

872-LTN2003 K1DM3 Technical Procedure

Hardware Lockdown Specifications

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K1DM3 Install: Loctite Application and Torque Procedure for Threaded Fasteners and Discussion of Installation of Locating Pins

K1DM3 Screw Tightening and Loctite Application

Outline

1. Objectives
2. Approach
3. General Guidelines: Typical torque values to use (stainless steel vs black oxide alloy steel)
4. Slides of each subassy, screws, torque values, disassembly requirements
5. Non-special fastening not covered
6. Assemblies to be pinned, pinning requirements

K1DM3 Screw Tightening/Pinning and Loctite Application

Objectives

1. Ensure no screws come loose or fall off of K1DM3
2. Ensure certain assemblies never move relative to each other, to maintain mirror pointing alignment
 - Upon disassembly and reassembly, certain parts need to maintain position relative to parent assembly to maintain alignment – these assemblies should have pins to maintain alignment (usually 2 pins per part)
 - Stationary part of hinge to bipod weldment
 - Moveable part of hinge to swing arm
 - Canoe spheres to swing arm
 - Ring Gear to inner drum
 - V-blocks to ring gear
 - V-blocks to bipod weldment
 - Other assemblies simply need to be secured to the parent assembly and relative position is not as important

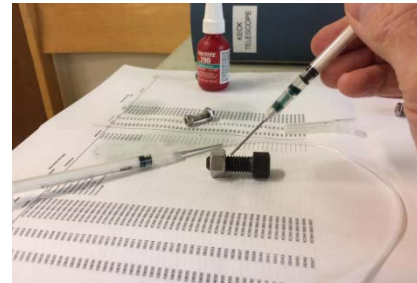
K1DM3 Screw Tightening and Loctite Application

Approach

1. Apply loctite to all screws (where practical, and no major disassembly is required), one screw at a time to minimize relative movement

1. Loctite to use:

- Wicking: Loctite 290, use syringe and/or tube if needed
- Screws 0.25 inches or less: Loctite 222 Purple
- Screws 0.25 to 0.75inches: Loctite 242 or 243 Blue



2. Apply Loctite and a specified torque to parts where high clamping force is desired (such as canoe spheres to the swing arm)
3. Mark all fasteners that have had Loctite applied, use a green paint marker (discuss this, it should show up for black oxide and stainless steel)

K1DM3 Screw Tightening and Loctite Application General Guidelines

- In general, refer to the Holo-Krome table for torque levels (75% of torque to yield the screw at minor diameter), we will need both the inch and metric tables. If the screws are stainless steel or something other than high strength alloy steel, **do not** use the Holo-Krome tables. The Holo-Krome socket head cap screw portion of the table is summarized below, the tensile strength of these screws are 170,000psi.
- If using 316 or 18-8 stainless steel, the tensile strength is 70,000psi so the Holo-Krome values should be multiplied by 70/170, which would be 6.5 in-lbs for a 4-40 screw made of 316 stainless steel
- Lesser values can be used, and certainly are appropriate in many cases of our designs, it is more important to use Loctite for these situations since loosening is more likely

Screw Size	Torque for SHCS's			
	per Holo-Krome		70,000 psi strength	
	in-lbs	Nm	in-lbs	Nm
M2	8	0.92	3	0.4
M2.5	17	1.9	7	0.8
M3	29	3.3	12	1.4
M4	69	7.8	28	3.2
M5	142	16	58	6.6
M6	239	27	39	11.1
M8	575	65	237	26.8
M10	1151	130	474	53.5
M12	1947	220	802	90.6
4-40	16	2	7	0.7
5-40	24	3	10	1.1
6-32	30	3	12	1.4
8-32	55	6	23	2.6
10-32	79	9	33	3.7
1/4-20	200	23	82	9.3
1/4-28	230	26	95	10.7
5/16-18	415	47	171	19.3
3/8-16	740	84	305	34.4

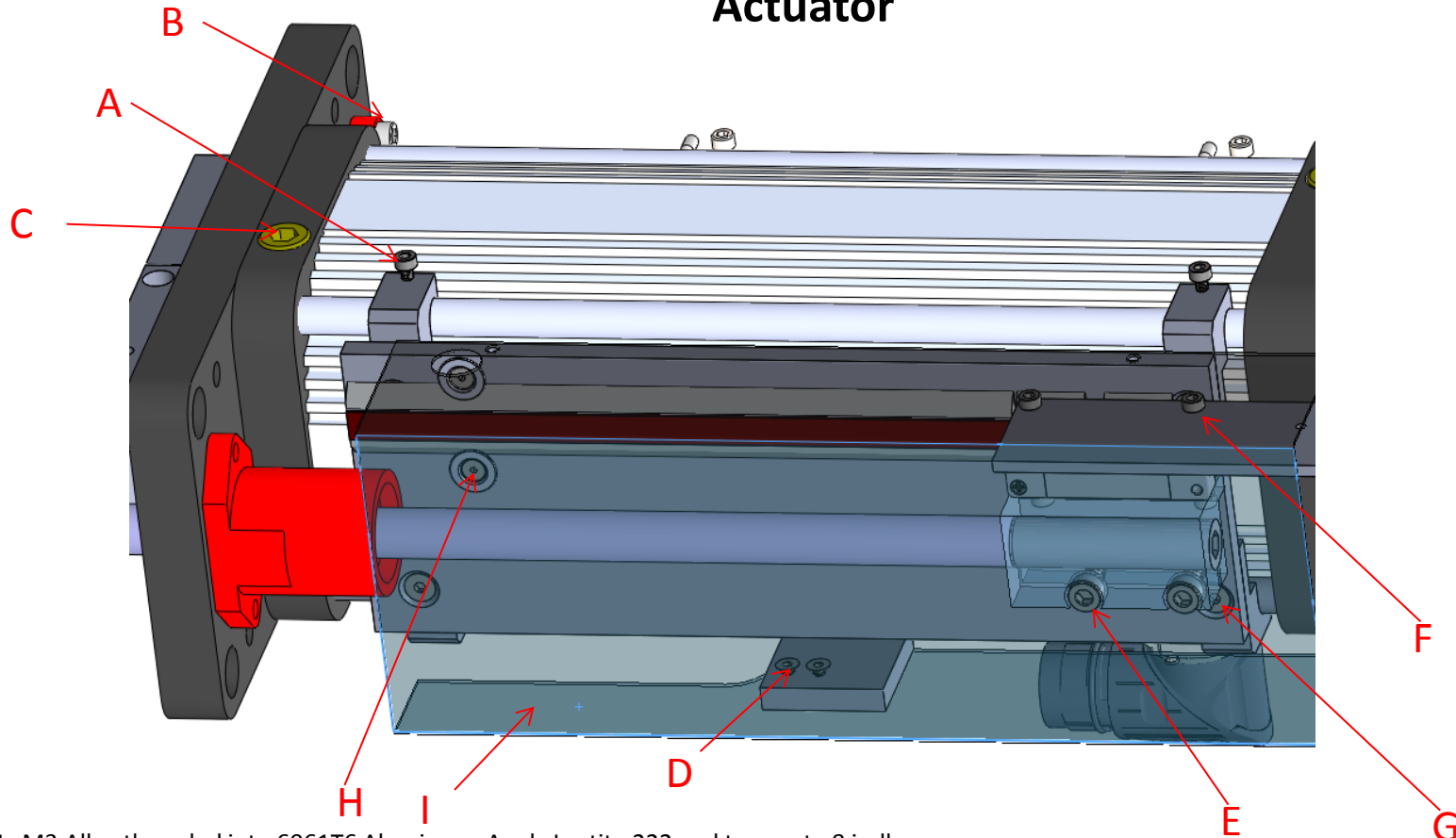
Table 1: Torque Table for Holo-Krome Alloy Steel
SHCS and 70,000 psi Stainless Steel SHCS

K1DM3 Screw Tightening and Loctite Application

- If screws are screwed into a soft and/or thin material, do not use the Holo-Krome tables
 - Verify screw has Loctite, partially unscrew a single screw in the bolt pattern, if it has Loctite, mark it with agreed upon method
- Flat head, button head, shoulder screws, and low head screws all have different torque specifications, refer to either the Holo-Krome “Socket Screw Selector” or similar for the various torque specs. Here I will specify the torque for each fastener in the assembly on subsequent slides
- The list of screws that intentionally do not have Loctite that need to eventually have Loctite:
 - Ring gear mounted v-block screws
 - M8 radial defining point screws
 - Lateral defining point jacking screws should be Loctited or removed after installation is complete
 - Canoe sphere to swing-arm screws
- Many screws are not intended to be torqued to 75% of yield values. The hinge screw pin is not torqued tight, but uses a Nyloc nut. The shoulder screws used to attach the Exlar actuator u-joint to the swing arm are not close to yield tightness to allow non-binding movement, so they require Loctite

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

Actuator

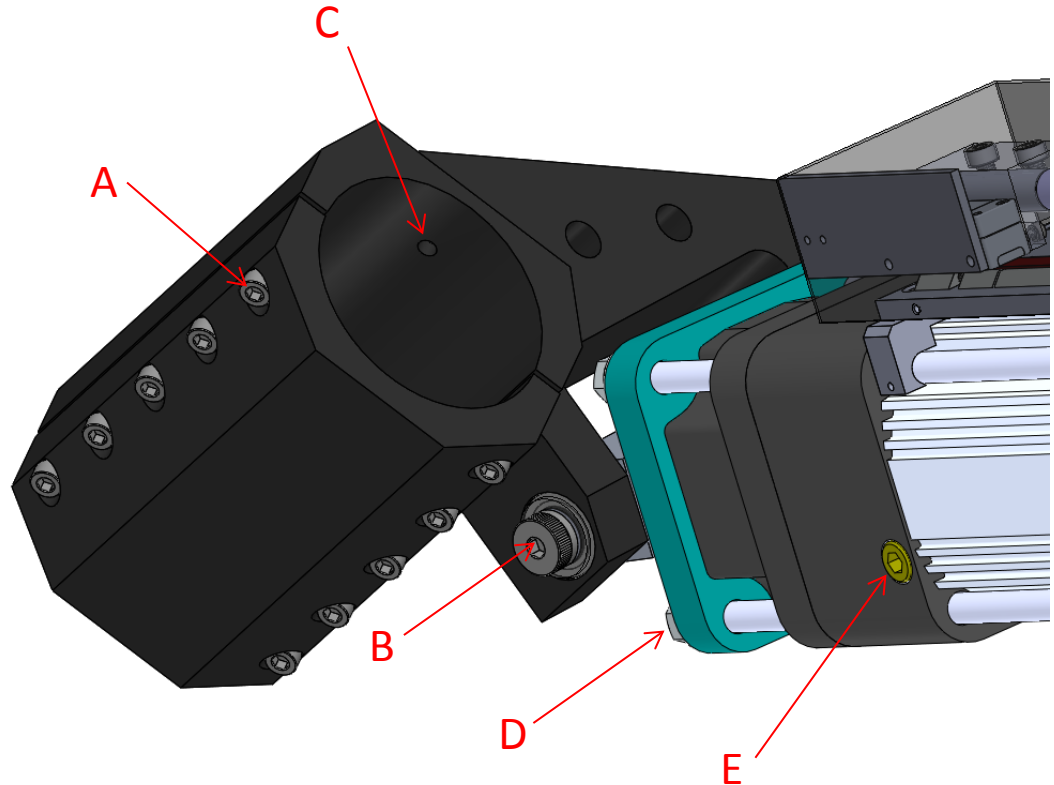


- A. 4x M3 Alloy threaded into 6061T6 Aluminum, Apply Loctite 222 and torque to 8 in-lbs
 - Need to ensure nothing shifts, one screw at a time
- B. 8-32 SHCS, factory torqued, do not torque unless otherwise specified
- C. Exlar plug, factory torqued, do not torque unless otherwise specified
- D. 4x M3 flat head screw screwed into 6061T6, apply Loctite 222 and torque to ~12in-lbs, igus chain is not shown in this view
- E. M5 SHCS threaded into 6061T6, apply Loctite 222 one at a time, torque to 40in-lbs, nothing can shift here
- F. 4x M3 SHCS threaded into Renishaw read head (some kind of aluminum), remove one at time, apply Loctite 222, tighten to roughly 8in-lbs
- G. 4x M4 flat head shcs threaded into 6061T6 Aluminum, two of these are inaccessible without shifting the Renishaw tape, if required fully disassemble and apply loctite, torque to approx 20 in-lbs, will require re-calibrating software, try to use wicking Loctite 290
- H. Renishaw tape fasteners, apply Loctite 290
- I. Cover I must be removed for most items above, its fasteners should have Loctite 222 applied and then torqued to ~10 in-lbs

