INSTALLATION MANUAL

Premium Monitoring System

Document #: EZDP-2040

CUTSFORTH

THE POWER OF INNOVATION™

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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 Electrical Contractor Services

In addition to our Field Service installation 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 WARRANTIES AS TO THE ACCURACY OF THE INFORMATION CONTAINED HEREIN AND SHALL NOT BE LIABLE FOR ANY ERRORS. 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

Additional information.

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.

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

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

Indicates possible injury from rotating parts.

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

3.2. General Safety Instructions

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.

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.

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.

4. Introduction

This manual is meant to act as a guide for the installation planning of the Cutsforth Premium Monitoring System. Please review the documentation that came with the original/OEM shaft grounding system for planning the removal of the OEM system.

This manual does not claim to 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 installation planning guide, please contact Cutsforth, Inc. Engineering Support.

5. Planning a Premium Monitoring System Installation

This section provides step-by-step guidance to plan the installation of the Premium Monitoring System.

The main steps in planning the installation are:

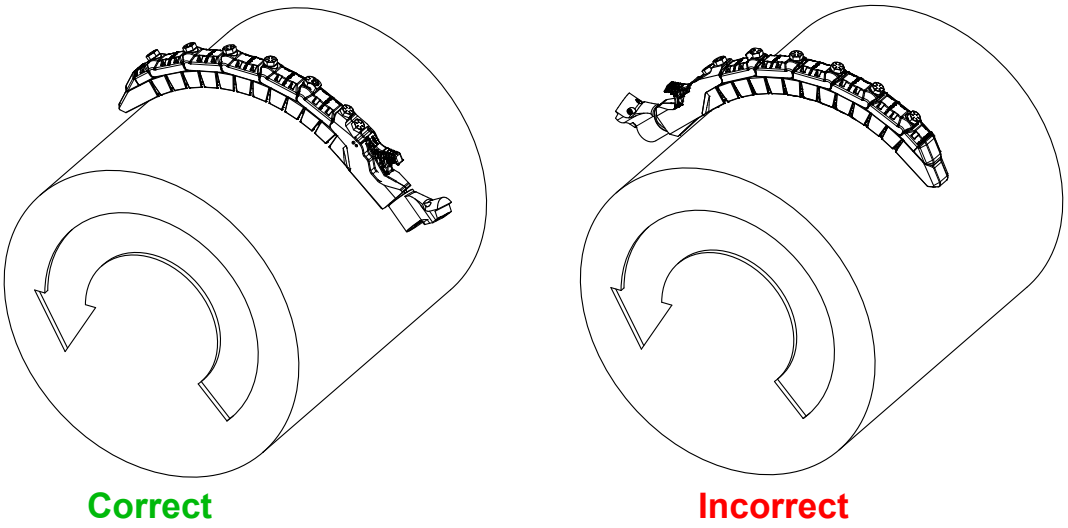
5.1. Installation Best Practices

Please review the list of best practices for installation below to help ensure maximum effectiveness of your Cutsforth Shaft Grounding System.

- Install **all** Series 1 and Series 2 Shaft Grounding Assemblies with a High Frequency Drain (HFD).
- Avoid sharp turns and bends in the grounding wire whenever possible. Bending the conductor can create induction back onto the bent wire. While the HFD will aid in dissipating this inductance, it is best to make turns as gradual as possible.
- Route the grounding conductor along the shortest possible path. When the HFD is installed, the ground conductor can extend up to 47 feet in total length when measured from the SGA grounding rope to the finished grounding terminal on the unit case.
- Mount the Shaft Ground Monitoring equipment so that the segment of conductor between the SGA and the monitoring equipment is no greater than 30 feet. If the signal lines between the SGA and the monitoring equipment are longer than 30 feet, the monitoring function starts to be diminished.

5.2. Identify Existing Grounding Equipment

The Cutsforth Shaft Grounding Assembly will be installed on the same portion of exposed shaft as the previous grounding equipment. The shaft assemblies (SGA and SCA) must be installed on the "uphill" side of the shaft rotation. Installing the shaft assemblies on this side of the shaft ensures that the rope will not bunch up or bind up inside the rope guide. See below image for example.



5.3. Determine Ground Conductor Termination Location

The goal when choosing a grounding location is to electrically bond the shaft to the unit case ground. Cutsforth suggests drilling and tapping into the lower half of the unit case to create a grounding location close to the SGA. To create a smooth, conductive surface, the location of ground wire termination should have all paint removed and be free of all contaminants.

