

Neutral Grounding Resistor with Second Ground Fault Protection NGR-2GFP

User Manual



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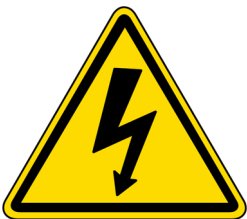
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Preface

General safety instructions



Hazard of electric shock!

High voltage signs are recommended. Please ensure the equipment is properly grounded before applying power. Prior to performing any maintenance, remove power and wait thirty (30) minutes for the resistor to cool down.



Hazard of fire or burn!

Neutral grounding resistors have the potential to reach high temperatures. Protection, such as a mechanical housing around the resistor assembly, should be provided by the installer to prevent injury to personnel that may come into proximity to the installation and prevent contact with material that could be combustible due to these temperatures. Do not allow combustible or metallic matter into the NGR; otherwise, fire or accident could occur.

Laws and guidelines

Follow all relevant local, regional and national electrical codes when installing this product.

Target group and required knowledge

This instruction manual is exclusively for trained electrical personnel. Trained personnel should have knowledge of the following:

- Relevant electrical codes: bonding, wiring, and signage requirements
- Airflow and ambient conditions
- Material handling capabilities: potential use of forklift or lifting crane
- Skills for installation: hardware mounting, electrical connections
 - Knowledge of grounding grids and rods
- Capability to operate and test application of product

Product description

The purpose of a Neutral Grounding Resistor with Second Ground Fault Protection (NGR-2GFP) is to increase the safety of an industrial or commercial electrical distribution system while maximizing continuity of service.

An NGR-2GFP increases the availability of a Neutral Grounding Resistor by adding feeder priority tripping. Feeder priority tripping permits operation with one ground fault and avoids tripping high priority sections of the electrical distribution system when a second ground fault on a second feeder occurs before the first ground fault has been cleared.

Each feeder is assigned a priority level and in the event of a second ground fault the system will trip only the lower priority feeders, allowing the rest of the electrical system to continue operating with the remaining ground fault on higher priority feeders.

NGR-2GFPs are recommended for applications that require continuous operation, such as oil refining, chemicals, synthetic fibers, fertilizers, pulp and paper, metal smelting, power stations, natural gas processing, waste water treatment, steel casting, lime calcining, cement, glass, etc. and for critical service installations in hospitals, data centers, transportation, telecommunication, government, financial institutions and utilities.

The main components of an NGR-2GFP are:

- Resistive elements
- Neutral Ground Fault and Resistor Monitor
- Coupling Device
- Neutral Current Transformer
- Feeder Ground Fault Current Monitors
- Feeder Ground Fault Current Transformers
- System Controller
- Communications Gateway

Additional components may include:

- Load-break Switch
- Zig-zag transformer
- Disconnect Switch
- Grounding Transformer
- Touchscreen Operator Panel
- Handheld Pulse Detector
- Portable Ground Fault Location System

Depending on the requirements of the particular installation, an NGR-2GFP can be supplied in different form factors: as an Integrated System (With all the components except the Feeder Ground Current Transformers in a single enclosure), as a Separated System (With the resistor in a separate enclosure), as an Rack System (plug-in module rack system with a separate resistor), as a Plate System (Back Plate and Front Plate combination with a separate resistor), or as Loose Components.

NGR-2GFPs are used with other electrical equipment, primarily power transformers and generators. Multiple components are involved in the design of a “neutral grounding system”. This manual provides the pertinent information on the different form factors and equipment that may be available.

This manual includes information about:

- Neutral grounding resistor
- Neutral grounding resistor monitoring
- Controls, alarms, and communications
- Ground fault protection relays
- Feeder current transformers
- Upstream equipment

Receiving, unpacking, and inspection

Pallets and enclosures must always remain upright and should not be stacked.

If a forklift is used, make sure not to damage any part of the enclosure. If eyebolts are available and are used for lifting, make sure the angle of the cables with the vertical is 45 degrees or less.