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

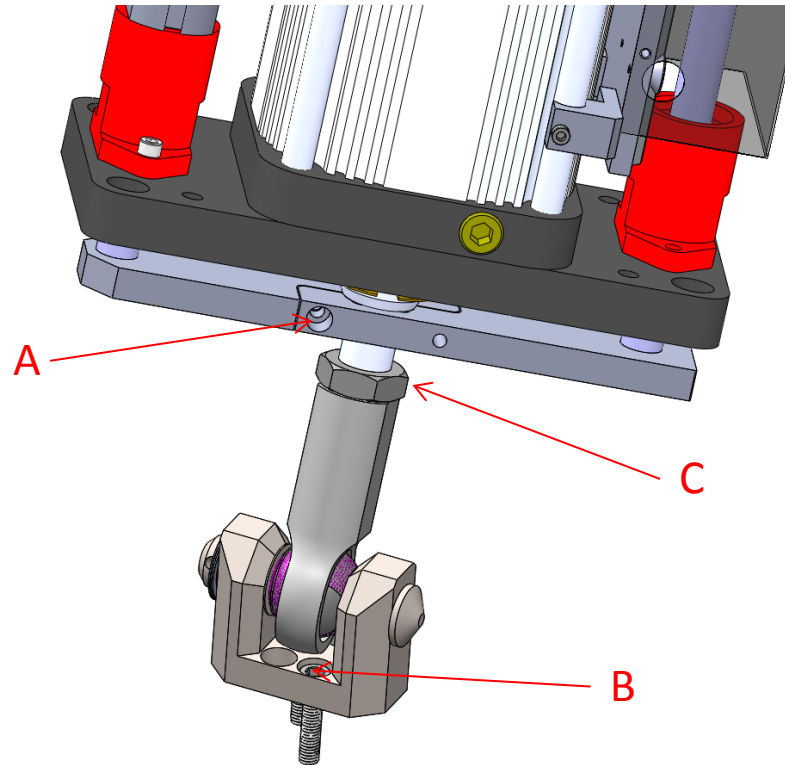
Actuator

- A. M6 Alloy threaded into 6061T6 Aluminum, Apply loctite and torque to 239 in-lbs, one at a time
- B. M12 Shoulder screw, already torqued to approximately 20 in-lbs with loctite already applied, mark accordingly
- C. Pin Hole, already pinned to swing arm
- D. Inch screw on Exlar actuator, do not torque unless otherwise specified
- E. Fluid plug on Exlar Actuator, do not torque unless otherwise specified



K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

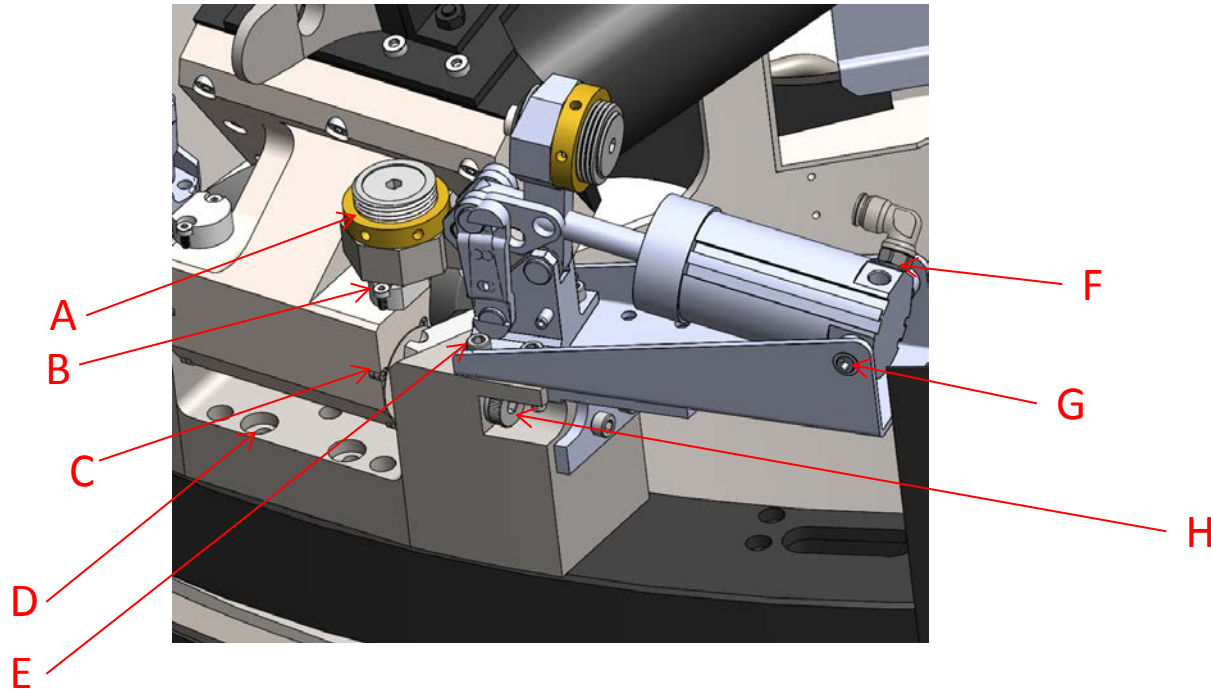
Actuator



- A. 2x 8-32 SHCS, apply Loctite 290 to the exposed threaded interface side
- B. 2x M6 alloy SHCS, must remove actuator first to access these screws. Remove pin and maintain spacer and spring order. Apply loctite and torque to 239 in-lbs, one screw at a time
- C. Lock nut, captive, do not need to loctite, re-torque to same torque prior to applying loctite to fastener A, maintain approximate angular position of rod end relative to Exlar extension rod

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

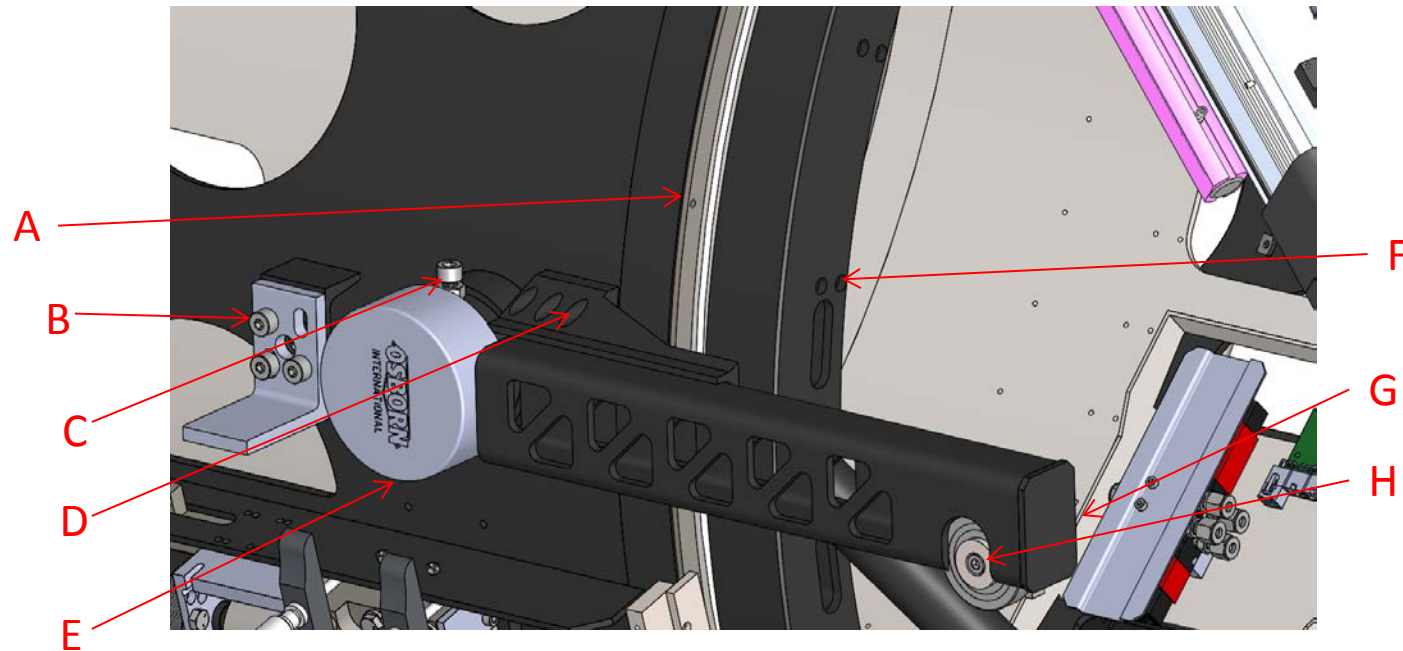
Hinge Clamps and Nearby items



- A. Use wicking Loctite, do not adjust, hinge clamps set for 200 lbs each of force application, bipod clamps set for 340 lbs each, very sensitive
- B. 2x M4 Use wicking Loctite or 222 if you can ensure no movement one screw at a time
- C. 8x M3 SHCS, either alloy or stainless, try to use wicking loctite here, if this does not work swingarm needs to be removed, screws removed, apply Loctite 222 and torque to 29 in-lbs
- D. 4x M6 alloy SHCS (not shown), talked to Jim Ward, these are torqued and Loctite has been applied, hinge is also pinned, so we just need to mark these with the gold paint
- E. 8x M6 alloy, apply Loctite and torque to 98 in-lbs
- F. Fittings, TBD, likely use bajo fitting with 1/8 BSPP, discuss application of Loctite
- G. SHCS (should be M5) from Destaco, APPLY Loctite 243, torque to 30 in-lbs
- H. ½ inch shoulder screw, no Loctite needed, Nyloc nut used

