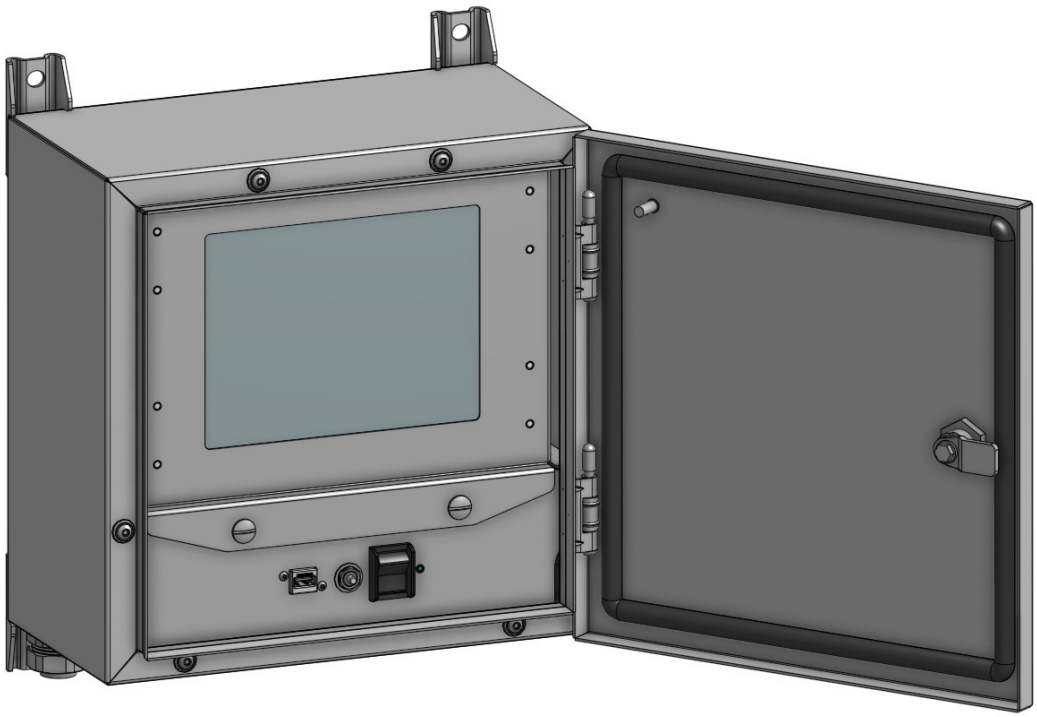
Installation Planning Guide

EZDP-2122 Rev -

Compact Brush Condition Monitoring



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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, 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 the 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 25+ 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

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 Cutsforth's turn-key monitoring system installations.

1.4. Cutsforth Electrical Contracting Services

In addition to our Field Service and Automation and Control services, Cutsforth offers turn-key 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 RELATED 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.

ROTATION 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 contacts 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.

4. Installation Planning for the Cutsforth Brush Condition Monitoring System

This manual is a guide for planning the installation of the Cutsforth Brush Condition Monitoring System (BCM).

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.

5. Installation Strategies

Determine the best component locations for your installation by applying the following strategies.

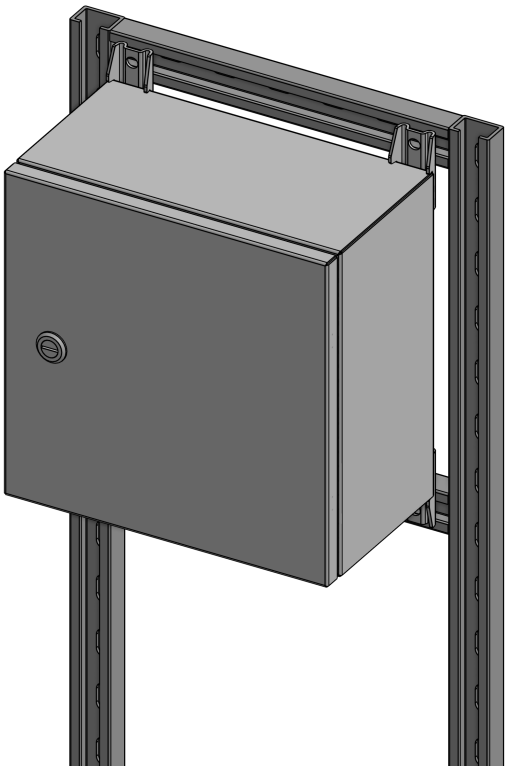
5.1. Identify a Suitable Installation Location for the Brush Condition Monitoring System Enclosure

