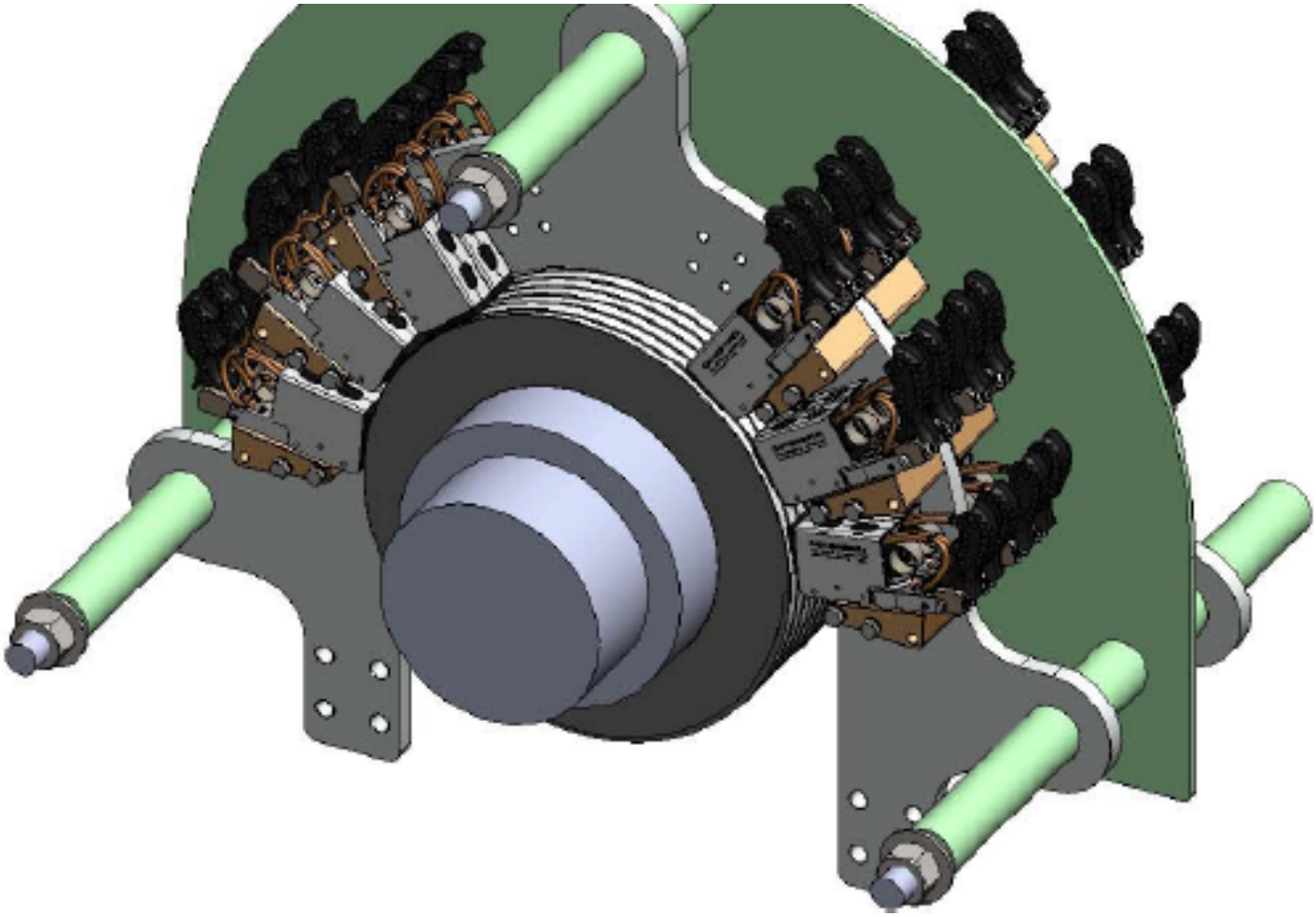
CUTSFORTH

Installation Manual
EZDP-2016 Rev C
EASYchange Brush Holder System



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1. About Cutsforth

Cutsforth specializes in developing innovative new technologies and services to support the power generation industry. Cutsforth's patented EASYchange® brush holder design, online truing service, InsightCM™ condition monitoring software, and patented shaft grounding and monitoring systems have been installed across the globe in generators of all sizes and in nearly every industry application, including nuclear, natural gas, coal, wind, and hydroelectric.

Cutsforth's knowledge and commitment to excellence drives our innovative solutions for the changing needs of the power industry. Whether it is a quick response to a critical situation or a new way of solving an old problem, our commitment to quality ensures that our customers receive best-in-class products and services—Cutsforth is the Power of Innovation.

Cutsforth, Inc. started back in 1991 as a small company focused primarily on making replacement brush holders for generators and exciters. Today, after 30+ years in business, Cutsforth's experience and innovative designs have brought its best-in-class excitation brush holder and shaft grounding replacements and collector ring services to some of the world's largest power companies.

1.1. Cutsforth Products

- EASYchange® Removable Brush Holders
- EASYchange® Brush Condition Monitoring
- Cutsforth Shaft Grounding Systems
- Rotor Flux Monitoring
- Electro-Magnetic Interference Monitoring
- InsightCM™ Condition Monitoring Software

1.2. Cutsforth Field Services

Cutsforth provides comprehensive product installations for all product offerings as well as on-site training after the installation. We work efficiently during your outage to ensure a smooth upgrade to our innovative solutions such as Product Installations, Online Collector Ring and Commutator Truing, Spiral Groove Restoration, and Consulting and Emergency Services.

1.3. Cutsforth Automation and Control Services

Cutsforth provides comprehensive Automation and Control services which include data historian integration, InsightCM™ integration, DCS logic, engineered drawings and much more. This further complements our turnkey monitoring system installations.

1.4. Cutsforth Electrical Contracting Services

In addition to our Field Service installation services, Cutsforth offers turnkey services including the electrical contractor scope of work as an additional service in select regions within the US. With this service offering, Cutsforth can greatly simplify the process of monitoring product installation from beginning to end.

2. Legal Information

2.1. Limited Warranty

This document is provided 'as is' and is subject to being changed, without notice, in future editions. Cutsforth reviews this document carefully for technical accuracy; however, CUTSFORTH MAKES NO EXPRESS OR IMPLIED WARRANTY AS TO THE ACCURACY OF THE INFORMATION WITHIN THIS MANUAL AS IT RELATES TO SPECIFIC INSTALLATION. THE CUSTOMER IS RESPONSIBLE FOR VERIFYING INSTALLATION AND OPERATING CONDITIONS AT EACH INSTALLATION LOCATION AND FOR EACH GENERATOR TYPE. Cutsforth warrants that its hardware products will be free of defects in materials and workmanship that cause the product to fail to substantially conform to the applicable Cutsforth published specifications for one (1) year from the date of invoice.

For a period of ninety (90) days from the date of invoice, Cutsforth warrants that (i) its software products will perform substantially in accordance with the applicable documentation provided with the software, and (ii) the software media will be free from defects in materials and workmanship. If Cutsforth receives notice of a defect or non-conformance during the applicable warranty period, Cutsforth will, in its discretion: (i) repair or replace the affected product, or (ii) refund the fees paid for the affected product. Repaired or replaced hardware will be warranted for the remainder of the original warranty period or ninety (90) days, whichever is longer. If Cutsforth elects to repair or replace the product, Cutsforth may use new or refurbished parts or products that are equivalent to new in performance and reliability and are at least functionally equivalent to the original part or product. You must obtain an RMA number from Cutsforth before returning any product to Cutsforth. Cutsforth reserves the right to charge a fee for examining and testing hardware not covered by the Limited Warranty.

This Limited Warranty does not apply if the defect of the product resulted from improper or inadequate maintenance, installation, repair, or calibration performed by a party other than Cutsforth; unauthorized modification; improper environment; use of an improper hardware or software key; improper use or operation outside of the specification for the product; improper voltages; accident, abuse, or neglect; or a hazard such as lightning, flood, or other act of nature.

THE REMEDIES SET FORTH ABOVE ARE EXCLUSIVE AND THE CUSTOMER'S SOLE REMEDIES, AND SHALL APPLY EVEN IF SUCH REMEDIES FAIL OF THEIR ESSENTIAL PURPOSE.

WARNING REGARDING USE OF CUTSFORTH SHAFT MONITORING EQUIPMENT: CUSTOMER IS ULTIMATELY RESPONSIBLE FOR VERIFYING AND VALIDATING THE SUITABILITY AND RELIABILITY OF THE PRODUCTS WHENEVER THE PRODUCTS ARE INCORPORATED IN THEIR SYSTEM OR APPLICATION, INCLUDING THE APPROPRIATE DESIGN, PROCESS, AND SAFETY LEVEL OF SUCH SYSTEM OR APPLICATION. PRODUCTS ARE NOT DESIGNED, MANUFACTURED, OR TESTED FOR USE IN LIFE OR SAFETY CRITICAL SYSTEMS, OR ANY OTHER APPLICATION IN WHICH THE FAILURE OF THE PRODUCT OR SERVICE COULD LEAD TO DEATH, PERSONAL INJURY, SEVERE PROPERTY DAMAGE OR ENVIRONMENTAL HARM (COLLECTIVELY, "HIGH-RISK USES"). FURTHER, PRUDENT STEPS MUST BE TAKEN TO PROTECT AGAINST FAILURES, INCLUDING PROVIDING BACK-UP AND SHUT-DOWN MECHANISMS. CUTSFORTH EXPRESSLY DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY OF FITNESS OF THE PRODUCTS OR SERVICES FOR HIGH-RISK USES.