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

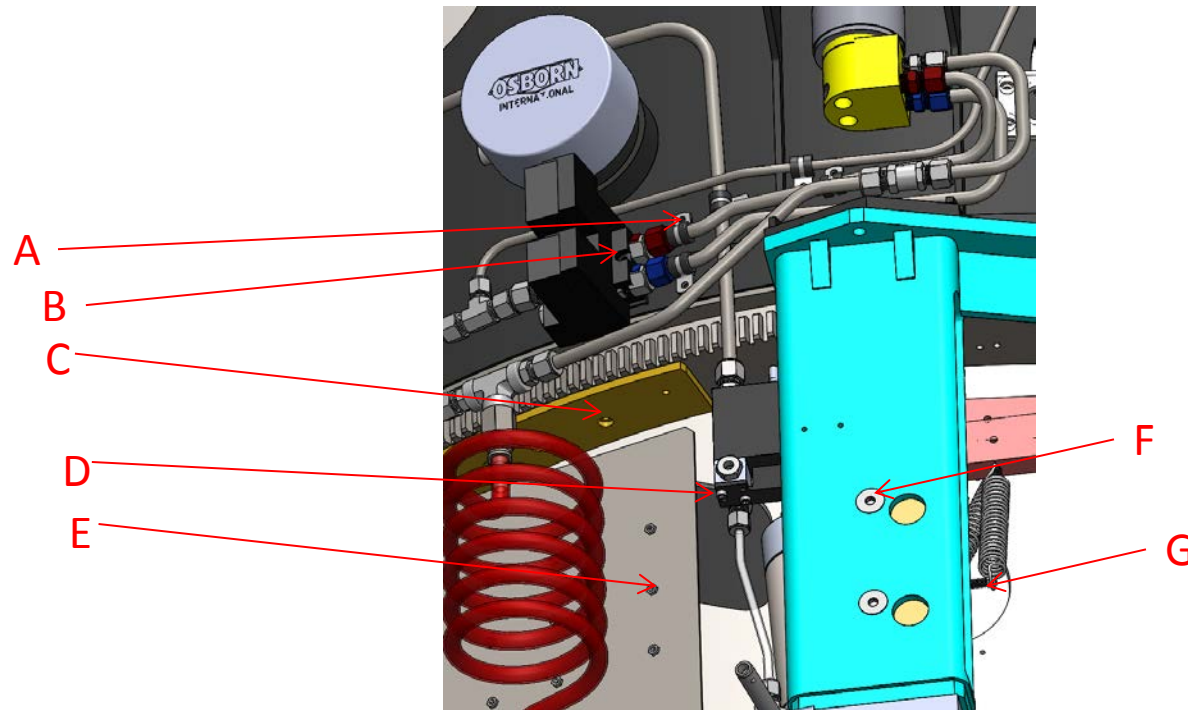
Wheel Assemblies & Brackets



- A. 24x Alloy M4, already has Loctite 222, verify and mark them
- B. 4x 3/8-16, Apply Loctite 243 and torque to 740 in-lbs (62 ft-lbs) after final wheel positioning,
- C. 4x M8 SHCS, stainless, apply Loctite 243 snug (10 in lbs) while wheel is tight,
- D. 12x M6 alloy SHCS (not visible), Loctite has been applied, Check, torque to 239 in-lbs
- E. 4x M8 set screws, after final wheel set, apply Loctite 243 and torque to 10 in-lbs
- F. 48x M6 alloy SHCS (not visible), Loctite has been applied, Check, torque to 239 in-lbs
- G. 8xM6 alloy SHCS (not visible), Apply Loctite 222 torque to 239 in-lbs
- H. 2x M8 alloy SHCS (not visible), Apply Loctite 243 torque to 575 in-lbs (48 ft-lbs), may already have Loctite

K1DM3 Screw Tightening and Loctite Application -Specific Subassemblies

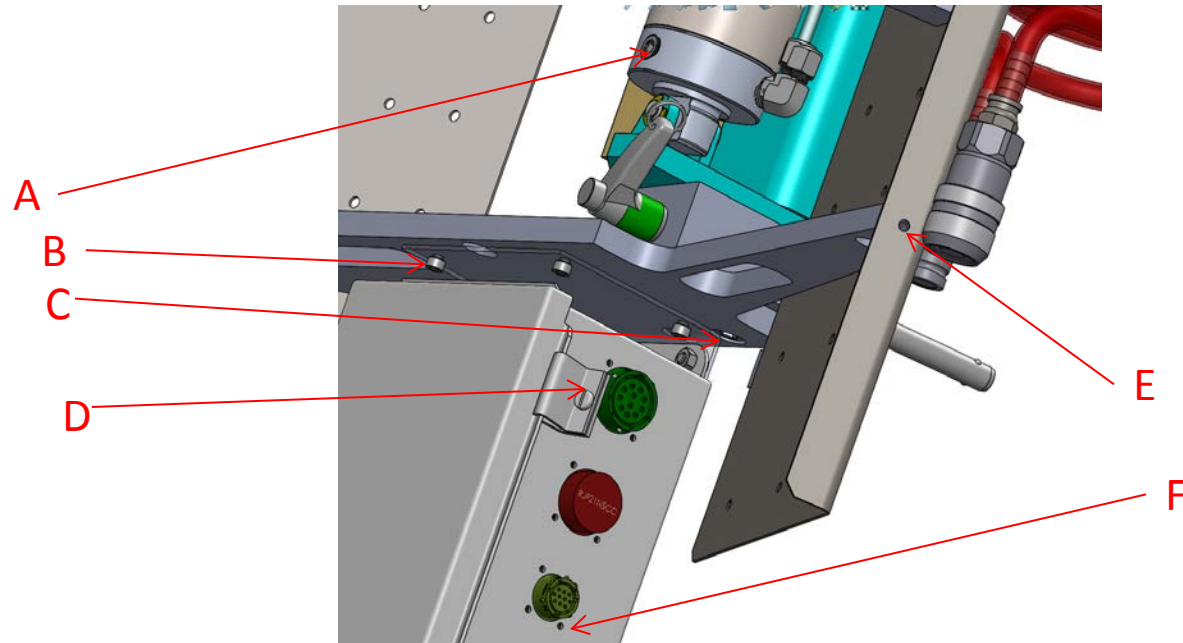
Detent Mechanism & Plumbing



- A. Very many, no count, clamps that hold down plumbing and wire harnesses on outer drum, fasteners can range from M3 to M4 and possibly others. Loctite 222 should be applied to all of them, torque to 15-20 in-lbs
- B. Not sure of fastener size holding Ingersoll Rand Solenoids, must be M4 or larger, likely an M5, apply Loctite 222 and torque to 20 in-lbs
- C. Attached counterweights, M6 Low head or SHCS, black oxide, apply Loctite 243 snug (60 in lbs)
- D. 2x 8-32 alloy SHCS (hold solenoid), apply Loctite 222, torque to 20-30 in-lbs
- E. Very many M4 screws, M3 screws and possibly #4 screws holding cables on electrical stress relief panel , apply Loctite 222 and torque to 10 in-lbs
- F. Counterweight flat head screws, M10x1.5, apply Loctite 243 torque to 100 in-lbs (8 ft-lbs)
- G. ¼-20 spring anchors - will not unscrew unless spring breaks, do not torque, apply Loctite 290

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

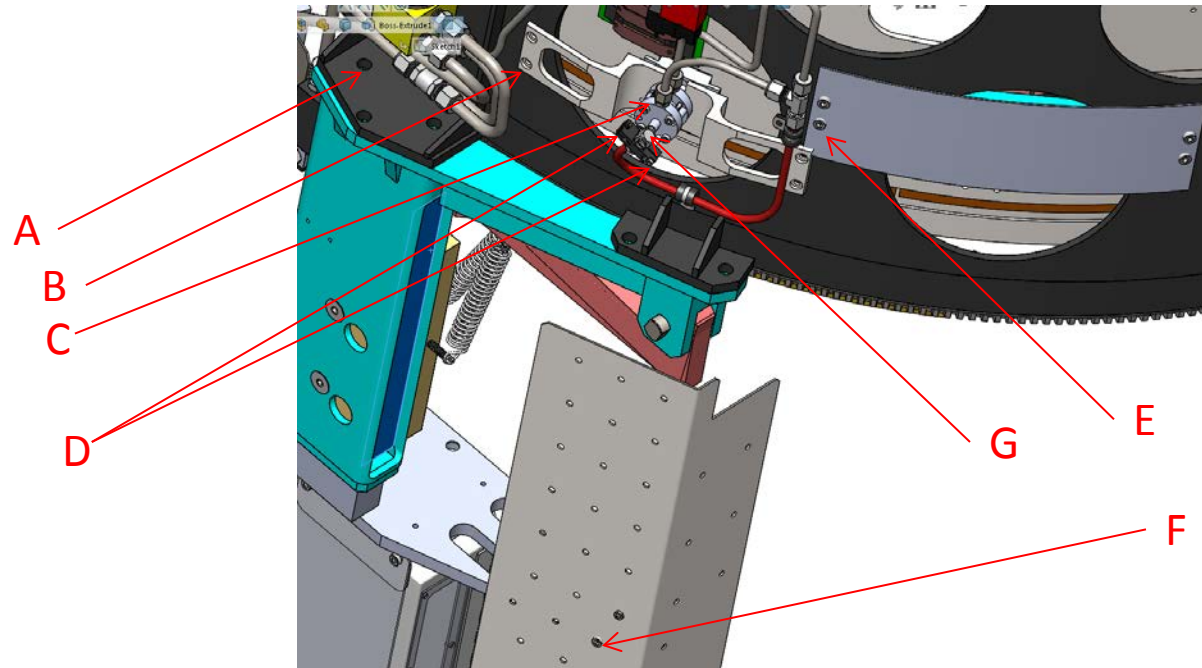
Detent Mechanism, Covers, & Connector Box



- A. Bimba Actuator Plug, factory installed, discuss, likely apply Loctite 290
- B. 4x M5, apply loctite and torque to 20 in-lbs
- C. 2x M10 SHCS, apply Loctite 243 snug (60 in lbs)
- D. Electrical box door screw, Loctite 222, torque to 10 in-lbs
- E. Very many M4 screws, M3 screws and possibly #4 screws holding cables on electrical stress relief panel , apply Loctite and torque to 10 in-lbs
- F. # 4 SHCS's each connector has 4, use Loctite 290, take care to not put on excess that could touch wires or connector surfaces