The Brush Condition Monitoring System (BCM) has an operating temperature range of -20°C (-4°F) to 70°C (158°F). Avoid mounting the enclosure in areas that approach or depart from this temperature range on a regular basis. If possible, avoid mounting the monitoring system in a location that experiences direct sunlight for extended periods of time throughout the day.

The monitoring system should be installed in such a way that does not complicate generator disassembly during outages.

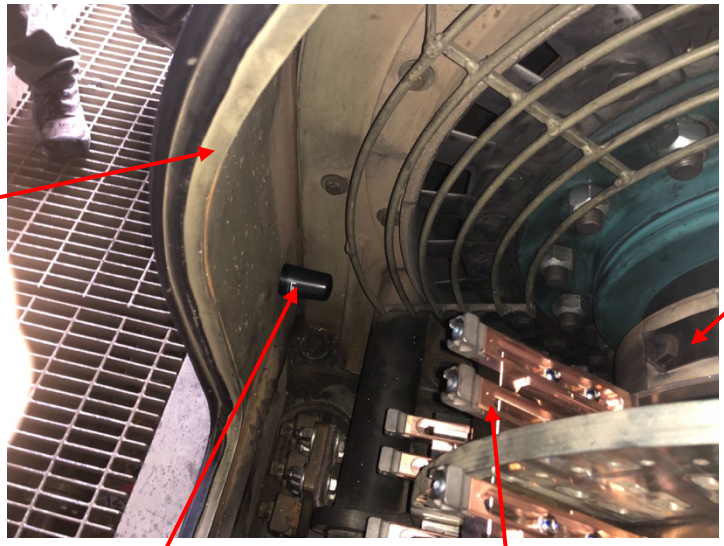
The monitoring system should be mounted in a location that does not experience excessive vibrations. Mounting directly to rotating equipment, such as a generator, or other structures with known vibrations, is not recommended. All cabling should be strain-relieved near input connectors. Take care to not directionally bias cable connectors when applying strain relief.

The Cutsforth Brush Health Sensors will be installed on Cutsforth EASYchange® brush holder equipment. This is a pre-requisite for the Brush Condition Monitoring installation. The BCM panel is the HMI (Human-Machine Interface) component for the system. It will be important to select a mounting location that is in close proximity to the collector area. A worker performing brush changes will interact with the BCM system and the brushes on a brush-by-brush basis. Therefore, a mounting location within a few steps of the brush gear makes sense whereas a distant location would not. See below image for example. The BCM enclosure is typically mounted using a Unistrut® frame as shown in the example below.



5.2. Determine Optimal Antenna Location

Physical barriers may be present between the Brush Health Sensors and BCM. The ideal antenna placement would be one which does not have any physical barriers between the Brush Health Sensors and the antenna. Penetrations may be required in the brush compartment in order to mount the antenna in the optimal position. Cutsforth recommends the antenna be place inside the exciter enclosure.