CUTSFORTH DOES NOT WARRANT, GUARANTEE, OR MAKE ANY REPRESENTATIONS REGARDING THE USE OF OR THE RESULTS OF THE USE OF THE PRODUCTS IN TERMS OF CORRECTNESS, ACCURACY, RELIABILITY, OR OTHERWISE. CUTSFORTH DOES NOT WARRANT THAT THE OPERATION OF THE PRODUCTS WILL BE UNINTERRUPTED OR ERROR FREE. INCIDENTAL AND CONSEQUENTIAL DAMAGES, INCLUDING LOSS OF USE, ARE SPECIFICALLY EXCLUDED FROM THIS WARRANTY; THE MAXIMUM VALUE OF A WARRANTY CLAIM CANNOT EXCEED THE ORIGINAL VALUE OF THE ASSEMBLY OR COMPONENT.

2.2. Copyright

2.3. Patents

Please send patent information requests to patents@cutsforth.com.

3. Safety Information

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

3.1. Safety Conventions

NOTE:

Additional information.

ELECTRICAL DANGER

Indicates an action or specific equipment area that can result in personal injury or death from an electrical hazard if proper precautions are not taken.

CAUTION

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury or equipment damage.

WARNING

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

ROTATING PART CAUTION

Indicates possible injury from rotating parts.

DANGER

Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

3.2. General Safety Instructions

ELECTRICAL DANGER

Only qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid injury should work with Cutsforth products. Among the many considerations are the following:

- Avoid contact with energized circuits.
- Avoid contact with rotating parts.
- Never install any component that appears not to be functioning in a normal manner.
- Always ensure proper installation of the holder assembly and shaft grounding rope.

ELECTRICAL DANGER

Before working on the generator, de-energize, lock out, and tag out all power sources to the generator, shaft, and accessory devices. Electric shock and death may result due to failure to heed this warning.

ROTATING PART CAUTION

High-voltage and rotating parts can cause serious or fatal injury. Installation, operation, and maintenance of this product must be performed only by qualified personnel, in accordance with all applicable safety regulations and guidelines.

WARNING

Cutsforth recommends that workers do not change Shaft Contact Assembly (SCA) meter ropes while the generator is energized and/or operational. It is recommended that meter ropes be inspected and if necessary, changed during outages when the generator has been secured. Since the SCA is generally installed in relatively close proximity to the collector/brush gear (energized equipment) and or other rotating hazards in this area of the generator, it may pose a risk to workers that may include but are not limited to the following:

- Risk of entanglement or rotational injury attempting to remove/insert a meter rope.
- Risk of electrical shock.
- Risk of creating a short circuit between energized parts and ground.

These conditions and limitations are to be carefully considered at the time of installation. It is recommended that procedures and policies be implemented by the end user so as to realize the full function of the monitoring system but avoid potential hazards. These conditions generally do not apply to the Shaft Grounding Assembly (SGA) equipment installation.

WARNING

Never mix different carbon brush grades or brushes from different manufacturers on the same unit.

4. The Cutsforth Brush Holder

This manual covers installing Cutsforth adapters, brush holders, and brushes. If these parts are replacing old parts, see the documentation that came with the old parts for how to remove them.

NOTE:

The number of brush holders may vary based on the exact configuration of the generator.

NOTE:

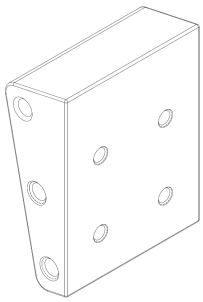
This manual does not cover all details or variations in equipment, nor does it consider every possible contingency for installation, operation, or maintenance. If you have questions or concerns that are not addressed in this manual, contact Cutsforth Engineering Support.

The sequence of modification, installation, and pre-operational inspection tests are optional and should be determined for the convenience of the site.

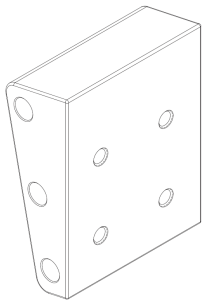
4.1. Components

The following parts are included in the Brush Holder installation package:

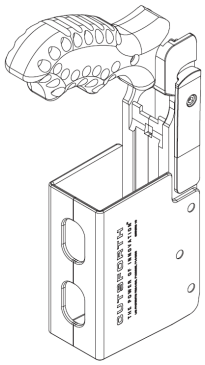
12 Adapters with cross-hole threads



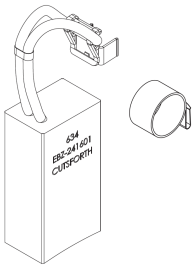
12 Adapters without cross-hole threads



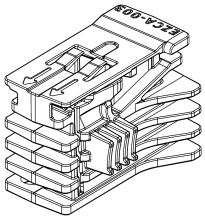
48 Cutsforth Brush Holders



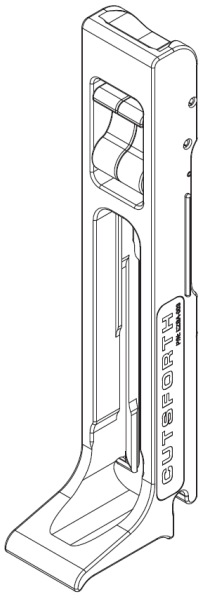
48 Brush kits



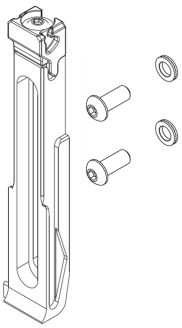
1 Brush changing key



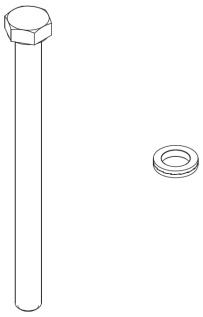
1 Height setter



48 Holder mounts with 1/4-28 in button head cap screws with NI6 Nordlock washers

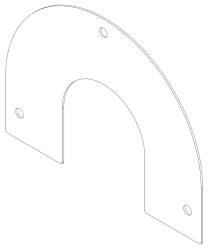


24 5/16-18 x 3.5 in Bolts and NL8 Nordlock washers

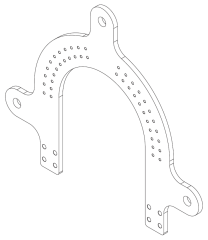


Salvage these parts from the old equipment. These parts do not require removal from the generator:

1 Barrier

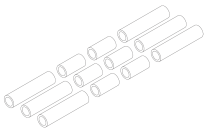


2 Yokes with hardware



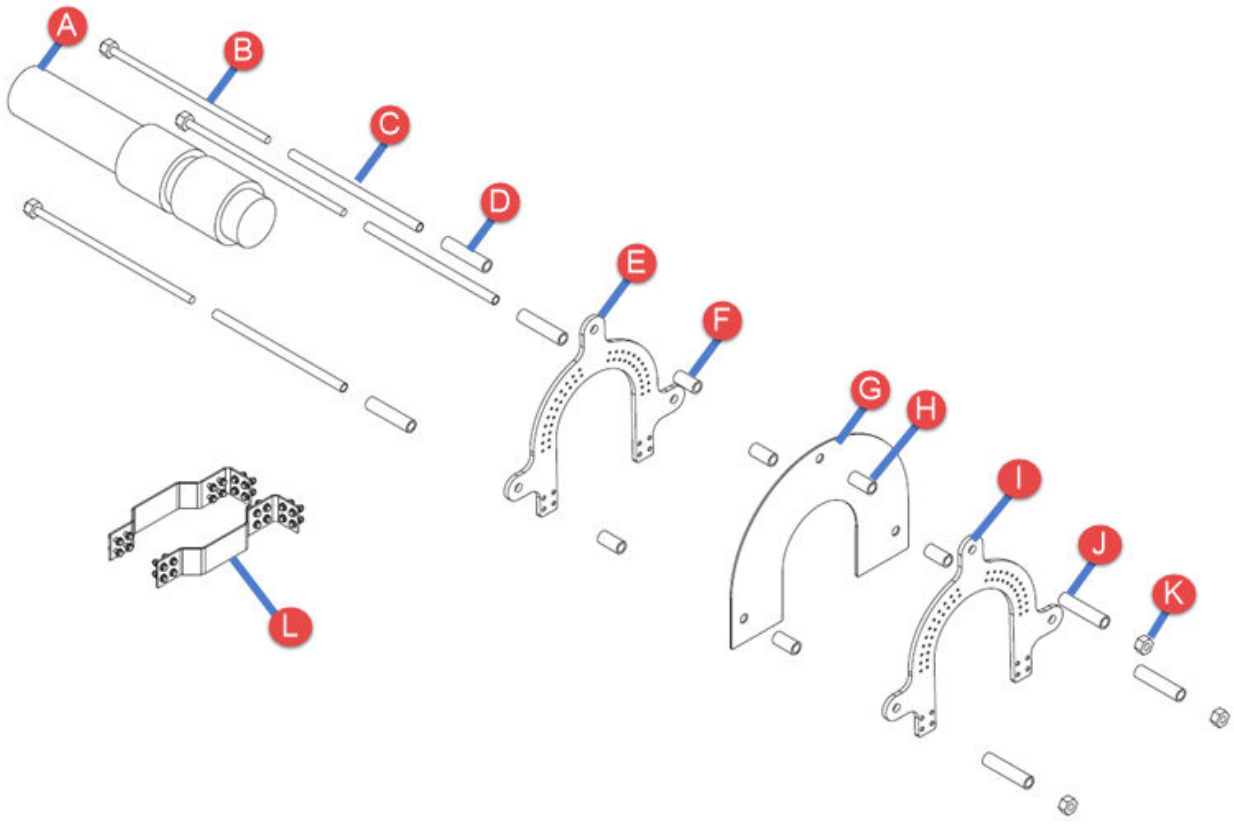
3 Stud insulation sleeves

12 Spacers



4.2. Rigging Assembly Exploded View

This exploded view image is generator-specific and may vary by unit type.