Do not use structural steel or station ground as grounding locations.

5.4. Identify an Accessible and Safe Mounting Location

The Premium Monitoring System contains an interactive control panel that should be placed:

- In a location that does not experience temperatures above the maximum operating temperature of the Premium Monitoring System.

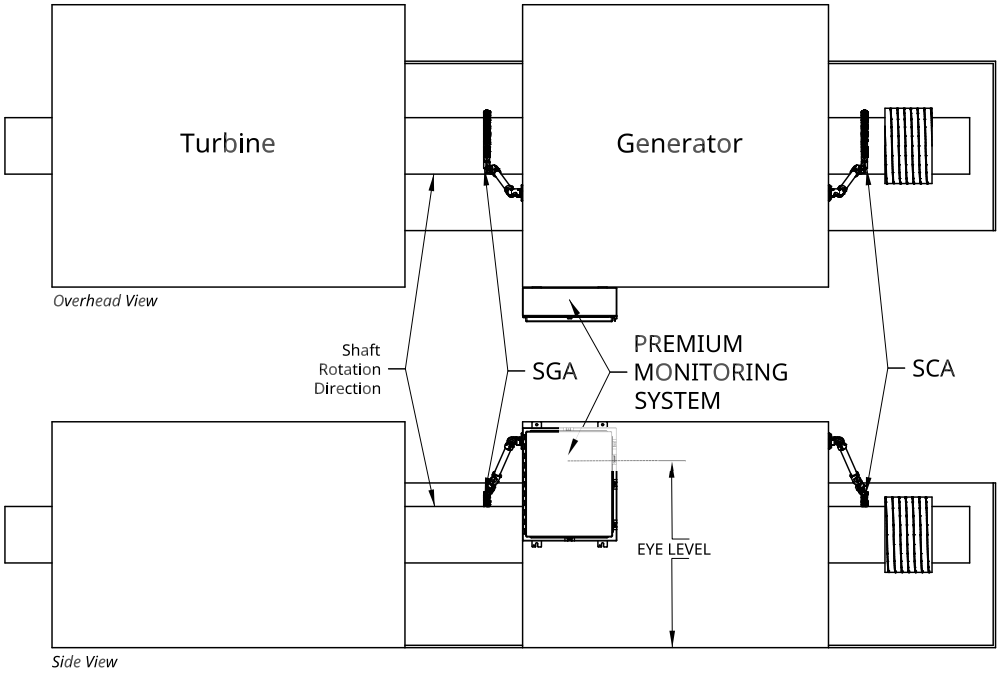
- In a location that is safe and accessible for plant personnel.
- At an ergonomic height so that the center of the touchscreen is roughly at eye-level.
- In a location that does not receive direct sunlight for extended periods of time (if possible).

The ground conductor must be routed through the Premium Monitoring System enclosure before terminating to the unit case. Therefore, the monitoring system should be mounted somewhere between the Shaft Grounding Assembly (SGA) and the unit case termination location. This placement also helps eliminate extensive lengths in the ground conductor run.

6. Diagrams

6.1. Equipment Layout

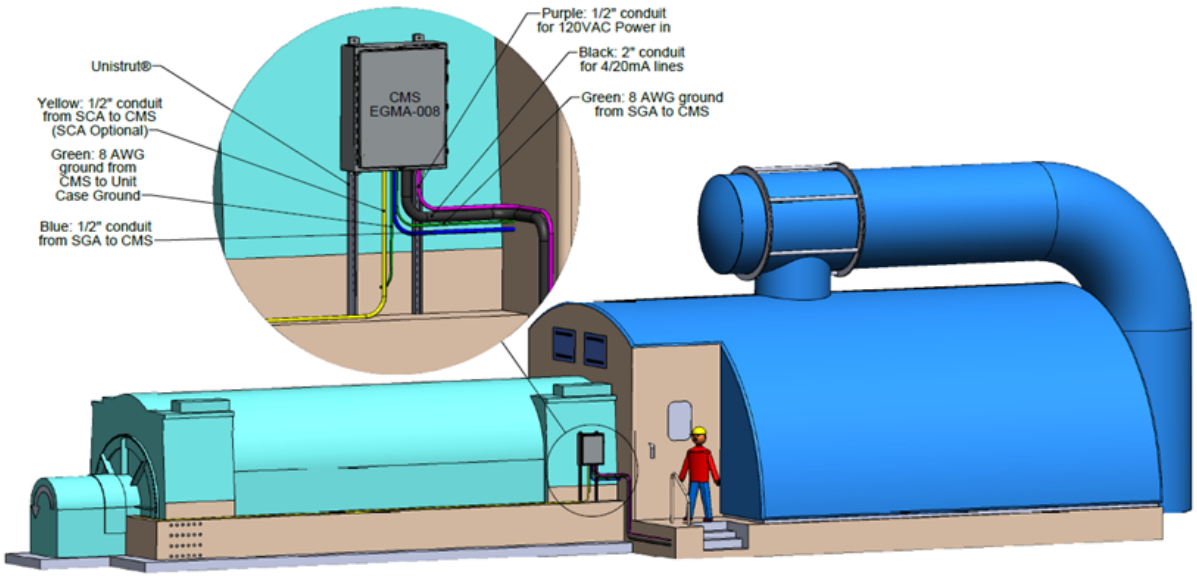
The diagram below represents a typical layout. Individual installations may vary.