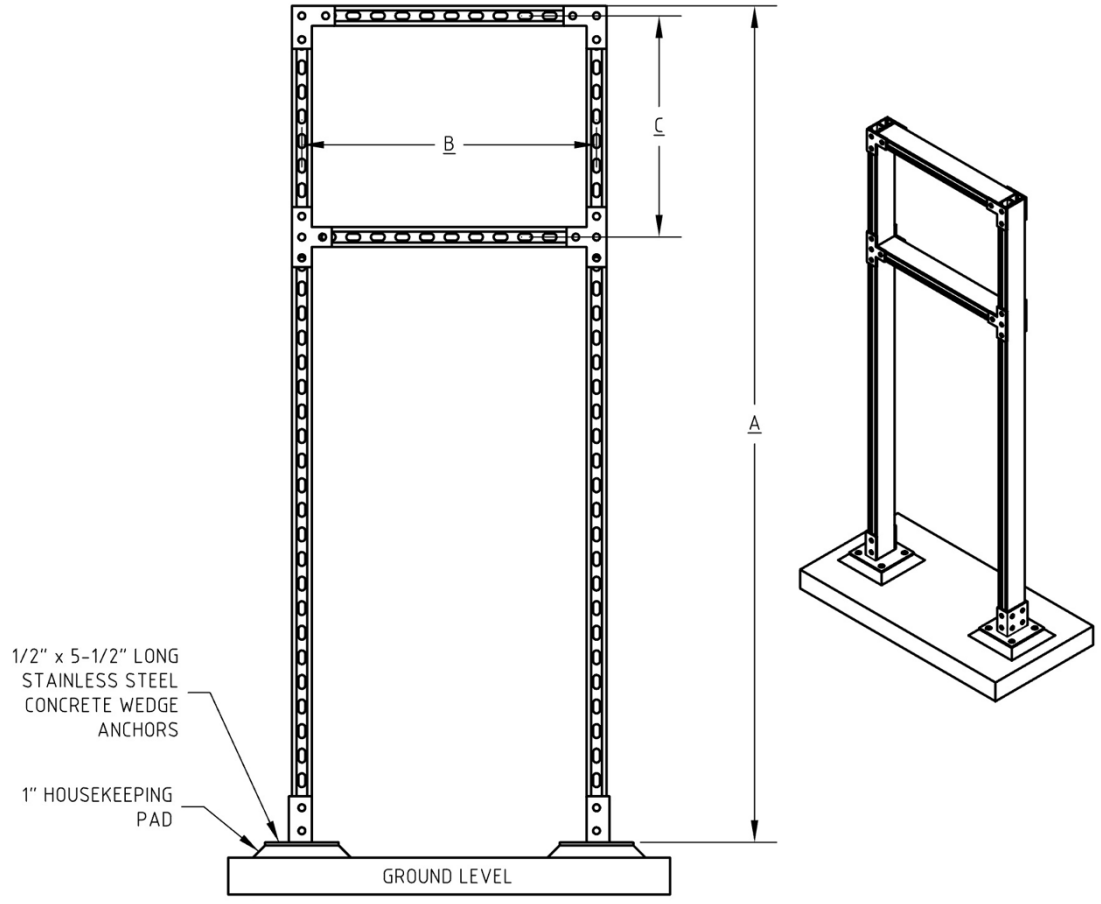
5.3. Power Requirements:

Power Requirement	Value
Voltage	85-264 VAC
Recommended breaker size	20 A
Recommended power cabling wire gauge	12 AWG
Actual operational current draw	~ 0.5 A at 120 VAC

5.4. Conduit and Strut Channel Recommendations

Component	Standard recommendation	Recommendation for high-corrosion environments
Conduit type	Galvanized rigid metal conduit (RMC)	Rigid aluminum conduit (RAC)
Conduit Fittings type	malleable	Aluminum
Strut channel type	hot dipped galvanized	316 stainless steel
Mounting hardware	316 stainless steel	316 stainless steel
Liquid Flexible Metallic Conduit	Type HCX	Type HCX

