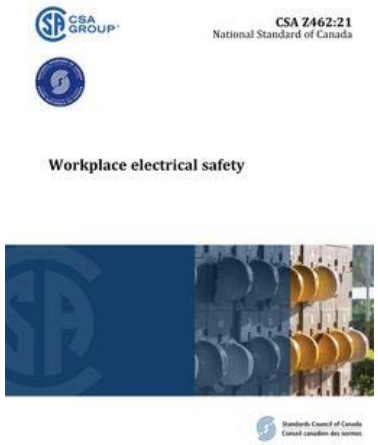
GARD

Technical Webinar Series 2021

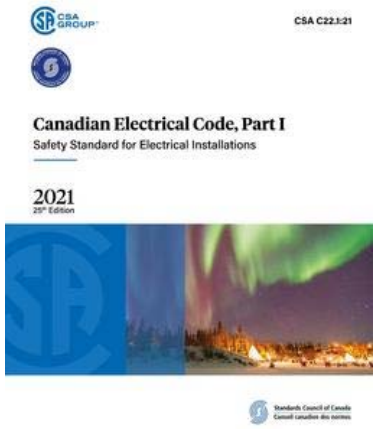
"Resistance Grounding for Data Center Applications"

- Presented by: **Sergio Panetta**
- Vice President of Engineering, I-Gard Corporation

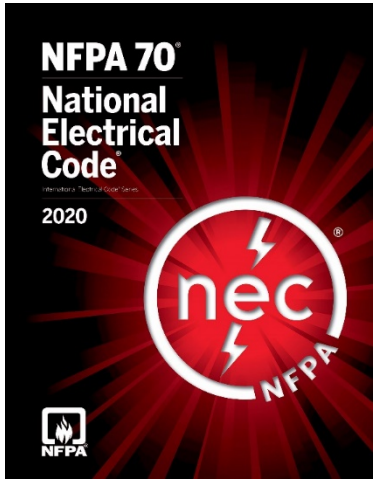
Standards



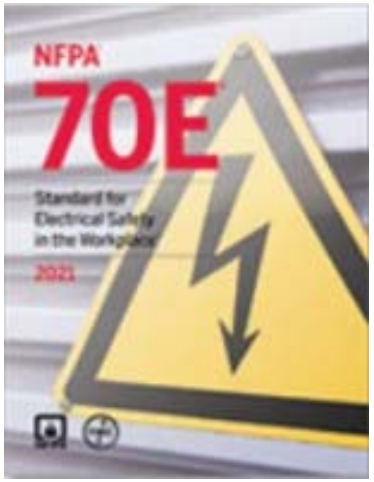
2021 CSA Z462



2021 CSA C22.1



2020 NFPA 70



2021 NFPA 70E

Solidly Grounded NEC

- **230.95 Ground-Fault Protection of Equipment.**
  - Ground-fault protection of equipment shall be provided for solidly grounded wye electric services of more than 150 volts to ground but not exceeding 1000 volts phase-to-phase for each service disconnect rated 1000 amperes or more. The grounded conductor for the solidly grounded wye system shall be connected directly to ground through a grounding electrode system, as specified in 250.50, without inserting any resistor or impedance device.
  - The rating of the service disconnect shall be considered to be the rating of the largest fuse that can be installed or the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted.

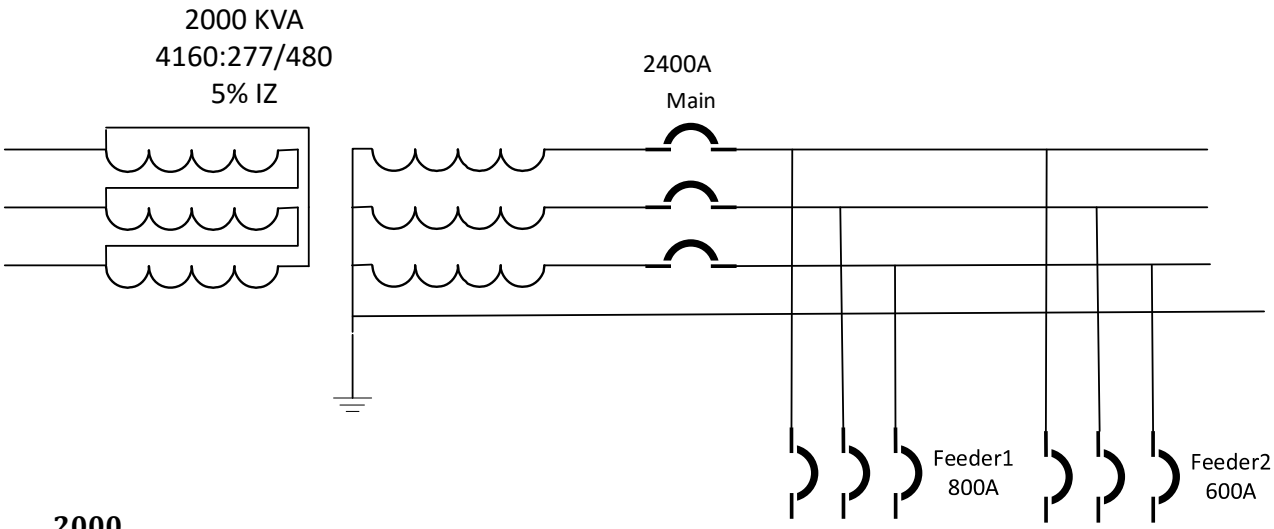
Solidly Grounded NEC

- 230.95(A) Setting.
  - The ground-fault protection system shall operate to cause the service disconnect to open all ungrounded conductors of the faulted circuit. The maximum setting of the ground-fault protection shall be 1200 amperes, and the maximum time delay shall be one second for ground-fault currents equal to or greater than 3000 amperes

Solidly Grounded (CEC)

- **14-102 Ground fault protection** (see Appendix B)
  - 1) Ground fault protection shall be provided to de-energize all normally ungrounded conductors of a faulted circuit that are downstream from the point or points marked with an asterisk in Diagram 3 in the event of a ground fault in those conductors as follows:
    - a) for circuits of solidly grounded systems rated more than 150 volts-to-ground, less than 750 V phase-to-phase, and 1000 A or more; and
    - b) for circuits of solidly grounded systems rated 150 V or less to ground and 2000 A or more.
  - 2) Except as permitted by Subrule 8), the maximum setting of the ground fault protection shall be 1200 A and the maximum time delay shall be 1 s for ground fault currents equal to or greater than 3000 A.

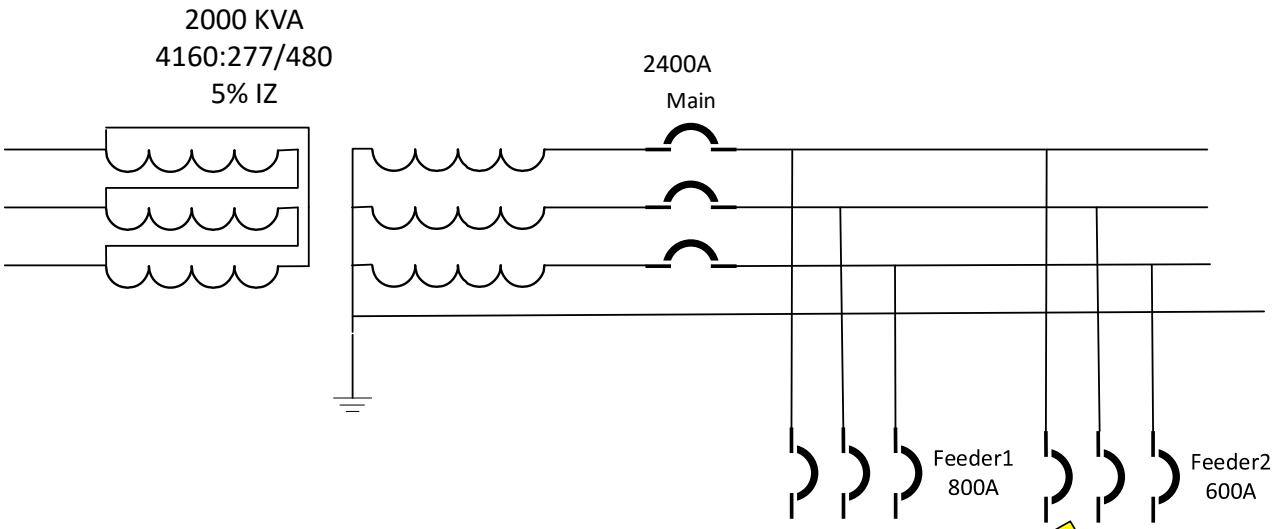
Solidly Grounded Example



$$I_{FLA} = \frac{2000}{\sqrt{3}x\ 0.48} = 2400\ A$$

$$I_{3\emptyset} = \frac{E_{LN}}{Z_t} = \frac{1}{.05} = 20\ pu = 48kA$$

Solidly Grounded Example



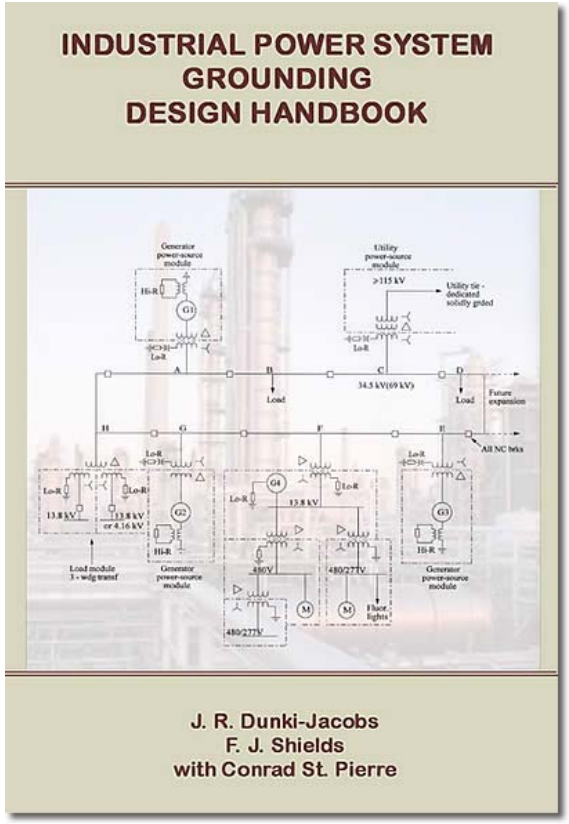
$$I_{Pri} = I_{Sec} X \frac{277}{4160} = 2.3\ kA$$

$$I_{LG} = \frac{E_{LN}}{Z_t + Z_G} = \frac{1}{.05+.02} = 14.29\ pu = 34.3\text{kA}$$

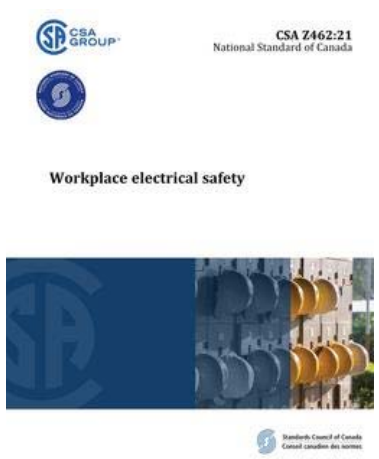
Most Common Faults

According to Industrial Power System Grounding Design Handbook - 95% of all electrical faults are phase to ground faults.