6.2. Conduit Layout

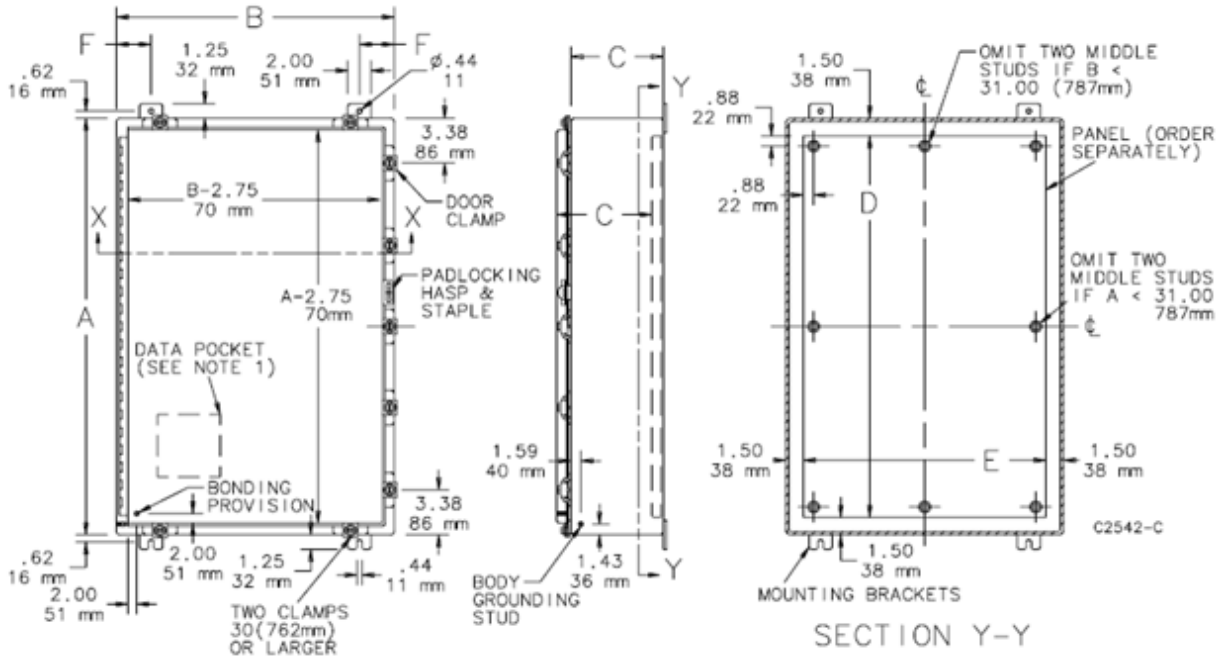
Color on Diagram	Conduit Run Description	Conduit Trade Size	Wire Qty	Wire Description	Purpose	Wire Supplied By
Blue	SGA to monitoring system	1/2"	1	3 conductors, shielded, 18 AWG, high temp	2 rope wear status, 1 shaft voltage	Cutsforth
Green	SGA to monitoring system	1/2"	1	Single conductor, 8 AWG	Ground from SGA to monitoring system	Cutsforth
Green	Monitoring system to unit case ground	N/A	1	Single conductor, 8 AWG	Ground from monitoring system to unit case ground	Cutsforth
Purple	Plant 120VAC Power to monitoring system	3/4"	1	120VAC Power (20A dedicated circuit, preferably with isolated ground)	Power for the monitoring system	Plant
Black	Plant DCS Drop to monitoring system	2"	7	4/20mA DCS signal lines	Monitoring output to plant's DCS system	Plant
Yellow*	SCA to monitoring system	1/2"	1	3 conductors, shielded, 18 AWG, high temp	1 rope wear status, 1 shaft voltage, 1 unused	Cutsforth