Part	Description	Quantity	Part	Description	Quantity
A	Shaft with collector rings	1	G	Barrier	1
B	Studs	3	H	Spacer 3	3
C	Sleeves	3	I	Yoke	1
D	Spacer 1	3	J	Spacer 2 (old adapter, set aside)	3
E	Yoke	1	K	Nuts	6
F	Spacer 2 (old adapter, set aside)	6	L	Power connection	1

4.3. Required Tools

These tools are required for installing the adapters and holder mounts:

- 1/2 in Box end wrench
- 5/32 in Hex wrench
- Torque wrench with 1/2 in socket and 5/32 in Hex driver

5. Preparing for Installation

This section explains the procedures to complete before you install Cutsforth Brush Holders.

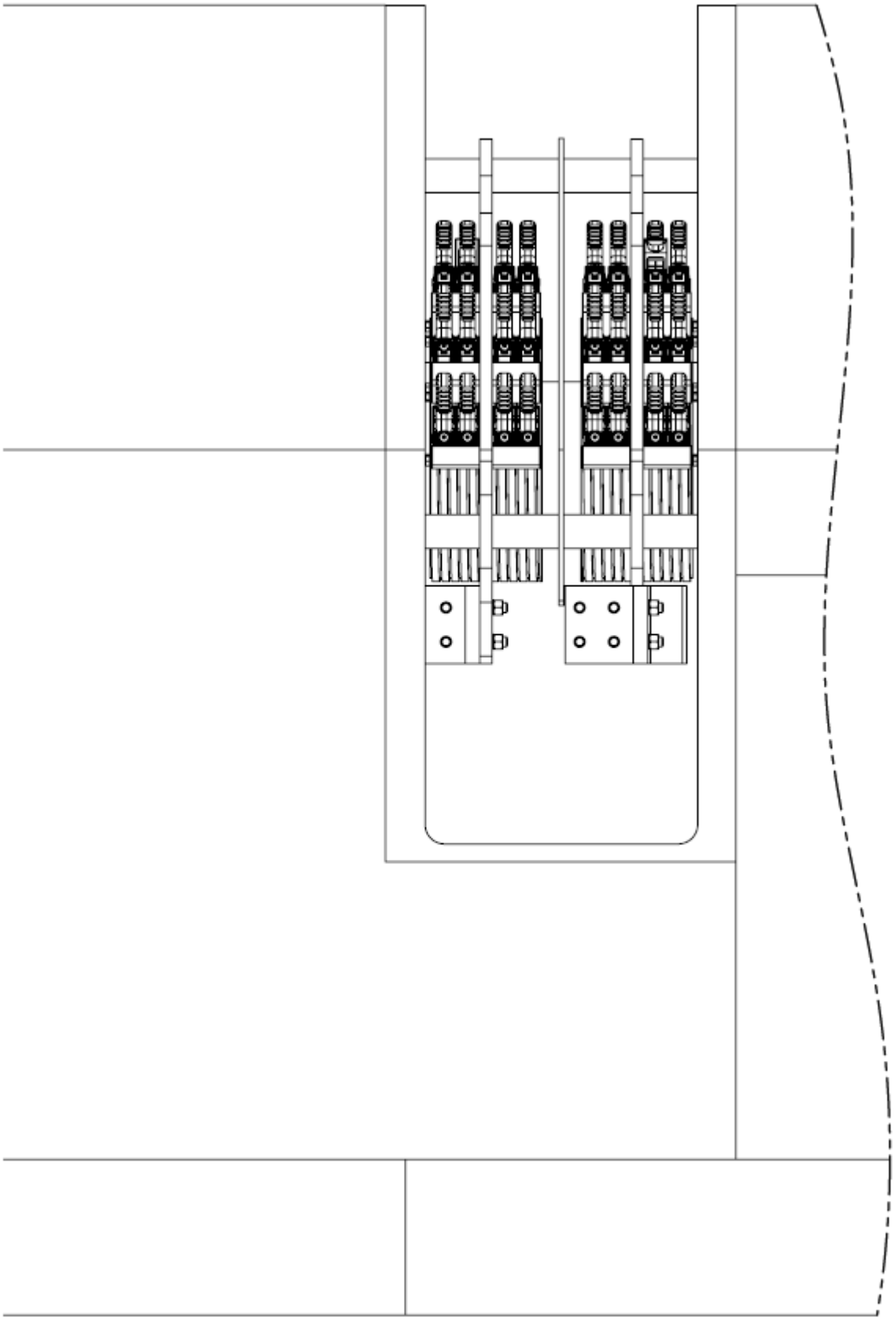
1. Powering Down (page 13)
2. Measuring the Brush Rigging Area (page 13)
3. Inspecting and Cleaning Components (page 15)

5.1. Powering Down

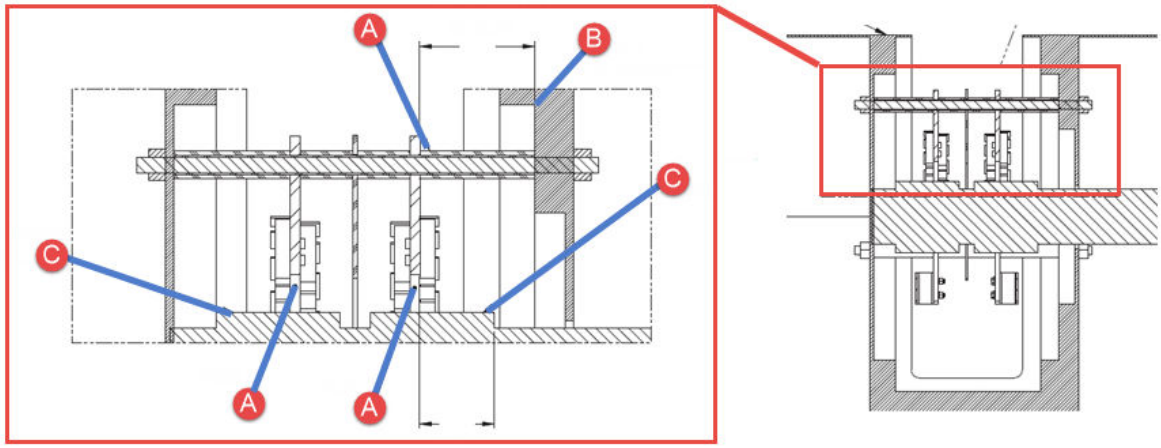
- Power down the generator and accessory devices.

5.2. Measuring the Brush Rigging Area

1. Remove the door to the brush rigging area.



2. Measure the yoke (A) to the end of of the spacer (B). Then measure the yoke (A) to collector ring (C) edge. Compare the values to the measurements from Step 1 in Powering Down.



3. For confirmation, examine the brush position offset from the ring film to check for shaft growth. Note the difference from the running location.

5.3. Inspecting and Cleaning Components

1. Remove the brush holders and brushes. For instructions, see the documentation that came with the old brush rigging.
2. Examine the yokes, spacers, insulation, and barrier for damage. Carefully remove any poor material conditions on the yoke stud insulation, and replace damaged components.
3. Set aside the brush holders and brushes.
4. Ensure collector rings are free from contamination and signs of arcing or burning. When at speed, brush vibration measured on the top of the brushes in mils of displacement should not be more than 4 mils.

   If collector rings are worn or damaged, contact Cutsforth for repair.
5. Clean the collector assembly. Use denatured alcohol to remove any dirt, oil residue, and carbon dust from the collector rings and all other accessible parts.
6. Clean the yokes with a scouring pad. To prevent film formation and possible rust, avoid hand or finger prints on the steel rings.

6. Installation Procedure

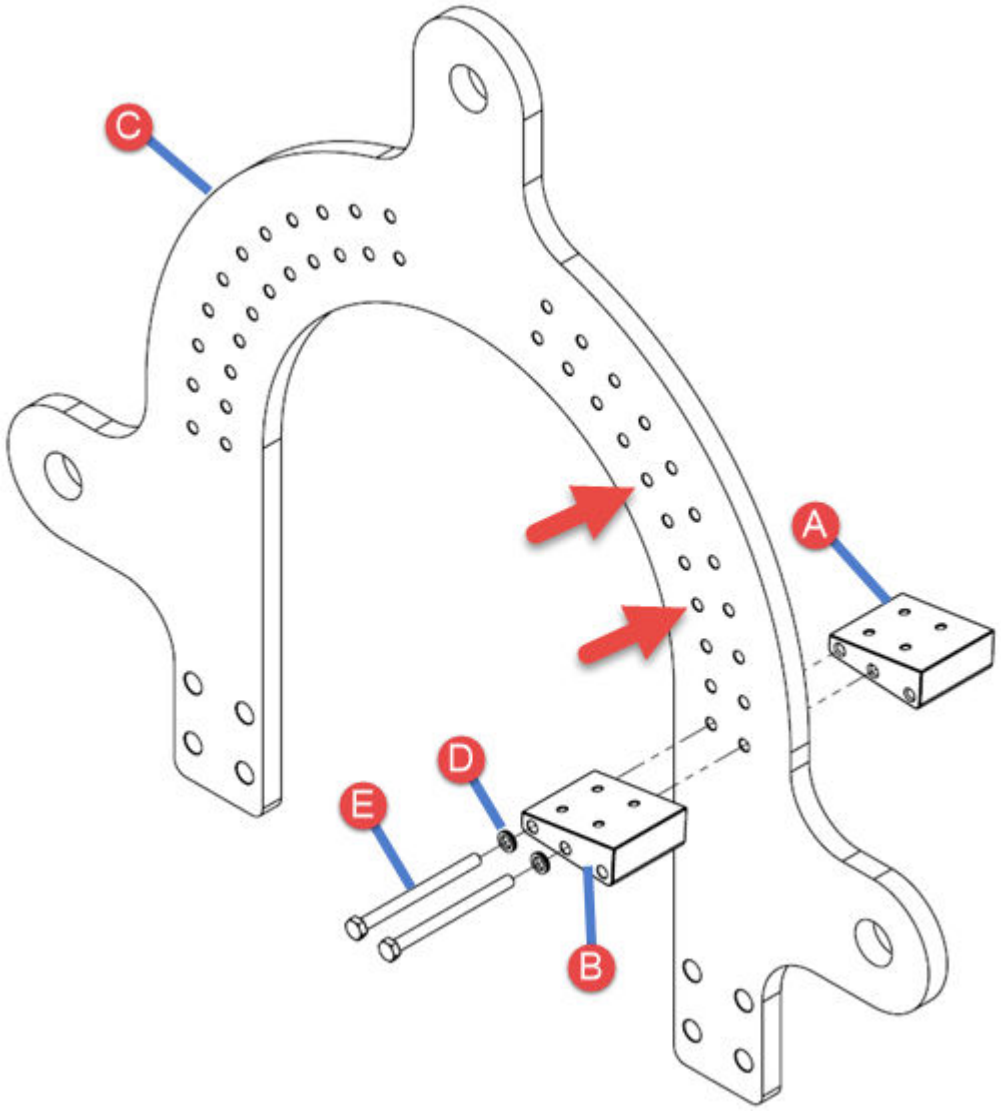
Complete the steps in these sections to install the brushes:

1. Installing Adapters on the Yokes (page 16)
2. Installing the Holder Mounts (page 19)
3. Installing the Brushes into the Brush Holders (page 25)

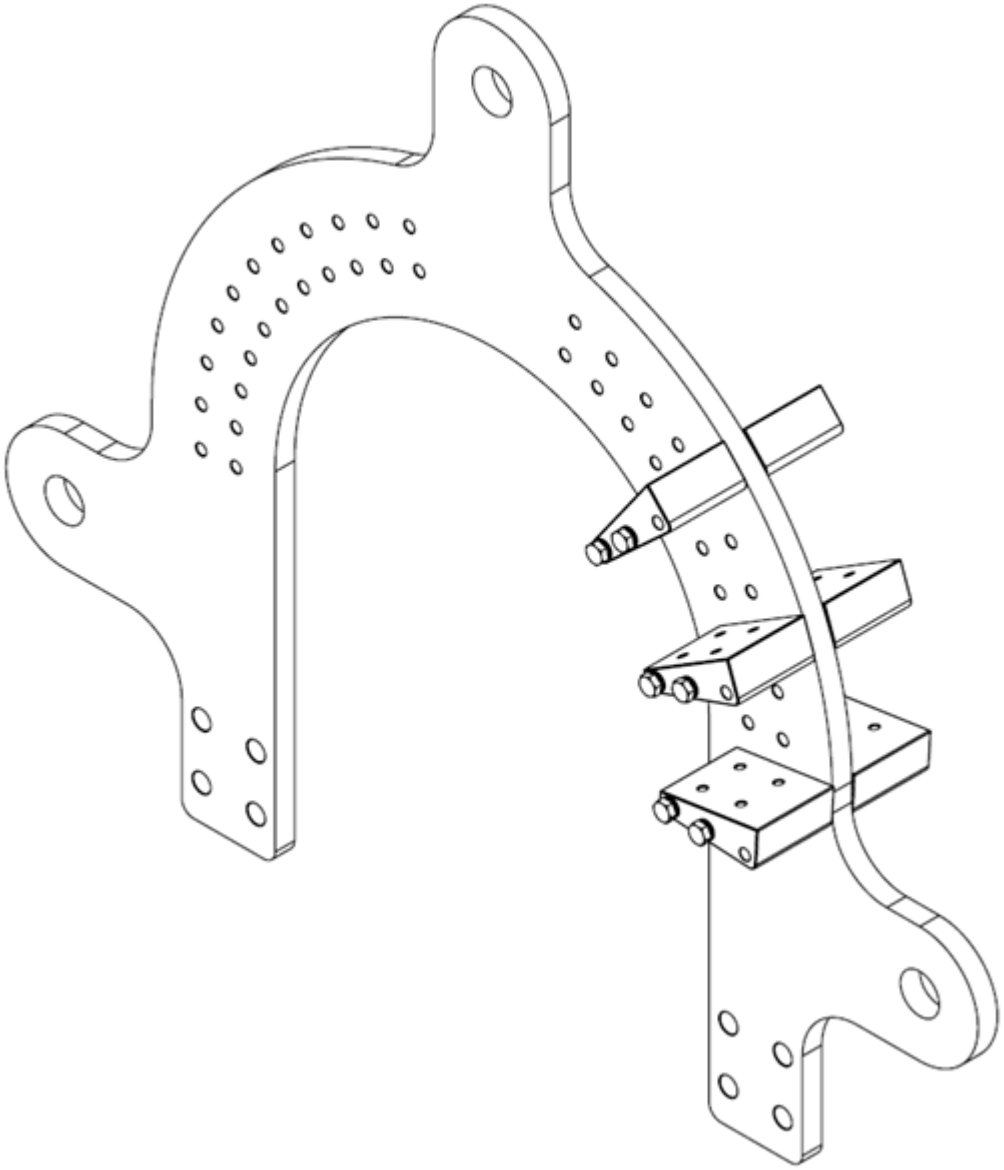
6.1. Installing Adapters on the Yokes

1. Align the first two adapters, one with cross hole threads A and one without B, with the holes on each side of the yoke C. Align the adapters with the mount side facing the center of the yoke.
2. Install the adapters at the first, fourth and seventh set of holes starting from the outside of the yoke.
3. Secure the adapters using NL8 Nordlock washers D and 5/16-18 x 4 in bolts E.

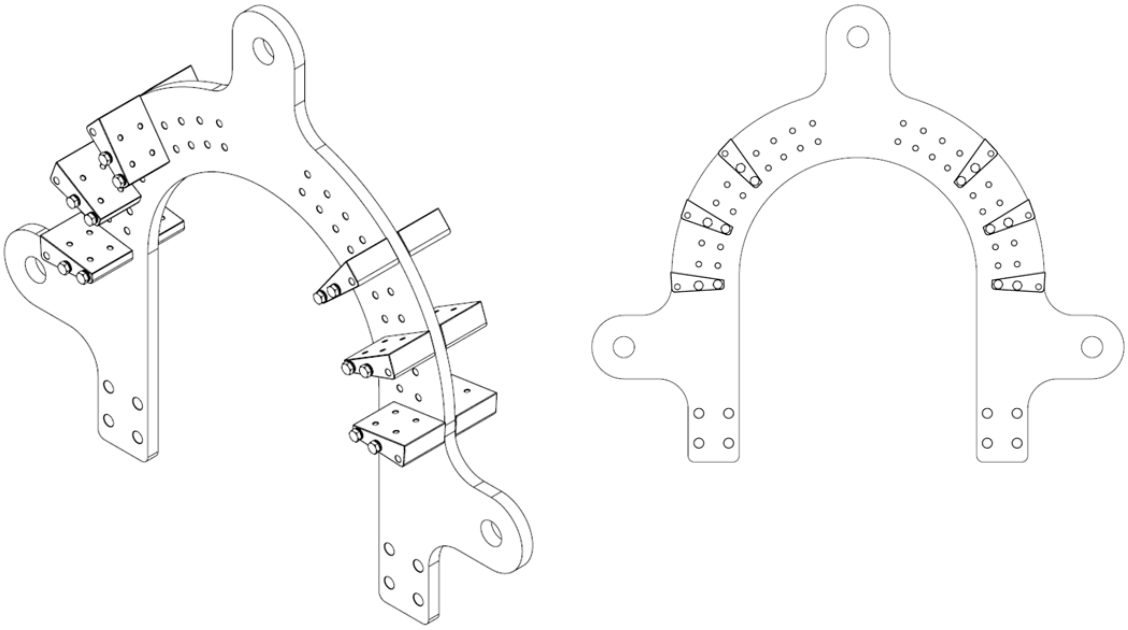
   Torque to 220-240 in lbs (25-27.5 Nm).



4. Repeat steps 1 through 3 for the next four adapters on the same side of the yoke.



5. On the opposite side of the yoke, align and attach the adapters facing the opposite direction of the first three adapter pairs.



6. Repeat steps 1 through 5 for the second yoke.

6.2. Installing the Holder Mounts

ELECTRICAL DANGER

Before working on the holder mounts, de-energize, lock out, and tag out all power sources to the generator, exciter, and accessory devices. Electric shock and death may result due to failure to heed this warning.

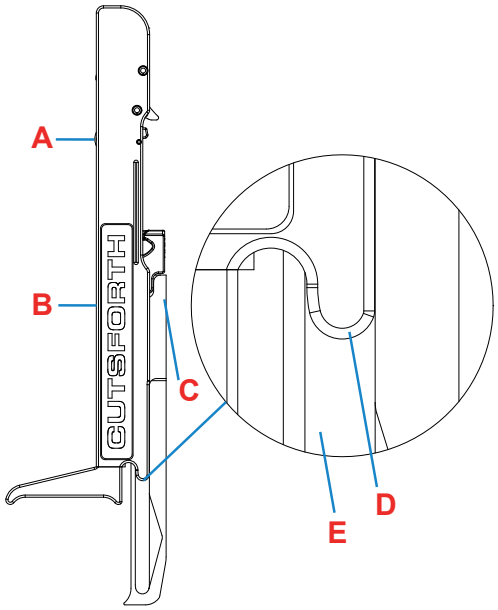
This section explains how to install the holder mounts using the height setter. The height setter verifies that the holder mount and the brush holders are at the correct distance from the collector ring.