By limiting the fault current to a low level, 10 amps or less, there is insufficient current for the arc to re-strike and it self-extinguishes.

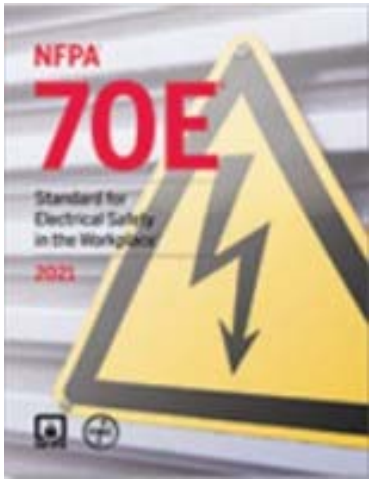


National Safety Standards



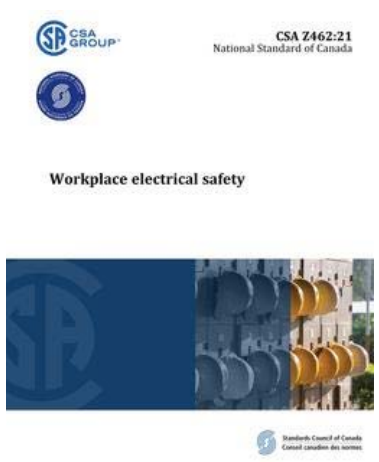
2021 CSA Z462

0.2.2
Design option decisions should facilitate the ability to eliminate hazards or reduce risk by doing the following:
(1) Reducing the likelihood of exposure
(2) Reducing the magnitude or severity of exposure
(3) Enabling achievement of an electrically safe work condition



2021 NFPA 70E

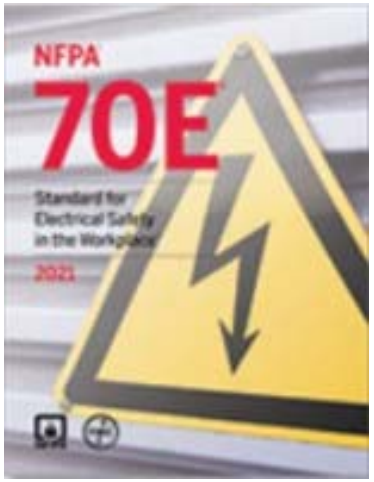
National Safety Standards



2021 CSA Z462

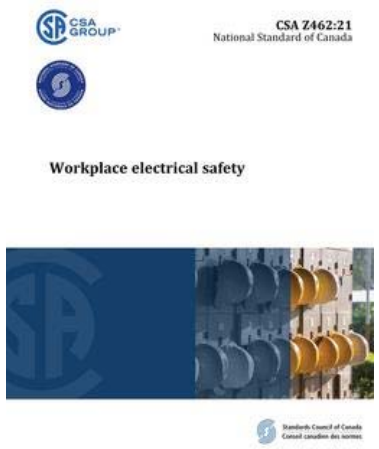
O.2.3 Incident Energy Reduction Methods.
The following methods have proved to be effective in reducing incident energy:

a) (1) Zone-selective interlocking.
b) (2) Differential relaying
c) (3) Energy-reducing maintenance switching with a local status indicator.
d) (4) Energy-reducing active arc flash mitigation system
e) (5) Energy-reducing line side isolation.
f) (6) Arc flash relay.
g) (7) High-resistance grounding.
h) (8) Current-limiting devices.
i) (9) Shunt-trip



2021 NFPA 70E

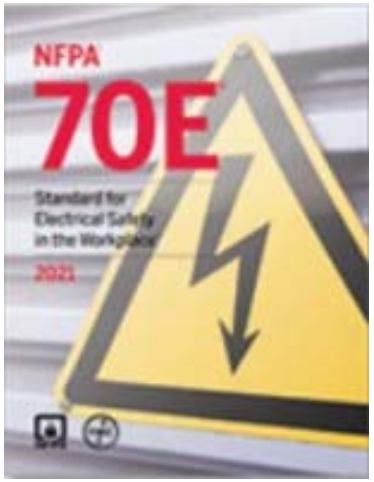
National Safety Standards



2021 CSA Z462

O.2.3

(7)High-resistance grounding. A great majority of electrical faults are of the phase-to-ground type. High-resistance grounding will insert an impedance in the ground return path and will typically limit the fault current to 10 amperes and below (at 5 kV nominal or below), leaving insufficient fault energy and thereby helping reduce the arc flash hazard level. High-resistance grounding will not affect arc flash energy for line-to-line or line-to-line-to-line arcs.



2021 NFPA 70E

Impedance Grounded Systems

250.36 High-Impedance Grounded Neutral Systems

High-impedance grounded neutral systems in which a grounding impedance, usually a resistor, limits the ground-fault current to a low value shall be permitted for 3-phase ac systems of 480 volts to 1000 volts if all the following conditions are met:

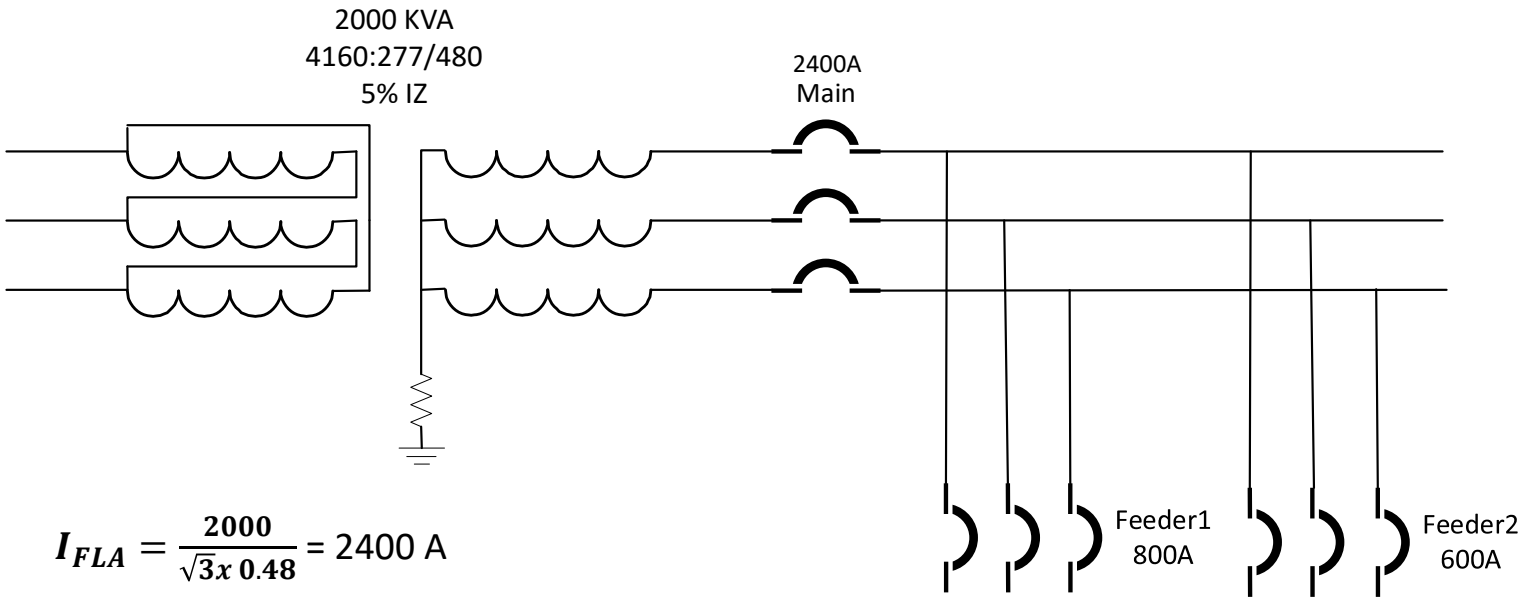
(1)The conditions of maintenance and supervision ensure that only qualified persons service the installation.

(2)Ground detectors are installed on the system.

(3)Line-to-neutral loads are not served.
High-impedance grounded neutral systems shall comply with **250.36(A)** through (G).

Informational Note: According to Annex O of *NFPA 70E*-2018, *Standard for Electrical Safety in the Workplace*, high-impedance grounding is an effective tool to reduce arc flash hazards.