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

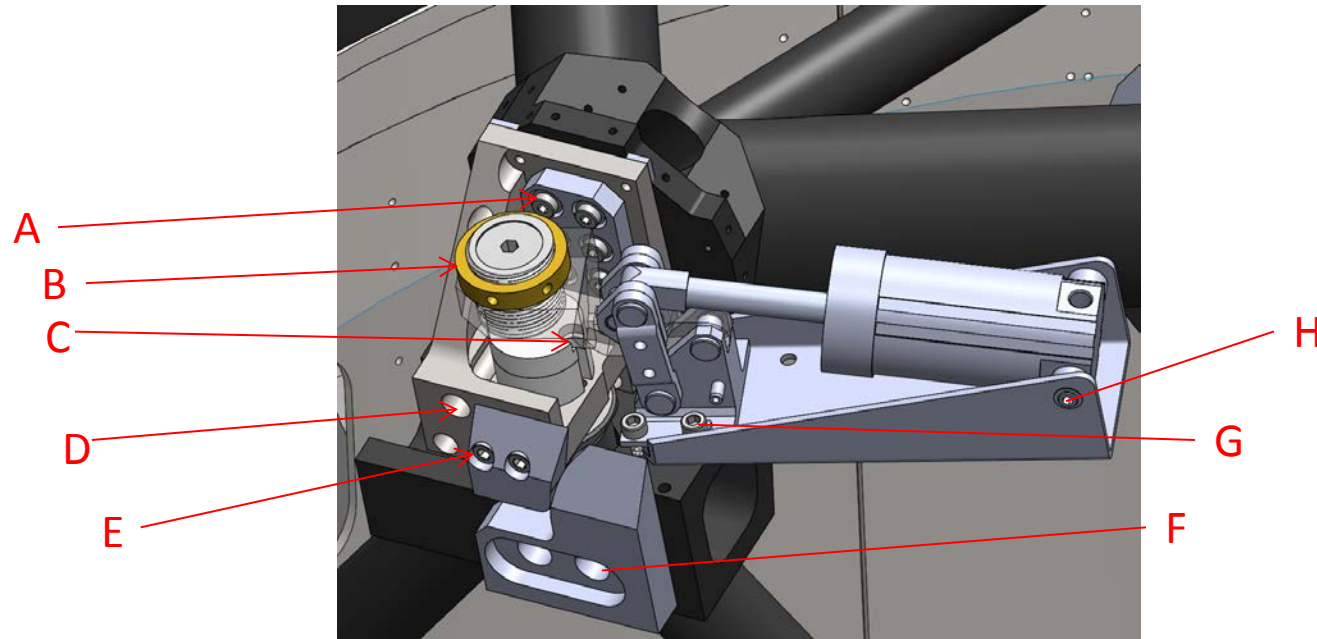
Air Injection Interface and Nearby items



- A. 5x M10 SHCS, remove one at a time and apply Loctite 243, torque to 1100 in-lbs (92 ft-lbs)
- B. Remove all 4 of these M5 screws, and see C.
- C. Remove rigid plumbing from Bimba, remove bracket from outer drum, apply Loctite 290 to the 4 M4 SHCS on the backside of the bracket at the thread interface (these screws hold the Bimba actuator onto the bracket), put bracket back on, apply Loctite 222 to each of the M5 screws and torque to 15-20 in-lbs, then reattach fittings and tighten appropriately
- D. 2x M3 clamp screws, apply Loctite 290 at threaded interface
- E. 4x M6, apply Loctite 243 and torque to 20 in-lbs
- F. Stress relief panel screws, M5, apply Loctite 222 and torque to 15-20 in-lbs
- G. Apply Loctite 290 to the guide post threads

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

Bipod Weldment Canoe Spheres and Nearby Items



- A. 6x M6 Low Head SHCS, Remove one at a time, verify alloy and not stainless, maintain washer order, apply Loctite 243, torque to 30-35 in-lbs
- B. Lock ring, do not check or adjust, apply small amount of Loctite 290 around perimeter
- C. 2x M5 SHCS, apply Loctite 290 at top of thread engagement
- D. 3xM6 SHCS, Remove one at a time, apply Loctite 243 and torque to 220 in-lbs (18.3 ft-lbs)
- E. 2xM6 SHCS, Remove one at a time, apply Loctite 243 and torque to 30 in-lbs
- F. 2xM6 SHCS, Remove one at a time, apply Loctite 243 and torque to 30 in-lbs
- G. 4xM6 SHCS, Remove one at a time, apply Loctite 243 and torque to 220 in-lbs (18.3 ft-lbs)
- H. Destaco axle screws, remove one at a time, maintain spacers etc., apply Loctite 222 and torque to 15-20in-lbs

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

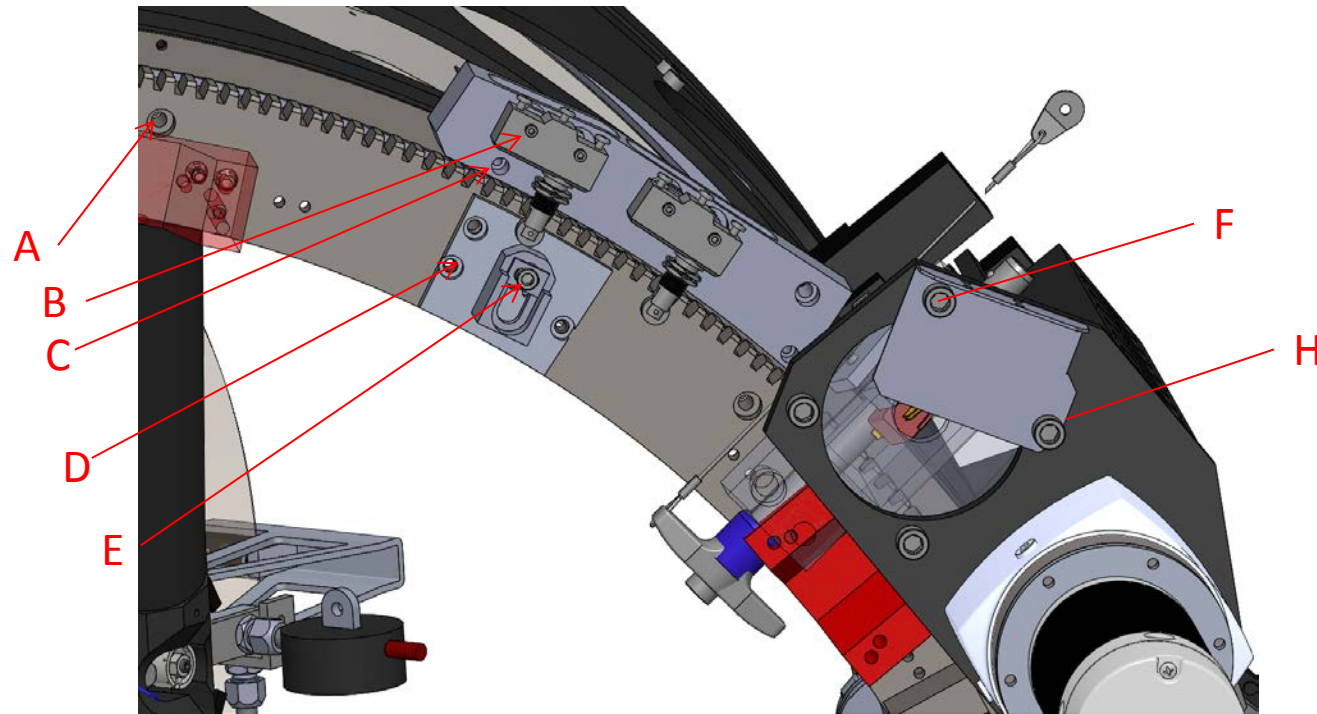
Hinge Clamps and Nearby items



- A. V-Block fastener, do not touch (verify with Jim if Loctite was applied), if no, torque to Holo-Krome M10 SHCS recommendations, 1100 in-lbs (91 ft-lbs)

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

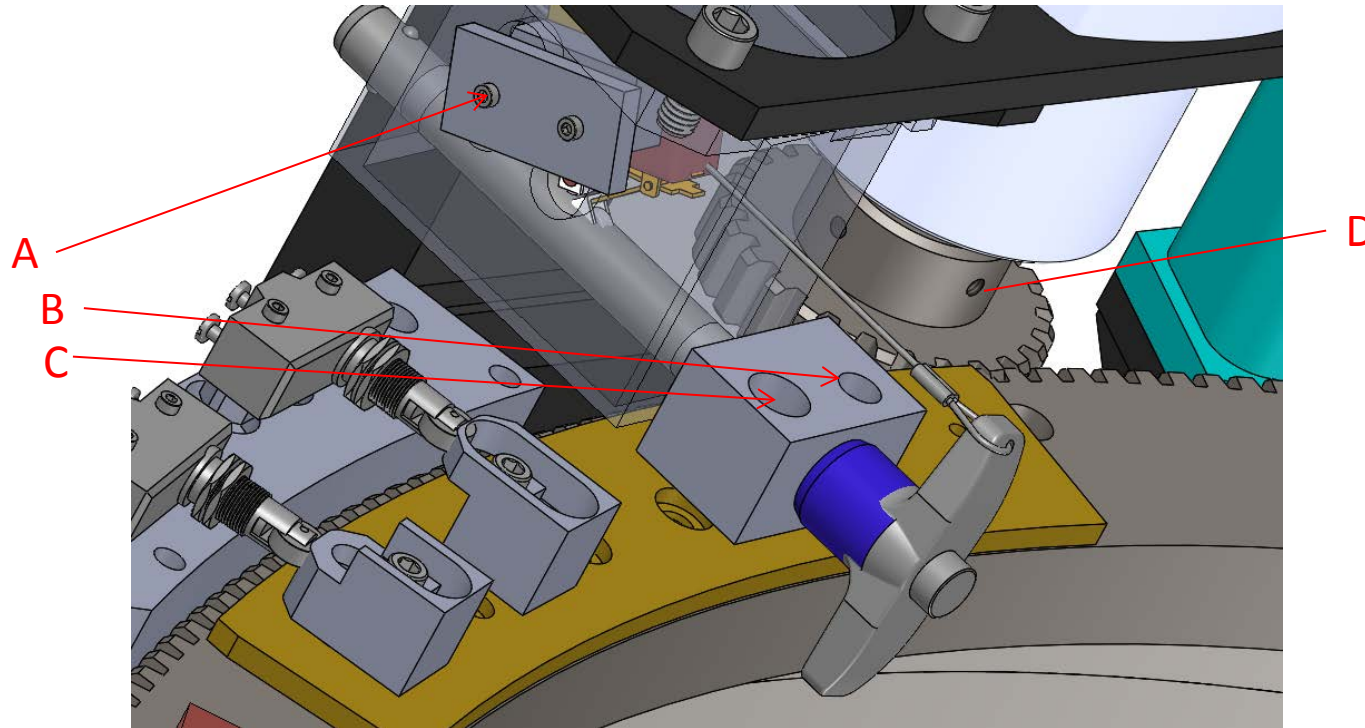
Drum Locking Pin, Switches, and Nearby Items



- A. 24x M6 SHCS, Remove one at a time, verify alloy and not stainless, apply Loctite 243, torque to 230 in-lbs
- B. Switch fastener, apply small amount of Loctite 290 at thread interface
- C. 2x M4 SHCS, remove one at a time, verify black alloy, apply Loctite 222 and torque to 28 in-lbs
- D. 3xM6 SHCS, Remove one at a time, apply Loctite 243 and torque to 220-230 in-lbs (18.3 ft-lbs)
- E. 1xM6 SHCS, apply Loctite 290 and at threaded interface
- F. 3x3/8-16 SHCS, Remove one at a time, apply Loctite 243 and torque to 100-200 in-lbs
- G. 4xM6 SHCS, Remove one at a time, apply Loctite 243 and torque to 220 in-lbs (18.3 ft-lbs)
- H. Destaco axle screws, remove one at a time, maintain spacers etc., apply Loctite 222 and torque to 15-20in-lbs