1. Remove packing slip and inspect contents, store documents in a safe place.
2. Unpack the unit carefully.
3. Inspect enclosure for any shipping damages, including deformities, dents, and large scratches. Do not accept the unit if significant damage is observed.
 - a. Units with significant shipping damage should be returned. Please see section on product returns. Significant shipping damage is defined as destruction of internal components and/or resistor assembly.
 - b. Units with minor shipping damage can be repaired in the field.
4. In the case of a product defect or malfunction, the original packaging should be used to return the product.

Grounding and bonding

Follow relevant electrical codes to adequately ground and bond the product.

Refer to the product drawing for bonding points on metallic enclosures, typically available as compression lugs or bolts. There may be multiple grounding points within enclosures, typically accessible as grounding bars (i.e. NEMA pads) or terminal blocks. All grounding terminals will be labelled as “G” or “Ground”.

Physical installation

Suitable locations

For all systems mount the enclosure(s) containing the neutral grounding resistor as close to the transformer or generator as practicable. If a forklift is used, make sure not to damage the bottom cover of the enclosure. If the eyebolts are used for lifting, make sure the angle of the cables with the vertical is 45 degrees or less.

Wall mounted and floor mounted enclosures must be bolted to brackets or to a concrete wall or pad using the hardware indicated in the corresponding drawing.

For rack and plate systems, system controllers must be installed in appropriate enclosures.

Loose components systems must be installed and wired according to supplied drawings and component manuals.

Install the current transformers in the monitored feeders as required. When connecting the current transformers, it is essential to consider the maximum cable lengths allowed for the cross section of the conductors used.

Connections

User connections are:

1. Power input or control voltage: Used to energize the system. Make sure to use the required voltage.
2. Current transformers: Used to monitor feeders and neutral.
3. Circuit breakers' shunt trip: Used to disconnect power in faulted circuits if a second ground fault occurs.
4. Voltage transformers: To monitor phase voltages.
5. Neutral and Ground terminals: Used as voltage references and return for fault currents.
6. Bonding terminals: Used to bond enclosures to ground.

These connections are clearly shown in the supplied technical drawings.

As important precautions, please consider:

1. The current transformer in the resistor enclosure may have its secondary terminals short-circuited with a jumper for protection against induced voltage. Remove the jumper before commissioning the system.

2. For units supplied with a neutral disconnect switch, please note that opening it will transform the system from High-Resistance grounded to Ungrounded while the switch is open.
3. Observe the minimum cable size required for each connection, according to the applicable regulatory code or manufacturer's guidelines.

Operation

An NGR-2GFP can be specified and configured for protection of multiples of 12 feeders up to a maximum of 120, considering up to six substations with different system configurations or bus arrangements.

System configuration, monitoring and operation is accessible with the Touchscreen Operator Panel.

The System may include color LED lamps to indicate the following conditions:

1. System Normal (Green)
2. Ground Fault (Red)
3. Resistor Fault (Red)
4. Pulsing Active (Amber)

Three auxiliary relays SPST, 250VAC, 5A in fail-safe mode indicate:

1. General Alarm
2. First Fault Alarm
3. Second Fault Alarm

The neutral monitoring relay is wired to a set of three relays 3PDT, 250 VAC, 10 A:

1. Ground Fault
2. Resistor Fault
3. Trip

After power up, in normal condition the front door green lamp labeled SYSTEM NORMAL is lit. When the system is energized and in normal status, all three auxiliary relays are energized.

If the ground current at any feeder reaches a preconfigured warning or first fault operation value, the green lamp will be turned off and the red lamp labeled GROUND FAULT will blink (in case of warning) or turn on (in case of ground fault). Auxiliary relay #0 and/or #1 will be de-energized.

While the first ground fault is present, the pulsing mechanism may be started from the corresponding SUBSTATION screen (for systems that use the NGRM500 relay) or from the FP200 interface (for systems using the NGRM700 relay). The faulted feeder will be indicated, and the pulse can then be traced to the fault using a portable detector.

If, while the first fault is still present, a second ground fault occurs in a different phase and feeder(s), the lower-priority feeder(s) will be tripped.