Recommended Strut Rack Design

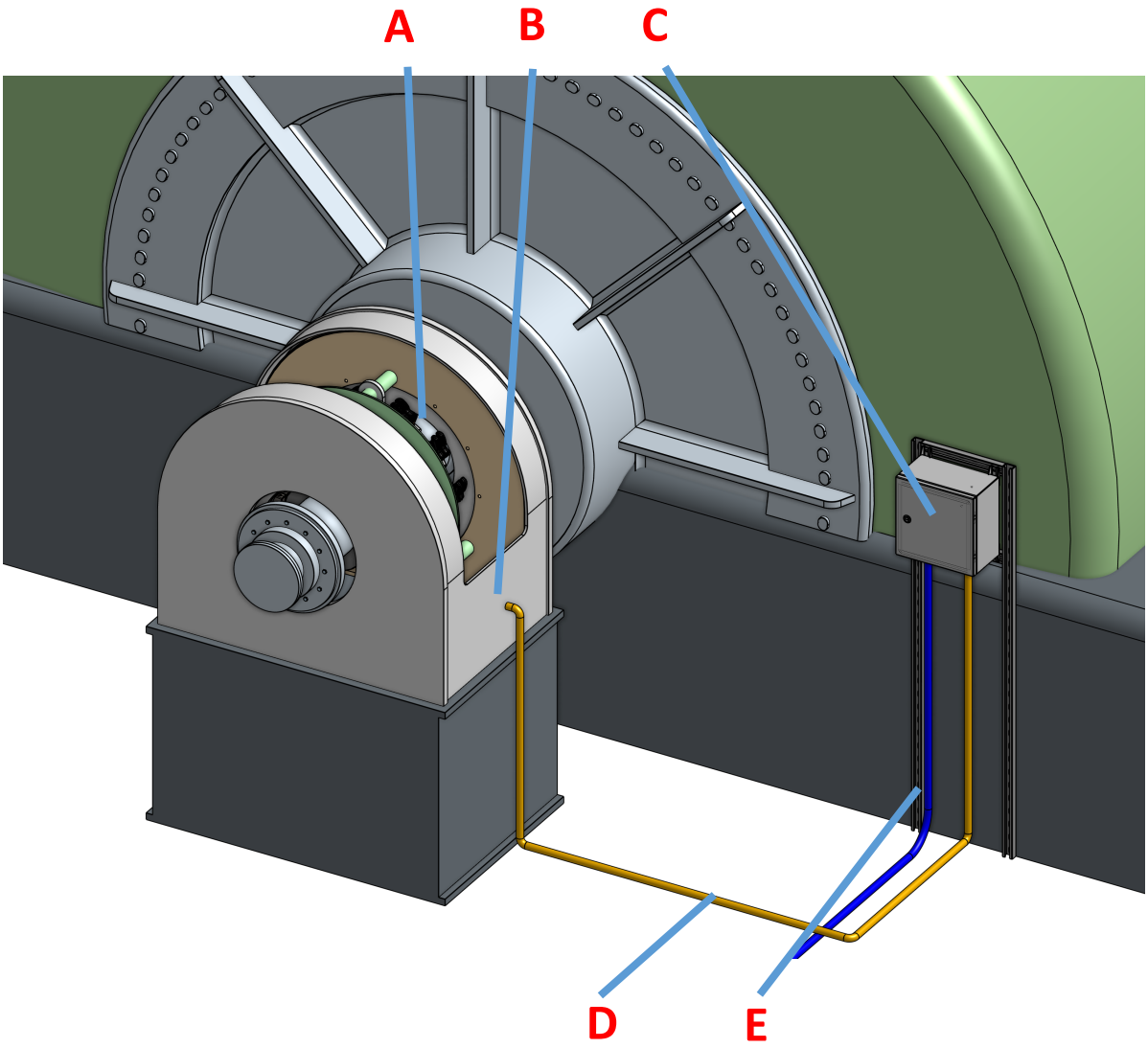


A (in (cm))	B (in (cm))	C (in (cm))
68 (173)	24 (61)	Refer to enclosure mounting feet dimensions