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

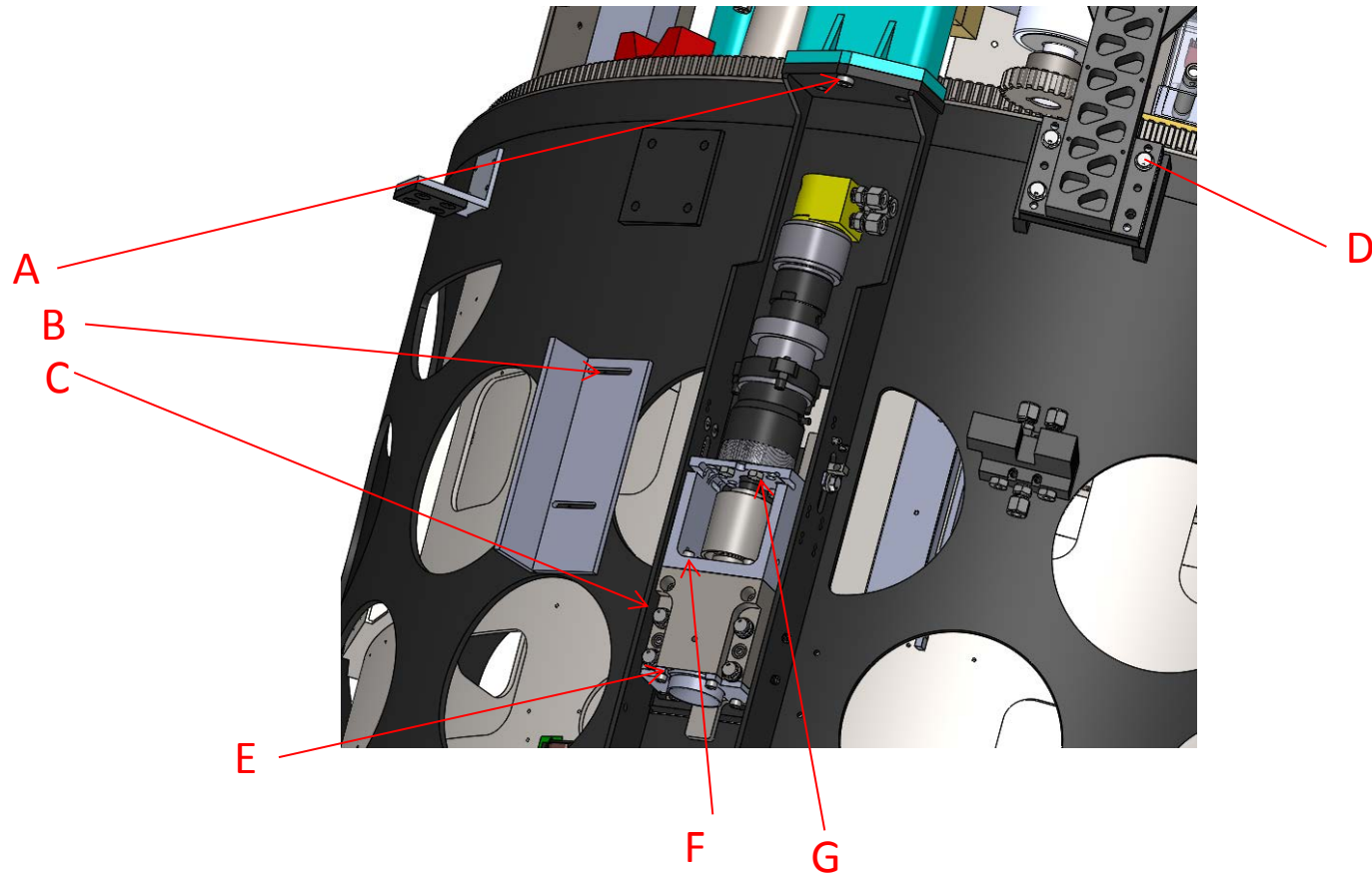
Drum Locking Pin, Switches, and Nearby Items



- A. 2x M3 SHCS, apply Loctite 290 at threaded interface if accessible, otherwise mark position and remove screws one at a time, apply 222 and torque to 10 in-lbs
- B. 1x M6, Remove, apply Loctite 243, torque to 220 to 230 in-lbs
- C. 1x M8 SHCS, remove, verify black alloy, apply Loctite 243 and torque to 300-400 in-lbs
- D. Set screws, already have Loctite applied, mark with gold paint marker

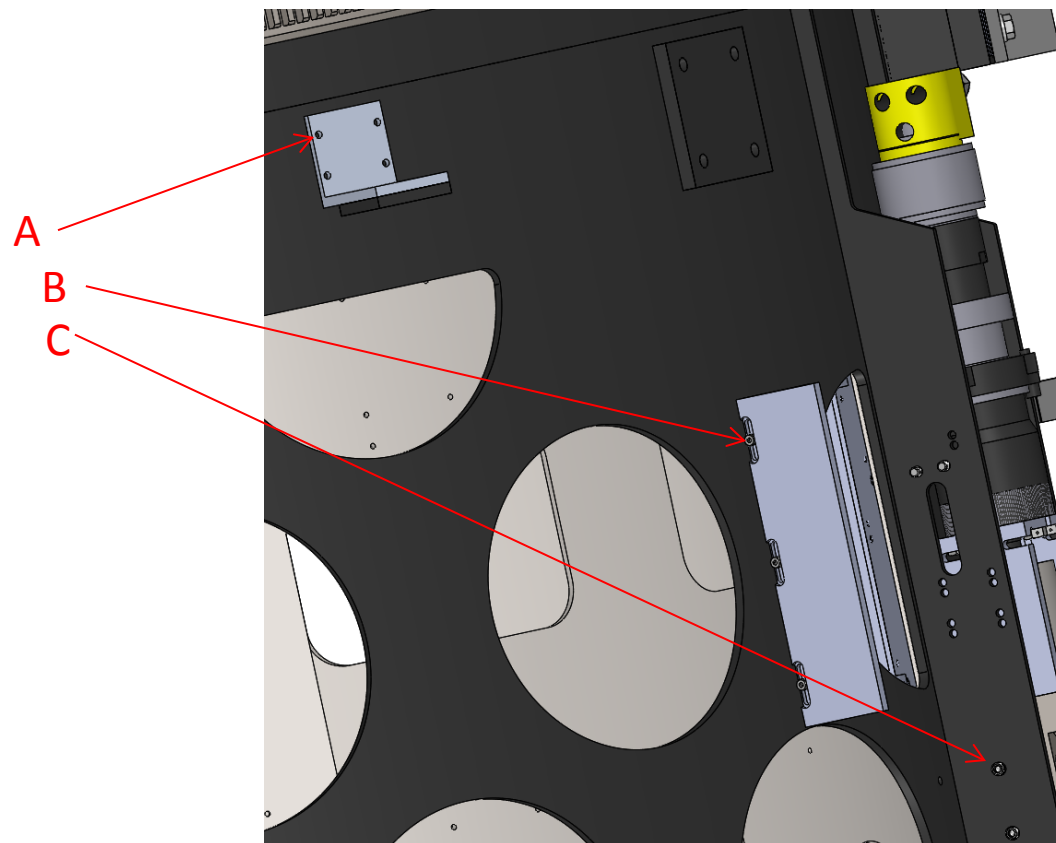
K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

Defining Point Assemblies and Nearby Items



- A. 3x M10 SHCS, apply Loctite 243 one at a time, torque to 500 to 1000 in-lbs (40-80 ft-lbs)
- B. 2x M4, Remove one at a time, apply Loctite 222, torque to 30-50 in-lbs
- C. 4x M8 SHCS, remove one at a time after alignment is complete, apply Loctite 243 and torque to 300-400 in-lbs
- D. 4x M8 SHCS, remove one at a time after alignment is complete, apply Loctite 243 and torque to 300-400 in-lbs
- E. Apply loctite 290 at threaded interface, use syringe with needle if appropriate
- F. Ask Jim if these hex heads were loctited, disassembly required to Apply Loctite 243, 4x M6, torque to 200-230 in-lbs
- G. Ask Jim if these hex heads were loctited, disassembly required to Apply Loctite 243, 4x 5/16-18, torque to ~400 in-lbs

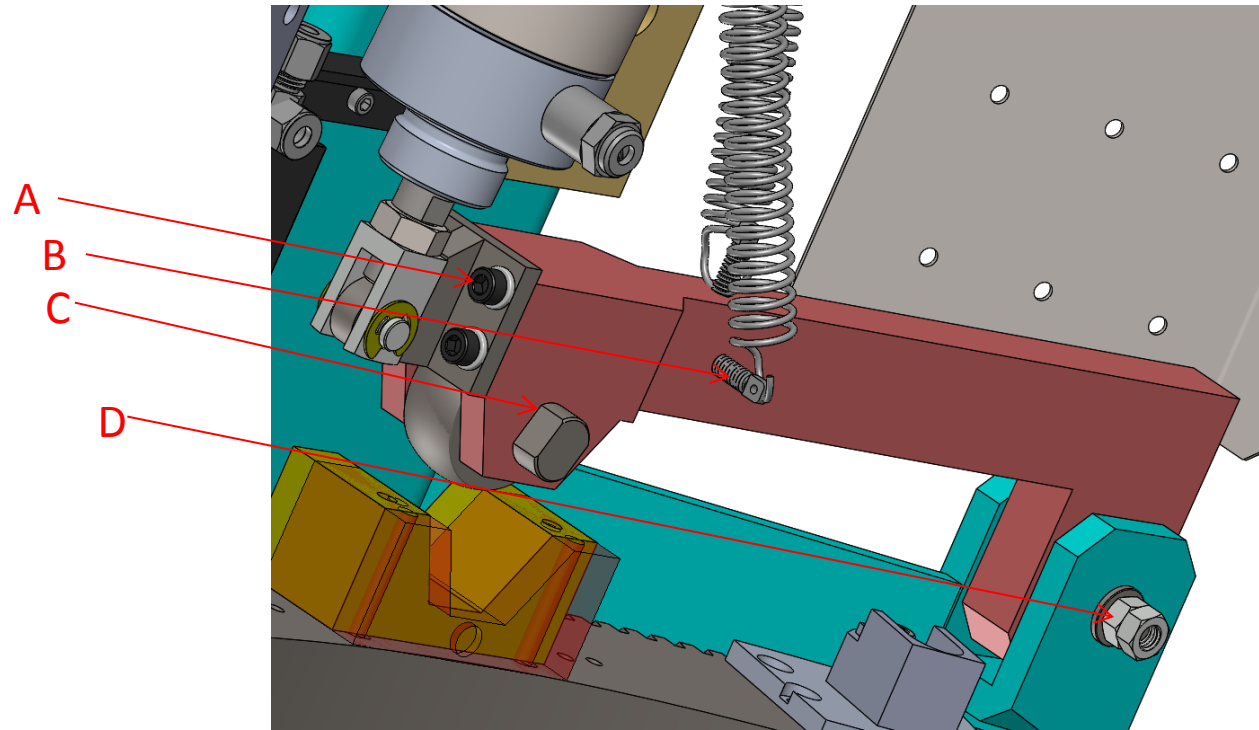
K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies Defining Point Assemblies and Nearby Items



