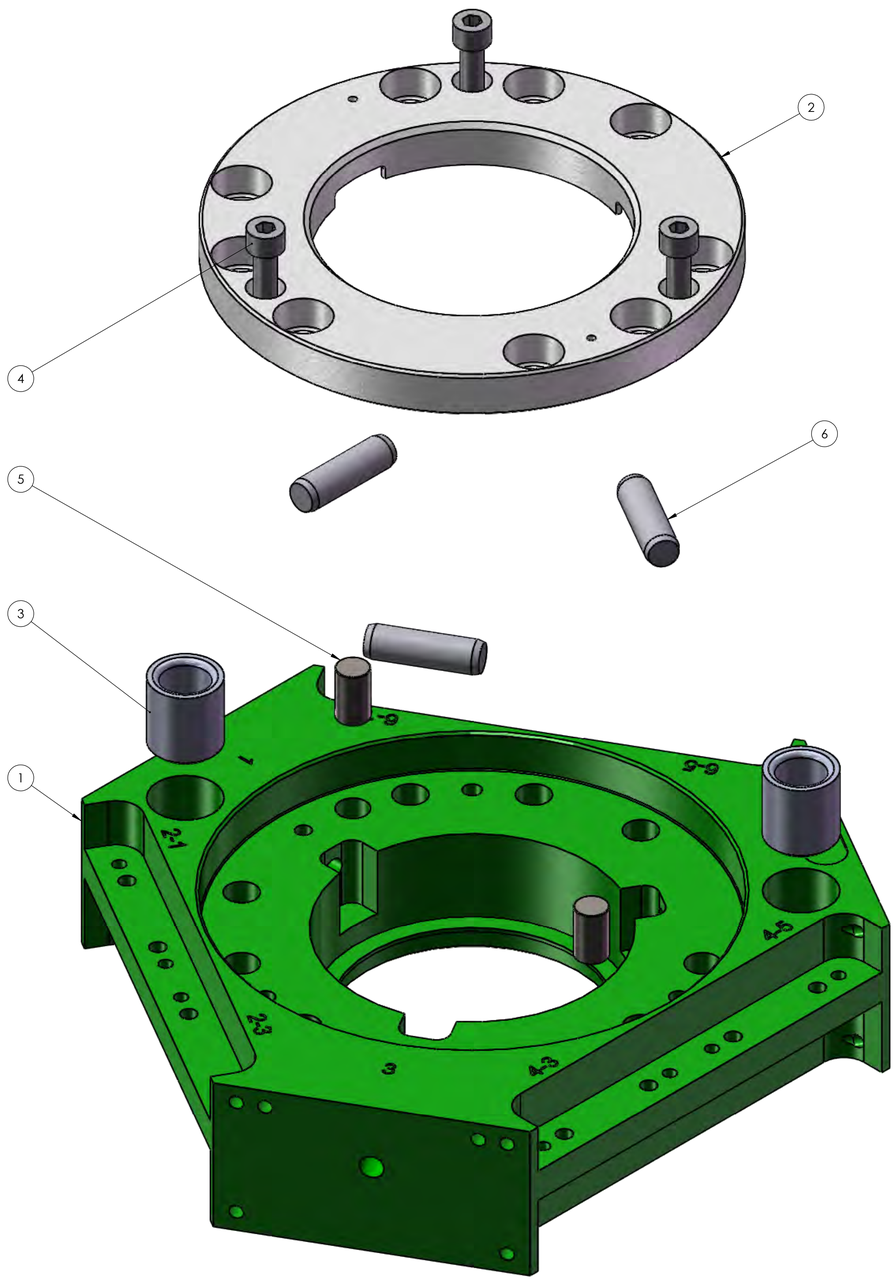
www.appliedrobotics.com

TITLE:
ETS160-100-N-C0000
-

SIZE	DRAWING NUMBER	REV
D	1504-D63A	01

WEIGHT: 6.31 kg | RoHs COMPLIANT: - | SHT. 1 OF 2

SIZE	DRAWING NUMBER	REV
D	1504-D63A	01



THIRD ANGLE PROJECTION	METRIC	DR: J. VALLELUNGA
	UNLESS OTHERWISE SPECIFIED:	CHK: S. CASEY
	UNTOLERANCED DIMS ARE BASIC	ENG: J. VALLELUNGA
	⌓ .25 A B C	MFG: C. BEST
	⌖ ∅ .25Ⓜ A B C	QC: M. DUDNATH
	ALL HOLE DIAMETERS +/- 0.25	3D MODEL NUMBER: 1504-D63A
	INTERNAL RADII & BROKEN EDGES TO BE .13-.38 ALL SURFACE FINISHES 1.6Ra	
	MAT'L: -	SCALE: 1:1 DO NOT SCALE DRAWING
PRINT DATE 4/1/2016	SURFACE TREATMENT: -	ISO 9001 REGISTERED

DIM. AND TOLERANCING IN ACCORDANCE WITH ANSI Y14.5M-1994

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TITLE: ETS160-100-N-C0000

-

SIZE	DRAWING NUMBER	REV
D	1504-D63A	01

WEIGHT: 6.31 kg | RoHs COMPLIANT: - | SHT. 2 OF 2