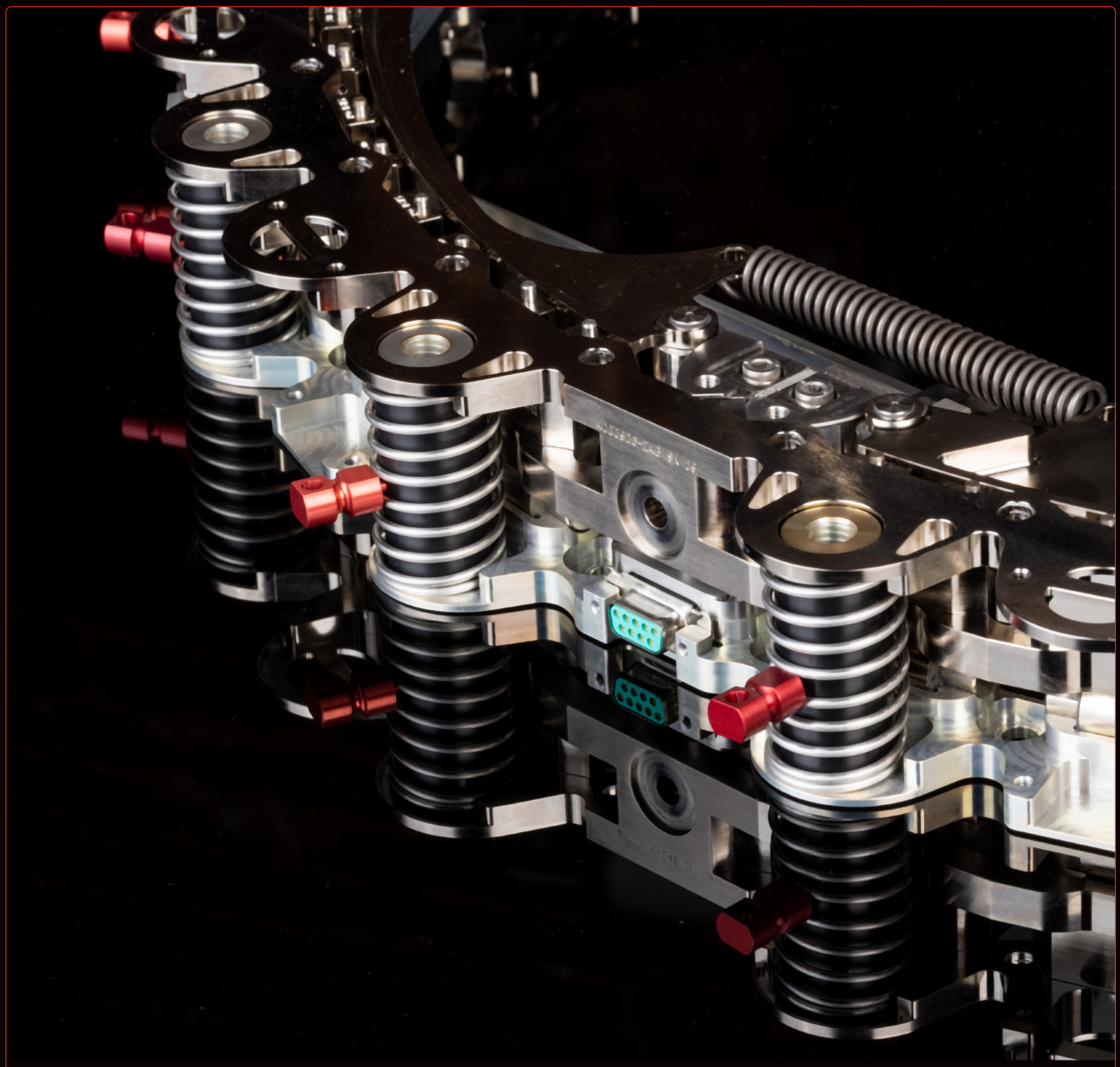


ADVANCED LIGHTBAND

Operating Procedure | 3000355E ALB

spacesystems@rocketlabusa.com
rocketlabusa.com

ROCKETLAB

Only personnel directly trained and approved by PSC via 3000316 ALB Training Record are authorized to operate a Lightband for any purpose.

Organization Name	
ALB Size (XX.XXX-XX)	
ALB Assembly Number & Revision	
ALB Serial Number	
Operation Purpose (electrical verification, final integration, etc.)	
Location	

This procedure does not involve any high-energy liquids, solid fuels, or any material with inherently hazardous physical or chemical properties.

Table of Contents

1. Revision History

Rev	Issued	Created	Reviewed	Change Description
-	See Previous Revisions			
D	14Jun24	RJB	DJ	• Updated step 12.2.5 to follow Figure 12-2 polarity. • Updated step 12.1.3 to allow 17V minimum. • Updated Table 12-1 to verify time to reach 0.25A. • Updated 8.3.5 back off turn. • Updated Figure 12-5, Figure 12-6, & Figure 12-7.
E	25Jul24	BB/DJ	JF	• Updated Table 3-1: ○ Added row for Upper Ring to check for stow screw hole damage. ○ Added row to Lower Ring to check for preload cam staking delamination. ○ Added common examples to Yield & Damage row ○ Added row to check for FOD with common examples

2. Acronyms and Abbreviations

- A (or Amps) – Ampere (SI unit of electric current)
- ALB – Advanced Lightband (used interchangeably with Lightband)
- AR – As required
- Atm – Standard atmospheric pressure (unit of pressure)
- AWG – American wire gauge
- C – Celsius (unit of temperature)
- Ch – Channel
- CMM – Coordinate measuring machine
- DB-9 – Common name for a specific electrical connector (used interchangeably with official size DE-9)
- div – Division (scale on oscilloscope)
- DMM – Digital multimeter
- ESD – Electrostatic discharge
- FLH – Flathead (type of screw head, conical shape)
- I – Current (measured in Amps)
- in – Inch (unit of length)
- lb – Pound force (unit of force)
- LV – Launch vehicle
- NTP – Normal temperature and pressure (20°C and 1 Atm)
- Ohm (Ω) – SI unit of resistance
- PSC – Planetary Systems Corporation
- QA – Quality assurance
- R – Resistance (measured in Ohms)
- Rev – Revision
- s – Second (SI unit of time)
- SHC – Socket head cap (type of screw head)
- SI – International System of Units
- SN – Serial number
- SV – Space vehicle
- V – Volt (SI unit of electric voltage)
- V_{DC} – Voltage direct current (measured in volts)
- W – Watt (SI unit of power)

3. Introduction

3.1 Scope

This document describes the steps required to adjoin and operate the Advanced Lightband (ALB). Training and certification by Planetary Systems Corp (PSC), verified via PSC document *3000316 ALB Training Record*, are required to operate any Advanced Lightband. The Training Record also specifies the certification's expiration date.

Ensure this is the latest version of the document by visiting PSC's website, https://www.rocketlabusa.com/space-systems/separation-systems/. If the version trained on was older than that on the website contact PSC to discuss the changes before continuing.

Read this entire document before attempting any procedures. Steps shall never be skipped unless specifically permitted otherwise.

Contact PSC to clarify any ambiguity or to answer any other questions.

3.2 Lightband Description

The Lightband is comprised of two separable halves. The Lower Ring contains the Hinged Leaves, Retaining Ring, Initiator, and Separation Springs. The Upper Ring, smaller and lighter, contains the Leaf engagement grooves. Typically, the Lower Ring is attached to the launch vehicle (LV) and the Upper Ring is attached to the space vehicle (SV). The electrical interface to operate the Lightband is a DB-9 socket connector on the outside of the Lower Ring +Y side. See Figure 3-1 and Figure 3-2. For more information on the Lightband see PSC document *2003336 Advanced Lightband User's Manual*.

The Lightband is not ESD-sensitive.

There are three Lightband operations.

Table 3-1: Lightband operations

Operation	Description	Requires electrical power to the motors?	Applicable Section
Mate	Compressing and locking the Separation Springs and placing the Upper Ring on the Lower Ring.	No	10
Stow	The Stow Screw is used to drive the Sliding Bracket in the stow direction and mechanically lock the Lower Ring and Upper Ring together.	No	11
Deploy (separate)	The electric motor drives components that mechanically release the Lower and Upper Rings. In flight, the Separation Springs will then elongate and impart relative velocity between the two Rings. On the ground, the Springs may not elongate due to Spring Locks.	Yes	12

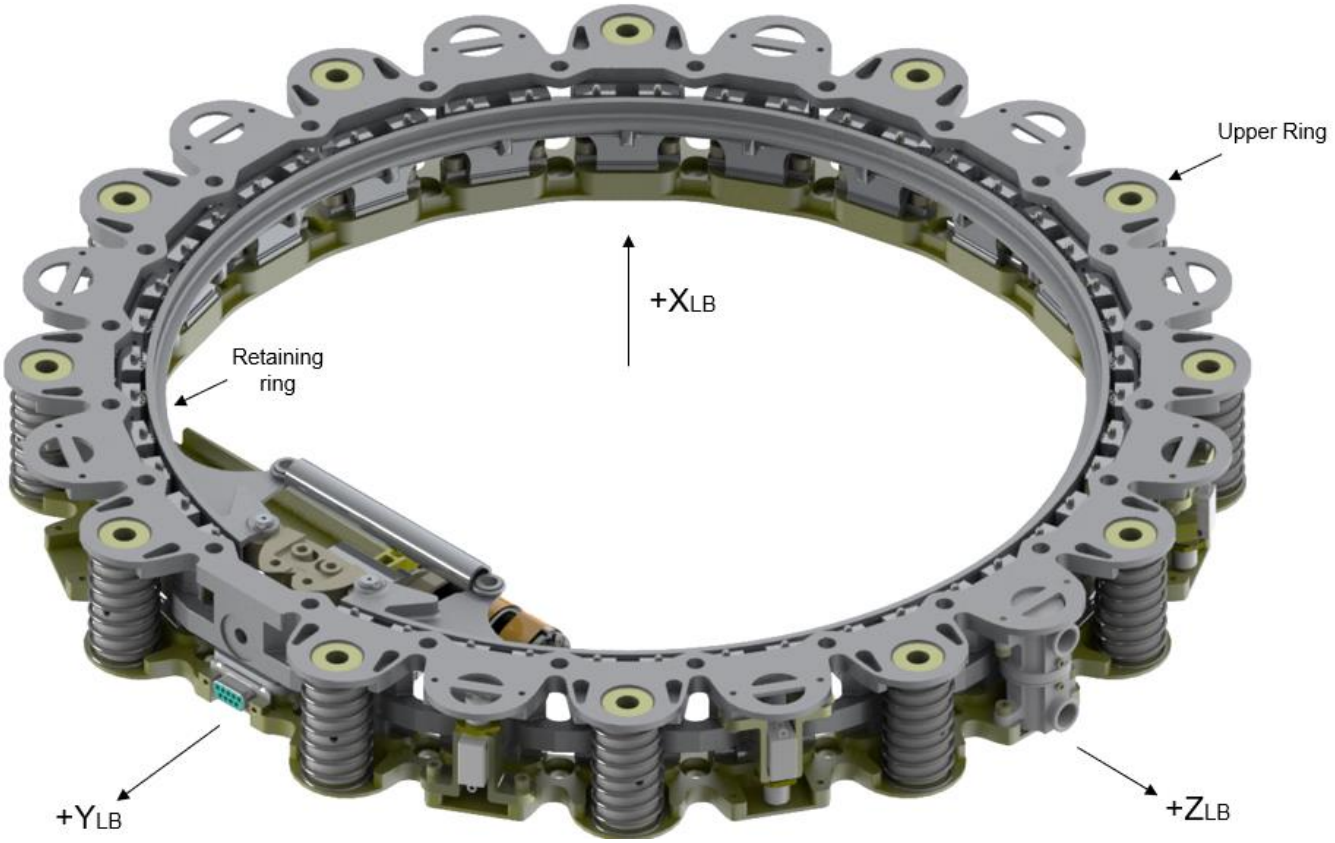


Figure 3-1: ALB15.000-24, Stowed

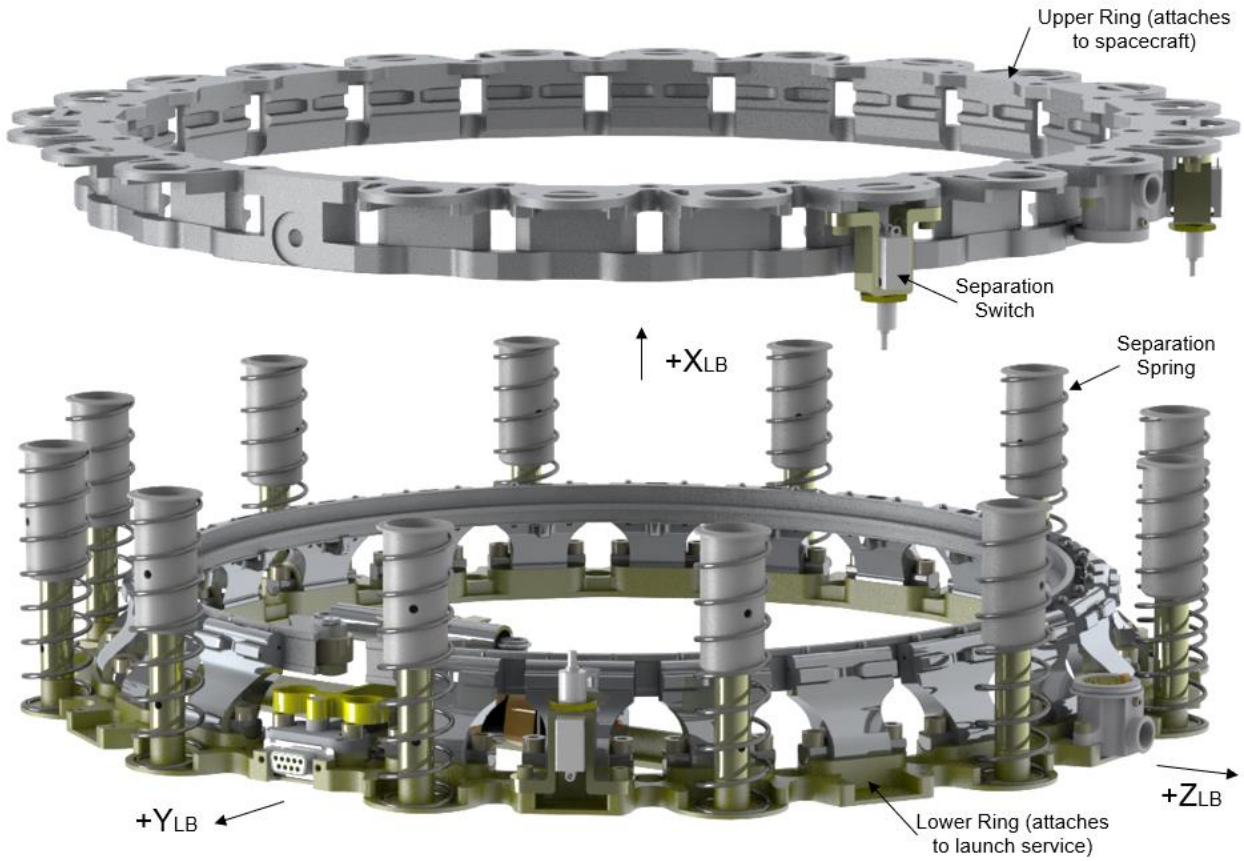


Figure 3-2: ALB15.000-24, Deployed (also referred to as separated)

3.3 Referenced Documents

The following documents are referenced throughout the procedure. Check https://www.rocketlabusa.com/space-systems/separation-systems/ to ensure the latest revision.