Selective operation is performed regardless of whether additional ground faults occur either simultaneously or consecutively—the power system will return to a first fault condition with the highest-priority feeder remaining energized. Auxiliary relays 0, #1 and #2 will be de-energized.

If required, auxiliary normally open contacts 250VAC, 5A are used for Tie circuit breaker permissive closing command.

Initial Screen

The initial screen shows current and voltage in the neutral grounding resistor:

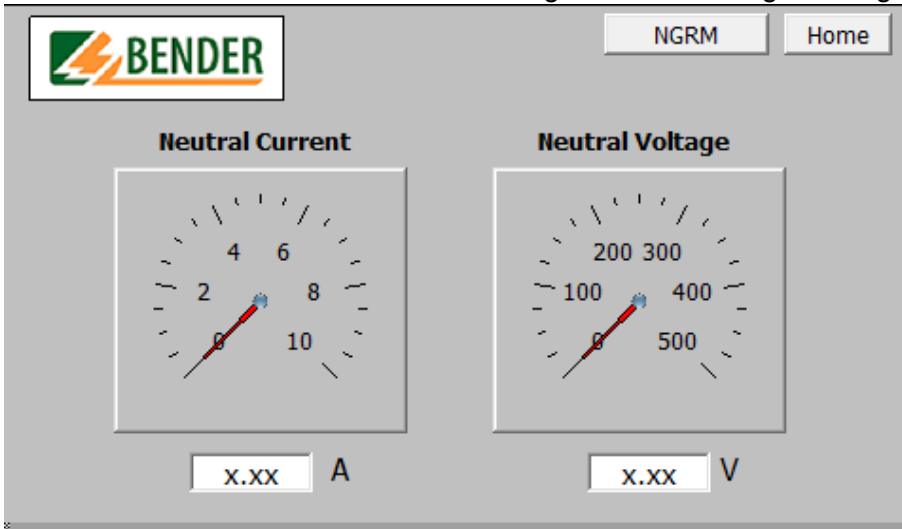


Figure 1 Initial Screen

Home Screen

Pressing the HOME button (top right corner of the initial screen) takes the operator to the HOME screen.

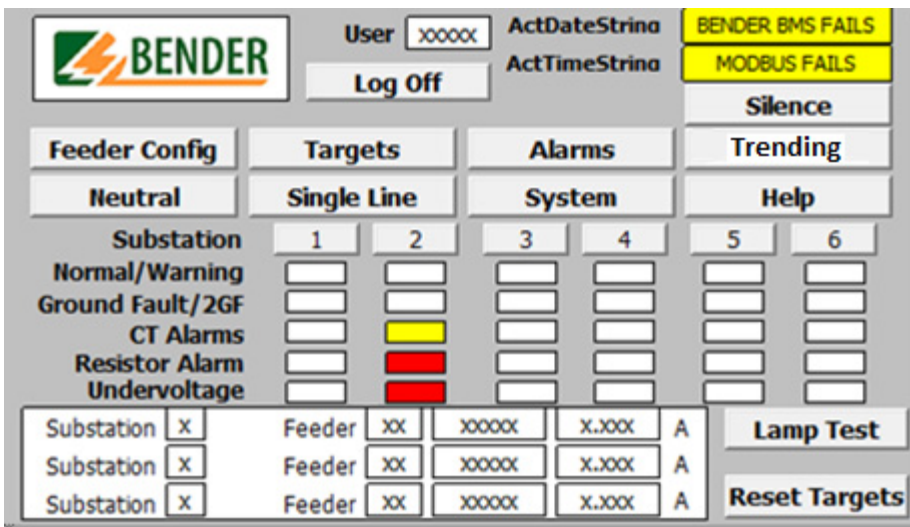


Figure 2 Home Screen

The HOME screen provides access to the different screens required for configuration/operation and system overall information using colored targets arranged in table format.

