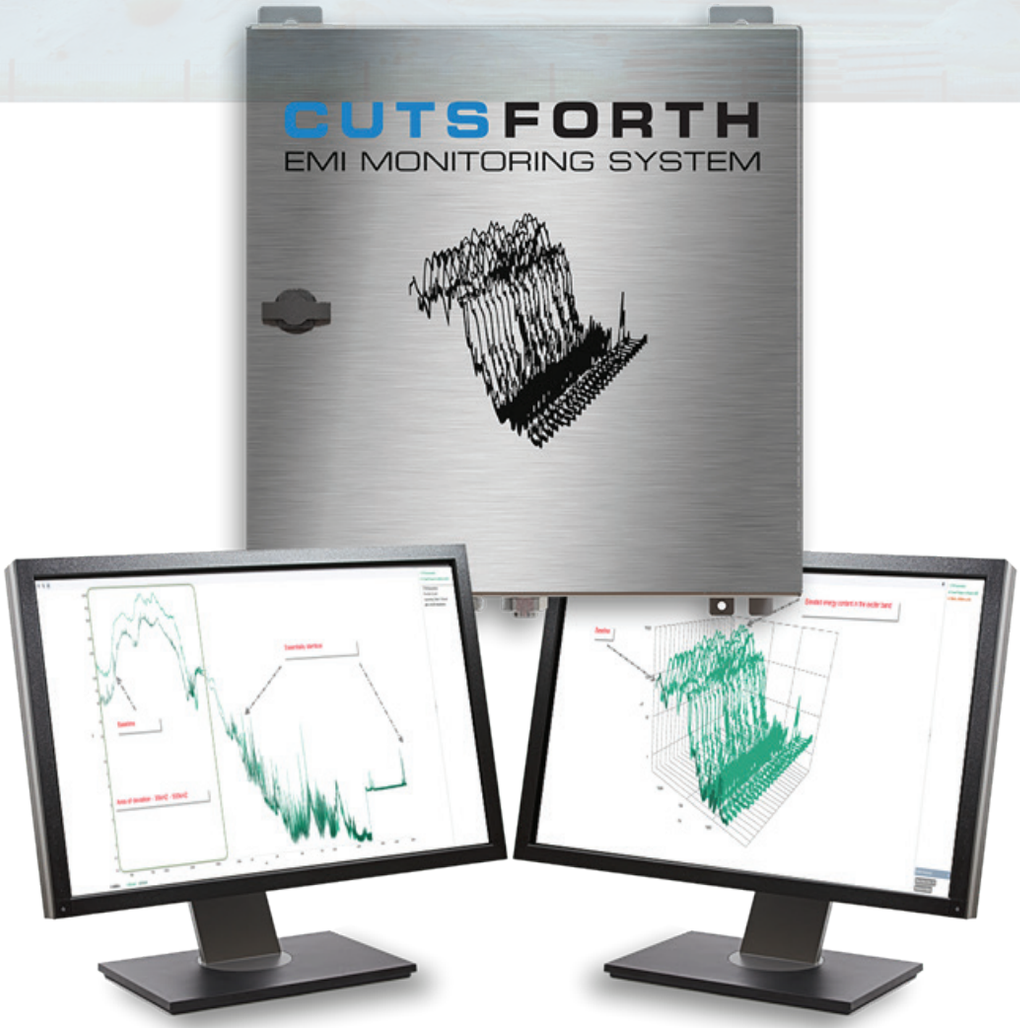
INSTALLATION PLANNING GUIDE

InsightCM Electromagnetic Interference (EMI)

Document #: EZDP-2056



CUTSFORTH

THE POWER OF INNOVATION™

Table of Contents

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 rope refresh kit.

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 Electro-Magnetic Interference (EMI) Monitoring 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. Equipment List

To install the EMI Monitoring system, you need the equipment listed below. Some are provided by Cutsforth, and some are provided by the electrical contractor.

- Cutsforth
  - Radio Frequency Current Transformer / High Frequency Current Transformer (CT):
    - EMMC-104 (32 mm)
    - EMMC-105 (65 mm)
    - EMMC-106 (127 mm)
  - NI-9065 4 slot rack
  - NI-9770 RF Monitor card
  - Water-tight enclosure – internal cooling or shaded if in sunny location
- Electrical Contractor
  - RG223 FRNC cable – double shielded Coax
  - N-type connector – PE4042 1403
  - SMA connector – PE4008 1352
  - Conduit – ½ in metal for shielding effect for the CT cable should be considered
  - Ethernet cable for connection to server
  - 600 volt rated power cable – 20 AWG minimum

6. Planning the Electromagnetic Interference (EMI) Monitoring Installation

This section provides step-by-step guidance to plan the EMI Monitoring installation.