Table 3-2: Referenced documents

Document	Necessary For
2003336 Advanced Lightband User's Manual	Adjoining structure flatness, Lightband circularity, detailed Lightband description
3000316 ALB Training Record	Verify approval to operate Lightband(s)

3.4 Required Equipment

The items listed below are proven to properly operate the Lightband as presented in this procedure. PSC strongly recommends using this equipment. All procedure steps listing recommended settings assume the PSC typically used equipment. All equipment substitutions shall be thoroughly vetted prior to use with the Lightband. For instance, some customers create a custom data acquisition system, thereby negating the need for an oscilloscope.

Table 3-3: Attaching Subsystems (section 8)

Qty	Item	Make & Model Typically Used by PSC
1	Torque driver, 35 in·lb capability	Cedar Digital DIW-4W
1	Torque wrench, 150 in·lb capability	Sturtevant Richmont CCM-150I
1	Torque wrench with reduced hex key attachment, 50 in·lb capability	Belknap VB5T-I with custom VB-1802019 attachment
1	7/64 inch hex key	-
1	5/32 inch square hex key	-

Table 3-4: Mechanical attachment (section 9)

Qty	Item	Make & Model Typically Used by PSC
1	Adjoining structure for Upper Ring	PSC 2000741 Transition Ring or PSC 2003310 I-Beam Transition Ring
1	Adjoining structure for Lower Ring	PSC 2000741 Transition Ring or PSC 2003310 I-Beam Transition Ring
AR	0.25 inch SHC fastener (to attach Lower and Upper Rings to adjoining structure)	NAS1351N4-XX
AR	0.25 inch nut (if applicable, to attach Lower and Upper Rings to adjoining structure)	NASM21043-4
1	3/16 inch hex key (minimum 1.5 inch shank length) with interface for torque wrench	-
1	5/32 inch hex key (minimum 1.5 inch shank length)	-
1	Torque wrench, 150 in·lb capability	Sturtevant Richmont CCM-150I
1	Small tweezers to aide in fastener handling	-
AR	Isopropanol (to clean adjoining structure and Lightband interfacing surfaces)	-
AR	Lint Free Wipes (to clean adjoining structure and Lightband interfacing surfaces)	-
AR	Ability to measure flatness of adjoining structures (granite table and thickness gages, CMM, laser, etc.)	Starrett 66 Thickness Gage and granite table
AR	Ability to measure and maintain circularity of Lower and Upper Rings adjoining structures (custom flat head screws or gage pins)	PSC 2002753 FLH Alignment Screw and 2000741 Transition Ring or 2003310 I-Beam Transition Ring

Table 3-5: Mating (section 10)

Qty	Item	Make & Model Typically Used by PSC
1/Spring	ALB Spring Lock	2003408 (PSC provided)
AR	Weights to offset Separation Connector and Separation Switch force	-

Table 3-6: Operating (sections 11 and 12)

Qty (1)	Item	Make & Model Typically Used by PSC
1	ALB Stow Screw	2003132 (PSC provided)
1	Torque driver, 26 in·lb capability	Sturtevant Richmont DS1F384CZHMC
1	Power source, adjustable, 32 V_{DC} and 6.5 A capability	BK Precision 1687B
8, 10	Patch cord (to create power and measurement and test circuits, minimum 3.5 A per line, recommend black and red colors)	Pomona, Banana-to-Banana, 18 AWG
1	Oscilloscope, 2 isolated channels	Tektronix TPS2014B
1	Ability to save oscilloscope data and transfer to computer	Compact flash card and reader
1	Current probe for oscilloscope, 0.05 to 4.0 A range	Tektronix A622
1	Adjustable timer relay with trigger, 0.5 to 1.5 s with 0.1 s or finer increments	Macromatic TD-78122
1	Trigger switch (minimum 7 A & 32 V)	-
1	10 Ω power resistor, ≥100 W, used to simulate Lightband motor	Dale HL-100-06Z-10R00-J-J
1	Digital Multimeter (DMM) with leads	Fluke 77IV
1	DB-9 pin breakout cable to connect to Lightband	custom made
1, 3	DB-9 socket breakout cable for Test Circuits	custom made
1	Digital camera and video camera to record operation	-

1) Items with dual numbers are the minimum required quantity followed by the recommended quantity. Having the recommended quantity will save time.

4. Warnings

Violating any of the below shall void PSC document *1001112 Planetary Systems Corporation Commercial Terms and Conditions of Sale*.

1. All technicians completing this procedure shall be trained directly by PSC and given authority to operate the Lightband(s) stated in PSC document *3000316 ALB Training Record*.
2. The Lightband shall only be operated using this procedure. This procedure shall be filled out for every operation of the Lightband. Steps shall not be skipped or modified unless they specifically permit otherwise.
3. If a Lightband ever fails to operate correctly, PSC shall be contacted for recommendations and troubleshooting techniques. Subsequent operations shall not be attempted without first understanding the cause of the failure. See section 5 Anomaly Reporting for instructions.
4. All fasteners shall be used when attaching the Lightband to adjoining structures. Fasteners shall not be omitted from any mounting hole in the Lightband.
5. The Upper Ring shall be physically separated from the Lower Ring after every Deployment. A Stow operation shall not be attempted without first inspecting the Lightband.
6. Always monitor the number of turns and torque when stowing. Failure to do so may result in detrimental damage of the ALB, see Figure 11-5.

5. Anomaly Reporting

If an anomaly occurs, contact psc.support@rocketlabusa.com with all the below requested data. Providing all data will avoid confusion and expedite PSC's response.

1. Stop immediately and maintain the existing configuration (if safe). If current configuration is dangerous, move to a safe configuration.
2. Thoroughly document the Lightband's state with pictures and notes. Pictures of the Initiator Assembly, Hinged Leaves, Preload Cams, and Upper Ring internal leaf grooves are often valuable when troubleshooting. Verify the quality and focus of every picture prior to sending.
3. Provide the three prior operation's electrical profiles (if applicable to anomaly) as an Excel file. Ensure all data is properly formatted, titled, graphed and labeled. Sending only the raw oscilloscope .CSV files will significantly increase PSC's response time. Ensure all date labels correspond to the actual event date.
4. Provide a copy of this as-run procedure.
5. Provide any relevant operation details including, but not limited to:
   a) Adjoining structures. To what is the Lightband bolted?
   b) To date, how many Lightband operations have been performed?
   c) Reason for operation. Was it an environmental test, avionics verification, integration, etc.? This informs potential failure modes.
   d) Are all components accessible? Are there any access restrictions? Is the Lightband in a clean room?

6. Nominal Reporting

PSC has interest in its customer's successful deployments. Contact psc.support@rocketlabusa.com with the following data.

1. Following final integration, provide this completed document to PSC.
2. Following on-orbit deployment, send PSC voltage and current time histories and rotation rate data as measured during and after separation if available.

7. Handling Precautions

Lower Ring

1. Do not touch the sides of the Leaves. Be especially careful when installing fasteners to attach the ALB to adjoining structures to prevent the tool from slipping and damaging Leaf. See Figure 7-1.
2. Do not touch the initiation components. See Figure 7-2.
3. Do not allow the motor to contact anything. This is especially crucial when rotating the Lower Ring. See Figure 7-3.
4. Do not use the Separation Springs to rotate the Lower Ring. Avoid contacting the Springs radially to prevent imparting a moment on the Spring parts that could cause damage the Spring assemblies. See Figure 7-4.

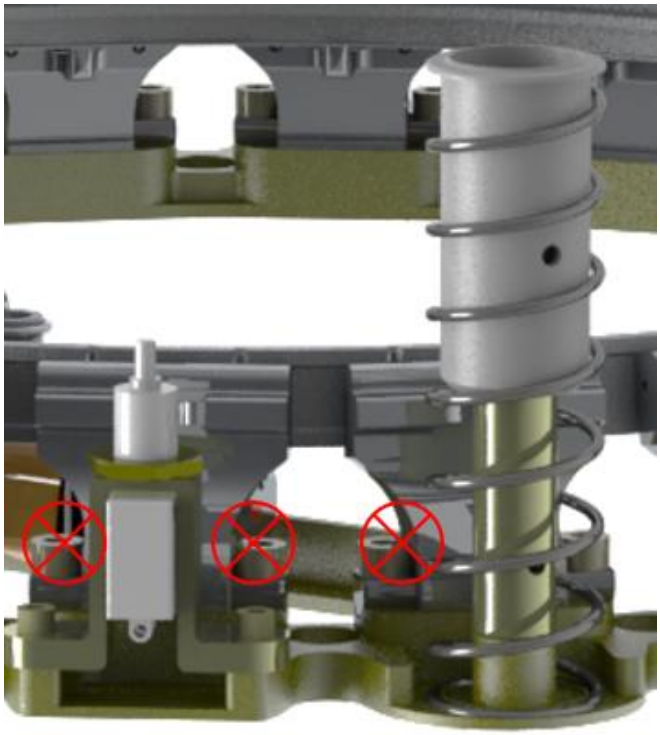


Figure 7-1: Exposed greased surfaces of Leaves

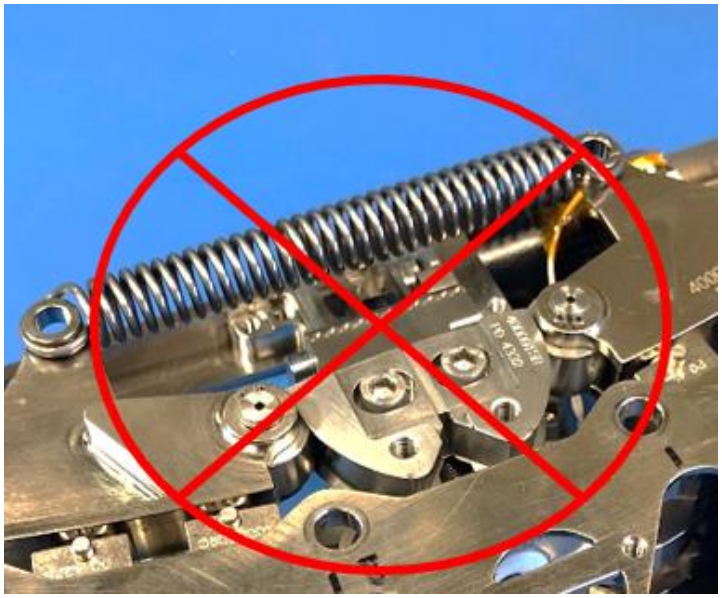


Figure 7-2: Avoid Initiation area when handling

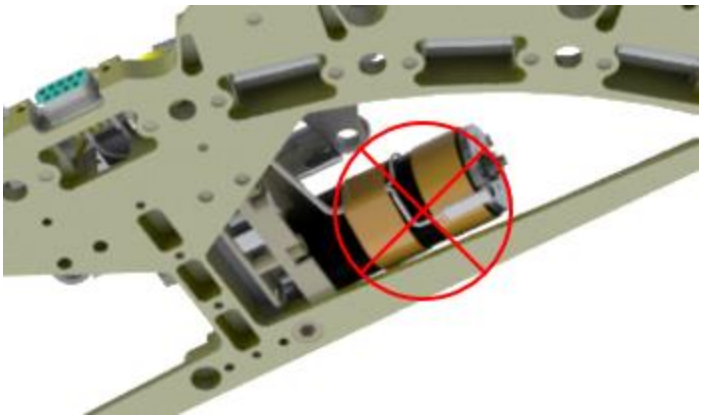


Figure 7-3: Do not allow the motor to contact the table or any other objects

Figure 7-4: Do not use Springs to rotate ALB

8. Attaching Subsystems (optional)

Step	Procedure	Date & Initials	
		Tech.	QA
8.0.1	Separation Connectors and Springs may only be attached in the deployed condition. Separation Switches may be attached in either the stowed or deployed condition.	-----N/A-----	-----N/A-----
8.0.2	See Figure 8-1 and Figure 8-2 for required tools, required torque, and parts for all ALB subsystems.		-----N/A-----