HRG Grounded Example



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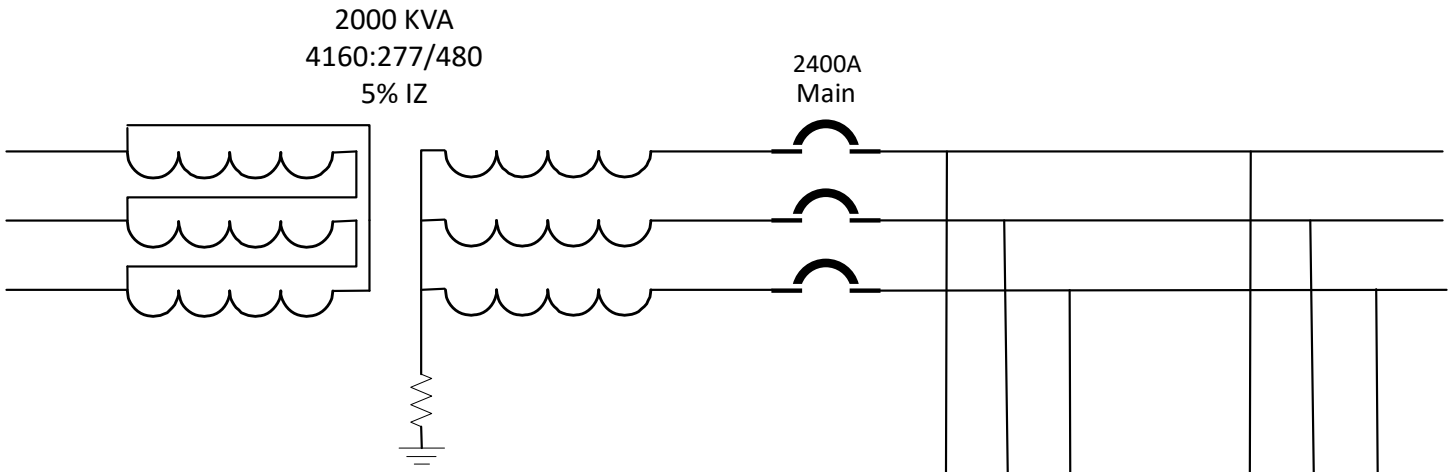
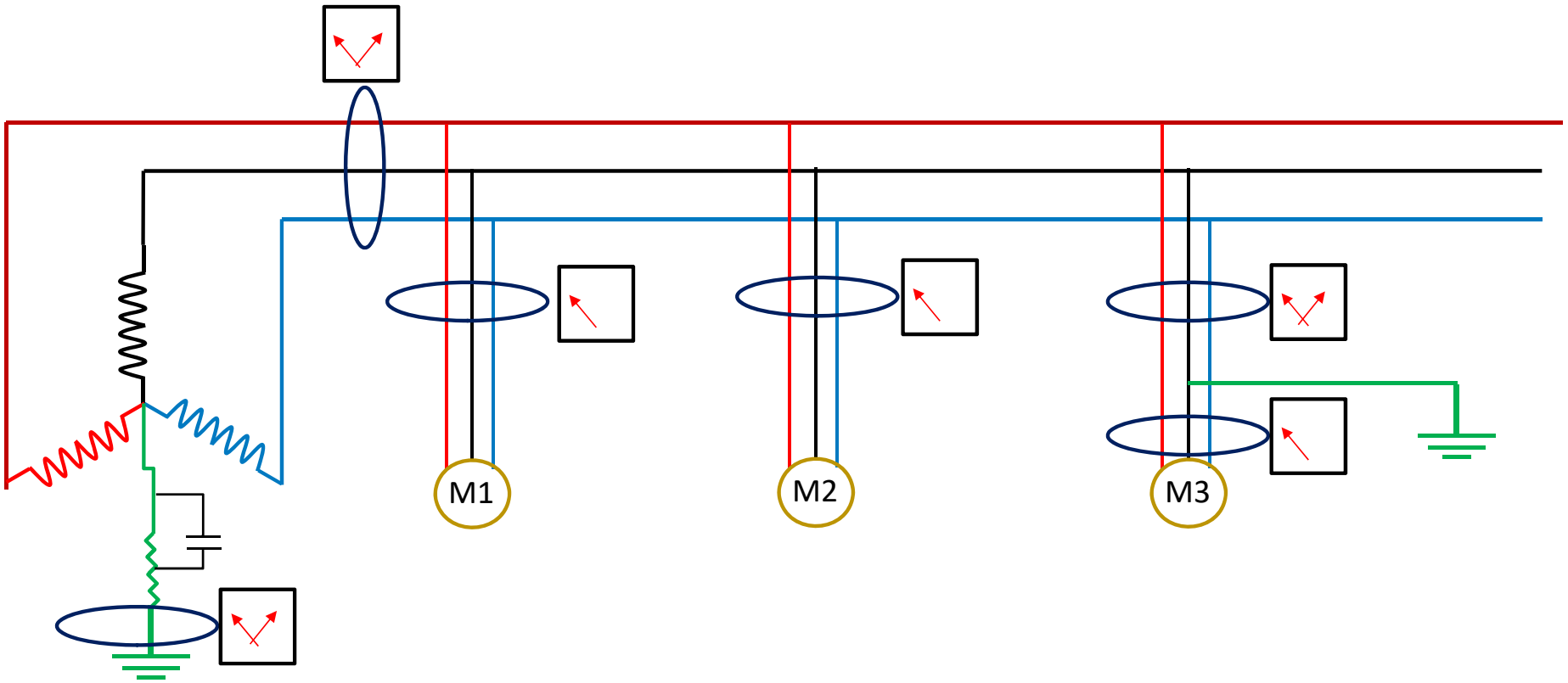
HRG Grounded Example



$$I_{Pri} = I_{Sec} X \frac{277}{4160} = 0.3\ A$$

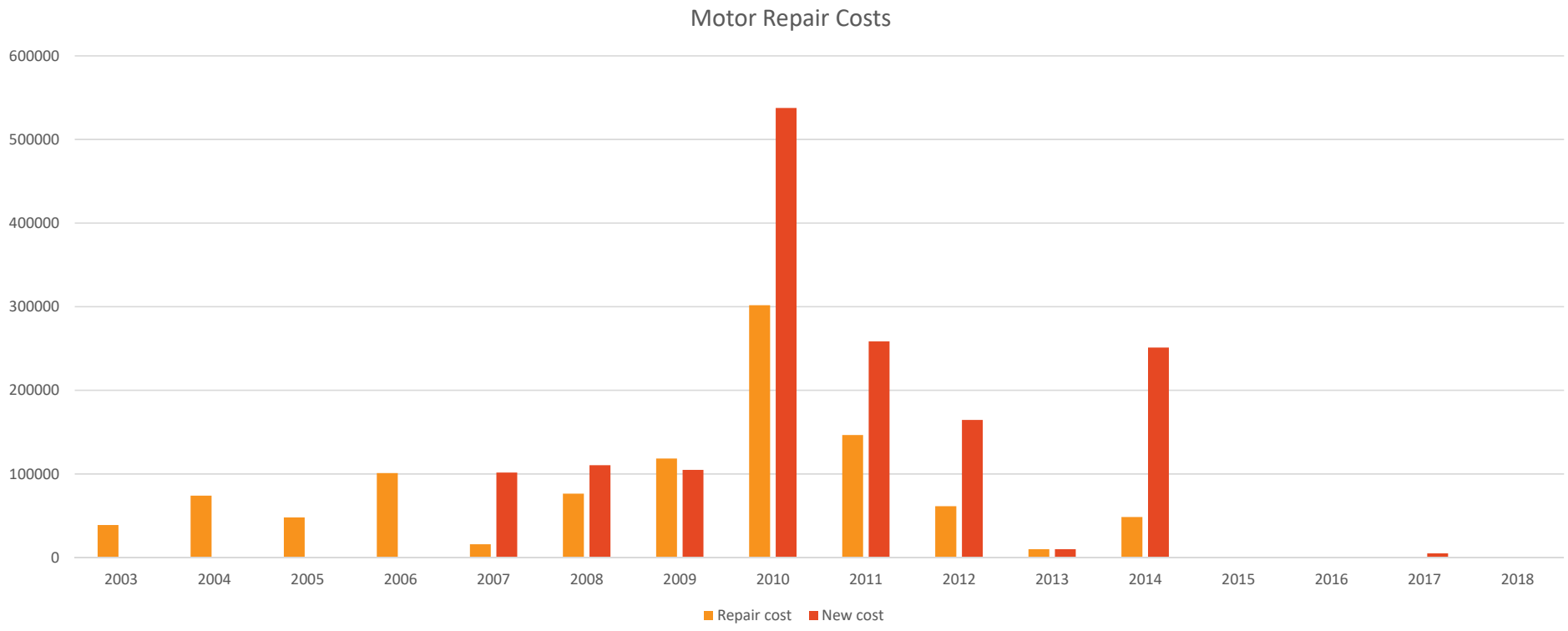
$$I_{LG} = \frac{E_{LN}}{Z_t + Z_G} = \frac{1}{.05+477} = 0.002pu = 5A$$


M1
M2
M3


FAULT PHASE A
FEEDER 03 IG100%
GARD
DSP
RESET
SETUP
NORMAL
ALARM
MUTE
ENTER

HRG v Solidly Grounded

Reliability



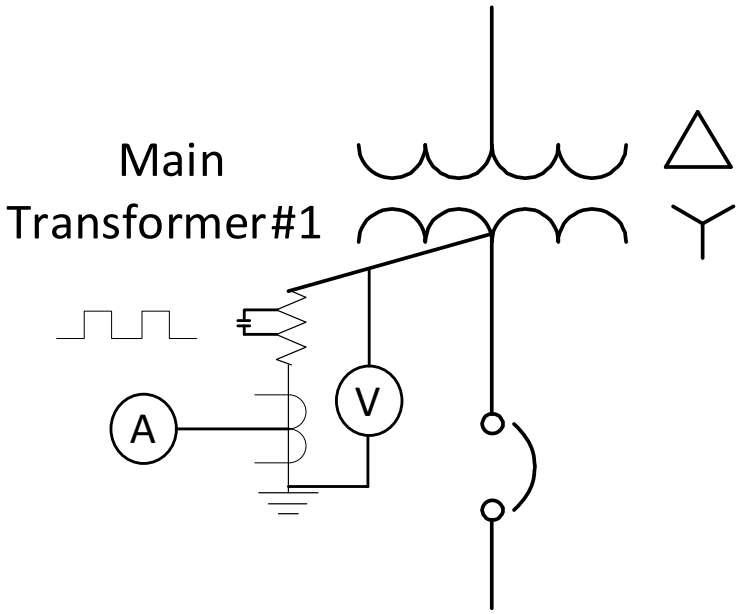
Comparison

	Solidly Grounded	High Resistance Grounded
• Ground Faults	• Trip on First Ground fault	• No tripping on Ground
• Serve Line to Neutral Loads	• Yes	• Yes with an Isolation transformer
• Safety	• Yes	• Yes
• Cost	• $$$	• $
• Reliability	• Add redundancy	• Increase reliability
• Other Benefits		• Reduce Burning and Melting effects
		• Reduce Mechanical Stress
		• Reduce Arc Flash Hazard to personnel
		• Reduce momentary voltage dip