6. Diagrams

6.1. Conduit Layout

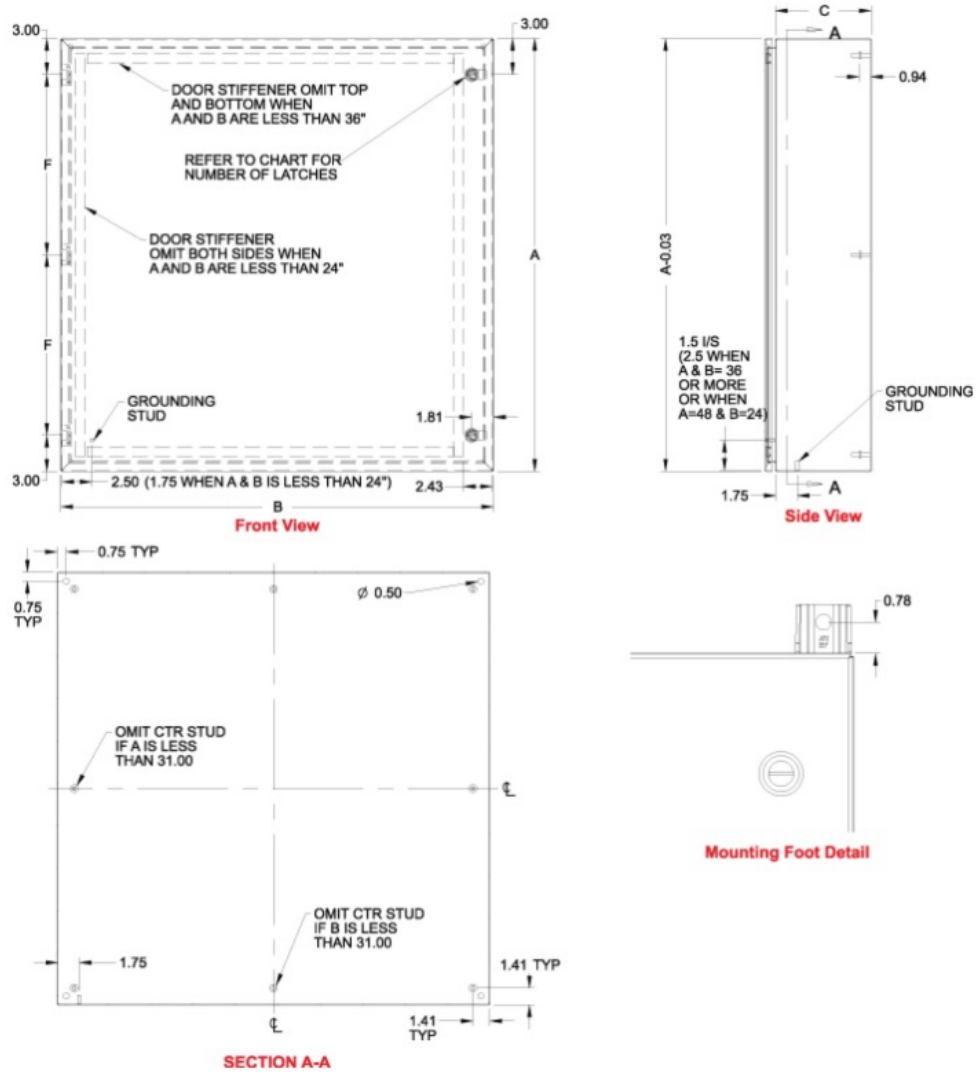
Color on Diagram [next page]	Conduit Run Description	Conduit Trade Size	Max Run Length	Wire Description	Purpose	Wire Supplied by	Conduit Supplied by
Gray	Plant 120VAC Power to BCM	3/4 in [2 cm]	N/A	AC 85-264 V AC, 47-440 Hz, 10 W 20 A Circuit	Power for the Monitoring System	Plant Electrical Contractor	Plant Electrical Contractor
Yellow	Primary Controller to Exciter Housing	1/2 in [1.27 cm]	18ft [5.5 m]	LMR-240 Coax with SMA ends	Brush Health Sensor antenna signal cable	Cutsforth	Plant Electrical Contractor