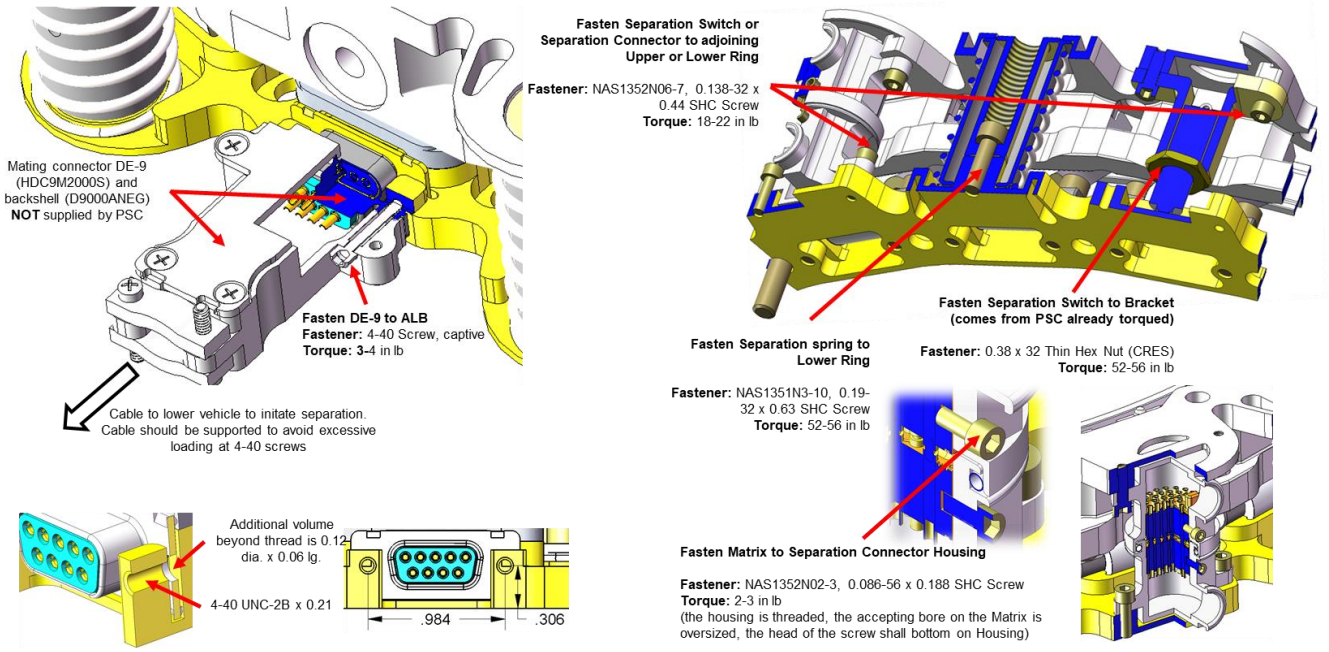


Figure 8-1: Fasteners and torque for accessories

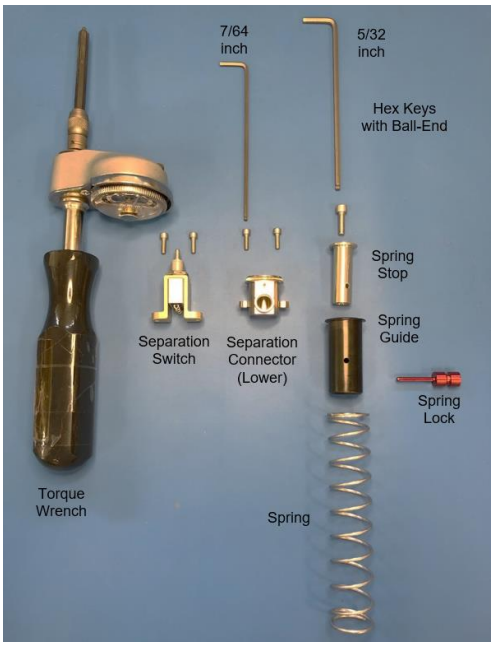


Figure 8-2: Tools and parts

8.1 Attaching Separation Springs (optional)

Step	Procedure	Date & Initials	
		Tech.	QA
8.1.1	Determine the desired locations of Springs. See 2003336 Advanced Lightband User's Manual for energy and rotation rate considerations. Figure 8-3 shows steps for attaching Separation Springs.		
8.1.2	Verify the Lower Ring accepting threads by installing a .19-32 x .63 SHC fastener. Ensure fastener threads in easily.		-----N/A-----
8.1.3	Assemble the Springs: 1. Place the .19-32 x .63 SHC fastener inside the Spring Stop 2. Place the Spring Stop inside the Spring Guide 3. Slide the Compression Spring around the Spring Guide		-----N/A-----
8.1.4	Install Spring on Lower Ring. Verify spring is concentric with circular lip on Lower Ring. Compress Spring enough so the screw is free running for the first few turns. Turn Screw until Spring Stop mates to Lower Ring. Align Spring Lock hole radially outward.		-----N/A-----
8.1.5	Torque .190-32 x .63 SHC fastener 52-56 in·lb per Figure 8-1.		
8.1.6	Ensure Spring is retained by Spring Guide and Spring Guide is retained by Spring Stop. Ensure the Spring is concentric with circular lip on Lower Ring.		

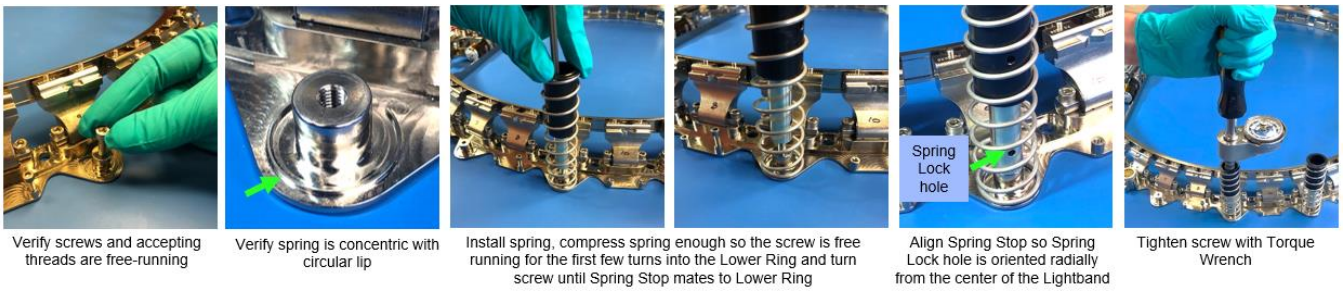
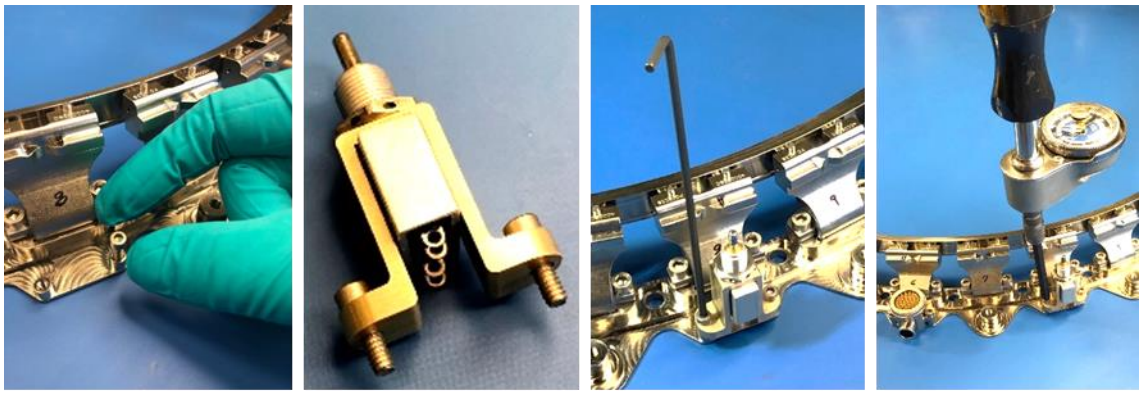


Figure 8-3: Attaching Separation Springs

8.2 Attaching Separation Switches (optional)

Step	Procedure	Date & Initials	
		Tech.	QA
8.2.1	Determine the desired locations of Switches. Figure 8-4 shows steps for attaching Separation Switches.		
8.2.2	Verify the Upper or Lower Ring accepting threads by installing a .138-32 x .44 SHC fastener. Ensure fastener threads in easily.		-----N/A-----
8.2.3	If needed, attach the Switch Bracket to the Separation Switch with the .38-32 thin nut provided with the Separation Switch. Torque 52-56 in·lb per Figure 8-1.		
8.2.4	Attach .138-32 x .44 SHC fasteners to the Switch Bracket.		-----N/A-----
8.2.5	Install Switch onto Upper or Lower Ring. Turn screws until Switch Bracket mates to Ring. Torque .138-32 x .44 SHC fasteners 18-22 in·lb per Figure 8-1.		



Verify screws and accepting threads are free-running

Attach screws to Separation Switch

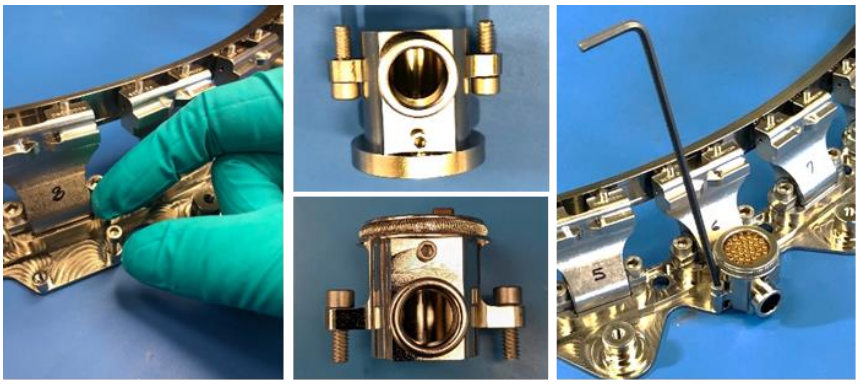
Turn the screws to hold the Separation Switch to the Upper or Lower Ring

Tighten screws with Torque Wrench

Figure 8-4: Attaching Separation Switches

8.3 Attaching Separation Connectors (optional)

Step	Procedure	Date & Initials	
		Tech.	QA
8.3.1	Separation Connector fasteners shall be torqued only when the ALB is in the stowed condition. Both halves of the Separation Connectors shall be installed but left loose during their initial stow operation. The Separation Connector halves need to be able to self-align during the stow operation. Note there is limited access to torque these fasteners.	-----N/A-----	-----N/A-----
8.3.2	Determine the desired locations of Separation Connectors. Figure 8-5 shows steps for attaching Separation Connectors.		
8.3.3	Verify the Upper or Lower Ring accepting threads by installing a .138-32 x .44 SHC fastener. Ensure fastener threads in easily.		-----N/A-----
8.3.4	Attach .138-32 x .44 SHC fasteners to the Upper and Lower Connectors.		-----N/A-----
8.3.5	Install Separation Connector halves onto Upper Ring and Lower Ring. Turn screws until Separation Connectors mates to Ring, then back off ~1/4 turn to allow Separation connectors to translate but not rotate. Separation Connectors shall be loose during initial ALB mate/stow to allow for proper alignment. Torquing will be completed in a subsequent step.		
8.3.6	Verify all Spring contact pins are below the mating surface of the connector housing.		



Verify screws and accepting threads are free-running

Attach screws to Separation Switch and Connector

Turn the screws to hold the Lower Separation Connector to the Lower Ring. Do NOT torque, only torque when ALB is stowed.

Figure 8-5: Attaching Separation Connectors

9. Lightband Mechanical Attachment (optional)

The ALB can be operated without attaching the Upper and Lower Rings to adjoining structures.

Step	Procedure	Date & Initials	
		Tech.	QA
9.1.1	Ensure the SN on the Upper Ring corresponds to the SN on the Lower Ring. Record all info on page 2 of this procedure. The assembly number and revision can be found above the Stow Screw cutout on the Upper Ring and on the Stiffening Rib on the Lower Ring. PSC document *3000316 ALB Training Record* also lists the ALB sizes and numbers.		
9.1.2	The Lightband is designed to accommodate 0.25 inch socket head cap (SHC) screws. Standard washers cannot be used. Have ready the required tools and hardware necessary to attach the Lightband to both upper and lower adjoining structures. See Table 3-3 and Section 14 for equipment.		-----N/A-----
9.1.3	Verify the flatness of the Lower Ring's adjoining structure complies with the most recent version of PSC document *2003336 Advanced Lightband User's Manual*. See note 1 below. Structure Description: _____ Required Flatness [in]: _____ Measured Flatness [in]: _____		
9.1.4	Verify the flatness of the Upper Ring's adjoining structure complies with the most recent version of PSC Document *2003336 Advanced Lightband User's Manual.* See note 1 below. Structure Description: _____ Required Flatness [in]: _____ Measured Flatness [in]: _____		
9.1.5	Verify the circularity of the Lower Ring's adjoining structure complies with the most recent version of PSC Document 2003336 Advanced Lightband User's Manual. See note 1 and Figure 9-1 below. Required Circularity [in]: _____ Measured Circularity [in]: _____		
9.1.6	Verify the circularity of the Upper Ring's adjoining structure complies with the most recent version of PSC Document 2003336 Advanced Lightband User's Manual. See note 1 and Figure 9-1 below. Required Circularity [in]: _____ Measured Circularity [in]: _____		

1) Measured flatness and circularity are the final assembled flatness and circularity, not the flatness and circularity of the individual part. Assembly will often warp structures so it is imperative to measure flatness and circularity after assembly. Measurement does not have to be real-time. Referencing a prior inspection is acceptable provided it was for the identical configuration.

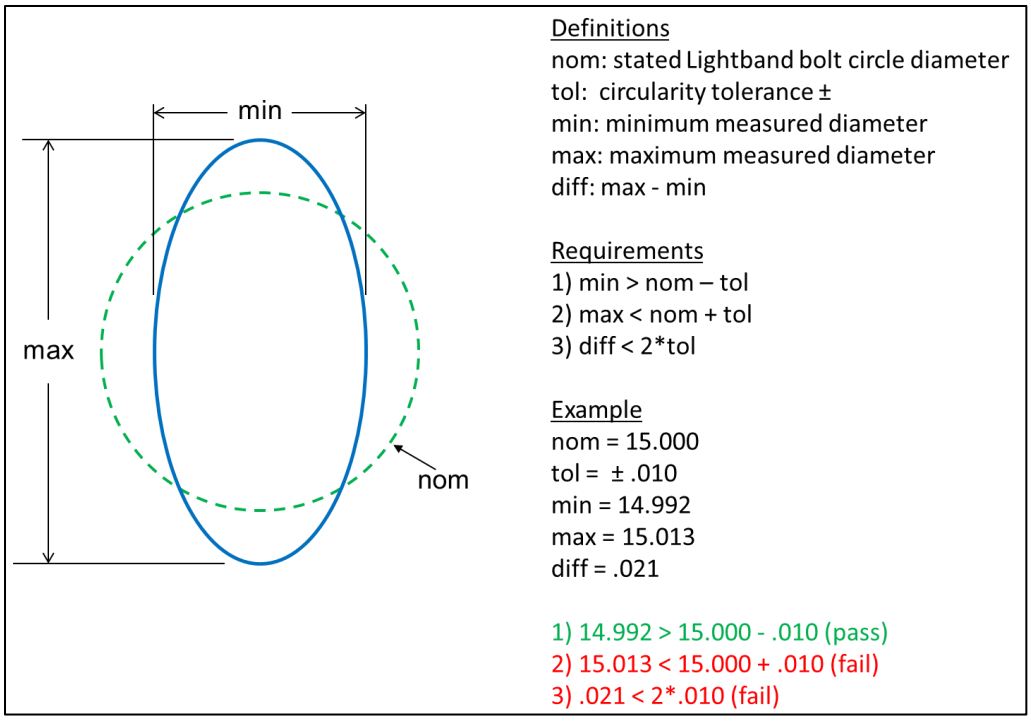


Figure 9-1: Circularity example

Step	Procedure	Date & Initials	
		Tech.	QA
9.1.7	The mating surfaces of both adjoining structures and the Lightband interface surfaces shall be visibility clean, to the normal unaided eye, of all particulate matter and non-particulate film matter. If not, clean with isopropanol-soaked lint free wipes.		
9.1.8	Place the Lower Ring on the adjoining structure. Use 3x FLH Alignment Screws or 3x Gauge Pins to ensure concentricity between Lower Ring and adjoining structure. Insert fasteners through remaining mounting holes. Tighten fasteners until hand tight. Replace alignment features with fasteners and tighten until hand tight. See Figure 9-2 and Figure 9-3.		
9.1.9	Torque all fasteners on the Lower Ring 115-125 in·lb per Figure 9-2. Higher torque is allowable for high line-loading. See note 2.		
9.1.10	Place the Upper Ring on the adjoining structure. Use 3x FLH Alignment Screws or 3x Gauge Pins to ensure concentricity between Upper Ring and adjoining structure. Insert fasteners through remaining mounting holes. Tighten fasteners until hand tight. Replace alignment features with fasteners and tighten until hand tight. See Figure 9-2 and Figure 9-3.		
9.1.11	Torque all fasteners on the Upper Ring 115-125 in·lb per Figure 9-2. Higher torque is allowable for high line-loading. See note 2.		