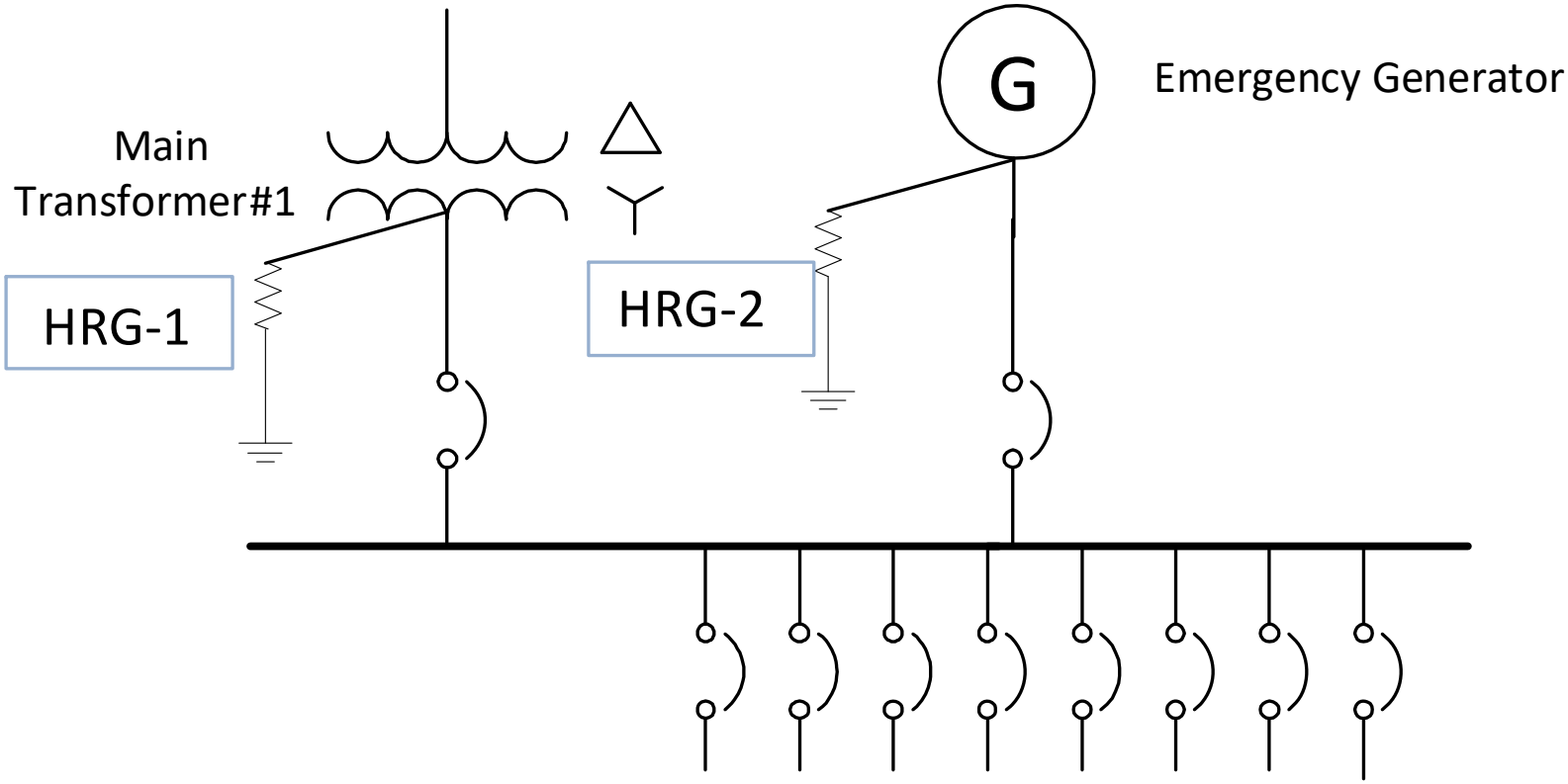
Standard High Resistance Grounding

Minimum Requirements
- Resistor to limit Fault
- Ammeter to measure current
- Voltmeter to measure voltage
- Pulsing Contactor