Jumping to other screens is done through the following pushbuttons:

1. FEEDER CONFIGURATION (Priority, Topology, Feeder Identification)
2. TARGETS (Protection targets and ground fault current values)
3. ALARMS (Configured alarms in the system)
4. SLD (Single line diagram)
5. PERFORM (System performance, power grid configuration)
6. NEUTRAL (Neutral current and voltage)
7. HELP (Usage instructions)
8. SUBSTATION 1 ... SUBSTATION 6 (Substation configuration, shown according to power grid configuration)

User and Password are required to enable feeder and substation configuration as described in corresponding sections.

At the top right corner, yellow flags will appear if system communications error occurs, in which case the green lamp will flash and General Alarm auxiliary contact #0 will open.

Target colors indicate:

NORMAL/WARNING	Green: Indicates normal condition
	Orange: The feeder ground current has exceeded the Warning Limit
GROUND FAULT/2GF	Yellow: The ground current has exceeded the First Ground Fault Limit
	Red: A low priority feeder has tripped due to a Second Ground Fault
CT ALARM	Yellow: Open or short current transformer
RESISTOR ALARM	Red: Open or shorted grounding resistor or neutral path*
UNDERVOLTAGE	Red: One or more phases in Undervoltage condition
	Optional, only available when NGRM700 is provided.

*To monitor the complete neutral path direct connections are required from the neutral terminal of the grounding resistor and from the neutral terminal of the coupling device to the transformer neutral terminal.

The three largest ground currents in the system, identified with the corresponding substation and feeder, are displayed at the bottom of the HOME screen.

Two additional buttons are provided to RESET ALARMS and perform LAMP TEST.

Feeder Configuration Screen

Feeder Configuration screen allows assigning priorities from 1 (Highest) to 99 (Lowest) to each feeder which may trip simultaneously or sequentially if involved in a second ground fault.

Different feeders may have the same priority without restrictions, in which case the tripping will occur in sequential order until the second fault has been cleared.

This screen is also used to enter feeder names, substation, and bus bars number.

Feeder Prioritization

Coordination of protection based on priorities is a superior method compared to time-overcurrent coordination as neither pickup adjustments nor time-delay increases for upstream circuit breakers is required. Fast tripping, with no coordination delay, minimizes fault energy.

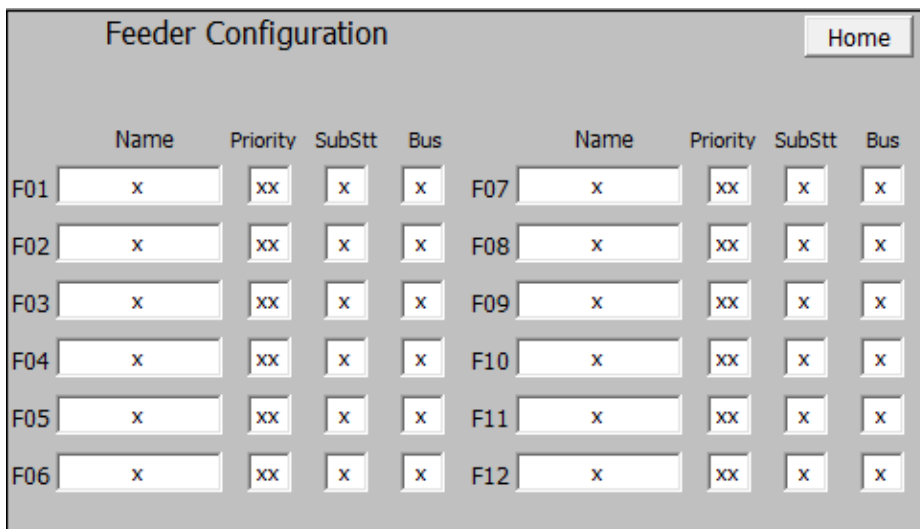
Assign priorities to each feeder from 1 (highest) up to 99 (lowest).

Highest priority corresponds to the most important or essential feeders, while lower priorities correspond to other feeders.

The feeders not being monitored are considered to have a priority above the highest priority: If the feeder with priority 1 has a ground fault, and a second ground fault occurs not being monitored by RCMS490, the feeder with priority 1 will be tripped.