2) Customer shall always perform a thorough bolted-joint analysis to ensure sufficient margin on material strength, joint slipping and joint gapping.

Fasten Upper Ring to Upper Vehicle (Satellite)
On bolt circle diameter 'D'
NOT supplied by PSC

Fastener: NAS1351N4-12, 0.25-28 x 0.75 SHC Screw
Torque: 115-125 in lb
Though Hole: 0.271±.005 in
True Position: Ø .01 in (constrained)
Flange thickness: 0.18 in
No room for washer

Fasten Lower Ring to Lower Vehicle (Launch vehicle)
On bolt circle diameter 'D'
NOT supplied by PSC

Fastener: NAS1351N4-12, 0.25-28 x 0.75 SHC Screw
Torque: : 115-125 in lb
Though Hole: 0.281 ±.005 in
True Position: Ø .01 in (constrained)
Flange thickness: 0.12 in
No room for washer

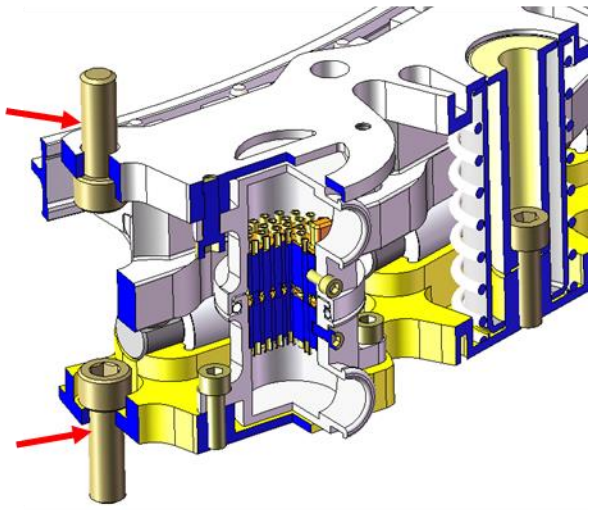
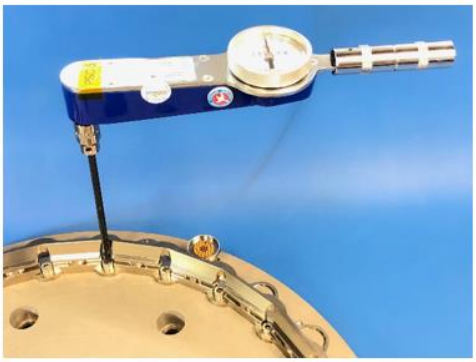
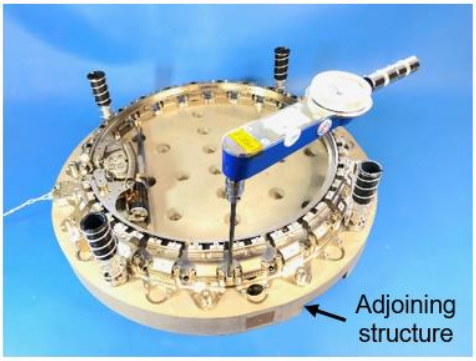


Figure 9-2: Fasteners and torques for adjoining structures

Though not essential, turned-down flat head screws may be used to align the Lightband bolt pattern to the pattern on the adjoining structure to within 0.005 inches

Install all the screws



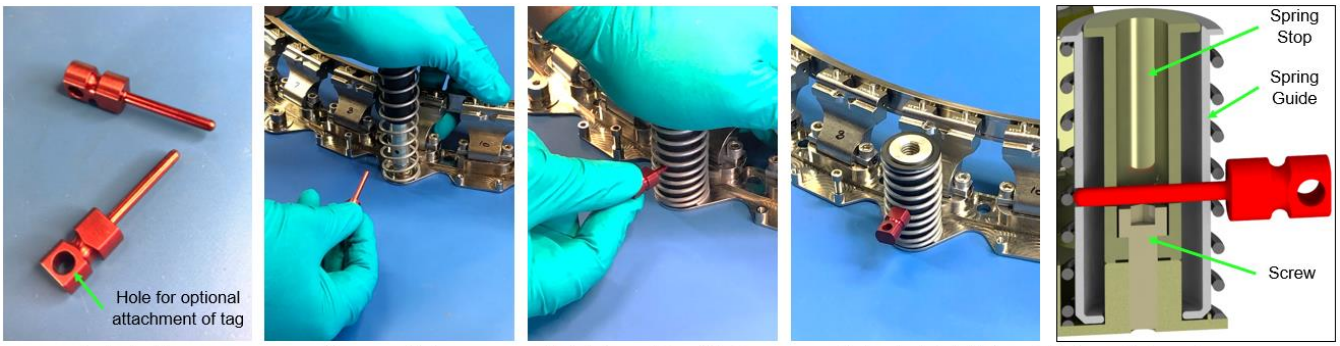


Use a torque wrench to tighten the screws

Figure 9-3: Attaching the ALB to adjoining structures

10. Mating the Lightband

Step	Procedure	Date & Initials	
		Tech.	QA
10.1.1	Compress Springs and install all Spring Locks. See Figure 10-1. Record number of Spring Locks used. Visually verify that Spring Lock passes through entire Spring assembly. If Spring Lock cannot be installed, ensure Spring is centered around the circular lip on the Lower Ring. If spring lock holes do not align, rotate the Spring and Spring Guide to align with Spring Stop. # Spring Locks used: _____		
10.1.2	Inspect the Lightband to verify it is visually free from damage		



Spring Locks | Compress Spring | Aligh holes and insert Spring Lock between coils of Spring | Spring Lock installed evenly between Spring coils

Figure 10-1: Installation of Spring Locks

Step	Procedure	Date & Initials	
		Tech.	QA
10.1.3	Measure latch-up distance (ds) and record below. See Figure 10-2. Note on the ALB8, most calipers will have to be inserted at an angle as there is limited space between the Sliding Bracket and the -Y side of ALB. ds [in]: _____ Note: a negative ds indicates the Flexure is inside the sliding bracket.		

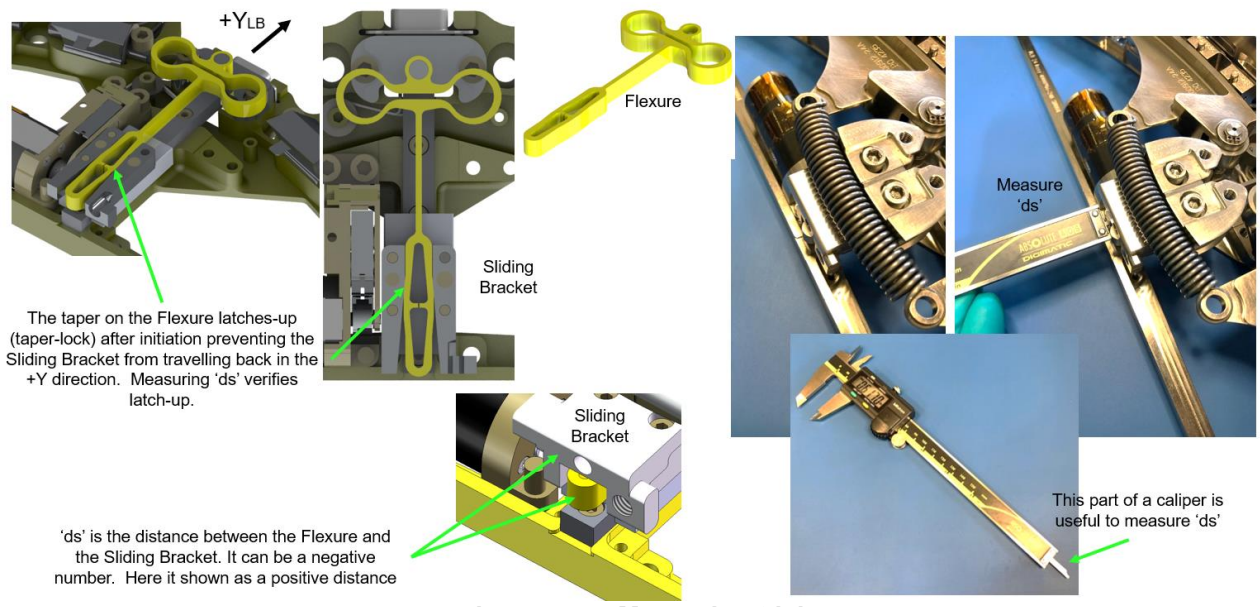


Figure 10-2: Measuring 'ds'

Step	Procedure	Date & Initials	
		Tech.	QA
10.1.4	Verify the Stow Screw threads are not damaged by turning into the Sliding Bracket from -Y-LB side or a 10-32 UNF-2B nut. See Figure 10-3.		
10.1.5	Turn the Screw Head and the Threaded Rod so that the exposed thread length increases until Stow Screw is hard stopped. See Figure 10-4. Record length of threads exposed on the Stow Screw. See Figure 10-5 for length definition. Verify Length is >2.95in. Measure the depth of the Threaded Rod from the Screw Head at the center of the hole. Record depth. See Figure 10-6 for depth definition Stow Screw thread length [in]: _____ Threaded Rod Depth [in]: _____		
10.1.6	Calculate minimum and maximum compression force needed if Separation Connectors or Separation Switches are attached. See 2003336 for most recent values of Switch Force (Fsw), Connector Force (Fsc), and Weight Supported per Spring Force (Fws). Min Force [lb] = (# of Switches x Fsw) + (# of Connectors x Fsc) Max Force [lb] = # of Springs x Fws Force Range [lb]: _____		

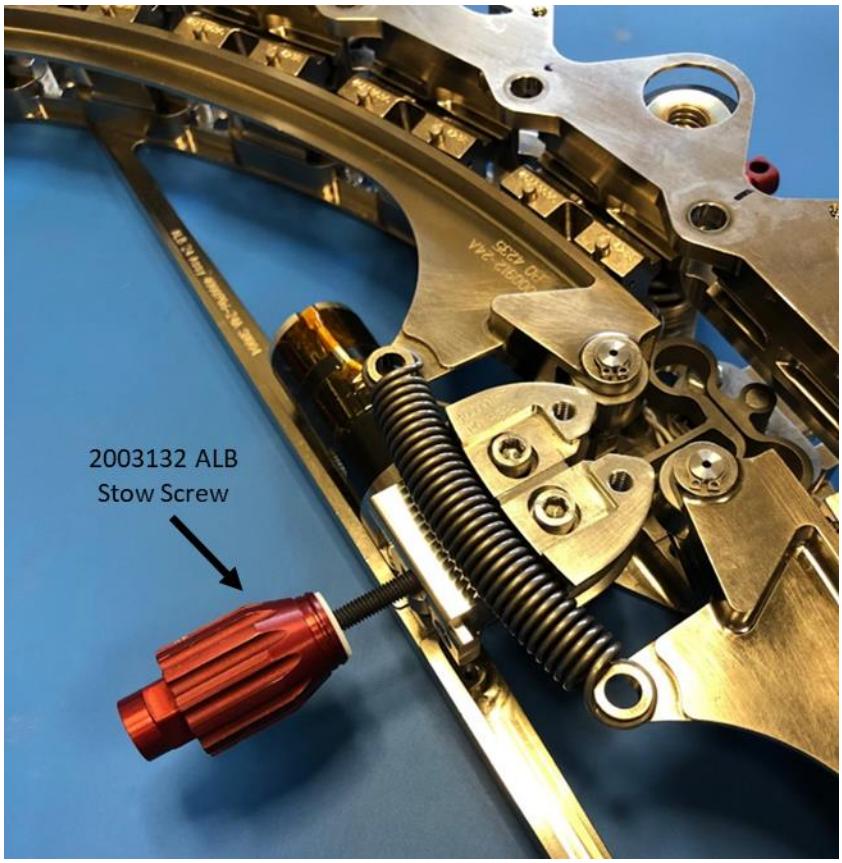


Figure 10-3: The quality of the threaded junction is verified by turning the Stow Screw into the Sliding Bracket from the inside (not enough room on ALB8 for this operation)