HRG



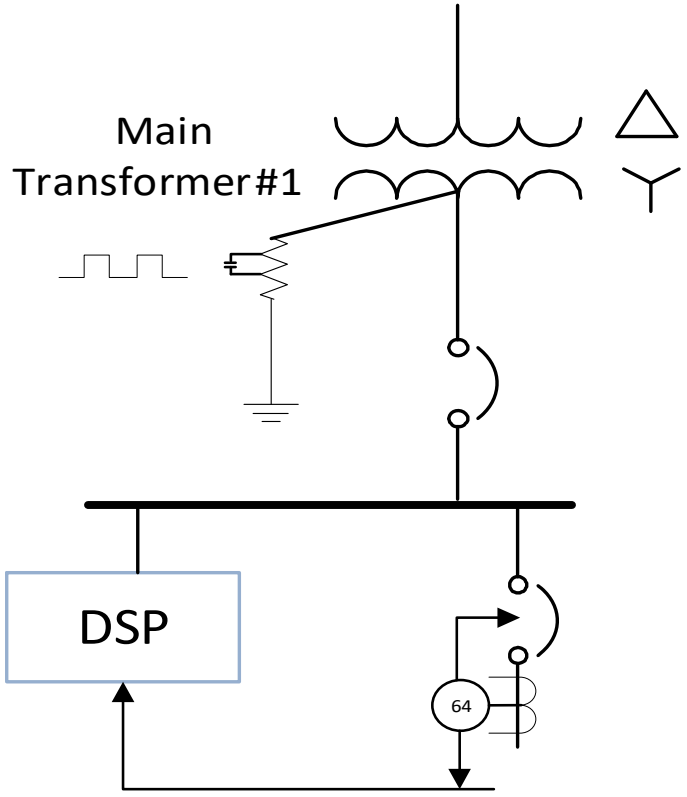
Typical Datacenter Topology

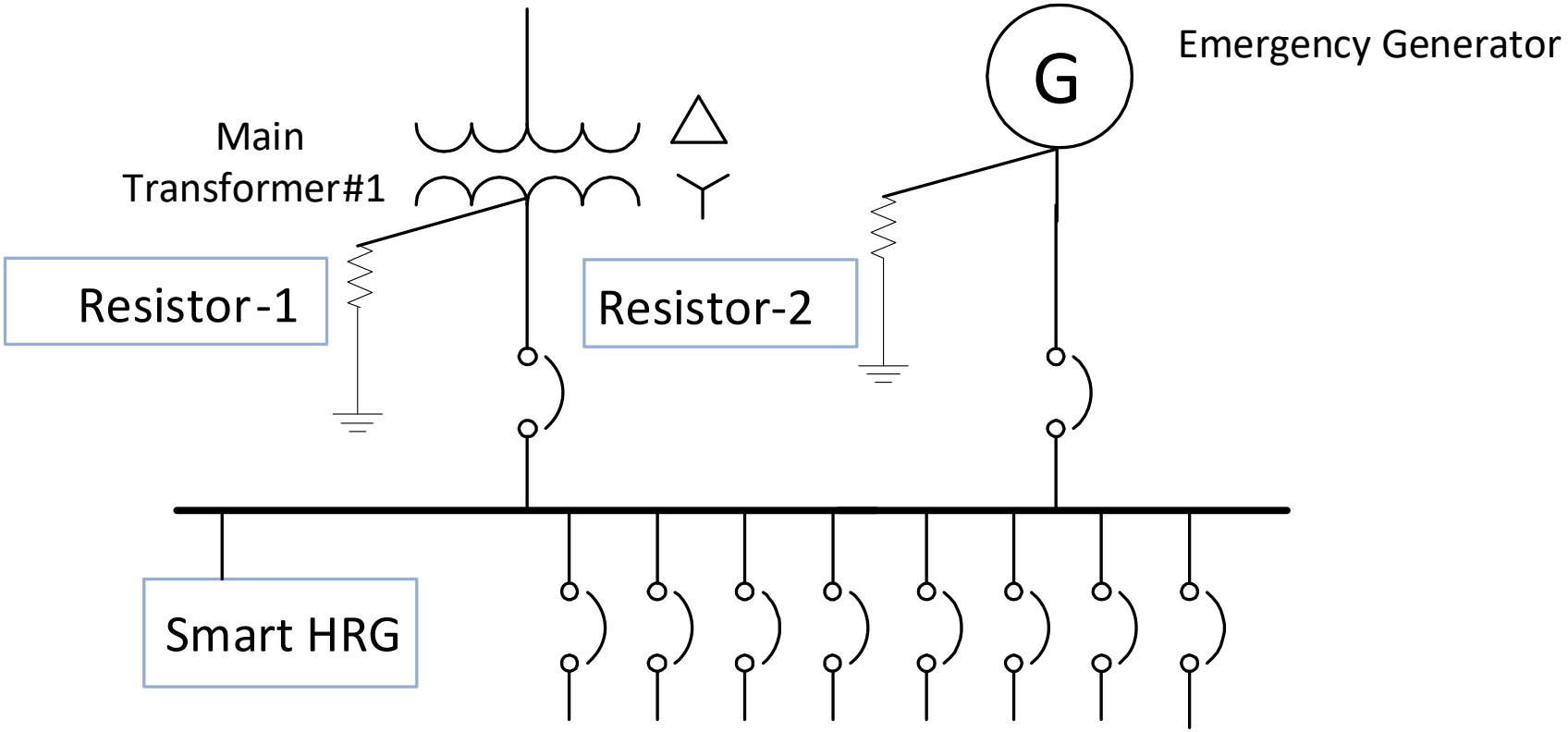


Smart HRG

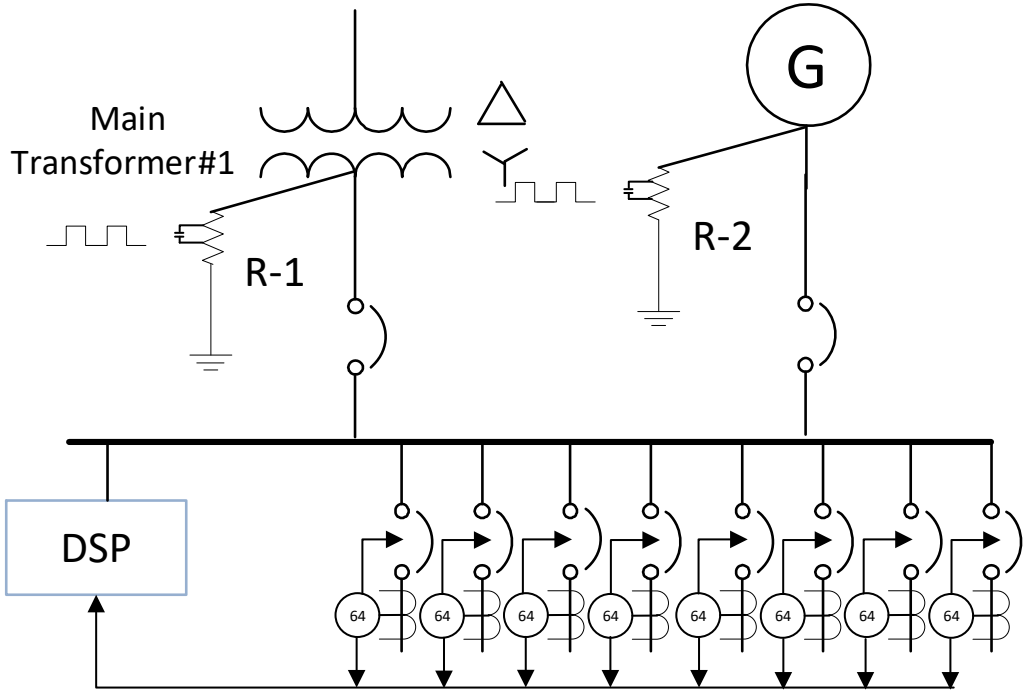
Minimum Requirements

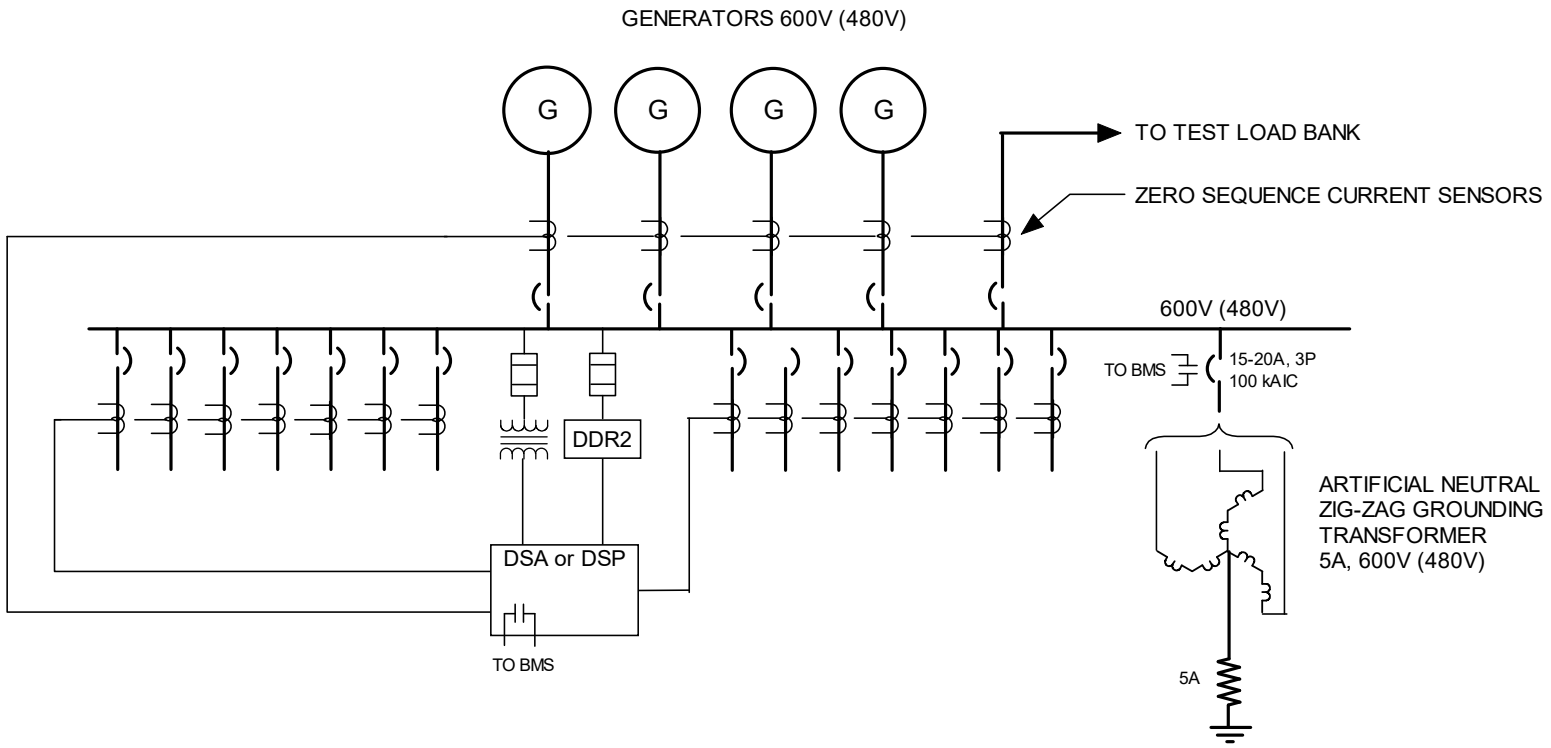
- Resistor to limit Fault
- Pulsing Contactor
- Option for resistor monitoring
- Feeder Indication
- Easier fault location
- SIFT/ adjustable timer
- Arc Flash Monitor