When more than two feeders are involved in the second ground fault:

1. If all the feeders have the same priority: Tripping will take place sequentially by feeder (one feeder at a time, until the second ground fault is cleared)
2. If at least one feeder has a different priority: Tripping will take place sequentially by priority (all feeders with the same priority at a time, starting with the lowest priority, until the second ground fault is cleared)



Name				Priority	SubStt	Bus	Name				Priority	SubStt	Bus
F01	x	xx	x	x	F07	x	xx	x	x				
F02	x	xx	x	x	F08	x	xx	x	x				
F03	x	xx	x	x	F09	x	xx	x	x				
F04	x	xx	x	x	F10	x	xx	x	x				
F05	x	xx	x	x	F11	x	xx	x	x				
F06	x	xx	x	x	F12	x	xx	x	x				

Figure 3 Feeder Configuration Screen

Target Screen

This screen shows the following information:

1. Feeder ground current
2. Feeder first fault condition (latched indication)
3. Feeder second fault operation (latched indication)
4. Feeder trip (latched indication)

The background colors for feeder ground current are:

1. **Green:** normal condition
2. **Orange:** alarm condition
3. **Yellow:** First fault has happened

When a second ground fault has been cleared, at least two feeders are faulted: the higher priority faulted feeder remaining in service and the one that tripped. To help locate the fault in the still-energized faulted feeder, the pulsing function can be activated from the corresponding SUBSTATION screen or from the Neutral monitoring relay. A Handheld Pulse Detector model HPD-6 or HPD-9 can be used to find the fault on energized feeders. An EDS3090-series portable ground-fault location system can be used to find the fault on de-energized feeders.

Targets										Reset Targets	Home
Feeder	Ground Current	Fault			Feeder	Ground Current	Fault				
		1st	2nd	TRIP			1st	2nd	TRIP		
	x.xxx	Yellow	Red	Red		x.xxx	Yellow	Red	Red		
	x.xxx	Yellow	Red	Red		x.xxx	Yellow	Red	Red		
	x.xxx	Yellow	Red	Red		x.xxx	Yellow	Red	Red		
	x.xxx	Yellow	Red	Red		x.xxx	Yellow	Red	Red		
	x.xxx	Yellow	Red	Red		x.xxx	Yellow	Red	Red		
	x.xxx	Yellow	Red	Red		x.xxx	Yellow	Red	Red		

Figure 4 Targets Screen

Alarms Screen

Any active alarm, acknowledged or not, will be shown on this screen.
If the alarm is no longer active, it will be cleared from the alarm list as soon as it is acknowledged.

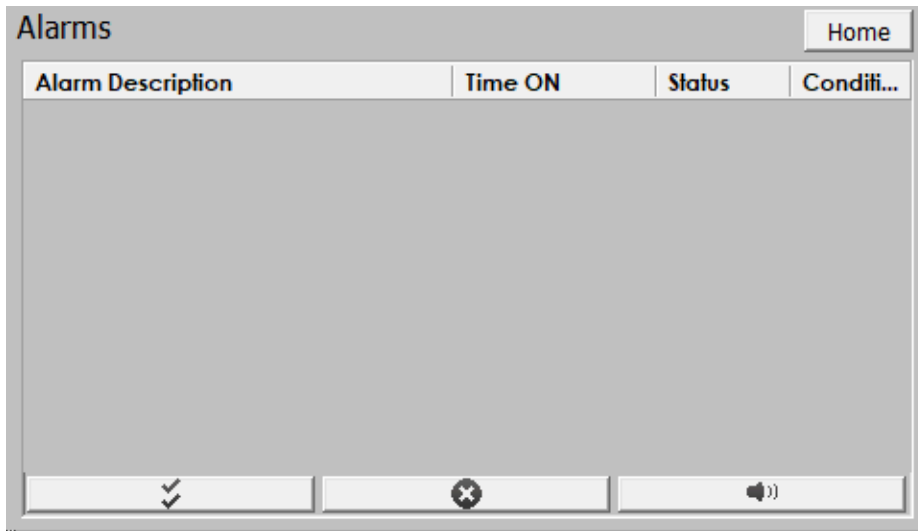


Figure 5 Alarms Screen

Double Check (or Double Tick) symbol acknowledges all active alarms, the message going from blinking colors to steady color (red).