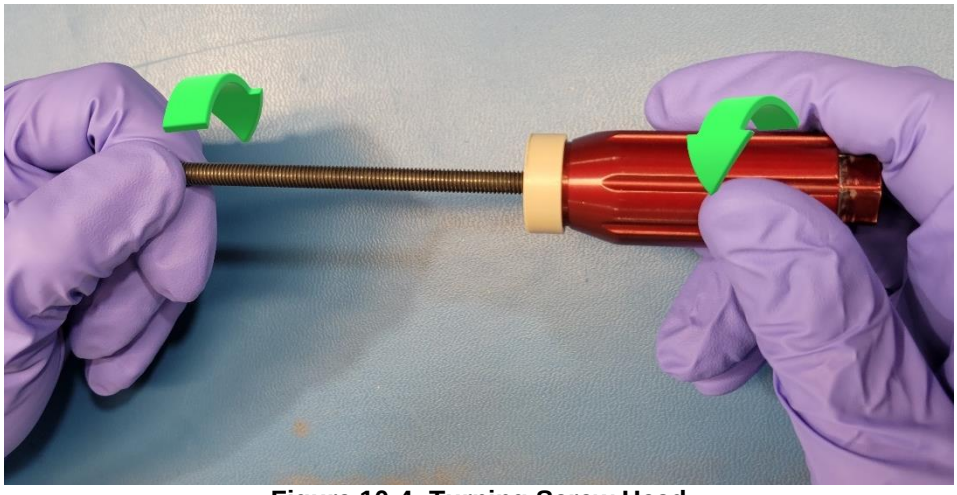


Figure 10-4: Turning Screw Head

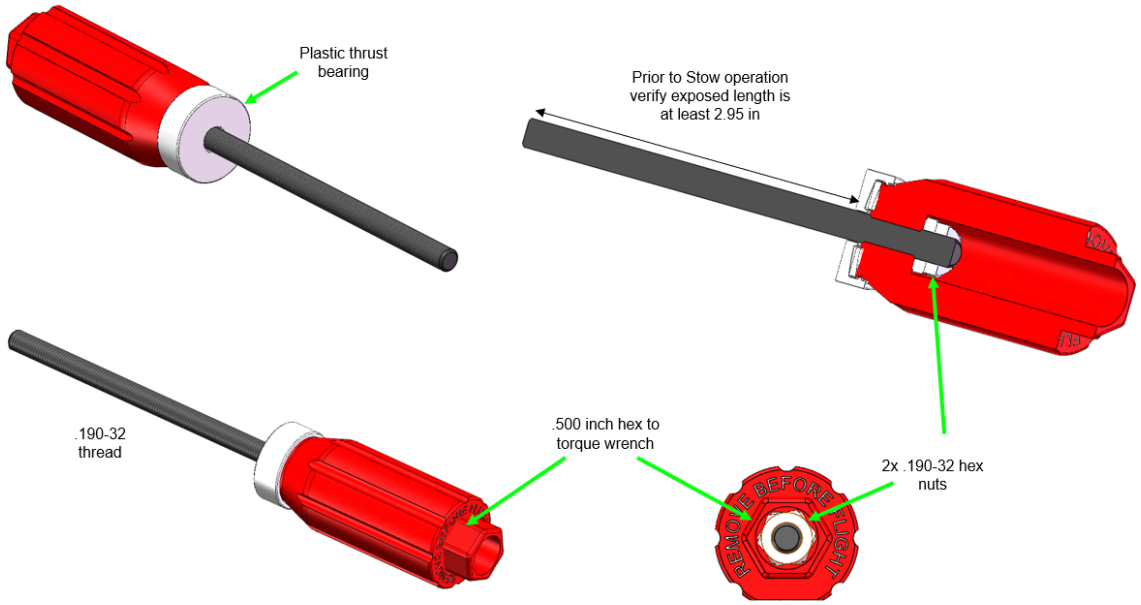


Figure 10-5: Stow Screw Description

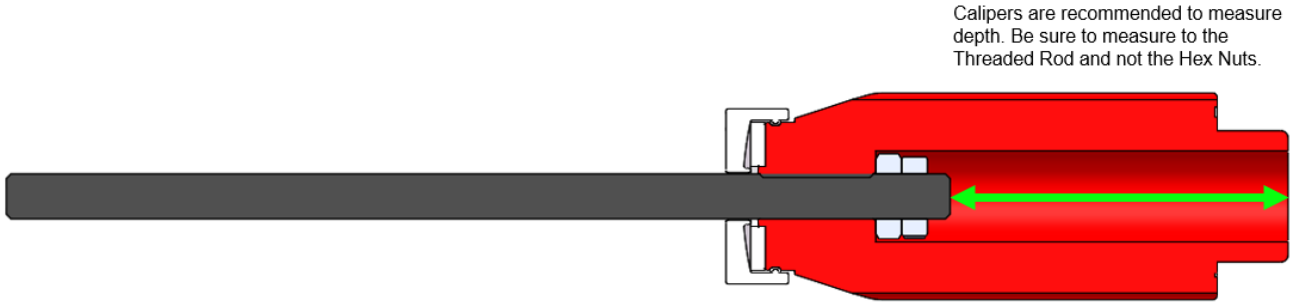


Figure 10-6: Measuring Threaded Rod Depth

Step	Procedure	Date & Initials	
		Tech.	QA
10.1.7	Record stiffness of member(s) supporting any load. Verify stiffness of member(s) is less than 2,000 lb per inch (Members supporting load include anything supporting the Upper Half and Lower Half: Crane, Table, Cart, etc) This compliance allows the ALB rings to move into alignment while stowing. Support member stiffness [lb/in]: _____		
10.1.8	If not performed in step 9.1.1, ensure the SN on the Upper Ring corresponds to the SN on the Lower Ring. Record all info on page 2 of this procedure. The assembly number and revision can be found above the Stow Screw cutout on the Upper Ring and on the Stiffening Rib on the Lower Ring. PSC document *3000316 ALB Training Record* also lists the ALB sizes and numbers.		

Step	Procedure	Date & Initials	
		Tech.	QA
10.1.9	Align and join the Upper and Lower Rings. See Figure 10-7. Apply compression force within the range calculated in step 10.1.6. Note: If this is the first time mating the Upper and Lower Rings with Connectors installed, ensure Connectors are loose prior to applying compression force. See Figure 10-9.		
10.1.10	Record and verify H is in tolerance at three equidistant locations around the ALB using a caliper or a telescoping hole gauge. See Figure 10-8 and 2003336 for H requirements. Location 1 [in]: _____ Location 2 [in]: _____ Location 3 [in]: _____		

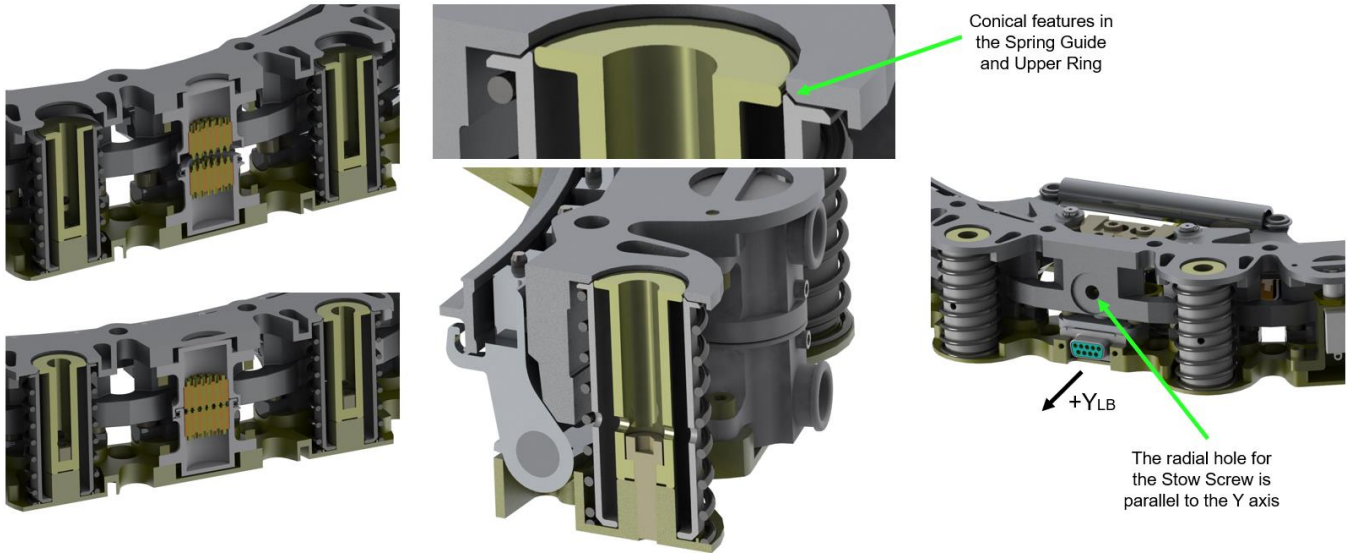


Figure 10-7: Aligning the Upper and Lower Ring

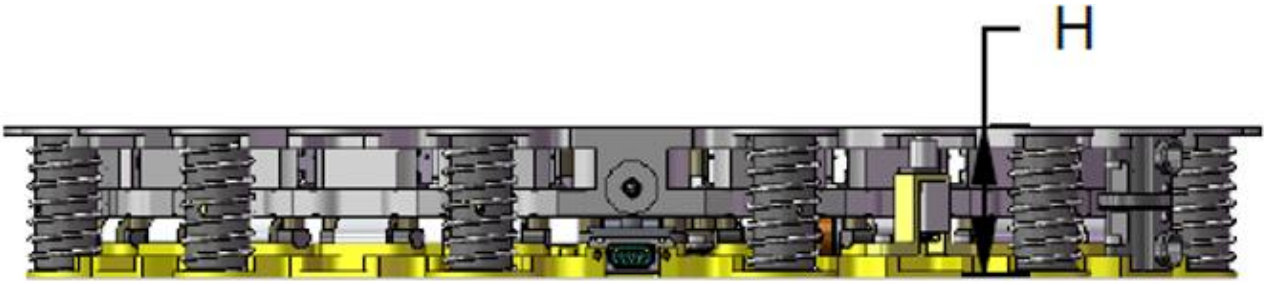


Figure 10-8: Verify H is in tolerance per 2003336 in at least 3 locations

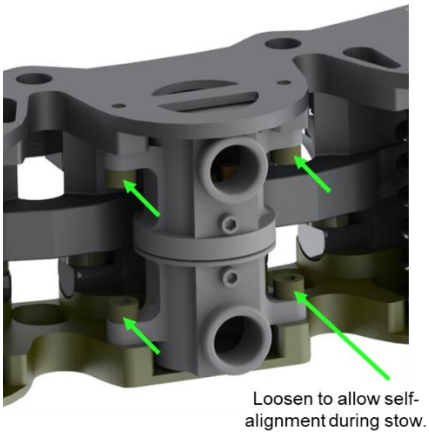


Figure 10-9: Separation Connector Alignment

11. Stowing the Lightband

This section will Stow the Lightband. The ALB may be Stowed with or without adjoining structures attached.

Operate the ALB before or after shipping, when taken from storage, following a critical test, or when verifying launch vehicle compatibility. This will test-verify stowing operations are within the specifications of this document.

11.1 Stow preliminary check

Step	Procedure	Date & Initials	
		Tech.	QA
11.1.1	Determine the maximum number of Stow Screw turns and maximum stow torque by referencing ds value in 10.1.3. ds measurement from step 10.1.3: _____ [in] Circle one: **ds < .075:** Maximum # of turns 48, Maximum stow torque 26 in-lb (32 in-lb for ALB24). Proceed to section 11.2. **ds ≥ .075:** Maximum # of turns 36, Maximum stow torque 26 in-lb (32 in-lb for ALB24). Proceed to section 11.3.		

11.2 Stow if ds < .075, Latched

Step	Procedure	Date & Initials	
		Tech.	QA
11.2.1	Ensure the Stow Screw length is still >2.95 in (see Figure 10-5 for Stow Screw length definition). Reverify the Screw Head is fully backed on the locking nuts by rotating Head counterclockwise while holding threads until hard stopped. Install the Stow Screw through the radial hole on +Y side of Upper Ring.		
11.2.2	Figure 11-1 shows expect torque vs turns profile. Turn Stow Screw into the sliding bracket until the Screw Head is just touching Upper Ring. This is the 0^{th} turn. See Figure 11-2. Verify the Stow Screw threads are sufficiently engaged with Sliding Bracket by remeasuring and depth from the top of the hex head of the Stow Screw to the threaded rod. Record depth below. Calculate Thread Disengagement by subtracting this depth from the initial depth measured in Step 10.1.5. Verify Thread Disengagement < .05". New Threaded Rod Depth [in]: _____ Thread Disengagement [in] = Depth from 10.1.5 – New Depth = _____		

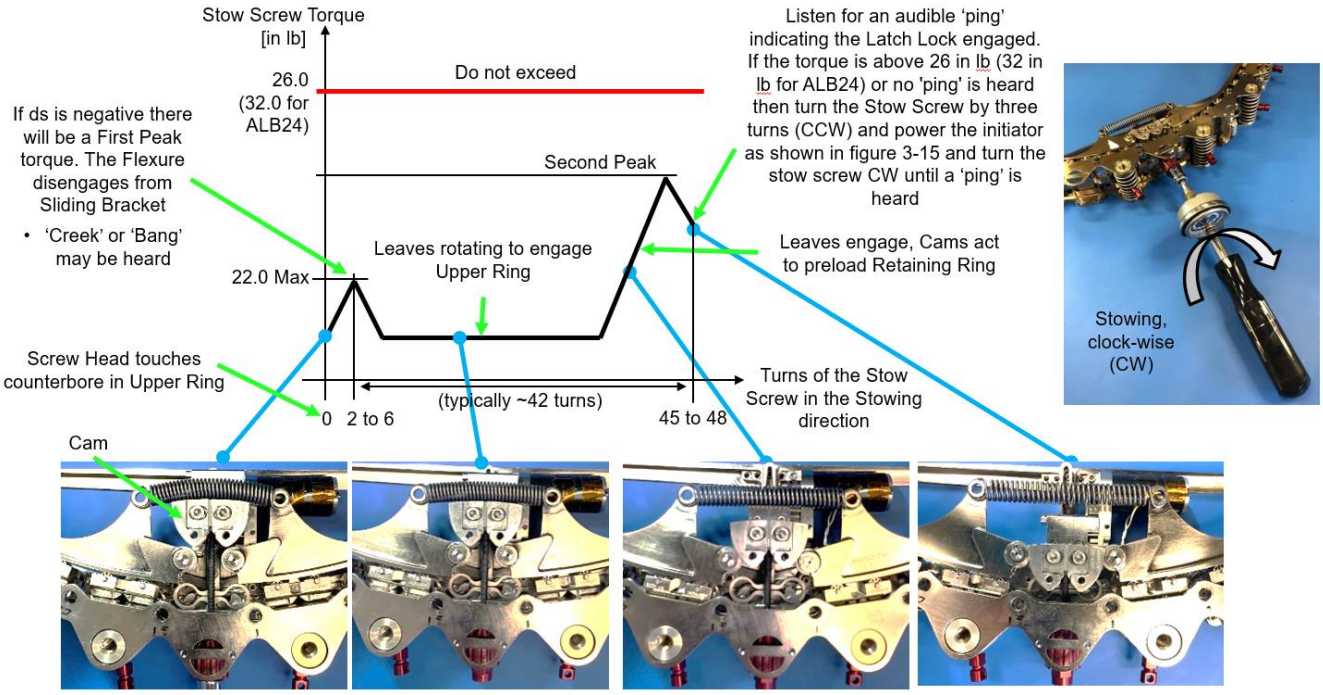


Figure 11-1: Stow Screw turns vs. Stow Screw torque, ds less than .075 in (-.135 in to .075 in)