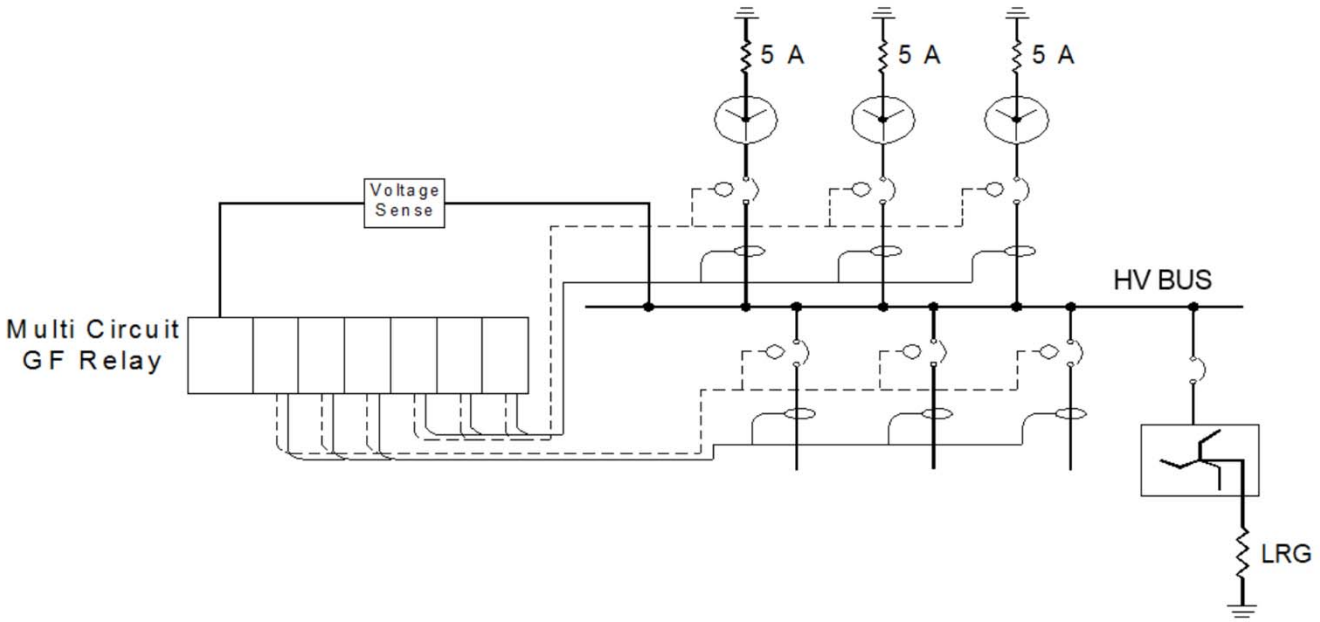

G
Emergency Generator
Main
Transformer#1
Resistor-1
Resistor-2
Smart HRG

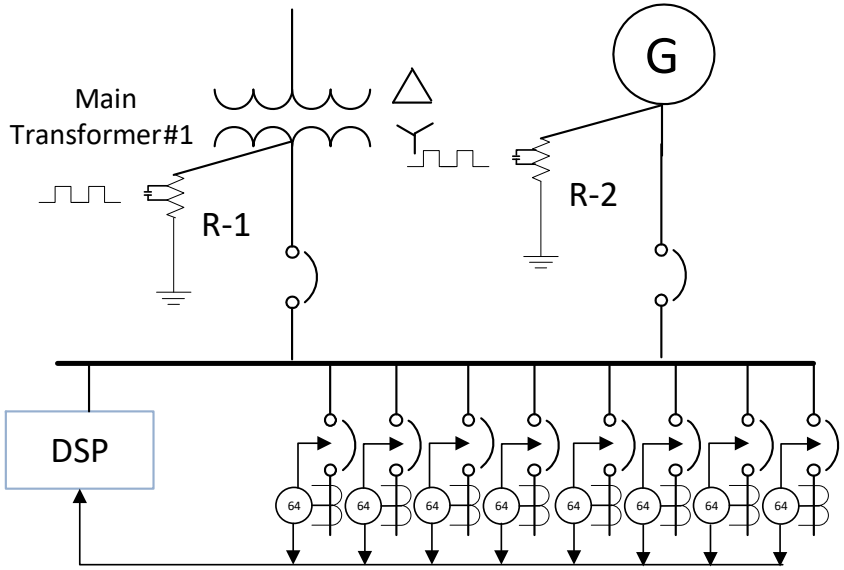
Selective Feeder Isolation

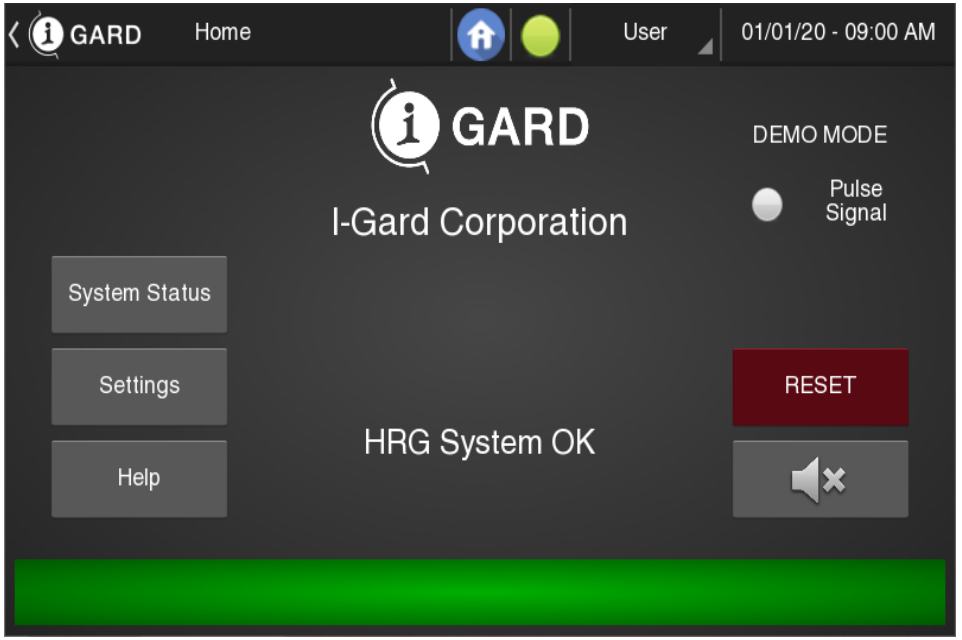


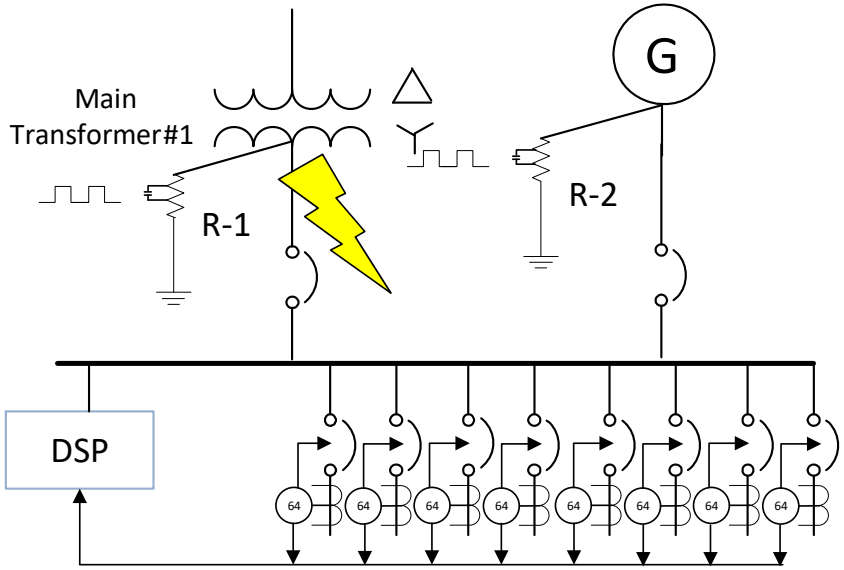

GENERATORS 600V (480V)
G
G
G
G
TO TEST LOAD BANK
ZERO SEQUENCE CURRENT SENSORS
600V (480V)
TO BMS
15-20A, 3P
100 kAIC
DDR2
DSA or DSP
TO BMS
ARTIFICIAL NEUTRAL
ZIG-ZAG GROUNDING
TRANSFORMER
5A, 600V (480V)
5A

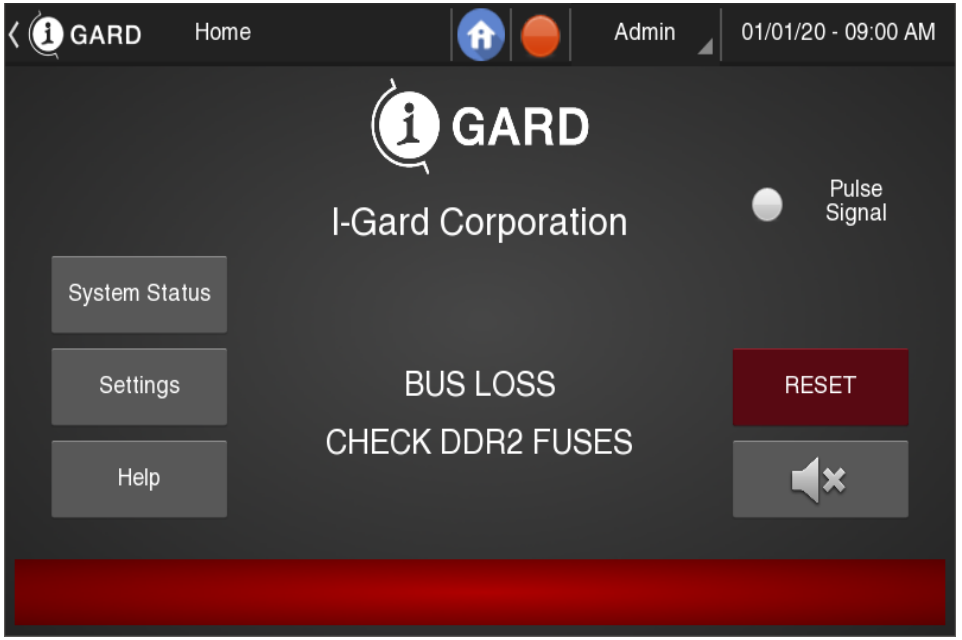
GARD

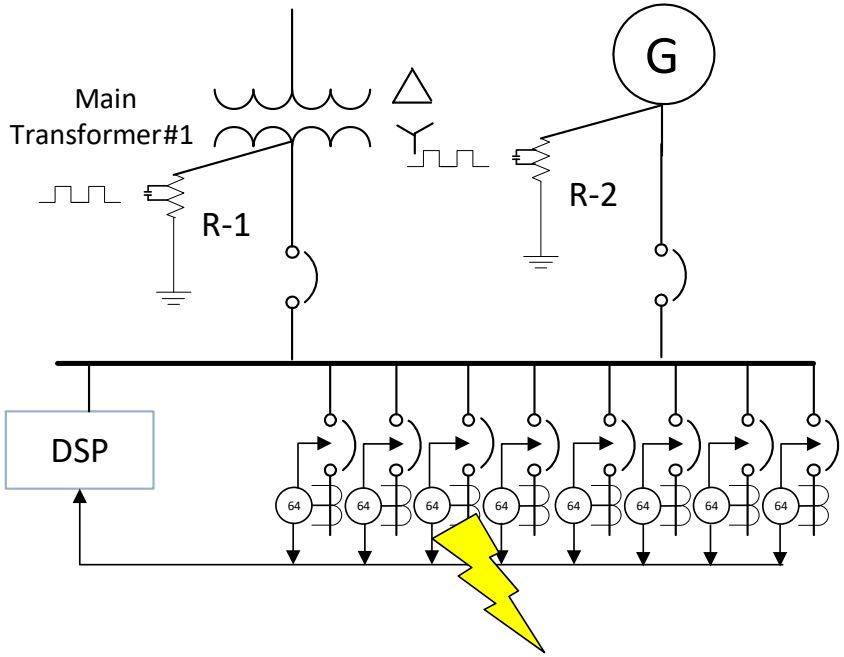



G
Main
Transformer#1
R-1
R-2
DSP
64
64
64
64
64
64
64
64

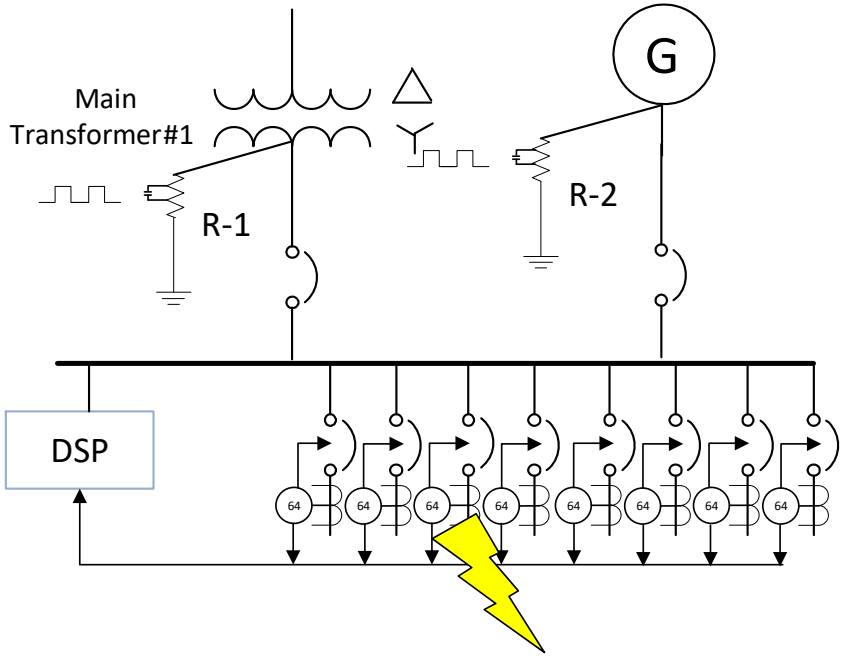

GARD
Home
User
01/01/20 - 09:00 AM
GARD
DEMO MODE
Pulse
Signal
I-Gard Corporation
System Status
Settings
Help
RESET
HRG System OK