X mark deletes all alarms that are no longer present.

Volume symbol is not used in this application.

The alarm list is as follows:

<i>Alarm Contact 0 released</i>	PLC, CT or communication alarm
<i>Alarm Contact 1 released</i>	First Fault Occurred
<i>Alarm Contact 2 released</i>	Second Fault Occurred
<i>Bender Comm Fails</i>	Comm fails between Gateway and RCMS490 or NGRM
<i>CT Open Feeder 1</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Open Feeder 2</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Open Feeder 3</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Open Feeder 4</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Open Feeder 5</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Open Feeder 6</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Open Feeder 7</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Open Feeder 8</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Open Feeder 9</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Open Feeder 10</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Open Feeder 11</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Open Feeder 12</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 1</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 2</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 3</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 4</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 5</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 6</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 7</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 8</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 9</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 10</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 11</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>CT Short Feeder 12</i>	Requires setting in RCMS490: Enable CT Monitoring
<i>Channel Oper 1</i>	RCMS490 channel 1 operates (Ground current >20A)
<i>Channel Oper 2</i>	RCMS490 channel 2 operates (Ground current >20A)
<i>Channel Oper 3</i>	RCMS490 channel 3 operates (Ground current >20A)
<i>Channel Oper 4</i>	RCMS490 channel 4 operates (Ground current >20A)
<i>Channel Oper 5</i>	RCMS490 channel 5 operates (Ground current >20A)
<i>Channel Oper 6</i>	RCMS490 channel 6 operates (Ground current >20A)
<i>Channel Oper 7</i>	RCMS490 channel 7 operates (Ground current >20A)
<i>Channel Oper 8</i>	RCMS490 channel 8 operates (Ground current >20A)
<i>Channel Oper 9</i>	RCMS490 channel 9 operates (Ground current >20A)
<i>Channel Oper 10</i>	RCMS490 channel 10 operates (Ground current >20A)
<i>Channel Oper 11</i>	RCMS490 channel 11 operates (Ground current >20A)
<i>Channel Oper 12</i>	RCMS490 channel 12 operates (Ground current >20A)
<i>Ground Current Warning Feeder 1</i>	RCMS490 ground current 1 > warning setpoint
<i>Ground Current Warning Feeder 2</i>	RCMS490 ground current 2 > warning setpoint
<i>Ground Current Warning Feeder 3</i>	RCMS490 ground current 3 > warning setpoint
<i>Ground Current Warning Feeder 4</i>	RCMS490 ground current 4 > warning setpoint
<i>Ground Current Warning Feeder 5</i>	RCMS490 ground current 5 > warning setpoint
<i>Ground Current Warning Feeder 6</i>	RCMS490 ground current 6 > warning setpoint

Ground Current Warning Feeder 7	RCMS490 ground current 7 > warning setpoint
Ground Current Warning Feeder 8	RCMS490 ground current 8 > warning setpoint
Ground Current Warning Feeder 9	RCMS490 ground current 9 > warning setpoint
Ground Current Warning Feeder 10	RCMS490 ground current 10 > warning setpoint
Ground Current Warning Feeder 11	RCMS490 ground current 11 > warning setpoint
Ground Current Warning Feeder 12	RCMS490 ground current 12 > warning setpoint
Modbus Comm Fails	Modbus comm not working between PLC and Relays
PLC stops	PLC application stopped
RCMS490 fails	RCMS490 internal fault
Feeder 1 Trip	PLC trips feeder 1
Feeder 2 Trip	PLC trips feeder 2
Feeder 3 Trip	PLC trips feeder 3
Feeder 4 Trip	PLC trips feeder 4
Feeder 5 Trip	PLC trips feeder 5
Feeder 6 Trip	PLC trips feeder 6
Feeder 7 Trip	PLC trips feeder 7
Feeder 8 Trip	PLC trips feeder 8
Feeder 9 Trip	PLC trips feeder 9
Feeder 10 Trip	PLC trips feeder 10
Feeder 11 Trip	PLC trips feeder 11
Feeder 12 Trip	PLC trips feeder 12

SLD (Single Line Diagram) Screen

This is a customized screen showing the Single Line Diagram arrangement.