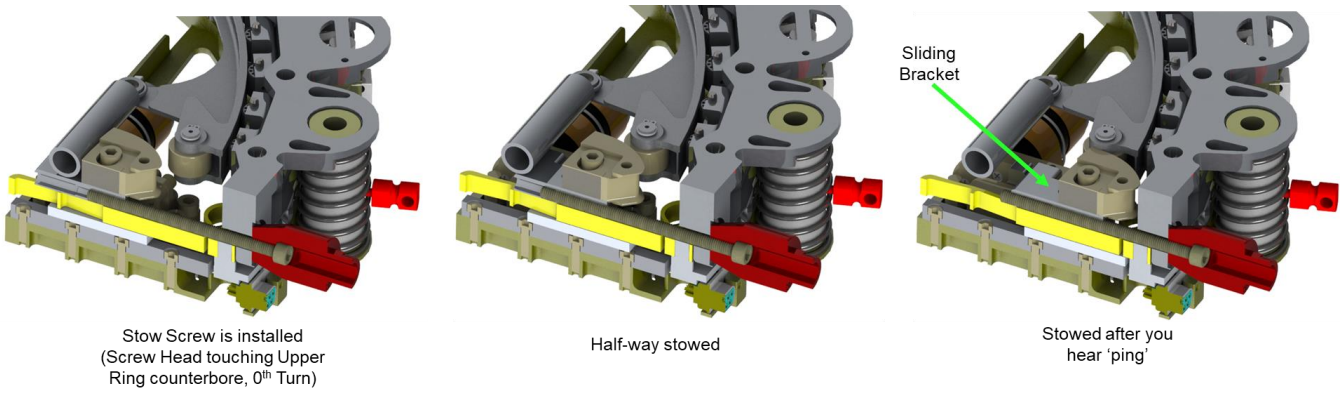


Figure 11-2: Sectional view of stowing

Step	Procedure	Date & Initials	
		Tech.	QA
11.2.3	Prepare to turn the Stow Screw clockwise, count number of turns, and measure torque. Do not exceed 22.0 in lb prior to delatching. Turn the Stow Screw clockwise while counting the number of turns. The torque will spike around 2 to 6 turns and a “creak” or “bang” may be heard as the Sliding Bracket comes off the Flexure. Record the number of turns and delatch torque once the flexure is disengaged from the sliding bracket. Delatch Torque: _____ [in*lb] Number of turns: _____ Does delatch torque exceed 22.0 in lb (Y/N)? _____ If not within limits, contact PSC. The Stow Screw Head will now gap off the Upper Ring. Continue turning the Stow Screw clockwise and counting turns until the Stow Screw Head again contacts the Upper Ring.		
11.2.4	Continue to turn the Stow Screw clockwise while counting turns until either an audible “ping” is heard, the maximum stow torque determined in step 11.1.1 is reached, OR the maximum number of turns determined in step 11.1.1 is reached. See Figure 11-2. Do NOT exceed maximum number of turns or maximum stow torque. Doing so may detrimentally damage the ALB. See Figure 11-5.		
11.2.5	If “ping” is heard, continue to step 11.2.7. If no “ping” is heard, the ALB may still have correctly stowed. In some integration environments, loud background noise can make hearing the “ping” difficult. ALB stow can also be verified visually by looking at the Latch through use of a borescope between the ALB Leaves. See Figure 11-6. If latched correctly per Figure 11-6, proceed to step 11.2.7.		
11.2.6	If ALB fails to stow upon reaching the maximum number of turns or maximum torque, remove the stow screw and power the initiator per section 12. Carefully remove the Upper Ring from the Lower Ring and return to section 10.		
11.2.7	Record peak torque and number of turns and verify it is within limits determined in step 11.1.1. Peak torque [in*lb]: _____ Number of turns: _____ Within limits of step 11.1.1 (Y/N)? _____ If not within limits, contact PSC. If yes, proceed to section 11.4.		

11.3 Stow if ds ≥ .075, Unlatched

Step	Procedure	Date & Initials	
		Tech.	QA
11.3.1	Ensure the Stow Screw length is still >2.95 in (see Figure 10- for Stow Screw length definition). Reverify the Screw Head is fully backed on the locking nuts by rotating Head while holding threads until hard stopped. Install the Stow Screw through the radial hole on +Y side of Upper Ring.		
11.3.2	Figure 11-1 shows expect torque vs turns profile. Turn the Stow Screw and ensure the Screw is threading into the Sliding Bracket and the Stow Screw Head is not just spinning on the threads. Turn Stow Screw until the Screw Head is just touching Upper Ring. This is the 0th turn. See Figure 11-2. Verify the Stow Screw threads are sufficiently engaged with Sliding Bracket by remeasuring the depth from the top of the hex head of the Stow Screw to the threaded rod. Record depth below. Calculate Thread Disengagement by subtracting this depth from the initial depth measured in Step 10.5.1. Verify Thread Disengagement < .05". New Threaded Rod Depth [in]: _____ Thread Disengagement [in] = Depth from 10.1.5 – New Depth: _____		

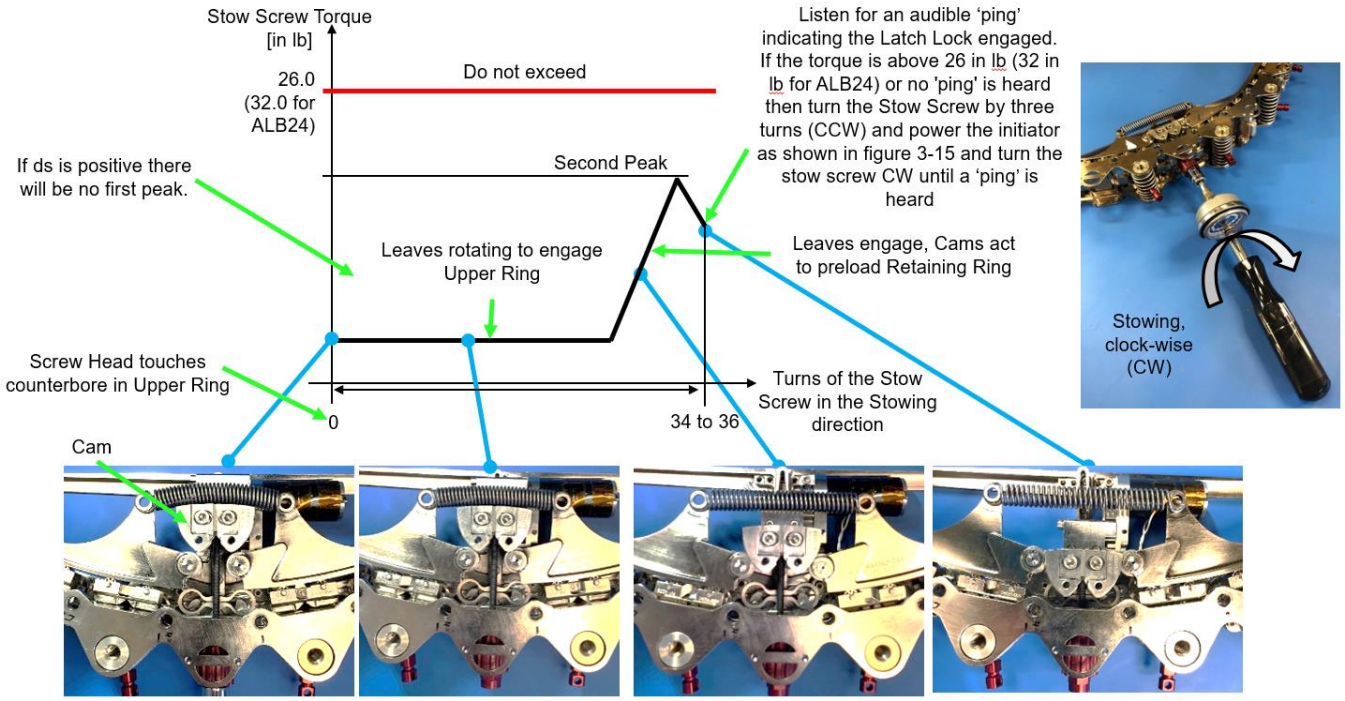


Figure 11-3: Stow Screw turns vs. Stow Screw torque, ds greater than or equal to .075 in

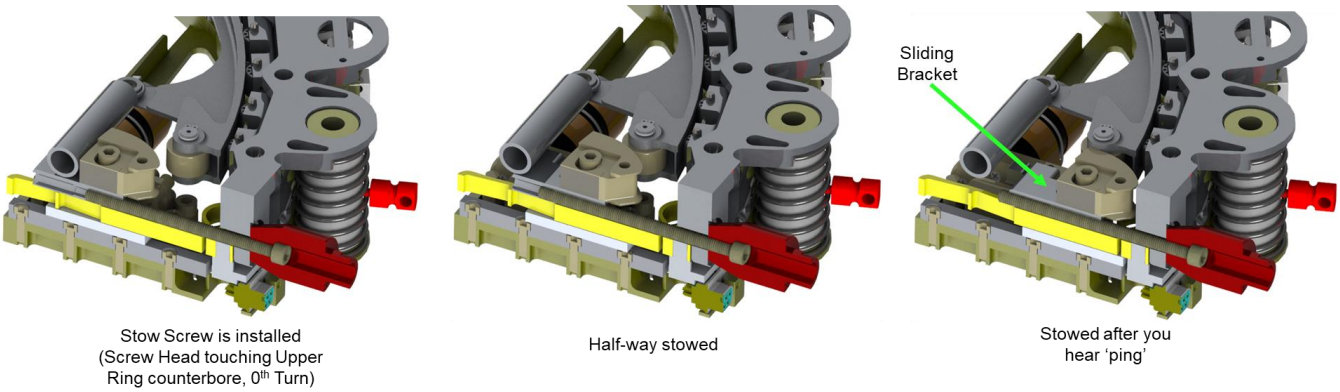


Figure 11-4: Sectional view of stowing

Step	Procedure	Date & Initials	
		Tech.	QA
11.3.3	Turn the Stow Screw clockwise while counting turns until either an audible "ping" is heard, the maximum stow torque determined in step 11.1.1 is reached, OR the maximum number of turns determined in step 11.1.1 is reached. See Figure 11-4. Do NOT exceed maximum number of turns or maximum stow torque. Doing so may detrimentally damage the ALB. See Figure 11-5.		
11.3.4	If "ping" is heard, continue to step 11.3.6. If no "ping" is heard, the ALB may still have correctly stowed. In some integration environments, loud background noise can make hearing the "ping" difficult. ALB stow can also be verified visually by looking at the Latch through use of a borescope between the ALB Leaves. See Figure 11-6. If latched correctly per Figure 11-6, proceed to step 11.3.6.		
11.3.5	If ALB fails to stow prior to reaching the maximum number of turns, remove the stow screw and power the initiator per section 12. Carefully remove the Upper Ring from the Lower Ring and return to section 10.		
11.3.6	Record peak torque and number of turns and verify it is within limits determined in step 11.1.1. Peak torque [in*lb]: _____ Number of turns: _____ Within limits of step 11.1.1 (Y/N)? _____ If not within limits, contact PSC. If yes, proceed to section 11.4.		

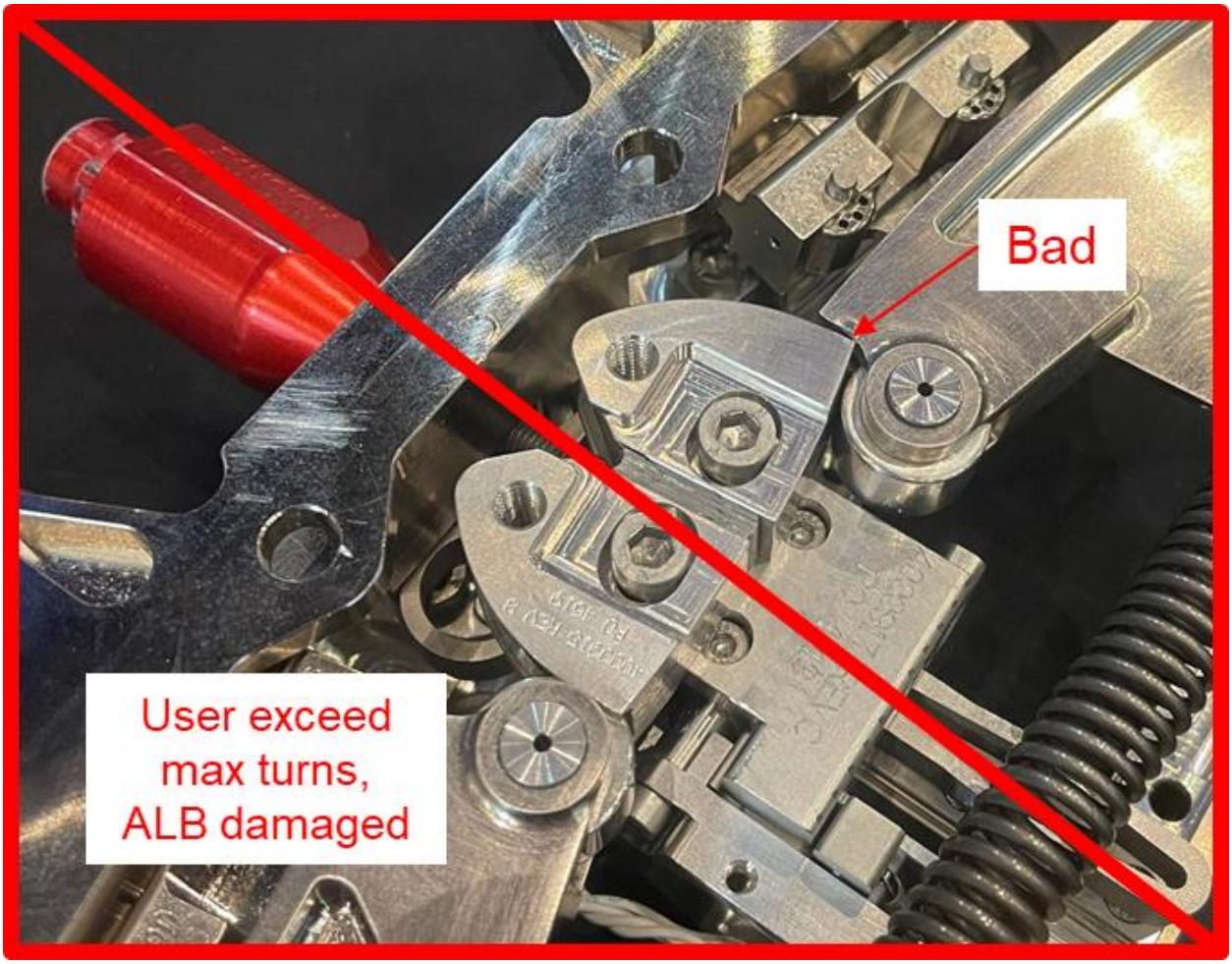


Figure 11-5: Over-stowed ALB

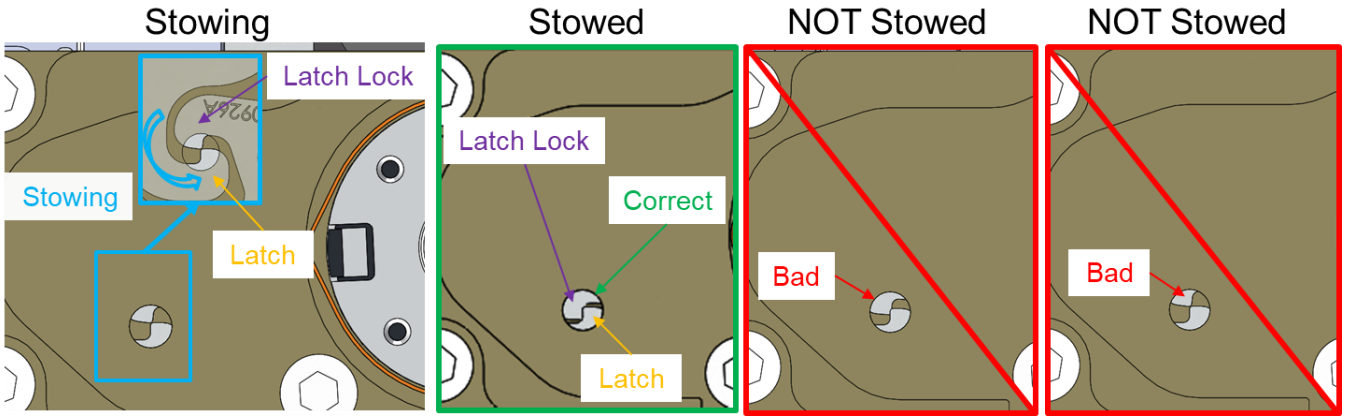


Figure 11-6: Visual Verification of Stowed Latch

11.4 Final stow steps

Step	Procedure	Date & Initials	
		Tech.	QA
11.4.1	Fully remove the Stow Screw from the ALB by rotating Stow Screw counter clockwise. **WARNING: ALB will not deploy if the Stow Screw is not fully removed.**		
11.4.2	If intending to separate, remove all Spring Locks. Record number of Spring Locks removed. # Spring Locks removed: _____ Verify that number of Spring Locks used in step 10.1.1 match number of spring locks removed in this step. **WARNING: ALB will not separate if the Spring Locks are not fully removed.**		
11.4.3	If Separation Connectors were installed and loose, torque attachment screws 18-22 in·lb per Figure 11-7 and Figure 11-8.		