G
Main
Transformer#1
R-1
R-2
DSP
64
64
64
64
64
64
64
64

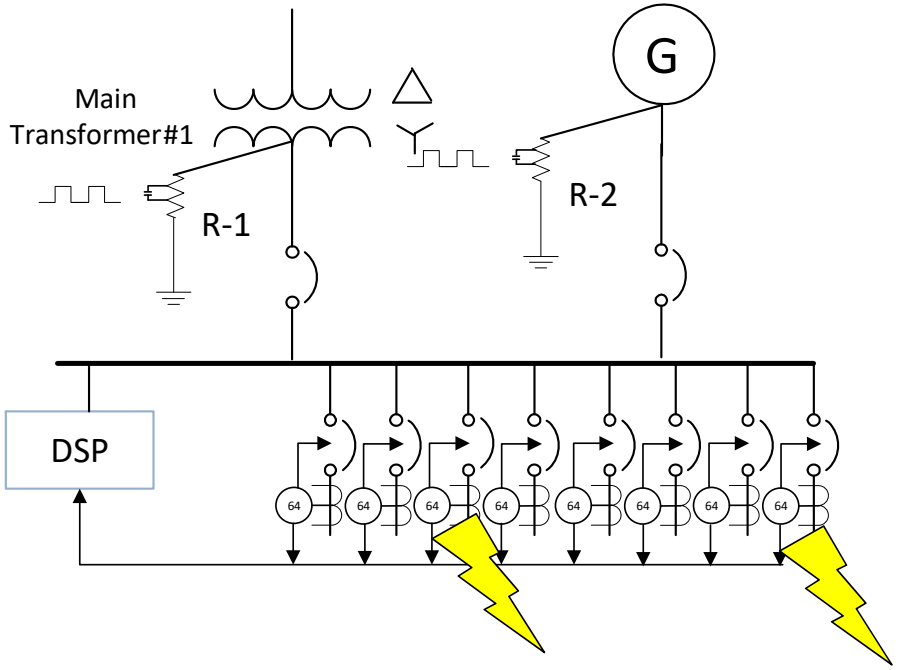

GARD
Home
Admin
01/01/20 - 09:00 AM
GARD
I-Gard Corporation
Pulse
Signal
System Status
Settings
Help
BUS LOSS
CHECK DDR2 FUSES
RESET


G
Main
Transformer#1
R-1
R-2
DSP
64
64
64
64
64
64
64
64

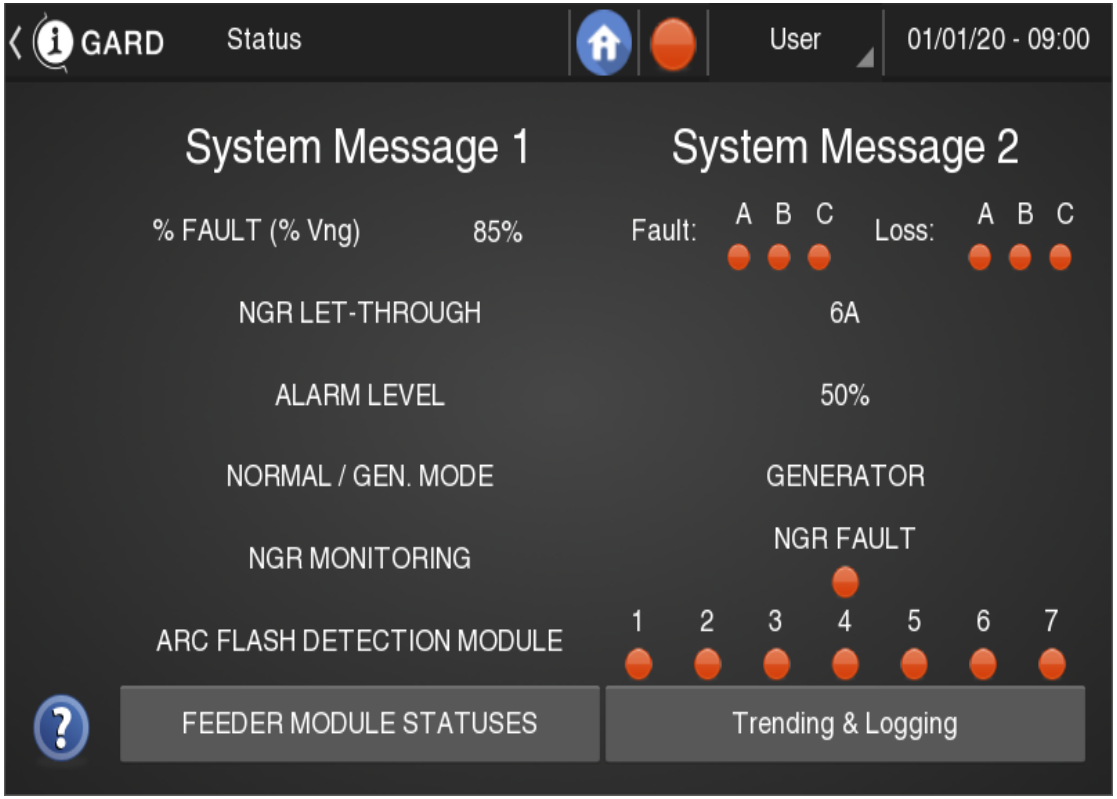

GARD
Home
Admin
01/01/20 - 09:00 AM
GARD
I-Gard Corporation
Pulse
Signal
System Status
Settings
Help
FDR FAULT 71% - Phase
FDR 3 - MCC - East Plant
Activate
Pulsing
RESET


G
Main
Transformer#1
R-1
R-2
DSP
64
64
64
64
64
64
64
64

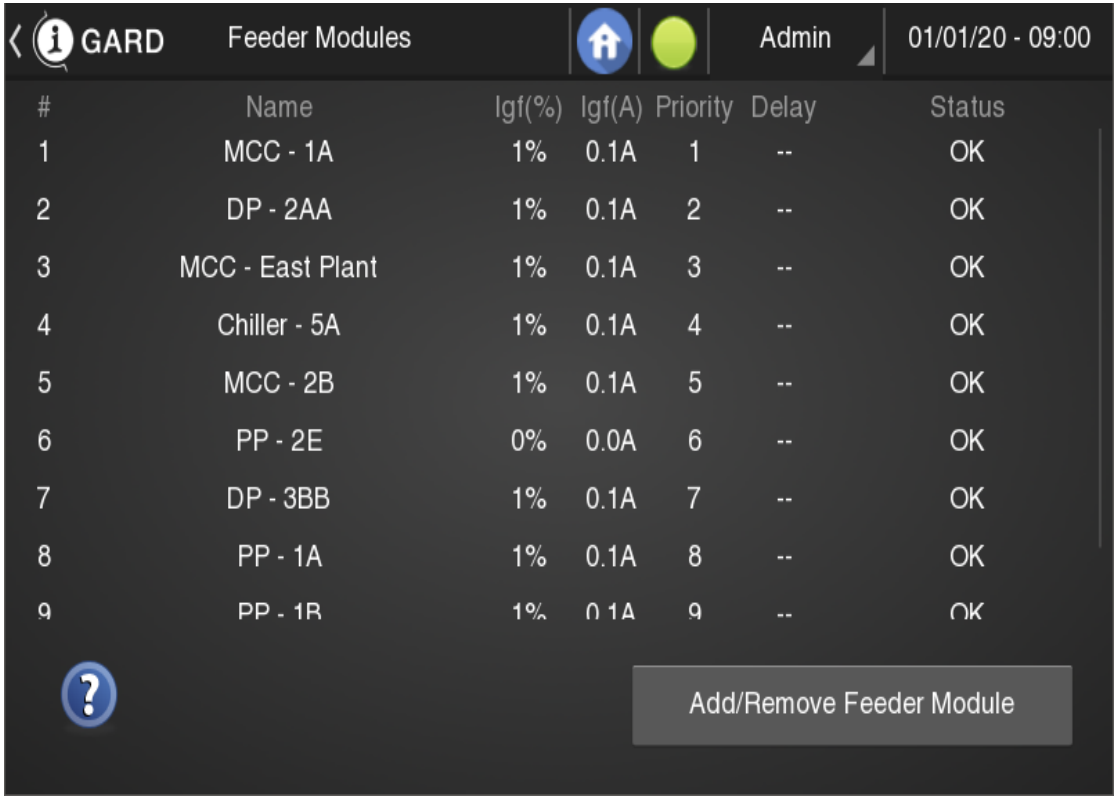

GARD
Home
Admin
01/01/20 - 09:00 AM
GARD
I-Gard Corporation
Pulse
Signal
System Status
Settings
Help
FDR FAULT 71% - Phase
FDR 3 - MCC - East Plant
Activate
Pulsing
RESET