*Applies only when optional SCA is being installed



6.3. NEMA 4X Enclosure Specifications

Catalog Number	AxBxC (in.)	Stainless Steel Type	Panel Size DxE (in.)	F (in.)	Clamps Qty.
A24H2006SSLP	24.00 x 20.00 x 6.00	304	21.00 x 17.00	3.00	5



7. Weld Support Arms on the Shaft Grounding Assembly

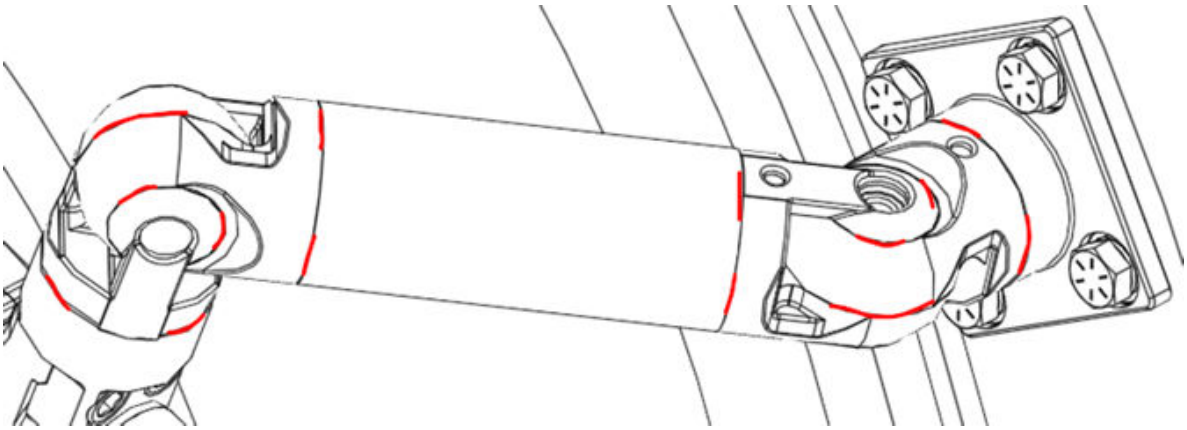
Refer to the following instructions when welding the Cutsforth Shaft Grounding Assembly Attachment Arm. The attachment arm is comprised of 300 series stainless steel. TIG welding is the preferred welding method. If weld filler is needed, AWS E/ER 308, 308L or 347 are acceptable.

The customer must provide a qualified welder to perform support arm welding.

1. Tack or stitch weld at the marks. The goal is a "stitch" or "fuse" weld. No additional welding material needs to be added at this time. The arm joints simply need to be locked in place by the tacks.

   If the tacking step is overlooked, and the welder commences to weld the seam, the attachment arm positioning will be compromised as this will result in a distorted arm. If this occurs, the arm is unusable and must be replaced.

2. Weld all of the seams as indicated with the red lines shown in the illustration below. Weld both ends and follow accepted welding practices to minimize distortions that would compromise proper alignments.