Complete the steps in these sections to install the holder mounts:

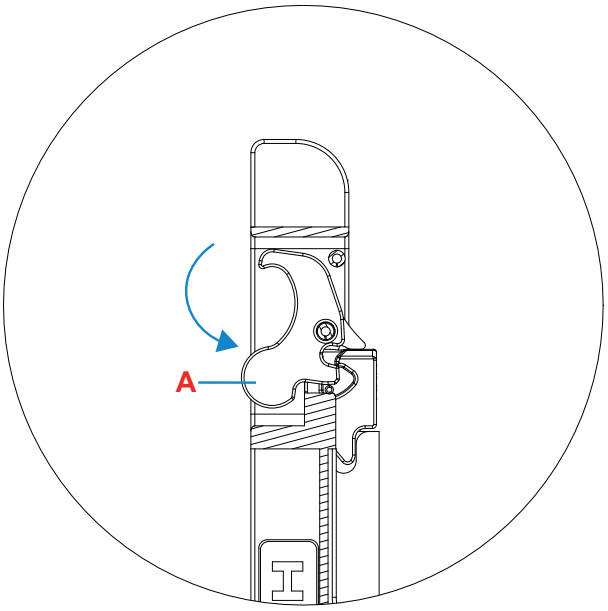
1. Install a Holder Mount Using the Height Setter (page 20)
2. Center the Brush Installation Area and Remove the Height Setter (page 23)
3. Install the Remaining Holder Mounts (page 24)

6.2.1. Install a Holder Mount Using the Height Setter

1. While holding the trigger (A) in its disengaged position, slide the height setter (B) onto the holder mount (C) until the guide boss (D) is bottomed out in the guide slot (E).



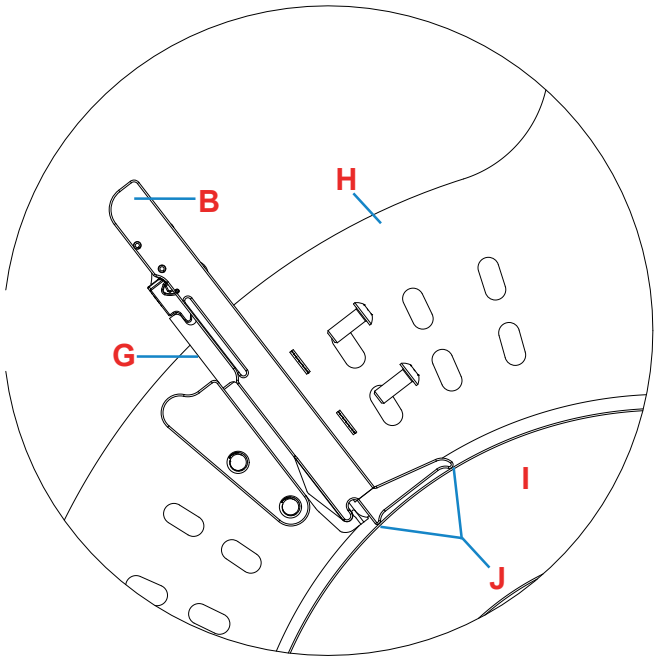
2. With the height setter positioned all the way down, release the trigger **(A)** and allow it to move to the engaged position **(F)**.



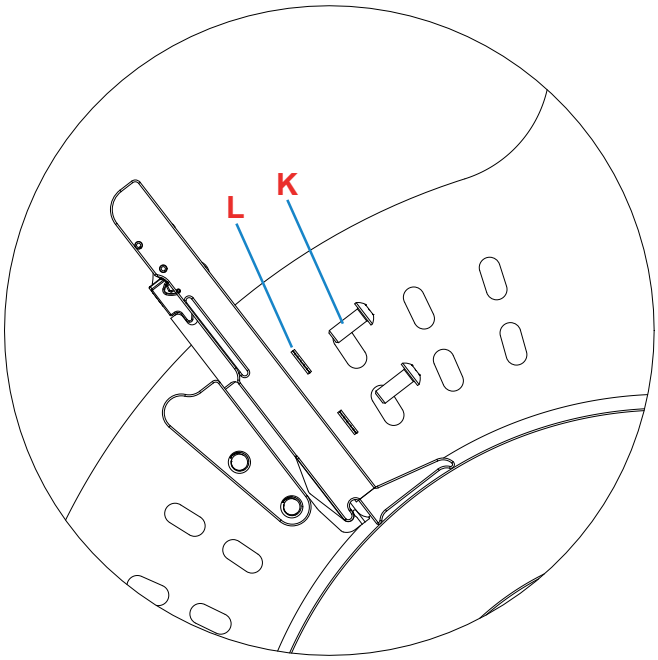
3. Ensure the height setter with holder mount **(B)** is on the mount side of the adapter **(G)**. Place the height setter with holder mount against one of the adapters on the yoke **(H)**. Position so that

the height setter rests against the collector ring **(I)** until both height setter ribs **(J)** contact the collector ring.

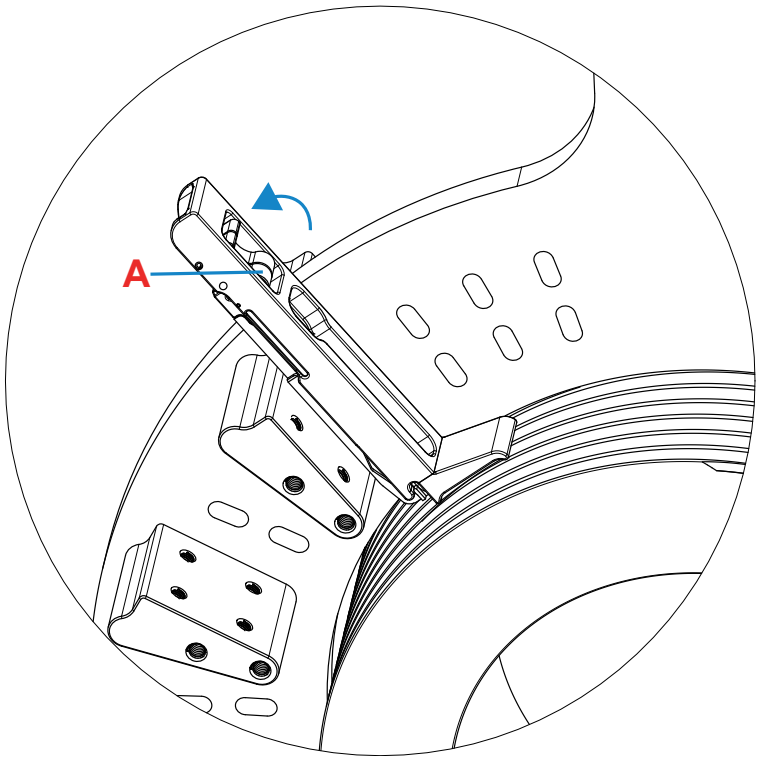
The adapter may need a rotational adjustment. To maximize ring coverage, use the alternate mounting positions on the adapters as needed.



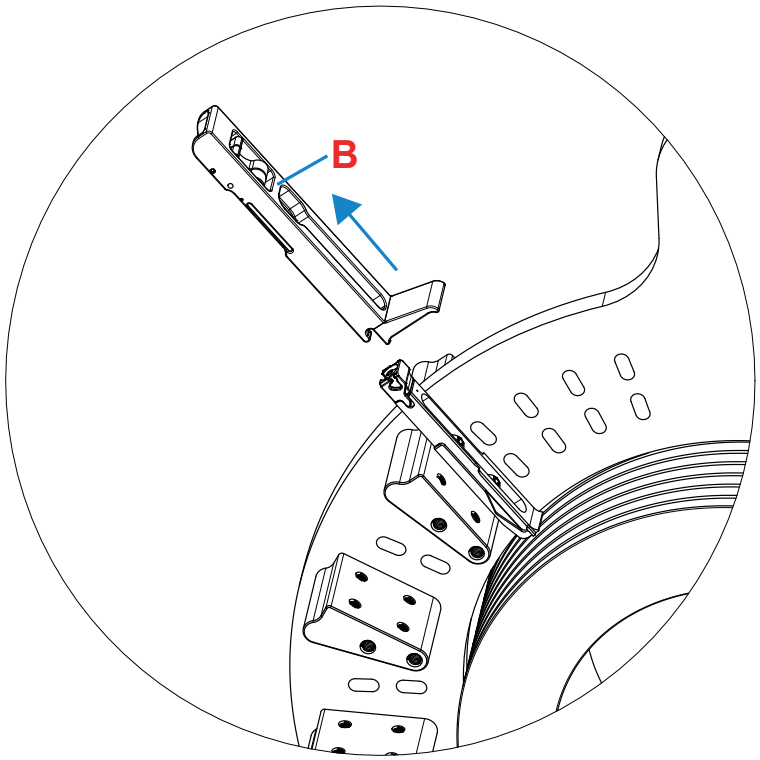
4. Using a 5/32 in Allen wrench, fasten the 1/4-28 button head cap screws **(K)** and NL6 Nordlock washers **(L)** to 110-120 in lbs (12-13.5 Nm) of torque.