G
Main
Transformer#1
R-1
R-2
DSP
64
64
64
64
64
64
64
64

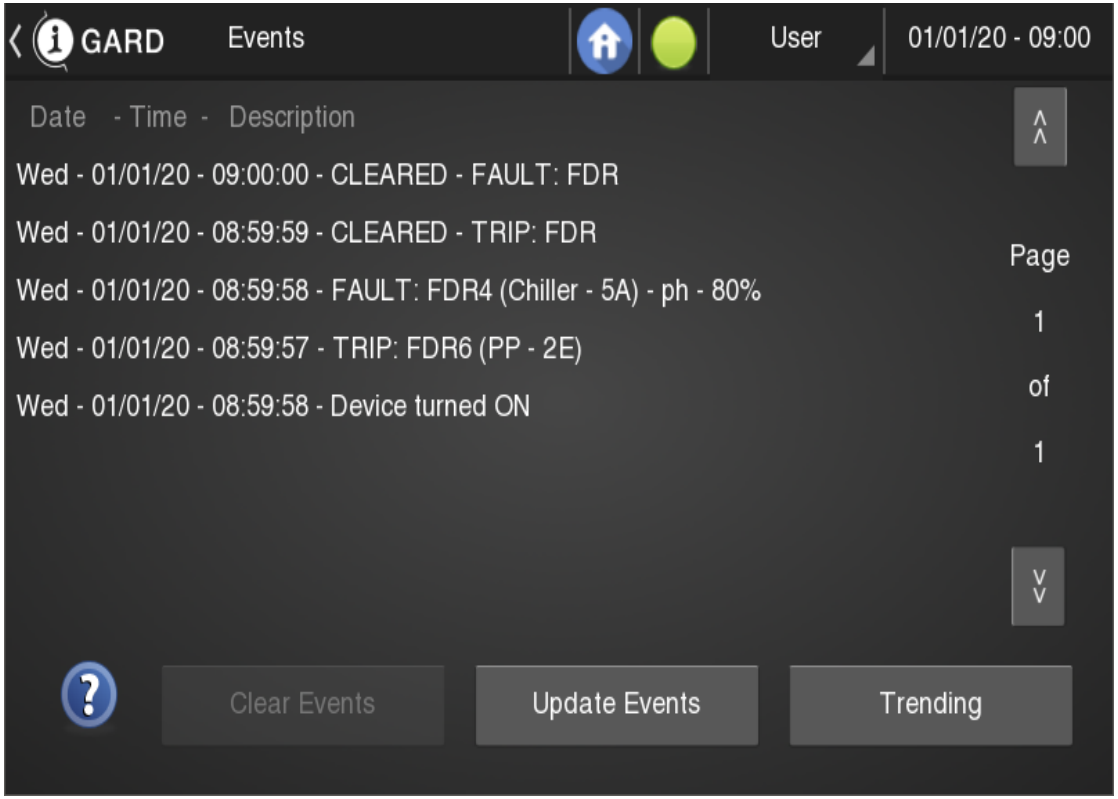

GARD
Home
Admin
01/01/20 - 09:00 AM
GARD
I-Gard Corporation
Pulse
Signal
System Status
Activate
Pulsing
Settings
FDR FAULT 71% - Phase
RESET
Help
FDR 3 - MCC - East Plant


GARD
Status
User
01/01/20 - 09:00
System Message 1
System Message 2
% FAULT (% Vng)
85%
Fault:
A B C
Loss:
A B C
NGR LET-THROUGH
6A
ALARM LEVEL
50%
NORMAL / GEN. MODE
GENERATOR
NGR MONITORING
NGR FAULT
ARC FLASH DETECTION MODULE
1 2 3 4 5 6 7
FEEDER MODULE STATUSES
Trending & Logging

GARD

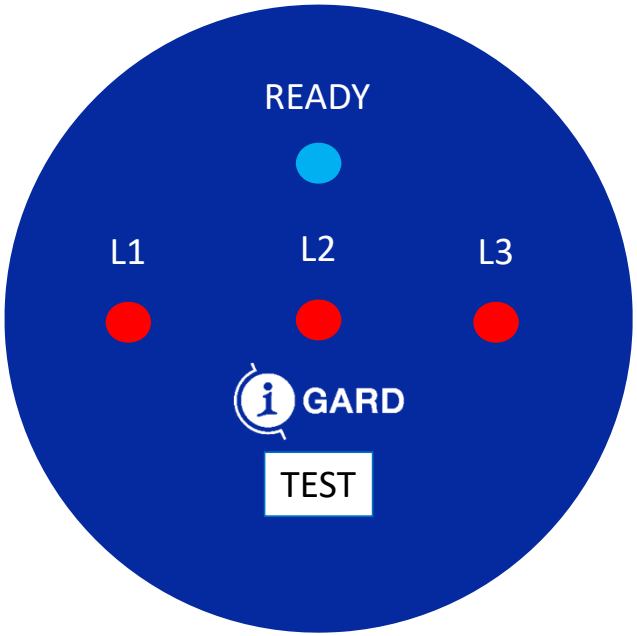

GARD
Feeder Modules
Admin
01/01/20 - 09:00
Name Igf(%) Igf(A) Priority Delay Status
1 MCC - 1A 1% 0.1A 1 -- OK
2 DP - 2AA 1% 0.1A 2 -- OK
3 MCC - East Plant 1% 0.1A 3 -- OK
4 Chiller - 5A 1% 0.1A 4 -- OK
5 MCC - 2B 1% 0.1A 5 -- OK
6 PP - 2E 0% 0.0A 6 -- OK
7 DP - 3BB 1% 0.1A 7 -- OK
8 PP - 1A 1% 0.1A 8 -- OK
9 PP - 1B 1% 0.1A 9 -- OK
Add/Remove Feeder Module

GARD

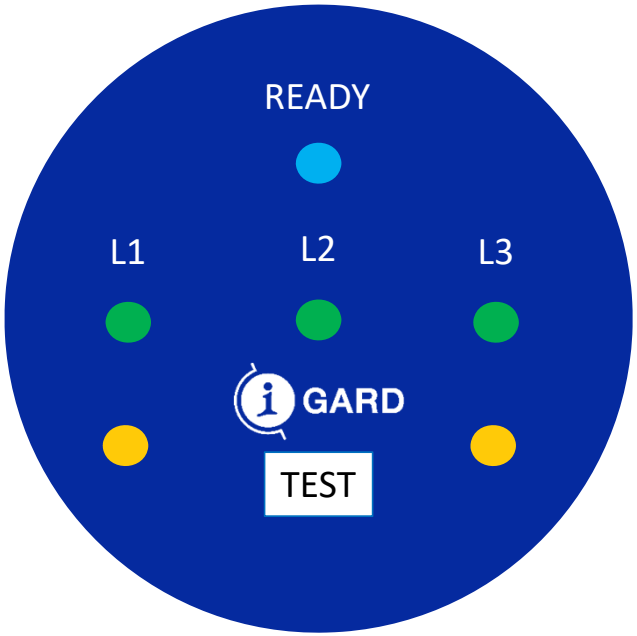

GARD
Events
User
01/01/20 - 09:00
Date - Time - Description
Wed - 01/01/20 - 09:00:00 - CLEARED - FAULT: FDR
Wed - 01/01/20 - 08:59:59 - CLEARED - TRIP: FDR
Wed - 01/01/20 - 08:59:58 - FAULT: FDR4 (Chiller - 5A) - ph - 80%
Wed - 01/01/20 - 08:59:57 - TRIP: FDR6 (PP - 2E)
Wed - 01/01/20 - 08:59:58 - Device turned ON
Page
1
of
1
Clear Events
Update Events
Trending


GARD
Trending
Admin
01/01/20 - 09:00 AM
10 min
10A
7.5A
5.0A
2.5A
0A
100%
75%
50%
25%
0%
2020-01-01
08:50:00
2020-01-01
08:53:20
2020-01-01
08:56:39
2020-01-01
08:59:59
<<
>>
+
-
Igf
Alarm Threshold
2 - DP - 2AA
1 - MCC - 1A

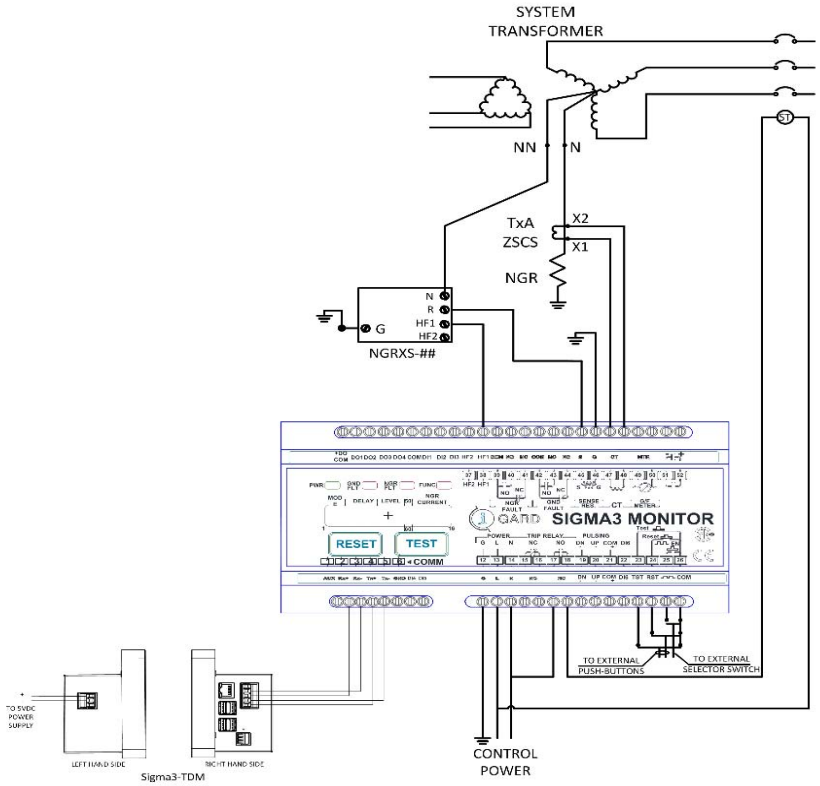
Shock Protection



Shock Protection



Smallest footprint OEM HRG




GARD
Status
User
28/11/20 - 06:20 AM
Fault Current
0.06 Amps
Neutral to Ground Voltage
0.0 Volts
Device ID: 0xb
Frequency: 60 Hz
System
Ground Fault
NGR Fault
> Lower Setpoint
NGR Value
IN RANGE
Pulsing
RESET
TEST
I/O
PULSING OFF
5A
IC² Power Supply
100-240 AC/DC
GARD SIGMA3 MONITOR
RESET
TEST

GARD

Questions