- A. 4x M4 SHCS, apply Loctite 222 one at a time, torque to 20 to 30 in-lbs
- B. 3x M4, Remove one at a time, apply Loctite 222, torque to 20-30 in-lbs
- C. 4x M8 set screws, remove one at a time after alignment is complete, apply Loctite 243 and torque to less than 10in-lbs

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

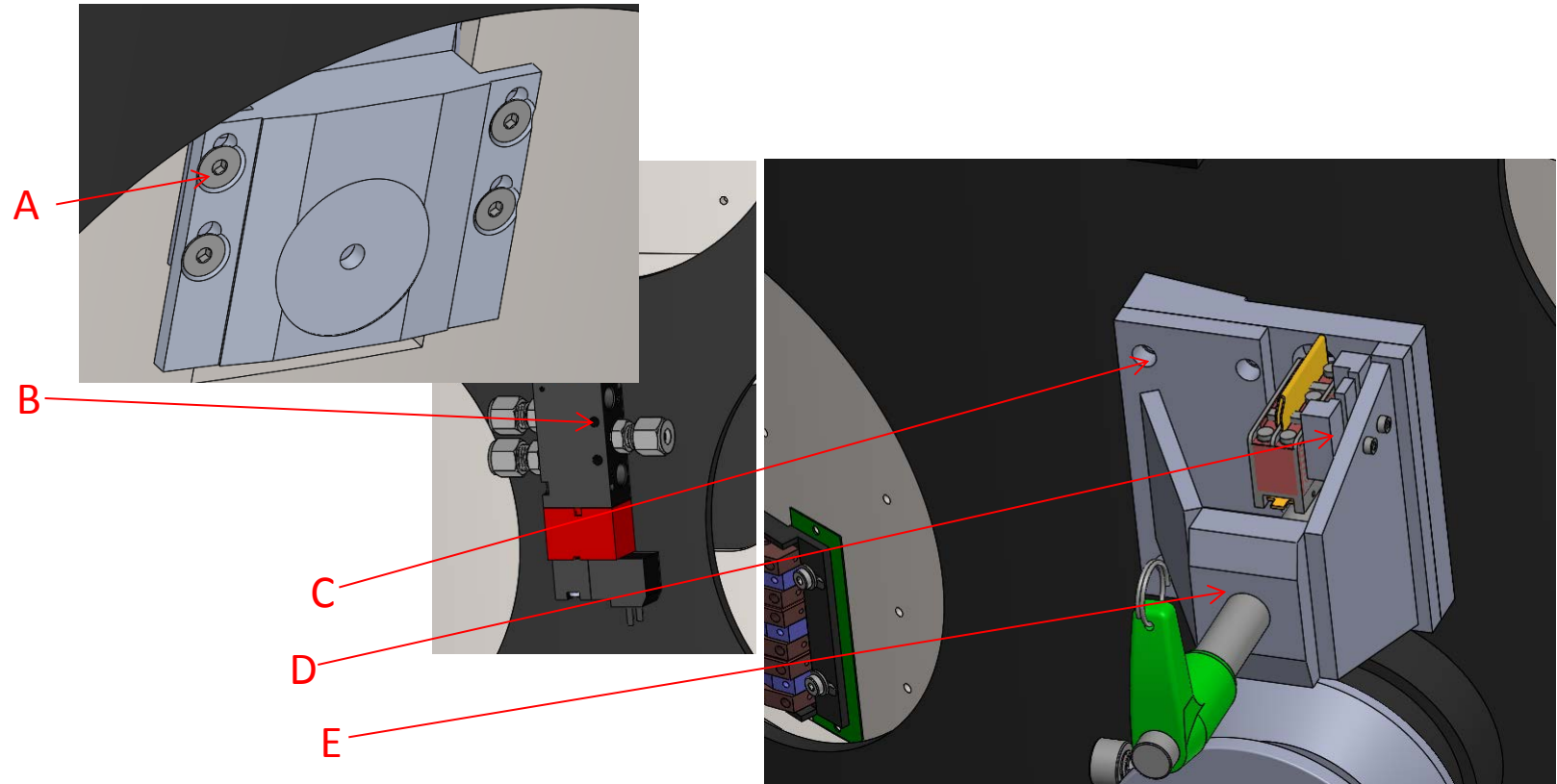
Detent Mechanism and Nearby Items



- A. 4x M6 SHCS, remove one at a time, apply Loctite 243, torque to 200 in-lbs
- B. 2x ¼-20 spring anchors, apply Loctite 290, no torque
- C. 1x M8, apply Loctite 290 on nut side thread interface
- D. M8 with lock nut, apply Loctite 290

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

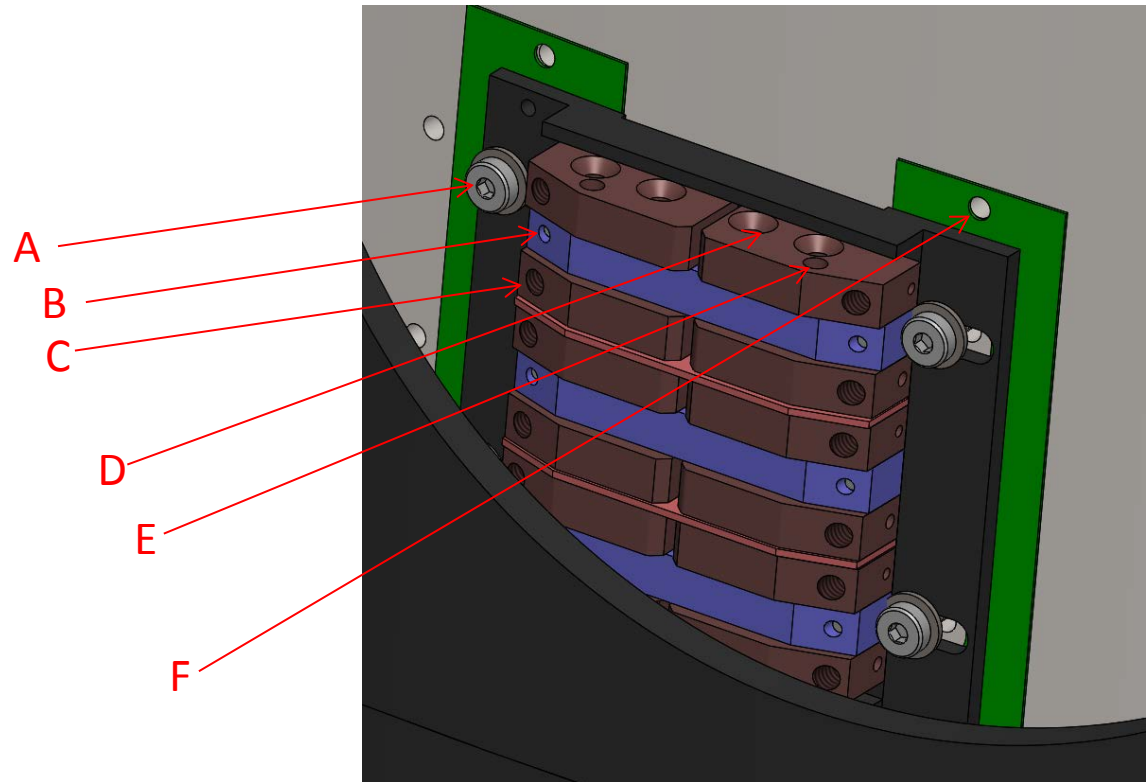
Inner Drum Air Interface, Solenoids, and Nearby Items



- A. 4x M6 SHCS, remove one at a time, apply Loctite 243, torque to 200 in-lbs
- B. M4 SHCS, remove one at a time, apply Loctite 222, torque to 10-20 in-lbs
- C. 5/16 or M8 SHCS, Apply Loctite 243, torque to ~200 in-lbs
- D. M3 switch fasteners, apply Loctite 290 to threaded interface
- E. Transfer punch and then drill after wheels are fully set (already done, is oblong hole OK, file for final fit?....)

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

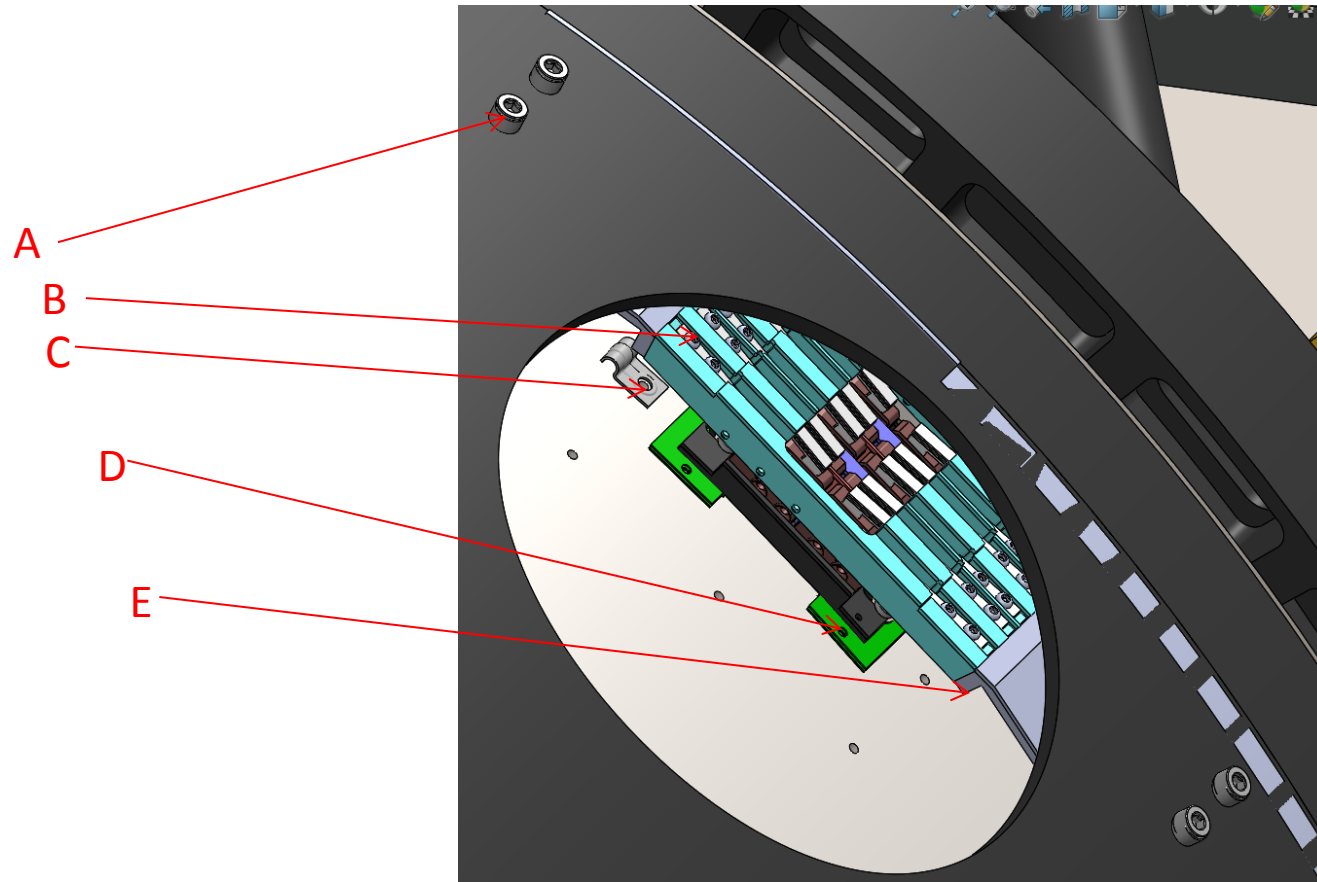
Inner Drum Brush Contact Assemblies



Verify Jim applied Loctite to all of these, use 290 if needed, may need to orient inner drum for access