5. Pull the trigger back to the disengaged position.



6. Remove the height setter.

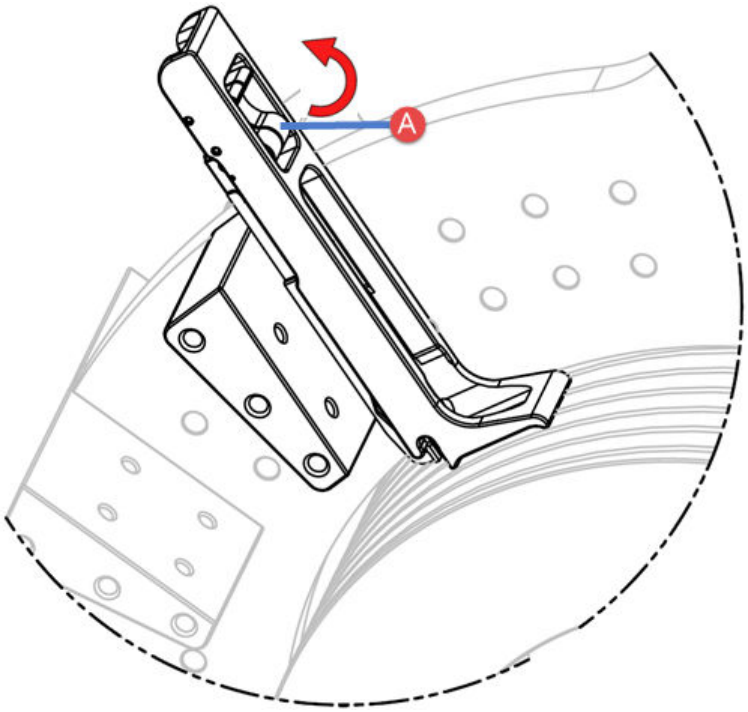


6.2.2. Center the Brush Installation Area and Remove the Height Setter

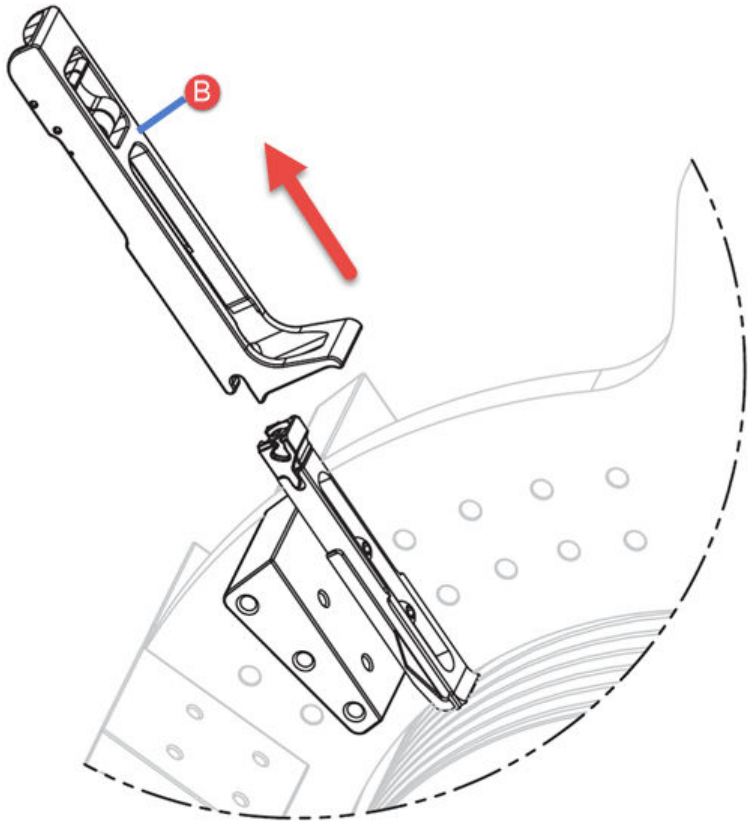
1. Use the height setter to check that the brush will be properly centered on the ring when the brush holder is installed. Measure the position of the height setter and compare to the position of the original brush found in Measuring the Brush Rigging Area (page 13).

   If necessary, insert or remove washers by the spacers so that the brush holder is properly centered.

2. Pull the trigger A back to the disengaged position.

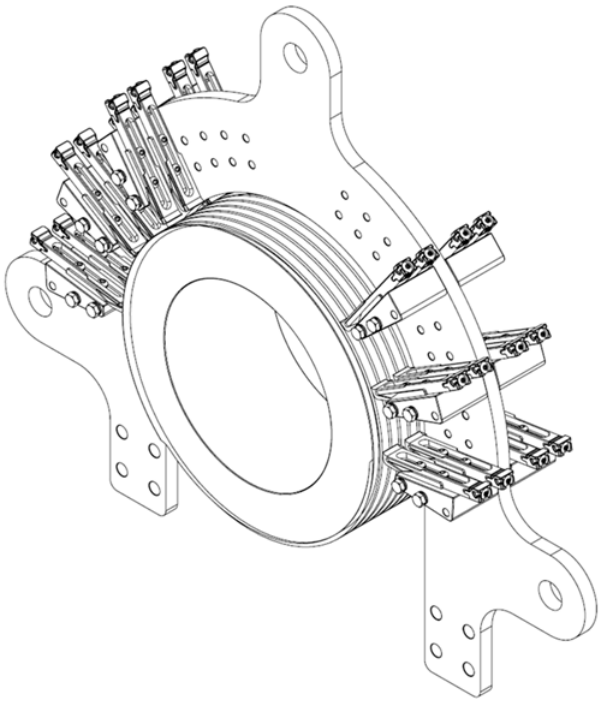


3. Remove the height setter B from the holder mount.



6.2.3. Install the Remaining Holder Mounts

1. Repeat the procedures in Install a Holder Mount Using the Height Setter (page 20) and Center the Brush Installation Area and Remove the Height Setter (page 23) for the remaining holder mounts.



2. Torque the 5/16 in adapter bolts to 220-240 in lbs (25-27.5 Nm).
3. If the yoke stud nuts are loose, tighten and torque the nuts to the manufacturer's recommended torque value.

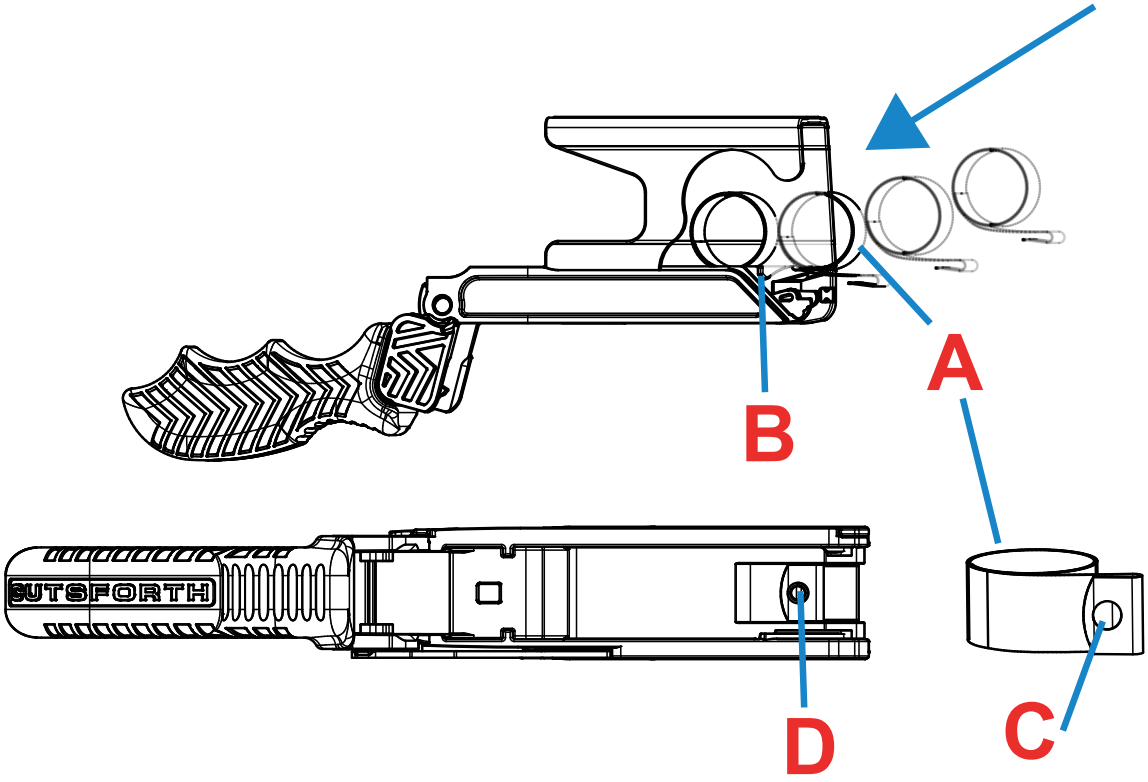
6.3. Installing the Brushes into the Brush Holders

Complete the steps in these sections to install the brushes into the brush holders.

1. Install a Brush Spring (page 26)
2. Install a Brush (page 27)
3. Position the Brush Shunts (page 30)
4. Install a Brush Holder (page 31)
5. Verify the Brush Holder Installation (page 32)

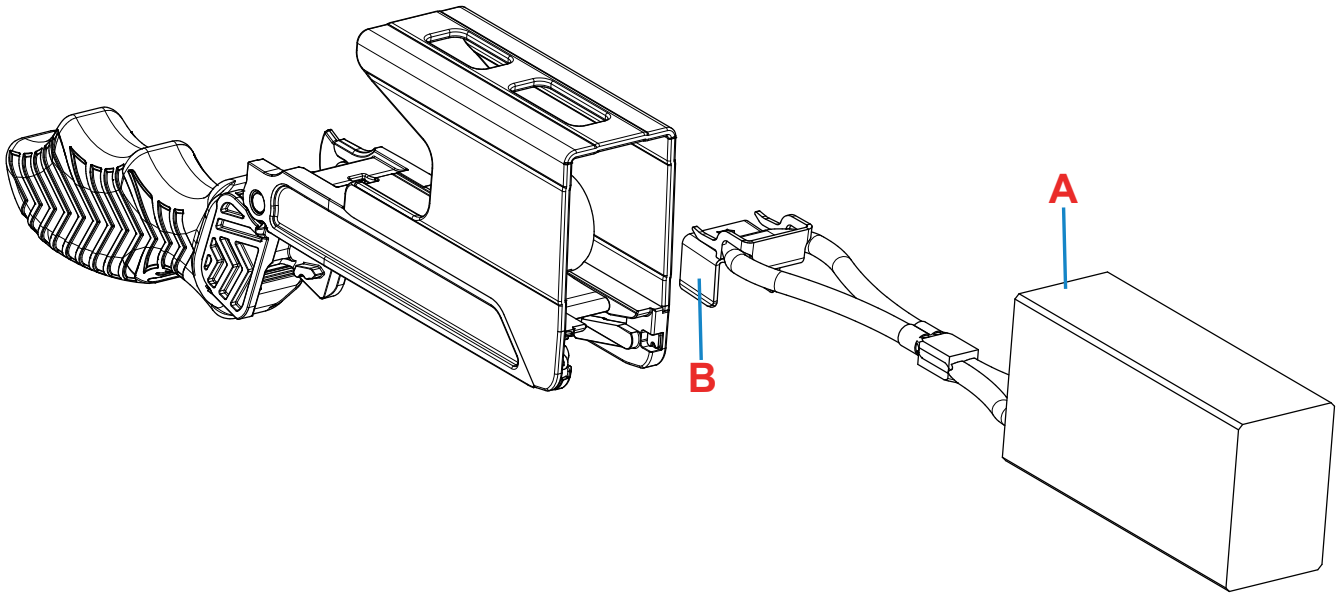
6.3.1. Install a Brush Spring

1. Insert a brush spring **(A)** onto the spring rib **(B)**.
2. Push until the spring hole **(C)** snaps onto the spring pin **(D)**.