The main steps in planning the installation are:

- Planning the Generator Current Transformer (CT) Location (page 10)
- Planning the Transformer CT Location (page 11)

6.1. Planning the Generator Current Transformer (CT) Location

This section provides guidance for planning the location of the Generator CT components:

- Neutral Ground Transformer (NGT) (page 10)
- Frame Ground (page 11)
- RTD Leads and RTD Termination Box (page 11)

6.1.1. Neutral Ground Transformer (NGT)

If the installation has a stand alone NGT cabinet and the lead coming into the NGT cabinet is in a conduit of a size that the EMMC-106 (127 mm) CT can fit around:

1. Open the EMMC-106.
2. Place the CT around the outside of the NGT lead conduit.
3. Latch the CT closed.

This preferred location gives the best EMI signal strength.

If the installation does not have a stand alone NGT cabinet or the lead coming into the cabinet is too large for the EMMC-106 CT, then place the CT around the cable going into the high side of the neutral ground transformer. This option is not preferred because:

- It requires a plant outage to perform
- The neutral ground lead must be insulated to the full generator output voltage
- CT must be restrained from moving or touching the cable

If the CT comes into contact with the cable, it may cause damage to the cable insulation and cause the NGT to be bypassed in a phase to ground fault condition. This condition could cause very high currents to be generated during the fault condition and cause major equipment damage.

6.1.2. Frame Ground

For locations where the NGT is inaccessible, you can use a generator frame ground for the CT location.

Portable monitoring with an interference analyzer should be performed during unit on line conditions to determine which frame ground location has the best signal strength.

The best signal is not always the one with the with the highest value but the one with the most internal noise values.

After the location has been determined, the vendor will most likely use the EMMC-104 (32 mm) CT. Some vendors use only the EMMC-106 CT for all monitoring purposes, but the EMMC-104 CT has similar response characteristics and is more cost effective.

For many Combustion Turbine Generators, the Exciter end frame ground is the lead of choice. Take care that the CT around the frame ground is coming directly from the frame casing and is not a combination of multiple ground leads. Having multiple ground leads introduces external noise and hampers the analysis process.

6.1.3. RTD Leads and RTD Termination Box

Resistance Temperature Detector (RTD) leads are used for monitoring Partial Discharge (PD) within generators using the PD time domain method. They can also be used for monitoring PD using the EMI Monitoring method. The signal from the RTD leads tends to be limited to generator internal winding defects, such as PD.

To gather information about defects in other generator locations, the CT should be located around the outside of the conduit going from the generator frame or enclosure to the RTD termination box. The CT should not be around the RTD leads themselves within the termination box.

If the conduit is attached to the generator frame, the best configuration is around the outside of the conduit. If the conduit only connects to the generator outer enclosure, some generator internal noise will be shunted through the frame ground, reducing the signal strength noted at the CT location.

You can use the EMMC-105 (65 mm) or the EMMC-106 CT around the outside of the RTD conduit when using this location.

6.2. Planning the Transformer CT Location

This section provides guidance for planning the location of the Transformer CT components:

- WYE Connection to Ground (page 12)
- Case Ground (page 12)
- Potential Transformer Casing Ground (page 12)

6.2.1. WYE Connection to Ground

On the Generator Step Up (GSU) transformer, the high-voltage side (grid side) usually has a WYE configuration with a neutral ground resistor to limit phase to ground fault currents. The center tap of the transformer WYE ties through this resistor to a ground connection. The connection to the tank ground and then grid ground is sometimes a bus bar connection and sometimes just a cable. Although you can use this configuration, it is:

- Susceptible to high levels of grid noise that can make EMI analysis for the transformer defects difficult to detect and cause false position indications.
- Not preferred location unless you are also looking for switchyard anomalies, although switchyard anomalies are very difficult to quantify and very little has been attempted for switchyard phenomena using this technique.

For Auxiliary transformers (Unit Auxiliary, Reserve Auxiliary, Start-up, etc.), the high-voltage side is a delta configuration and the low-voltage side (plant load) is a WYE connection to the ground through a neutral ground resistor to limit phase to ground fault currents. If the CT is located around this lead to ground, then internal plant noise may interfere with the noise signals generated from faults within the transformer proper. You can use this ground lead but ensure the EMI analyst is aware of the location, so analysis of internal plant components become part of the analysis process.

6.2.2. Case Ground

A normal transformer frame case ground is a location that can be used for all transformer types. Portable monitoring with an interference analyzer should be performed during unit on line conditions to determine which frame ground location has the best signal strength.

The best signal is not always the one with the with the highest value but the one with the most internal noise values.

In some cases, multiple frame grounds are tied together and then ported to the grid / earth ground location. Although using a frame ground from multiple locations is acceptable, take care to determine if the WYE neutral lead is ported through that particular ground bundle.

6.2.3. Potential Transformer Casing Ground

While monitoring of the Isolated Phase Bus (IPB) can be done with a CT monitoring generator, some clients may wish to have additional monitoring of the IPB area in an attempt to have better localization. Almost any ground attached to the outer PT enclosures can be used for this location. Multiple grounds ported to the earth through one ground lead can be used without much concern for external noise except the ground lead antenna affect: the longer the ground lead the more external noise it may pick up.