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

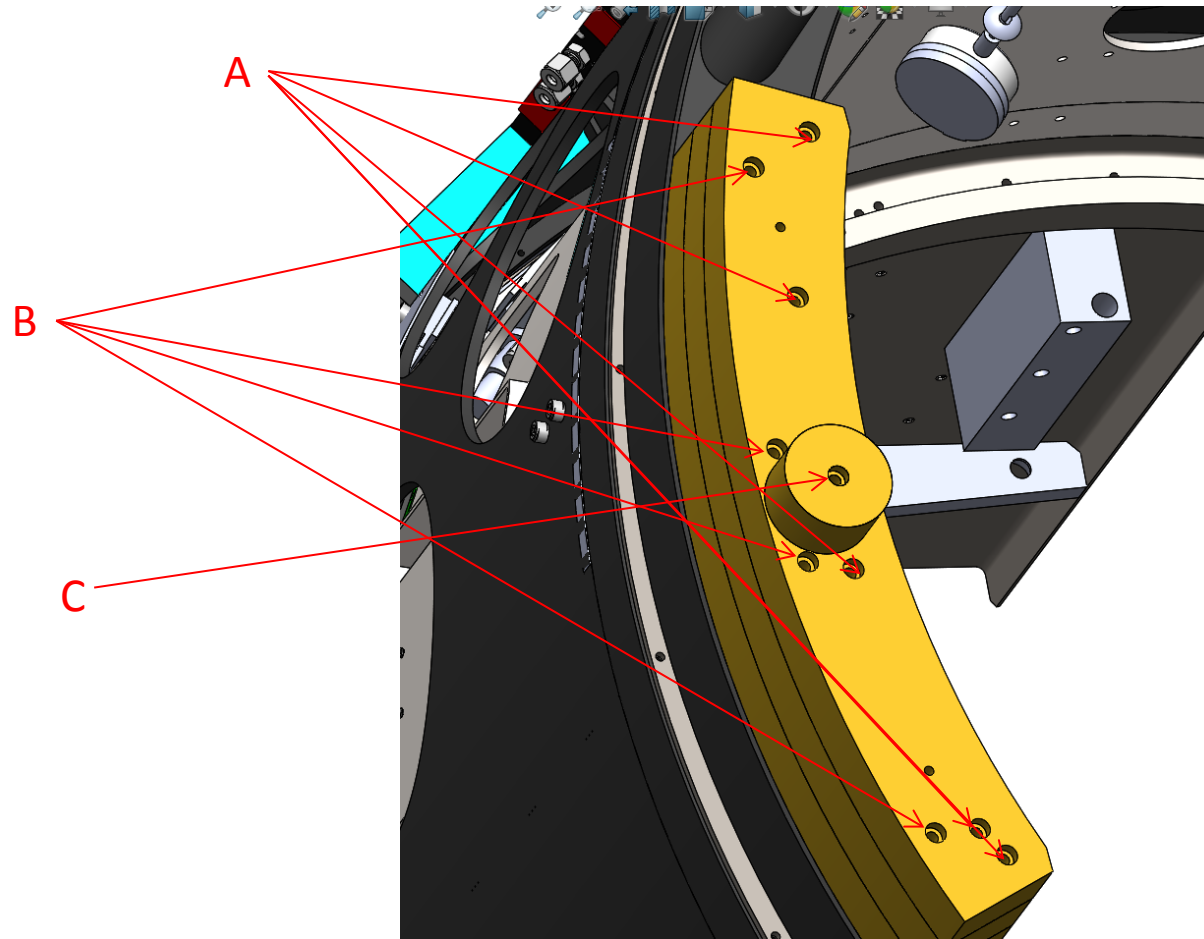
Outer Drum Brush Assemblies



Verify Jim applied Loctite to all of these, use 290 if needed, may need to orient inner drum for access

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

Top Ring Balance Masses



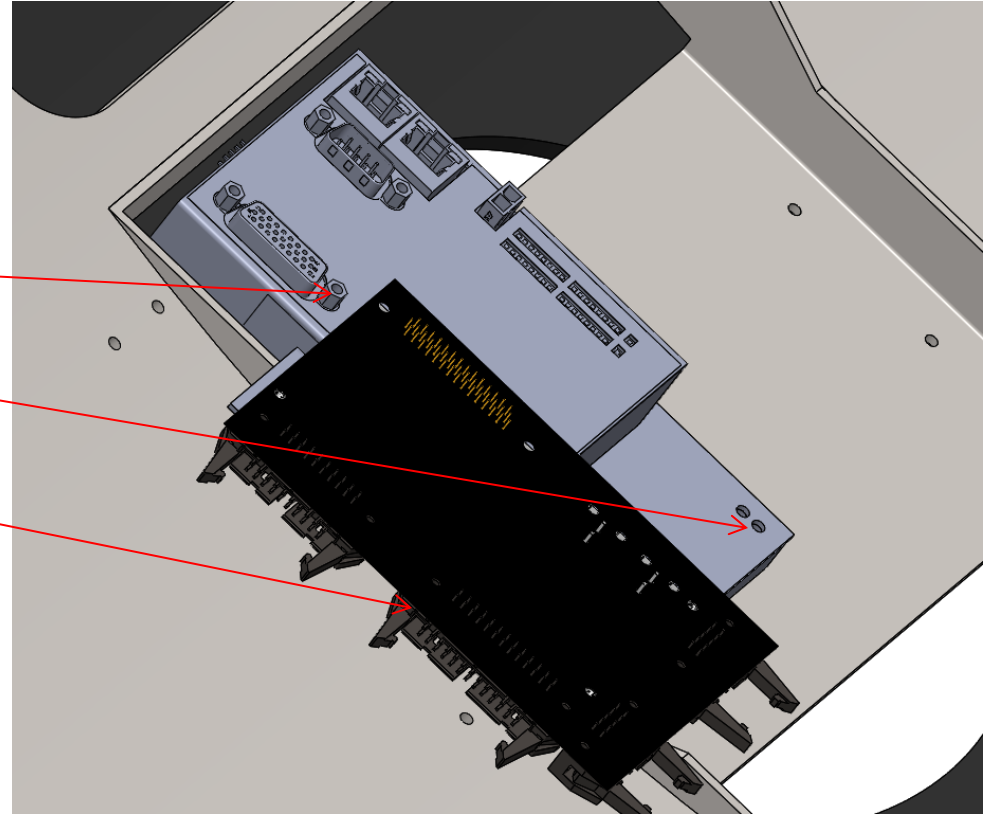
- A. 3x M6 SHCS, remove one at a time, apply Loctite 243, torque to 100 in-lbs, likely only 3 of 5 holes will be filled, this is OK
- B. 4x M6 SHCS, remove one at a time, apply Loctite 243, torque to 25 in-lbs (threads into brass)
- C. 1x M6 SHCS, apply Loctite 243, torque to 25 in-lbs (threads into brass)

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

Steel Wheel, Electronics & Board Assemblies

A →
B →
C →
D →

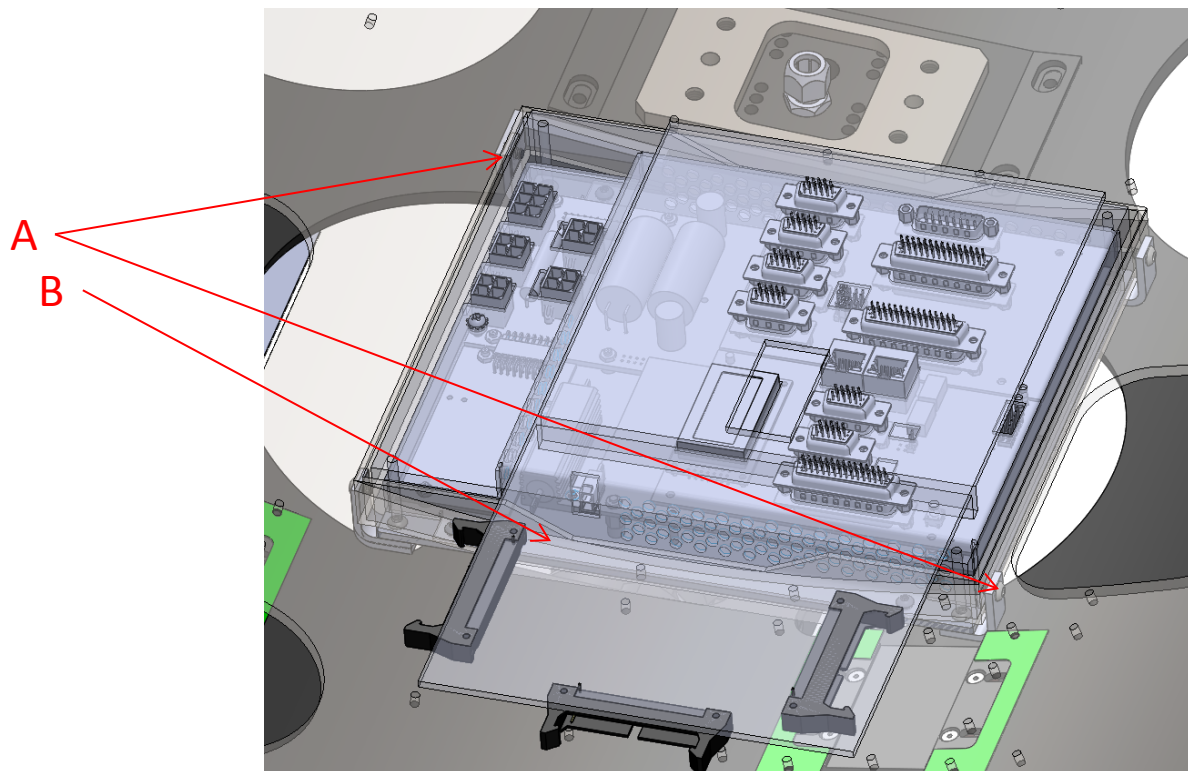
The Safety Rio PCB now has a protective cover plate over it which is attached to support posts by 8-32s (23 in-lbs). The posts are attached to the inner drum with M4s (28 in-lbs). Use Loctite Purple 222 on both.