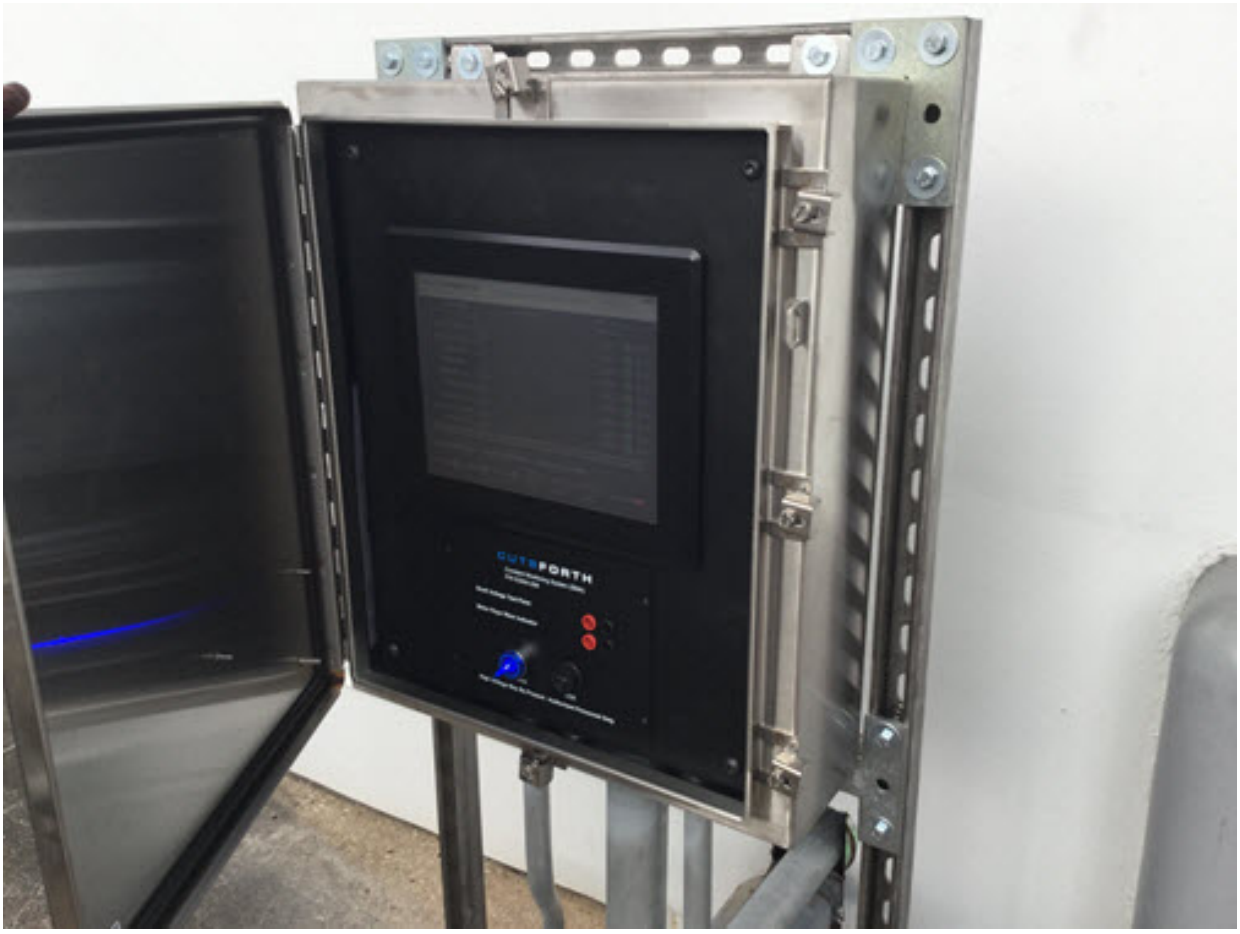


3. Clean up the surface with a wire wheel.
4. Return the fully welded arm to the Cutsforth Technician for final assembly on the generator.

8. Frequently Asked Questions

8.1. What is the best way to mount the Premium Monitoring System?

The monitoring system is typically mounted using a Unistrut® frame as shown below.



8.2. How much power does the Premium Monitoring System require during normal operation?

The monitoring system requires an AC supply voltage of 120V 5A. The monitoring system has an internal breaker rated at 5A, so any typical dedicated 15- or 20-amp circuit is more than adequate. If it is shared on a circuit with other devices, the plant should plan to dedicate 600 Watts for this device.

The actual power draw of the monitoring system is *typically* around 0.5A at 120V AC during normal operation.

8.3. What shaft voltage and ground current values should we expect to see on our generator?

This question would be best answered by the generator manufacturer.

We suggest focusing on the trending of data more than the specific voltage and current values. For example: Are the values changing over time? Are the changes significant? How are they changing?

8.4. To what values should we set our alarm thresholds?

Plants often elect to have their threshold settings align with their acceptance criteria, which:

- Is provided by the generator manufacturer
- Is unique to each generator
- Should ultimately be determined by the plant.

The Premium Monitoring System comes from the factory with thresholds intentionally set to a level at which an alarm will never trigger. These thresholds are used so that plant personnel do not mistake the factory settings as being applicable to their generator.

9. Installation Responsibilities

Responsibilities	Cutsforth	Plant
Provide shaft growth value at grounding location		√
Indicate shaft rotation direction		√
Review planning guide document		√
Determine enclosure mounting position and conduit routes customized to the generator and ensure it is within system guidelines		√
Mount enclosure(s) and install required conduit		√
Ensure the shaft is off turn gear and stationary		√
Ensure the shaft is fully coupled		√
Ensure the bearing caps immediately adjacent to the shaft grounding area are in place		√
LOTO requirements: Main excitation system, ground detection system, and turning gear		√
Provide 120V GFI protected power		√
Provide adequate working access to installation site including scaffolding		√
Install Cutsforth shaft assembly	√	
Provide welding support		√
Run wiring in completed conduit raceways	√	
System wiring terminations not including grounding termination to generator case	√	
Identify main grounding termination point on the unit case	√	
Electrical support to make ground terminations		√
System testing and commissioning	√	
Control room support for testing 4-20mA outputs if connecting to DCS		√

10. Additional Information

For more information on the Cutsforth Premium Monitoring System, please refer to the *Premium Monitoring System Operations Manual - EZDP-2038*.