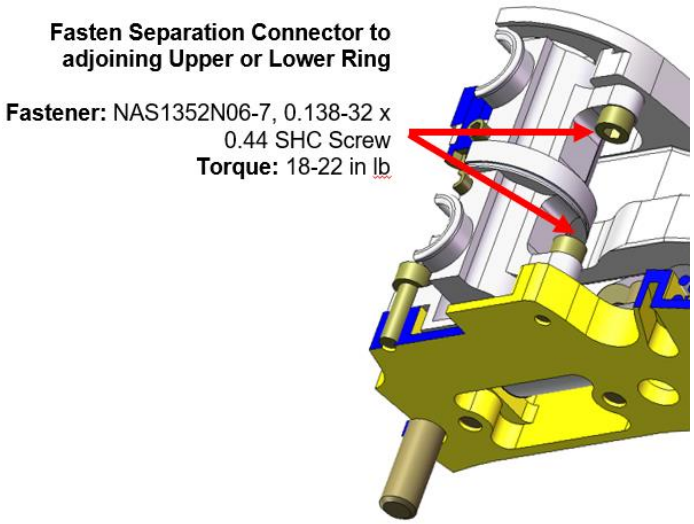
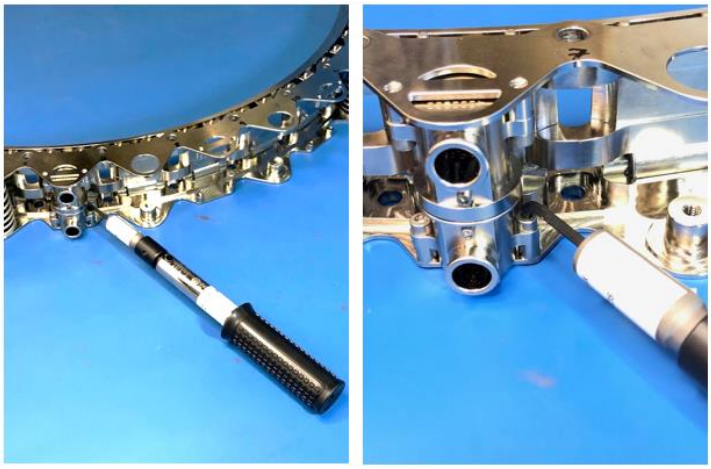


Figure 11-7: Separation Connector attachment torque



After stow, tighten the screws holding the separation connector(s) to the ALB with a torque wrench

Figure 11-8: Torquing Separation Connector

12. Deploying the Lightband

This section will Deploy the Lightband. Prior to Deploying, a test circuit will be operated to verify proper power and data acquisition. The ALB may be Deployed with or without adjoining structures attached.

Operate the ALB before or after shipping, when taken from storage, following a critical test, or when verifying launch vehicle compatibility. This will test-verify initiation and separation operations are within the specifications of this document. This section can be run with either GSE or the flight avionics.

12.1 Deploy Test Circuit

Step	Procedure	Date & Initials	
		Tech.	QA
12.1.1	Oscilloscope shall record voltage and current per the following requirements: 1. Sample rate: ≥ 1,000 Hz 2. Voltage resolution: ≤ 0.2 V 3. Current resolution: ≤ 0.02 A		-----N/A-----
12.1.2	Set up the deploy power and measurement and deploy test circuit per Figure 12-1. Connect the DB-9 connector of the power and measurement circuit to the DB-9 connector of the deploy test circuit.		

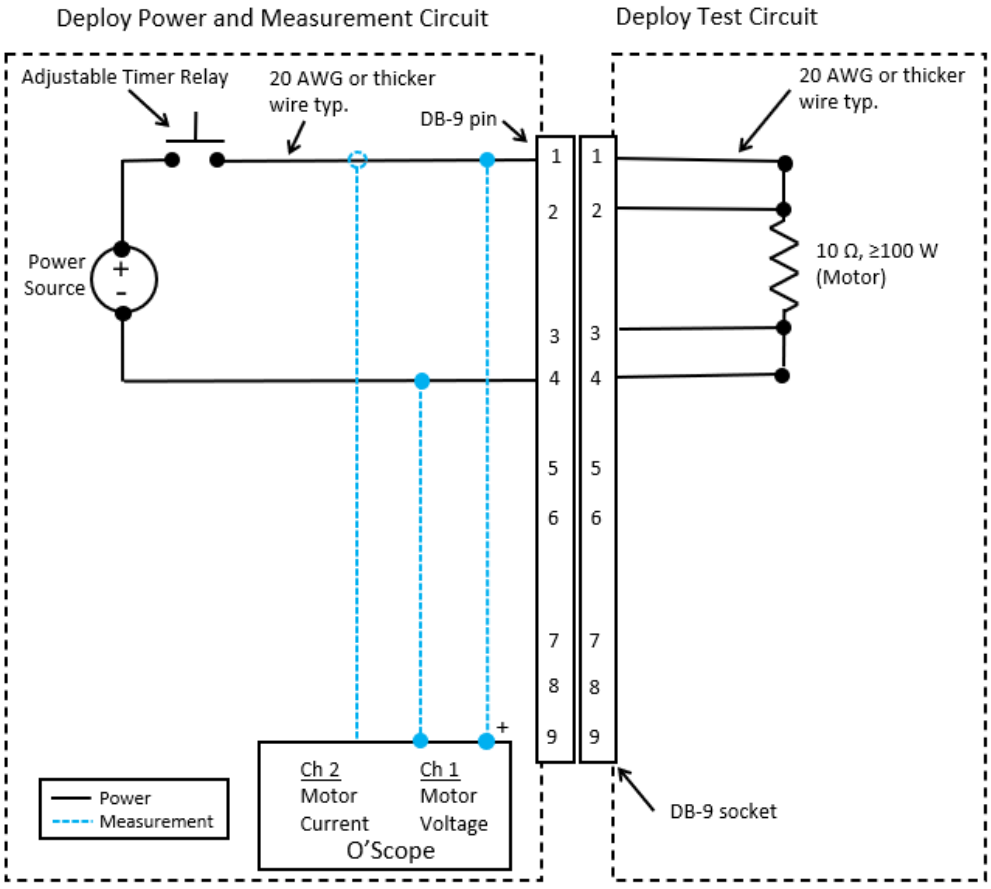


Figure 12-1: Deploy test circuit

Step	Procedure	Date & Initials	
		Tech.	QA
12.1.3	Set the power source voltage according to the revision of ALB being operated. **17 to 32 V_{DC}** for rev E and later ALBs and **24 to 32 V_{DC}** for rev D and earlier ALBs**.** Verify the revision of ALB with cover page of this document. When possible, use the minimum voltage as this maximizes the Lightband's operating life and verifies worst-case torque margin.		
12.1.4	Set the current limit on the power source to **6.0 ± 0.1 A.**		
12.1.5	Set the timer relay to apply power for **0.1 to 1.0 s (Tp)** per 2003336 Advanced Lightband User's Manual. If using the recommended timer, set its function to *'D: One Shot'*.		
12.1.6	Adjust oscilloscope to properly capture all channels. Verify 1. Current probe scale matches oscilloscope on Ch. 2 (10 A/V on oscilloscope & 100 mV/A on current probes) 2. Current probes are zeroed 3. Voltage scale on Ch. 1 (recommend 5 V/div) 4. Vertical position on Ch. 1 (recommend zero at 1 div from bottom of screen) 5. Current scale on Ch. 2 (recommend 500 mA/div) 6. Vertical position on Ch. (recommend zero at 1 div from bottom of screen) 7. Horizontal time scale will capture entire duration (recommend 100 ms/div) 8. Horizontal trigger position (recommend 1 div from left of screen) 9. Vertical trigger level and channel (recommend Ch. 1 set to 2 V)		
12.1.7	Perform the following to operate the test circuit. 1. Turn on the power source output. 2. Verify the oscilloscope trigger is active and ready to acquire data. 3. Activate the timer relay. 4. Verify the following occurred: 4.1. Voltage and current recorded per step 12.1.1 4.2. Measured voltage meets requirement in step 12.1.3 for Channel 1. 4.3. Measured Voltage [V]: _____ 4.4. Measured current value is approximately 1/10th of applied voltage for Channel 2. 4.5. Measured Current [A]: _____ 4.6. Timer relay applies power per step 12.1.5 4.7. Measured time [s]: _____ 4.8. Data saves and is readable on a computer 5. Verify V/I ≈ 10 Ω. 6. If positions or scales were altered to examine data, ensure they are returned to their original values. 7. Turn off the power source output. If any parameters are not met, make the required changes and repeat this step.		
12.1.8	Remove the DB-9 of the deploy test circuit from the DB-9 of the deploy power and measurement circuit		-----N/A-----

12.2 Deploy

Step	Procedure	Date & Initials	
		Tech.	QA
12.2.1	If Spring Locks are installed, the ALB will not separate (ensure this is your intention).		-----N/A-----
12.2.2	If accessories are attached and/or Spring Locks removed, a force will push apart the Upper and Lower Rings when applying power to the ALB. Calculate and apply compression force below to ensure Rings are properly restrained. See 2003336 for most recent values of Fsw, Fsc, Fss, and Fws. Min Force [lb] = (# of Switches x Fsw) + (# of Connectors x Fsc) + (# of Springs without Spring Locks installed x Fss) Max Force [lb] = # of Springs x Fws Force range [lb]: _____		
12.2.3	Verify Stow Screw is not attached to the ALB. Leaving the Stow Screw in during deploy **can** damage the ALB. See Figure 12-3.		
12.2.4	Verify the DB-9 pin connector that will be connected to the ALB is visibly clean. Any debris could detrimentally contaminate the Lightband's mating socket connector.		
12.2.5	Connect the Lightband to the deploy power and measurement circuit per Figure 12-2. Do not apply power to the Lightband. Ensure the circuit polarity is as depicted.		