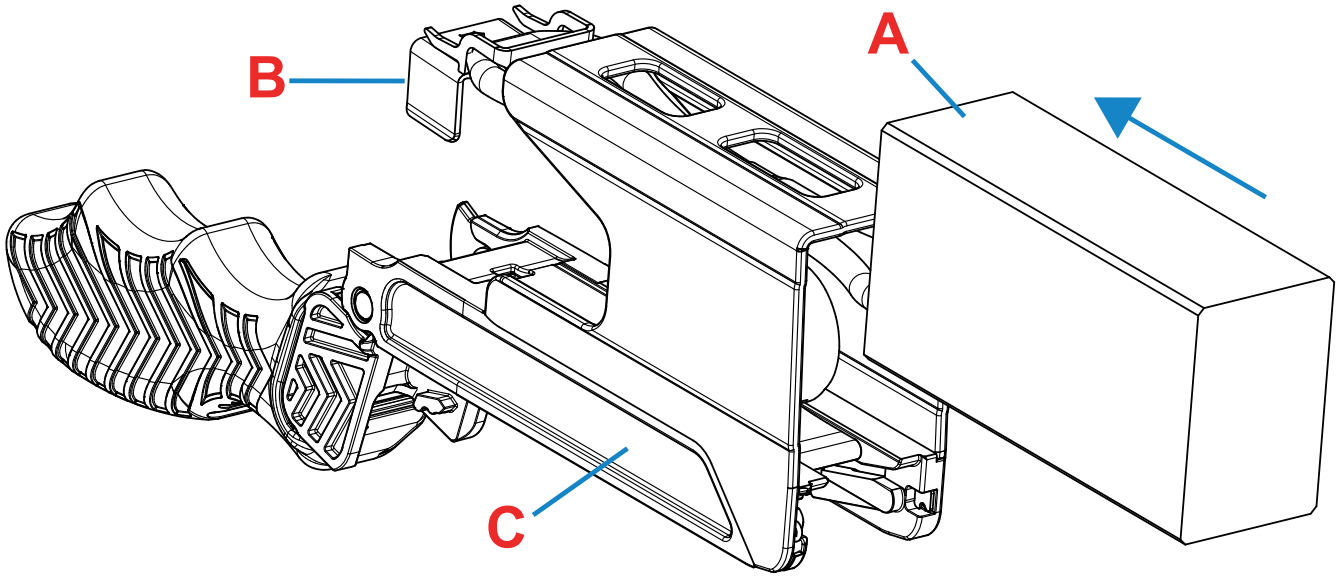


6.3.2. Install a Brush

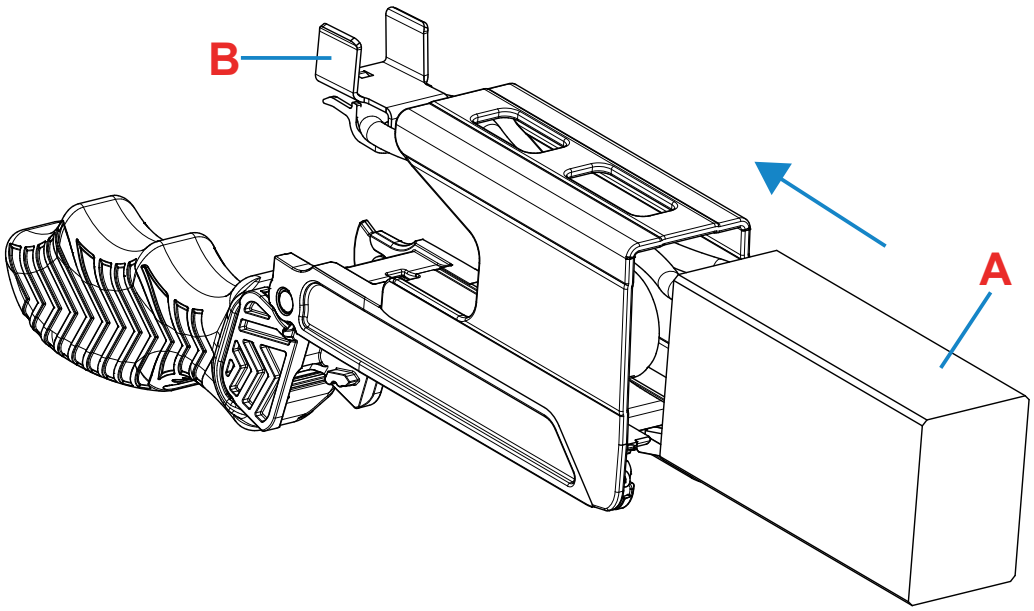
1. Rotate the brush **(A)** so the terminal ears **(B)** point down.



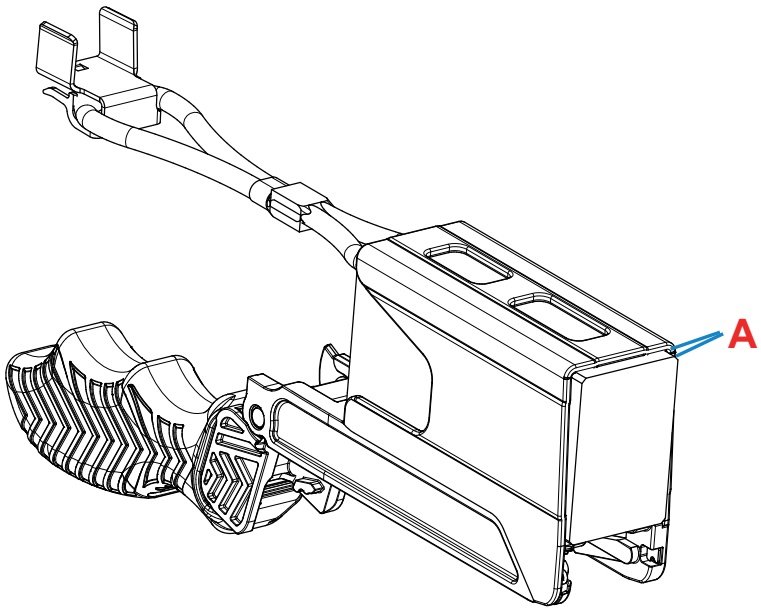
2. Insert the brush **(A)** into the holder **(C)** until the terminal ears **(B)** pass the brush spring.



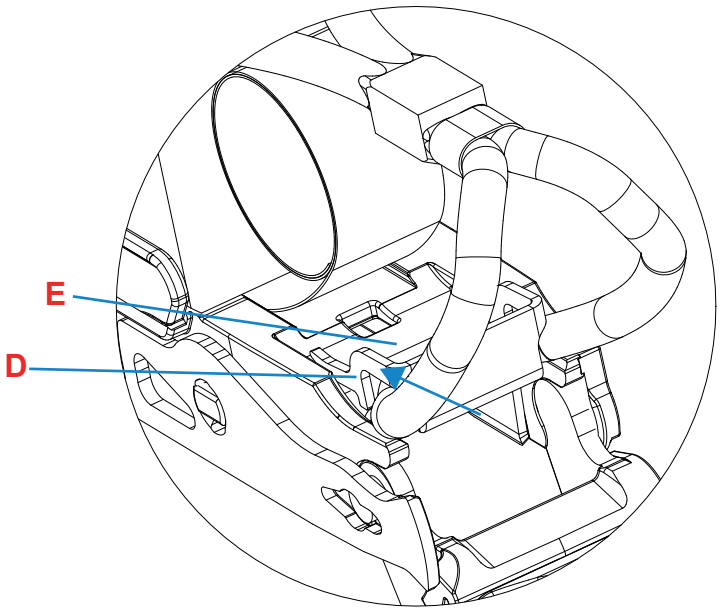
3. Rotate the brush **(A)** so the terminal ears **(B)** point up and start to insert the brush into the holder.



4. Insert the brush **(A)** the rest of the way into the holder until approximately 1/8 in (3.2 mm) extends out of the brush box.