7. Technical Specifications

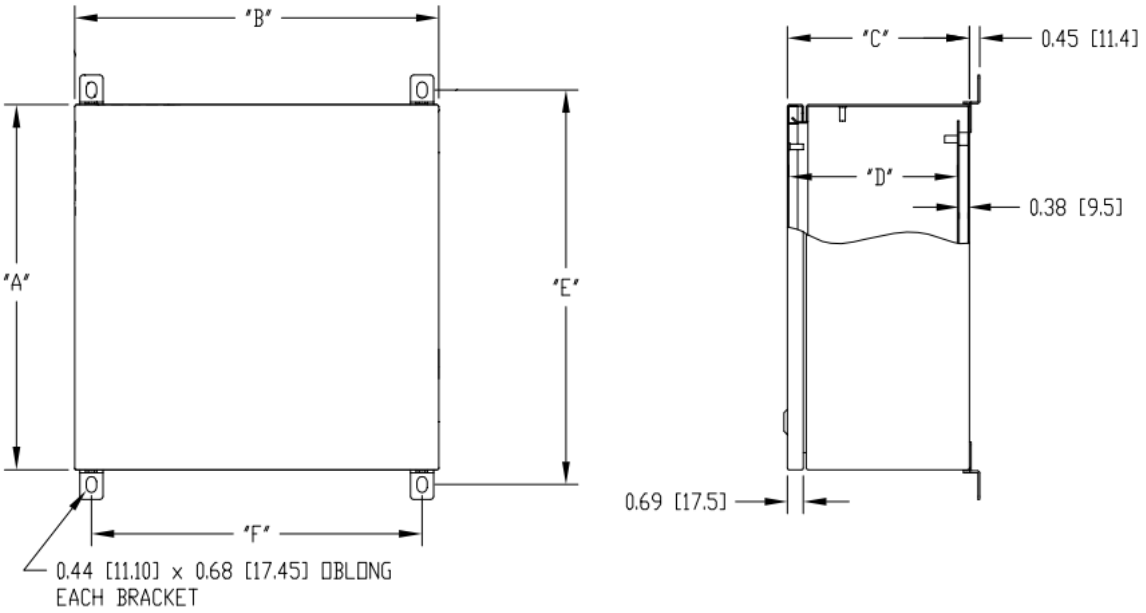
This section provides the technical specifications for the EMI Monitoring installation:

7.1. Wall-Mount Enclosure Specifications

This enclosure's seamless foam-in-place gasket provides a secure seal against contaminants in indoor and outdoor corrosive environments that require a water-tight seal. The enclosure has 16-gauge, stainless steel bodies and doors, and the mounting flanges have 3/8-inch or M10 bolts.

Designed to meet NEMA 1, 2, 4, 4x,12, 13 and IP66 ratings. UL listed and tested to UL508-4X. UL meets UL50E requirements.

Part Number	A	B	C	D	E	F
SNB-3737-SS	15.75 in (400 mm)	15.75 in (400 mm)	7.87 in (200 mm)	7.29 in (185.1 mm)	17.02 in (432.3 mm)	12.52 in (318 mm)



7.2. AC Power Supply Requirements

Plant-supplied power source	120 V, 60 Hz AC or 240 V, 50 Hz
Circuit breaker	Internal 120 V, 5 A
Circuit draw under normal usage	Approximately 0.6 A

7.3. DC Power Converter

Please refer to the manufacturer's datasheet:

https://www.us.tdk-lambda.com/ftp/Specs/dpp120-240.pdf

7.4. Environmental Requirements

Storage temperature	-40 °C to 85 °C
Operating temperature	-40 °C to 70 °C
Storage humidity	5% RH to 95% RH, non-condensing
Operating humidity	10% RH to 90% RH, non-condensing
Maximum altitude	5,000 m

8. Glossary

AWG	American Wire Gauge
Current Transformer (CT)	A device used to measure alternating current (AC).
Electromagnetic Interference (EMI) Analysis	The capture and analysis of both controlled and uncontrolled electromagnetic emissions absorbed by electrical utility equipment (generators,motors, transformers, switchgears, etc.) to determine if any uncontrolled sources of discharge are being emitted from within the electrical utility equipment.
Generator Step-Up Transformer (GSU)	A transformer that takes the voltage from the generator and brings it up to the proper transmission voltage.
Neutral Ground Transformer (NGT)	A device used to provide a path to ground in an effort to bring the system ground and system neutral to equal potentials.
Partial Discharge (PD)	According to IEC 60270 standard: *Partial discharge (PD) is a localized electrical discharge that only partially bridges the insulation between conductors and which may or may not occur adjacent to a conductor.*
Resistance Temperature Detector (RTD)	A device that measures temperature by detecting the changes in resistance of an internal thermometer element.

CUTSFORTH

THE POWER OF INNOVATION™

nqa. ISO 9001 Registered Quality Management

ANAB ACCREDITED ISO/IEC 17021 MANAGEMENT SYSTEMS CERTIFICATION BODY

For Additional Support
Cutsforth.com/Support

Re-Order Consumable Parts
Cutsforth.com/Order

General Sales Inquiries
Cutsforth.com/Sales
800.290.6458 x. 1
info@Cutsforth.com