Part	Name
A	EASYchange® Brush Holders and Brush Health Sensors
B	Antenna (inside exciter housing)
C	Compact Brush Condition Monitoring System Controller
D	Yellow: 1/2 in. (1.27 cm) conduit from Primary Controller to exciter housing
E	Blue: 3/4 in. (2 cm) conduit from plant power supply to Primary Controller

6.2. Enclosure Specifications

Catalog Number	Dimensions [in(mm)]	Stainless Steel Type
EN4SD12126S16	12.0 (305) x 12.0 (305) x 6.0 (152)	316



UL 508 Listed; Type 3R, 4, 4X, 12
NEMA Type: 3R, 4, 4X, 12, 13
CSA Type: 3R, 4, 4X, 12
IP66

7. Responsibilities

The following tables summarize the responsibilities of Cutsforth and the Plant during the three project phases.

7.1. Planning Phase

Task	Cutsforth	Plant
Review this planning guide and share it with key plant personnel involved in the project.		✓
Determine enclosure mounting position and conduit routes customized to the generator and ensure that they are within system guidelines.		✓
Select an Electrical Contractor and Coordinate		✓

7.2. Preparation for Service Phase

NOTE

The responsibilities listed in the following table are critical to technician safety and proper installation of the Cutsforth equipment. Failure to comply may result in significant delays and additional charges.

Task	Cutsforth	Plant
Determine enclosure mounting position and conduit routes customized to the generator and ensure it is within system requirements.	*	✓
Mount Monitoring System enclosure with supporting strut channel and install required conduit, complete with conductors installed	*	✓
Install antenna in close proximity to brush gear	*	✓
LOTO the following components: Main excitation system, ground detection system, and turning gear. LOTO needs to be in place prior to arrival of Cutsforth technicians.		✓
Provide 120V GFI protected power.		✓
Provide adequate working access to installation site including scaffolding, if applicable. Scaffolding must be erecting prior to arrival of Cutsforth technicians.		✓
Ensure that the shaft is off turn gear and stationary.		✓
Ensure that the shaft is fully coupled for installation.		✓
Ensure that the bearing caps immediately adjacent to the shaft grounding area are in place.		✓

*Cutsforth will perform these tasks if selected as the Electrical Contractor

7.3. Cutsforth Service Phase – Cutsforth Technicians Onsite

Task	Cutsforth	Plant
Install antenna wiring in completed conduit raceways	✓	
Make system wiring terminations	✓	
Install Brush Health Sensors on EASYchange® brushes	✓	
System testing and commissioning – Perform pairing of wireless Brush Health Sensors with Primary Controller	✓	
If connecting to DCS, InsightCM™, or plant historian, provide control room support for verification of signal outputs	✓	✓

8. Glossary

antenna	A device used to increase the signal strength of the Bluetooth communication between Brush Health Sensors and the Primary Controller
Antenna Placement Mode	An optional mode included in the Brush Condition Monitoring System which displays the wireless signal strength of each sensor in order to assist in optimal placement of the antenna
attenuation	The reduction of the amplitude of a signal due to excessive cable length.
AWG	American Wire Gauge
Brush Condition Monitoring System	A Cutsforth product which connects wirelessly to Cutsforth's EASYchange® Brush Holders to provide automated measurements and brush health analytics
Brush Health Sensor (BHS)	A data logging device which processes sensor data and reports it back to the Brush Condition Monitoring System at a regular interval over a 2.4 GHz wireless link.
DCS	Distributed Control System
LOTO	Lock-out, tag-out
Modbus RTU	Modbus Remote Terminal Unit
Modbus TCP	Modbus Transmission Control Protocol
Primary Controller	The main enclosure of the Brush Condition Monitoring System, which contains the computer and power supply as well as the main touchscreen interface.