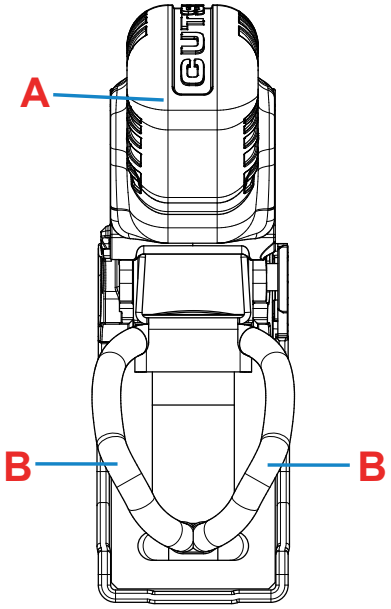


5. Insert the brush terminal **(D)** onto the terminal mount rib **(E)**.

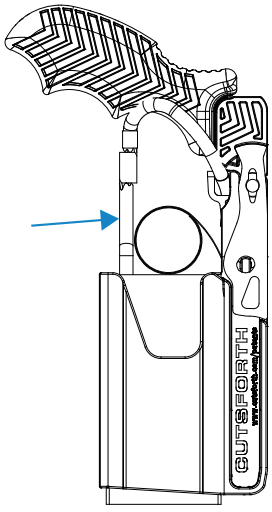
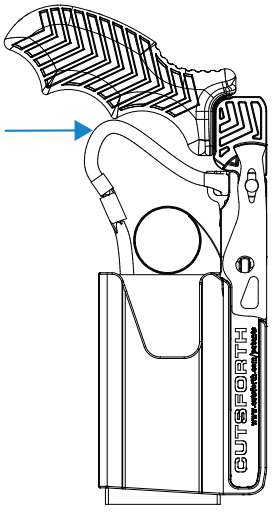


6.3.3. Position the Brush Shunts

- To prevent brush binding, lead damage, and interference with the handle **(A)**, position the brush leads **(B)** as shown:

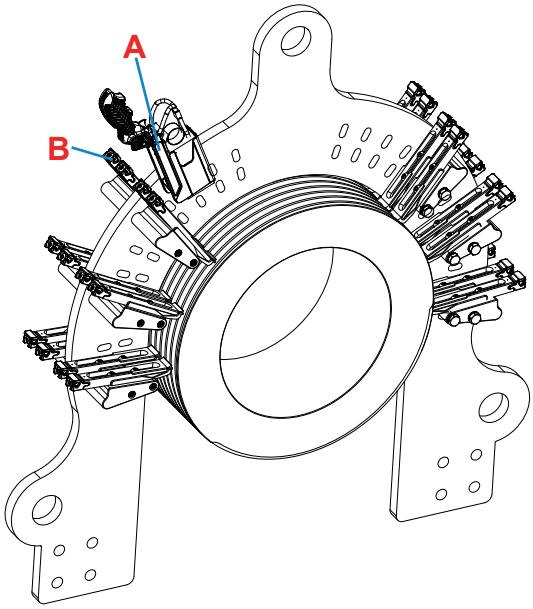


Review these correct/incorrect examples for additional clarification:

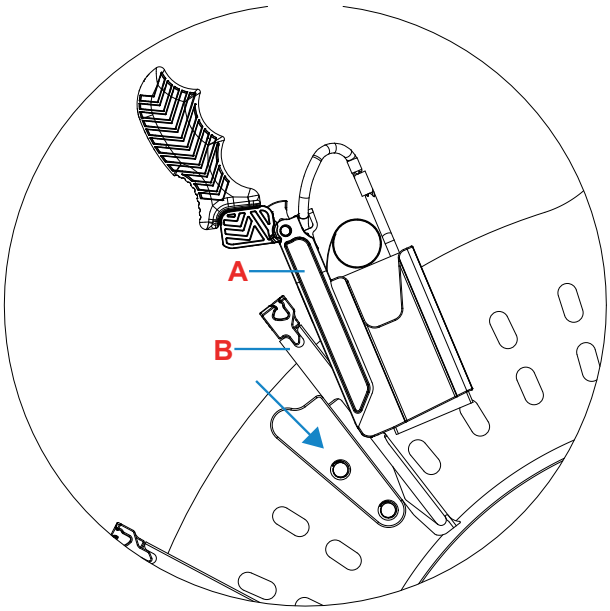
Correct	Incorrect
In this correct example the brush shunts are formed straight up so that they will not catch on the box. 	Do not position the brush leads as this example shows. In this position the leads will restrict free movement of the brush (hang up). 

6.3.4. Install a Brush Holder

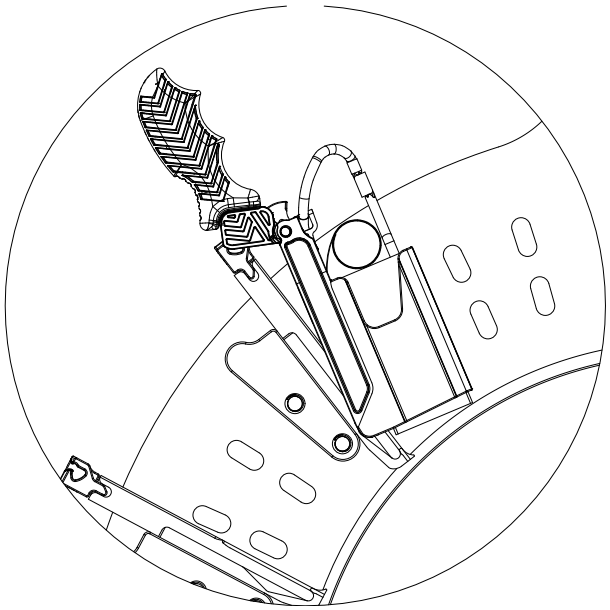
1. Align the brush holder **(A)** with the grooves on the side of the holder mount **(B)** and slide into the holder mount.



These example images provide additional clarification:



2. Rotate and lock the handle **(C)** into place while applying light pressure toward the collector ring **(D)**.

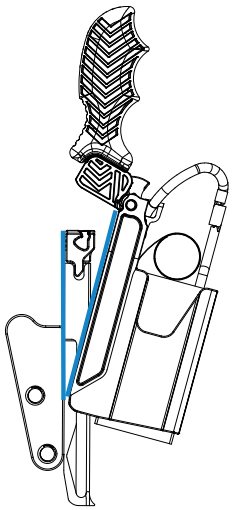
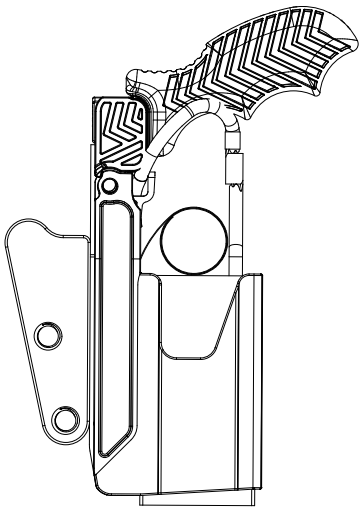


3. Repeat the steps in Install a Brush Spring (page 26), Install a Brush (page 27), Position the Brush Shunts (page 30), and this section for the remaining springs, brushes, and brush holders.

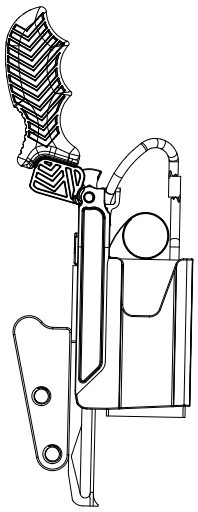
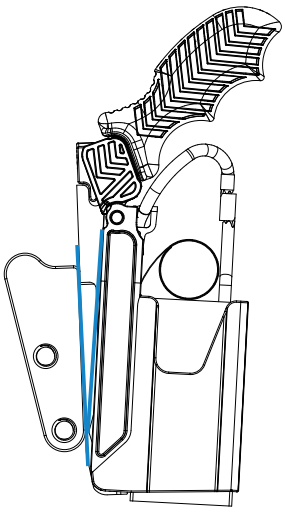
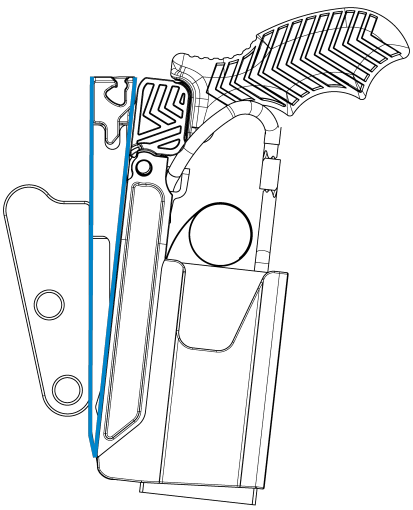
6.3.5. Verify the Brush Holder Installation

This section provides visual examples of correctly and incorrectly installed brush holders.

6.3.5.1. Correctly Mounted Brush Holders

Correctly Aligned Insertion	Properly Engaged Terminal and Holder
	

6.3.5.2. Incorrectly Mounted Brush Holders

Misaligned Insertion	Brush Holder not Fully Engaged	Handle Engaged with Brush Holder Misaligned
		

7. Reinstalling the Doors and Starting Up

1. Reinstall the doors.
2. Upon initial startup of the generator, apply a low current.
3. Increase the current gradually over several hours, allowing brushes to conform to the rings before full current is reached.

8. Verifying Proper Function

Complete these steps to verify that the rigging and brushes work properly after the generator is in operation:

1. Verify brushes ride within ring edges.
2. Take brush vibration readings to ensure they are below 4 mils.
3. Verify the brushes are not chattering or sparking.

9. Glossary

adapter	A Cutsforth device used as an intermediary connection between the EASYchange Brush Holder and the yoke.
arcing	Electrical discharge caused by the breakdown of a non-conductive medium.
brush change key	A Cutsforth product that assists in removing carbon brushes and constant force springs from an EASYchange Brush Holder.
brush rigging	An assembly that securely holds carbon brush holders in place.
carbon brush	A device which provides a sliding contact used to transmit electrical current to and from static and rotating equipment in a motor or generator.
collector ring (a.k.a. slip ring, main field ring)	The surface upon the rotating equipment to which the carbon brush makes contact to transmit electrical current.
EASYchange Brush Holder	A Cutsforth product and patented brush holder system.
Height Setter	A Cutsforth product used to properly position the lower mount using the surface of the collector ring as a reference.
Lower Mount	A Cutsforth product to which the EASYchange holder mounts, ensuring proper alignment and positioning of the carbon brush to the collector ring running surface.
Mil	One thousandth of an inch. An imperial measurement used to communicate vibration reading.
polarity barrier	A structure made from a non-conductive material, which is used to limit proximity and physical access across opposing electrically charged components.
yoke	Structural component of the brush rigging which supports the mounting of brush holders and or adapters.