For more information on the Cutsforth Shaft Grounding System, please refer to the *Shaft Grounding Assembly Operations Manual - EZDP-2035*.

11. Glossary

attenuation	The reduction of the amplitude of a signal due to excessive cable length.
AWG	American Wire Gauge
DC average	The average of the DC component measurements during a 0.02-second snapshot as calculated by $\Sigma x/N$, where x is the array of samples acquired and N is the number of samples.
DCS	Distributed Control System
FEP	Fluorinated Ethylene Propylene (high-temperature cable jacket material)
ground conductor	An 8 AWG ground conductor that runs from the Shaft Grounding Assembly to the junction box, then to unit case ground.
ground current	The electrical current between the shaft and the unit case ground through the ground conductor.
ground rope	The left rope in the shaft grounding assembly, which provides the primary path to unit case ground through the 8 AWG ground conductor.
Ground Rope HI	A user-set threshold at which a ground rope fault is triggered, calculated as a ratio of PERIOD1 / PERIOD2. Shown on the Rope Stats Page as LIMITS.
High-Frequency Drain (HFD)	A 12 AWG conductor that splits off from the meter rope, runs through a low-inductance resistor, and then connects to unit case ground in less than 4 ft 6 in (1 m 15 cm). The HFD ensures that high frequency voltage spikes are grounded properly.
impedance	The resistance to change in the current of a circuit.
junction box	An enclosure that contains the current-sensing equipment and is placed between the Shaft Grounding Assembly and the grounding location.
LOTO	Lock-out, tag-out

Metering Rope HI	A user-set threshold at which a metering rope fault is triggered, calculated as a ratio of PERIOD1 / PERIOD2. Shown on the Rope Stats Page as LIMITS.
meter rope	The right rope in the shaft grounding assembly, which provides a shaft contact point at which shaft voltage readings are taken. It also provides a secondary path to unit case ground through the High-Frequency Drain.
oscilloscope resolution	A setting that determines the granularity of a waveform (like the resolution of a photograph).
Premium Monitoring System	A Cutsforth product that connects to Cutsforth's Shaft Grounding Assembly to provide waveform-level shaft voltage and ground current settings and to store historical data for trending purposes. The monitoring system can also be connected to plant DCS systems for real-time data in the control room.
RMS	Root Mean Square. A method of measuring the voltage or current of an AC waveform calculated by *Xrms* = sqrt[(1/*n*) * (SUM(*Xn*))], where *X* is the array of samples acquired and *n* is the number of samples acquired.
Shaft Grounding Assembly (SGA)	A Cutsforth product designed to provide a best-in-class ground connection, as well as a shaft contact point at which shaft voltage can be measured.
shaft voltage	The voltage potential between the shaft and the unit case ground as measured by the metering rope.
signal cable	A shielded, twisted-pair cable that carries voltage signals from the Shaft Grounding Assembly to the junction box and the Assurance Monitoring System.
soft reset	A Premium Monitoring System Application subcomponent restarts when not functioning properly or efficiently. The Premium Monitoring System Application does not close and the computer does not have to reboot.
TC/TC-ER	Ratings that describe the crush and impact requirements for cable types. For more information, see *Type TC vs. Type TC-ER Cable* at http://www.ecmweb.com/nec/type-tc-vs-type-tc-er-cable.
TDMS	Technical Data Management Streaming (file format)
unit	The equipment being monitored by the Cutsforth monitoring system.

unit case ground	The lower half of the turbine case, generator case, or coupler case near the Shaft Grounding Assembly to which the shaft can be grounded.
voltage divider	A component that reduces the voltage in a circuit by a predetermined ratio.
zero-to-peak	A measurement of a signal calculated by |max(x)| or |min(x)|, whichever is greater, during a given period of time, where x is the array of samples acquired during that period.

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ISO 9001 Registered Quality Management

ANAB ACCREDITED ISO/IEC 17021 MANAGEMENT SYSTEMS CERTIFICATION BODY

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