- A. 4x 1 ¼ nut, apply Loctite 290 when alignment is complete, Do not move or loosen, vertical set screws do not seem to fully constrain although they should, torque to 1200 in-lbs (100 ft-lbs) unless during alignment (way under fully torqued, but not practical to go full torque)
- B. Connector fasteners, do not apply Loctite unless instructed otherwise, verify fasteners are captive to wire harnesses
- C. Rio attachment fasteners, apply Loctite with good judgement

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

Electronics & Board Assemblies

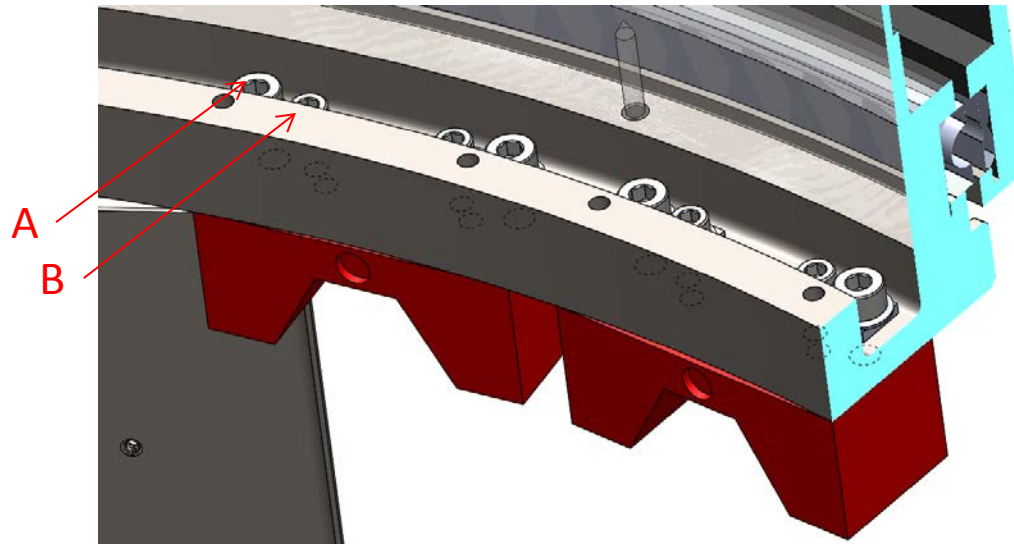


- A. 8x M3 or 4-40 SHCS, this will require moving the inner drum to where screws are accessible, remove one at a time, apply Loctite 222, torque to ~6 in-lbs or less, use good judgement
- B. For pcb attachment, standoffs and wire fasteners, apply Loctite 222 to non-captive fasteners, torque to 1/2 of torque tables, use good judgement, "snug" is fine if Loctite is applied, only use 290 where you will not spill on sensitive conductor, may be able to use syringe

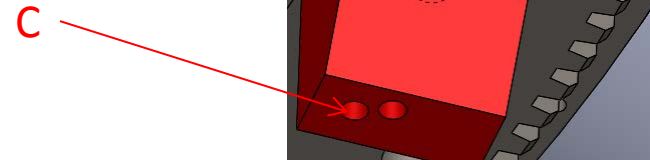
The Galil PCB now has a protective cover plate over it which is attached to support posts by 8-32s (23 in-lbs). The posts are attached to the inner drum with M4s (28 in-lbs). Use Loctite Purple 222 on both.

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

V-Blocks to Ring Gear

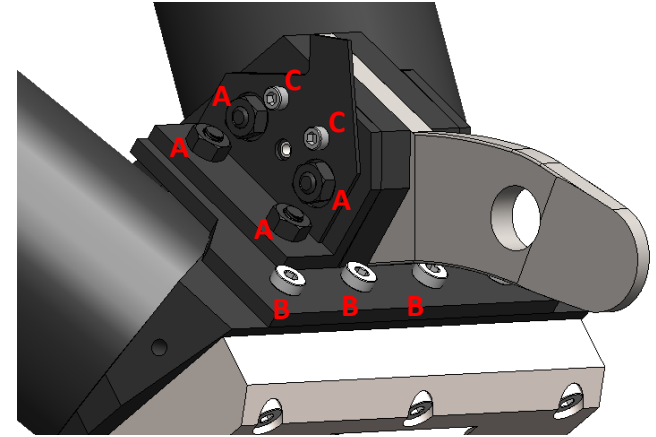
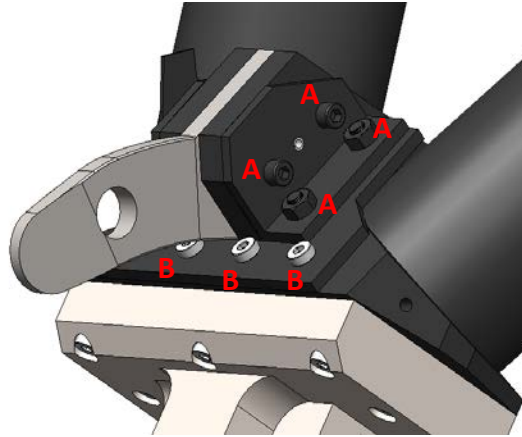
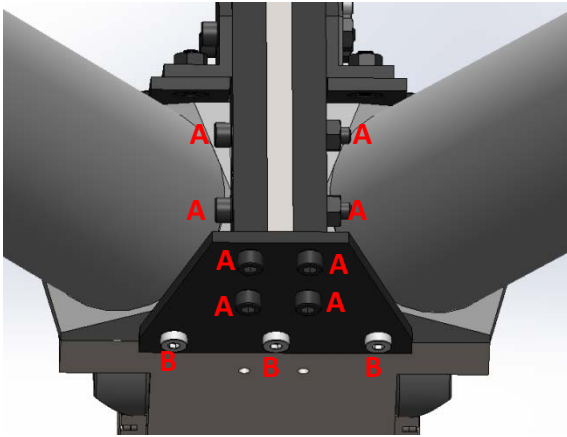


- A. 2x M8 per v-block, after alignment is complete, apply Loctite 243, torque to ~500 in-lbs if black oxide alloy
 - B. 2x M6 per v-block, after alignment is complete, apply Loctite 243, torque to ~200 in-lbs if black oxide alloy
- Either A or B will be required, not both, depending on final adjustment position
- C. Drill and pin, guide holes exist as shown, use 6mm reamer, pin with interference fit dowel pin with internal thread, pin should be flush or recessed



K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

Swing-Arm Docking Tang Assembly

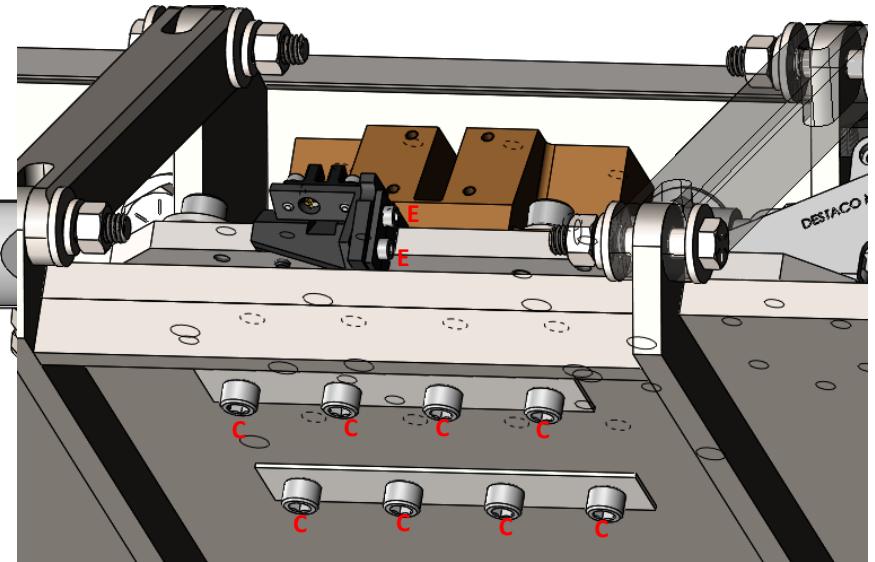
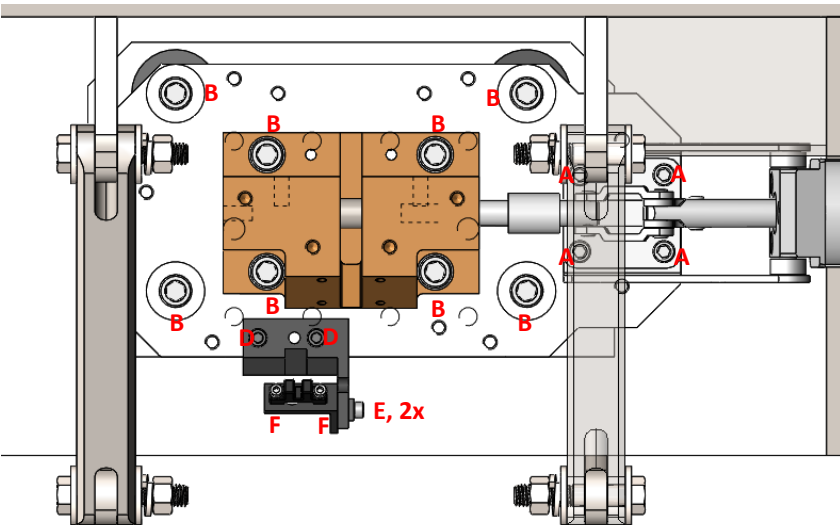


Remove each faster one at a time - apply Loctite and torque to specifications

HW	Type	Loctite	Torque (in-lbs)
A	¼ - 20	Purple 222	82
B	M6		39
C	8 - 32		23

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies

Swing-Arm Docking Tang Assembly



Remove each faster one at a time - apply Loctite and torque to specifications

HW	Type	Loctite	Torque (in-lbs)
A	$\frac{1}{4}$ - 20	Purple 222	82
B	$\frac{3}{8}$ - 24	Blue 243	305
C	$\frac{5}{16}$ - 16		171
D	10 - 32	Purple 222	33
E	8 - 32		23
F	6 - 32		12

K1DM3 Screw Tightening and Loctite Application - Specific Subassemblies Swing-Arm Come-along Eye



The come-along will need to be removed during the alignment and adjustment of the mirror assembly so it should be left for last after those operations.

M12s - Apply Blue Loctite 242 and torque to 200 in-lbs

K1DM3 Fasteners Not Covered in Prior Slides

Guidelines

If we do not have a demand for high clamping force, most fasteners do not need to be torqued precisely

- Not using torque wrench allows faster progress in applying Loctite and reassembly, non-critical fasteners can be torqued by appropriate “feel” as long as Loctite is applied
- Applies to wire harness loop clamps, and plumbing clips, solenoid mount screws, or anything that was not covered prior slides
- Use of epoxy or other methods is allowed, whatever the method is should be tested or already have been proven to be reliable

K1DM3 Final Pin Plan

Pin the following when install and alignment is complete

1. Ring gear Mounted v-blocks (v-block side pre-drilled, 6mm reamer)
2. 3 defining point blocks (use 2 pre-drilled holes per block)
3. Bipod weldment to inner drum (Done)
4. Ring gear to inner drum (Done)
5. (2) Canoe sphere mounts to swingarm (Done)
6. Exlar u-joint connection to swing arm (Done)
7. Canoe spheres to canoe sphere mounts (Done)