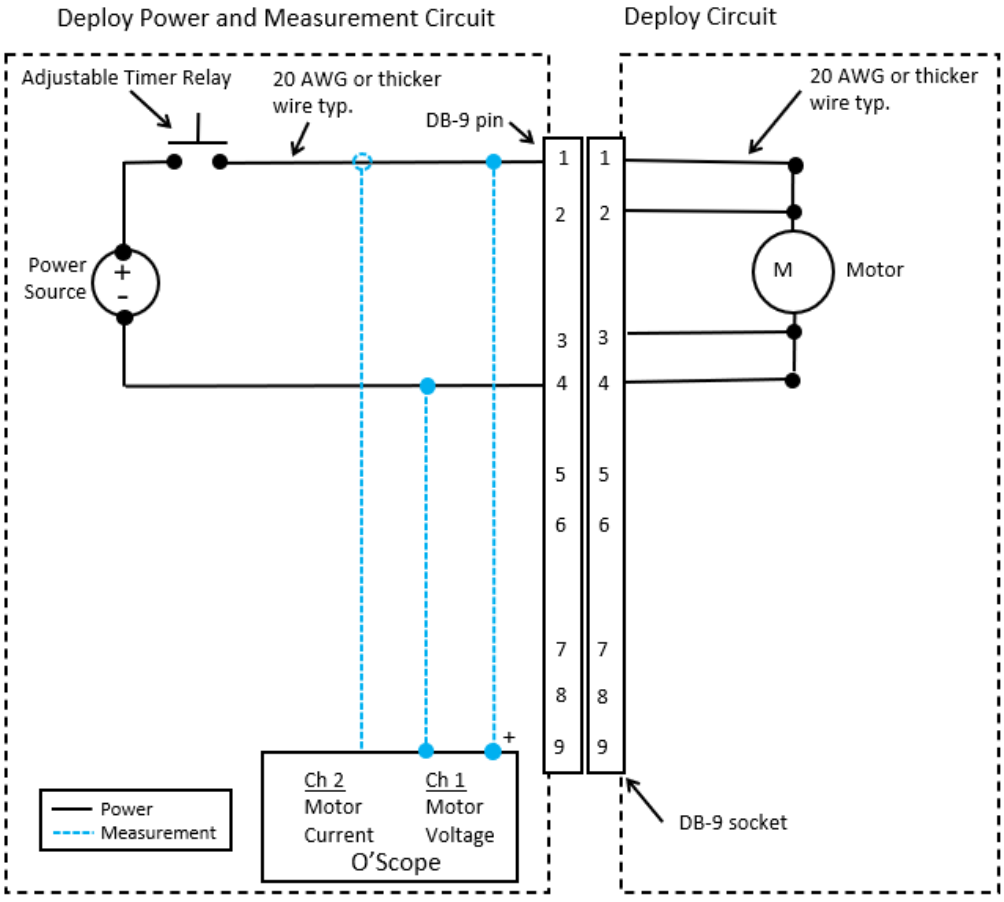


Figure 12-2: Deploy circuit

Figure 12-3: Removing the Stow Screw and Spring Locks

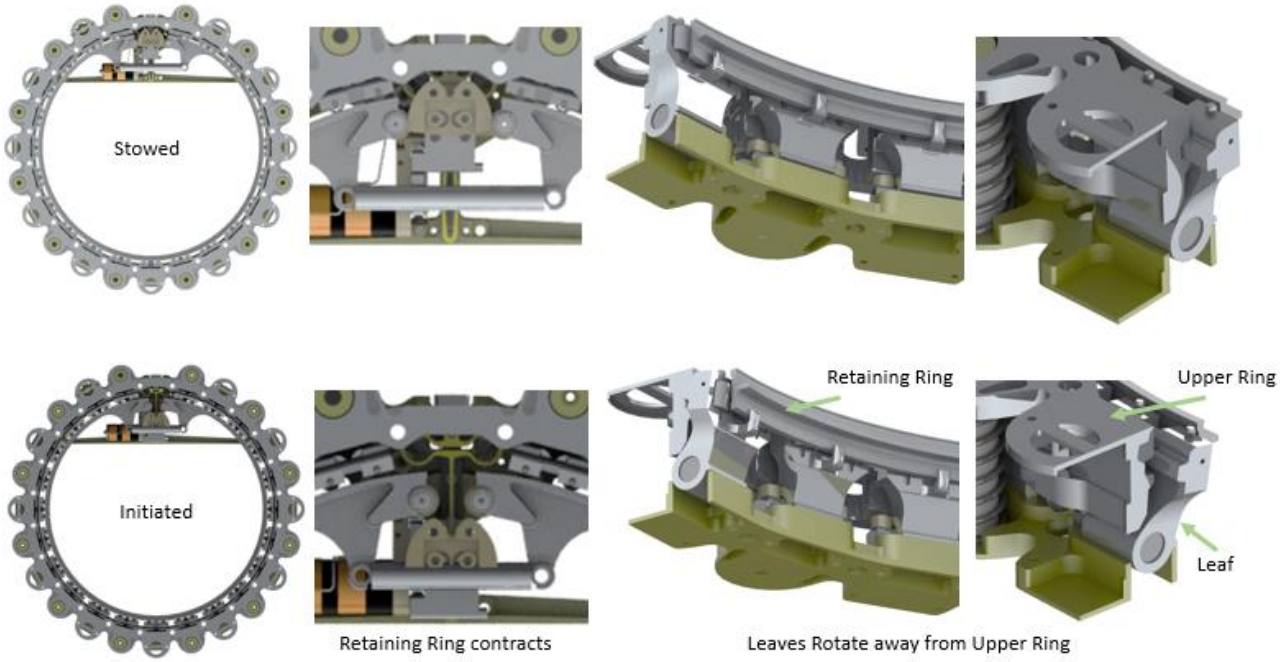


Figure 12-4: Deployment

Step	Procedure	Date & Initials	
		Tech.	QA
12.2.6	PSC recommends recording video and audio of the Deploy operation. This is not required but has proven very helpful in determining root cause in the unexpected event of an anomaly.		-----N/A-----
12.2.7	To Deploy the Lightband: 1. See Figure 12-6, Figure 12-7, and Table 12-1 for the anticipated current draw and power duration. 2. Designate a person to watch the power source output display. 3. Turn on the power source output. 4. Verify the oscilloscope trigger is active and ready to acquire data. 5. Activate the timer relay. This will send power to the motor and Deploy the Lightband. The Lightband should Deploy in ≤ 0.1 s. The motor can be heard rotating at about 60 cycles a second after initiation. Manually cut power if the current limit is reached or the timer relay runs longer than specified. Then contact PSC per section 5. A visual inspection of the Lightband may be performed, but do not change configuration. Figure 12-4 shows how the ALB deploys. Figure 12-5 shows how the motor initiates the ALB.		

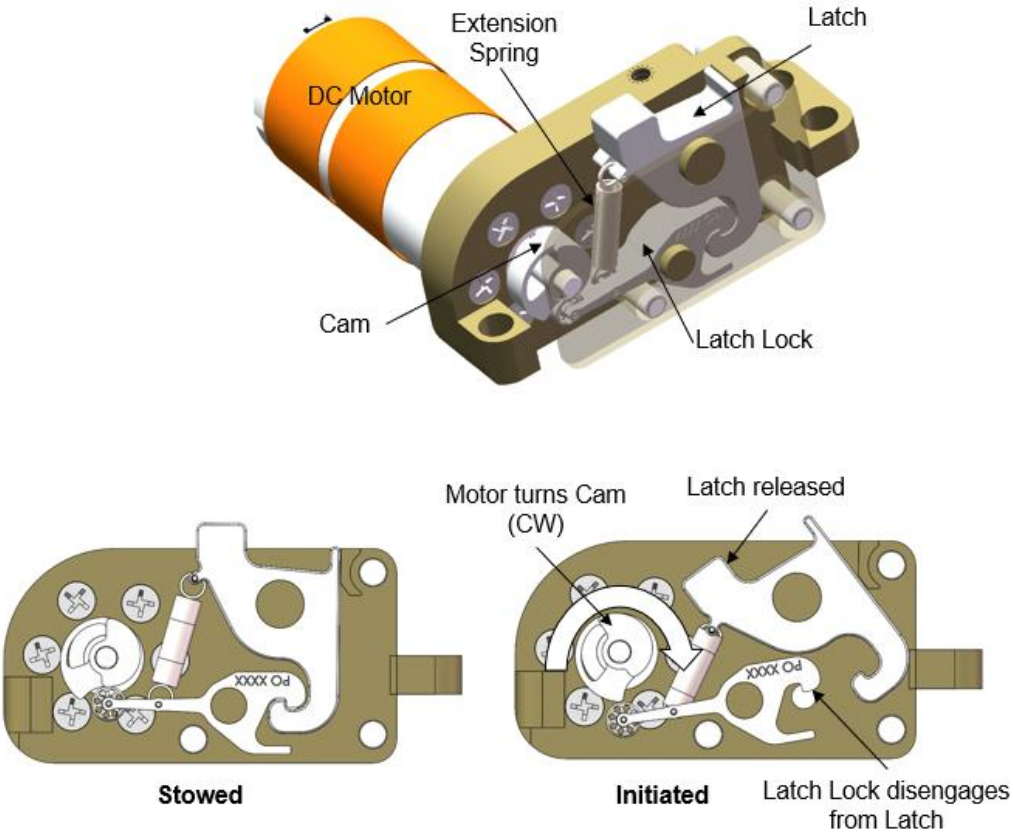


Figure 12-5: Powered Motor and initiation

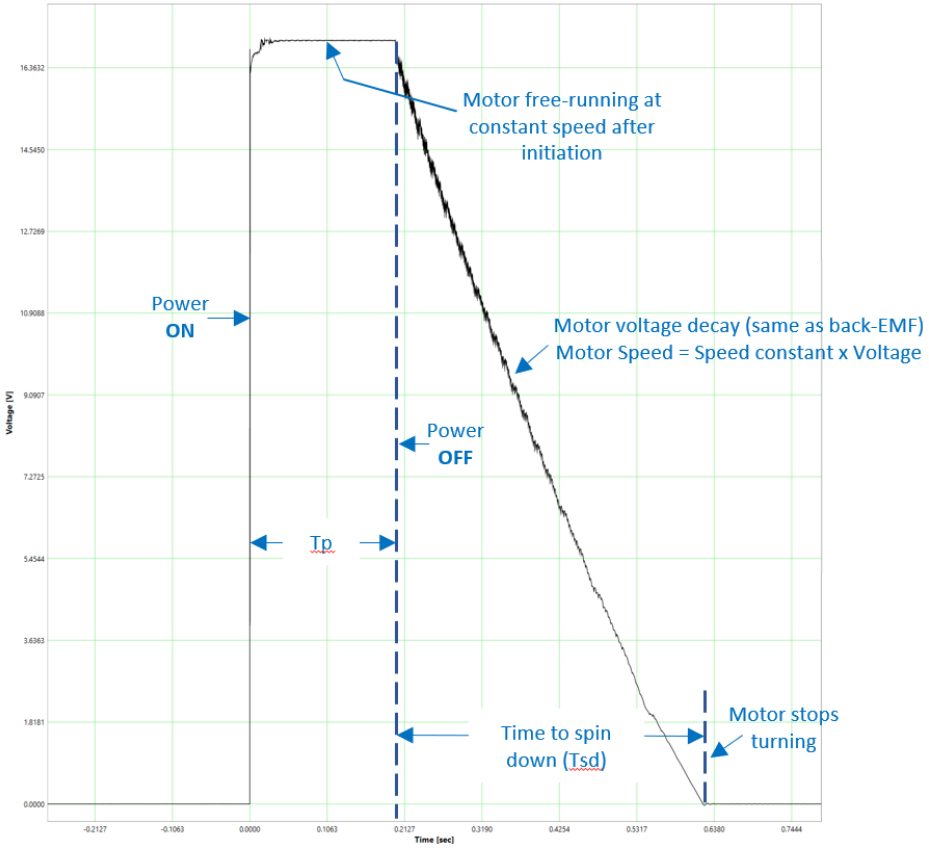


Figure 12-6: Example Deploy voltage profile at NTP

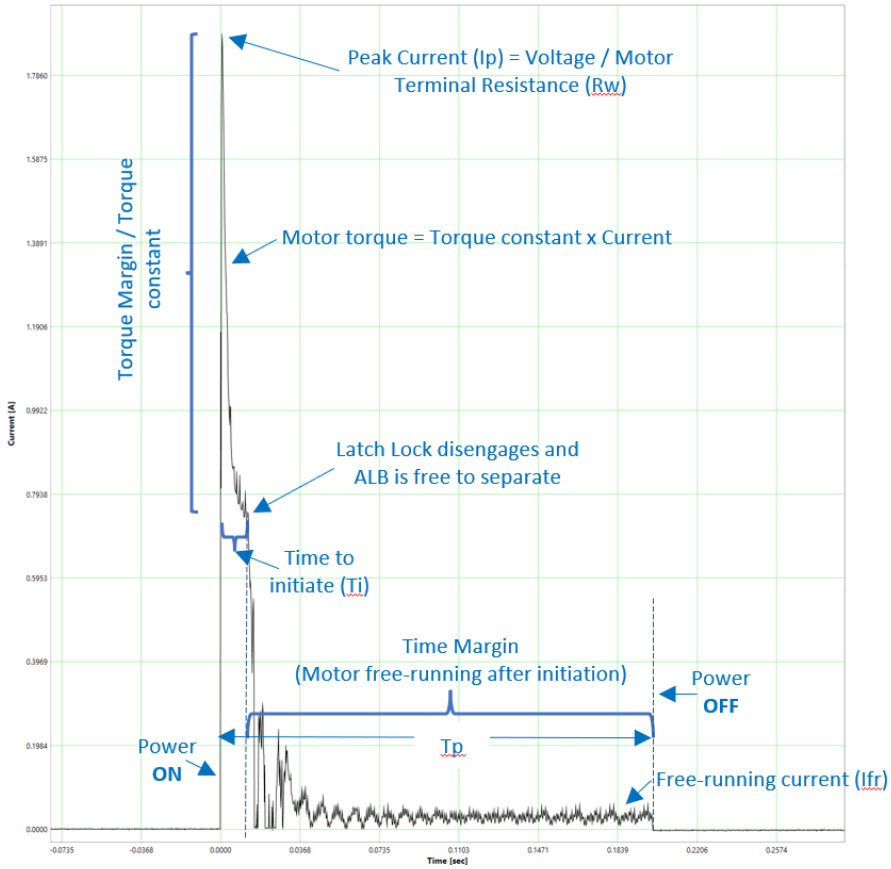


Figure 12-7: Example Deploy current profile at NTP

Step	Procedure	Date & Initials	
		Tech.	QA
12.2.8	Take a picture of the oscilloscope screen in case data inadvertently gets erased.		
12.2.9	Turn off the power source output.		
12.2.10	Save the voltage and current profiles for the motor and verify the data is readable.		
12.2.11	Complete Table 12-1 to verify all parameters are within tolerance. Single data point exceedances are acceptable. Also, a slow sample rate may alias data. Do not filter data. Contact PSC immediately if a discrepancy is found. Remember to account for non-zero offsets in the voltage or current measurements.		

Table 12-1: Deploy electrical verification (values apply only at NTP)

Item	Description	Units	Allowable		Value
			Min	Max	
1	Commanded time to apply power (Tp)	s	0.1	1.0	
2	Measured time to apply power (Tp)	s	0.1	1.0	
3	Time to fall below 0.25A	s	-	0.025	
4	Time to spin down (Tsd)	s	0.3	-	
5	Peak Current (Ip)	A	-	5.4	
6	Voltage at same time as Ip (V)	V	-	32	
7	Motor Terminal Resistance (Rw = V/Ip)	Ohm	5.9	11.4	

Step	Procedure	Date & Initials	
		Tech.	QA
12.2.12	If Spring Locks were removed, carefully offload compression weight and manually remove the Upper Ring from the Lower Ring to verify separation.		
12.2.13	If Spring Locks were not removed, manually remove the Upper Ring from the Lower Ring to verify separation. Restrain Springs by hand while removing Spring Locks and allow Spring to elongate slowly.		

13. Inspecting the Lightband

Step	Procedure	Date & Initials	
		Tech.	QA
13.1.1	Complete table 13-1 following deployment of the ALB. Contact PSC per section 5 if any answers are No. The ALB may be inspected at any time as long as it is separated.		

Table 13-1: ALB Inspection

Section	Item No.	Item Description	Tech Date & Initials	QA Date & Initials	Yes or No?
Fasteners	1	Are all accessible fasteners in place and tight (can only be loosened with tools)?			
Connectors and Switches	2	Are all Separation Switch plungers extended?			
	3	With the unaided eye, do Separation Connector pins have acceptably uniform pin heights and appear free of debris that could inhibit nominal travel or operation?			
Upper Ring	4	Is Stow Screw threaded hole free of damage that prevents proper engagement of the Stow Screw?			
Lower Ring	5	Is Latch-up distance (ds) within tolerance per 2003336 Advanced Lightband User's Manual?			
	6	Is Separation Spring stroke (deltas) within tolerance per 2003336 Advanced Lightband User's Manual?			
	7	Does the Preload Cam staking show signs of delamination?			
Yield & Damage	8	Is the ALB free of any yield or damage that prevents nominal operation? Critical Areas: • Flexure • Sliding Bracket • Preload Shims • Preload Cams • Leaf to Upper Ring Engagement Surfaces • Separation Springs (Note: the above list is not meant to be exhaustive – all areas of the ALB are to be visually inspected for damage)			

	9	Is the ALB free of Foreign Object Debris (FOD)? Critical Areas: • Upper Ring Leaf Grooves • Initiator • DE9 Connector • Stow Screw Threaded Hole • Separation Springs • Flexure • Bearings and Preload Cams (Note: The above list is not meant to be exhaustive – all areas of the ALB are to be visually inspected for FOD)			

14. Recommended Support Equipment

The following is a list of equipment PSC has developed over years of Lightband operation and training. This equipment is not required for proper Lightband operation but is very useful. PSC does not supply any of the items listed below. See PSC's website to download drawings of these parts.

Table 14-1: Support equipment

Tip	Steps	Best Practice / Lesson Learned	Image
1	9.1.8 9.1.10	PSC uses custom aluminum transition rings as adjoining structures for all Lightband operations and testing. They provide the necessary stiffness to operate the Lightband and ease attachment to other structures. They also facilitate Lightband circularity requirements. Part: *2000741 Transition Ring or 20003310 I-Beam Transition Ring*	
2	9.1.8 9.1.10	PSC ensures circularity of Lower and Upper Rings by aligning to adjoining structures with custom flat head screws. They are 82° flat head screws with the head diameter reduced to fit between Leaves. Part: *2002753 FLH Alignment Screw*