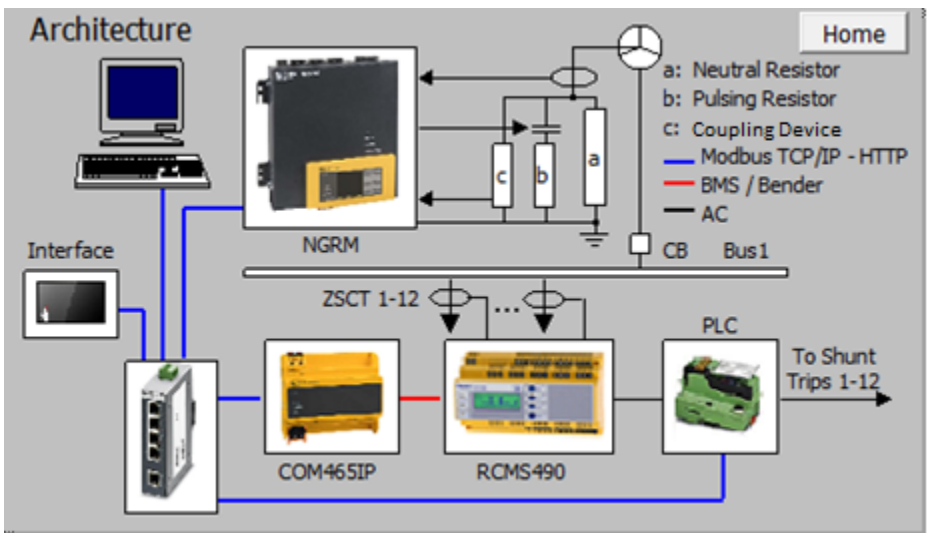


Figure 6 SLD Screen

System Screen

Use the SYSTEM screen to:

Review:

1. Maximum (since energized) and most recent PLC scan time in microseconds.
2. Controller number of errors.
3. HMI status

Configure:

1. Number of substations (from 1 to 6)
2. Total number of feeders (12 up to 120)
3. Alarm (Warning) threshold in Amps.
4. First Fault threshold in Amps.
5. Second Ground Fault Tripping OFF Delay in milliseconds (see note below)
6. Pulse Duration in milliseconds
7. Selected Language: English, Spanish, Portuguese, French, German.
8. Ground Fault and Resistor Monitoring Relay being used: NGRM500 or NGRM700.

Notes:

To prevent false tripping due to inrush currents, Ground Fault Relay Response Time for all channels should be increased. Typical value is 20 to 30 milliseconds. Use Tripping OFF Delay as required to extend tripping signal duration.




System	IP addresses	Credits	Home
PLC errors	<input type="text" value="x"/>	Active Controller	<input type="text" value="x"/>
Maximum Scan Time	<input type="text" value="xxxx"/> microsec	HMI running	<input type="text" value="x"/>
Last Scan Time	<input type="text" value="xxxx"/> microsec		
Alarmas active	<input type="text" value="xxx"/>	Spanish	 <input type="radio"/>
Number of Substations	<input type="text" value="x"/>	English	 <input type="radio"/>
Number of Feeders	<input type="text" value="xx"/>	French	 <input type="radio"/>
Ground Fault Warning	<input type="text" value="x.xx"/> A		
First Fault	<input type="text" value="x.xx"/> A		
Trip Off Delay	<input type="text" value="xxxx"/> millisec	HMI Password: abc123	

Figure 7 System Screen

Configuration and Screen Passwords

1. For configuring Feeders and Substations, User Name and Password may be required:

Factory username: Config

Factory password: hrg

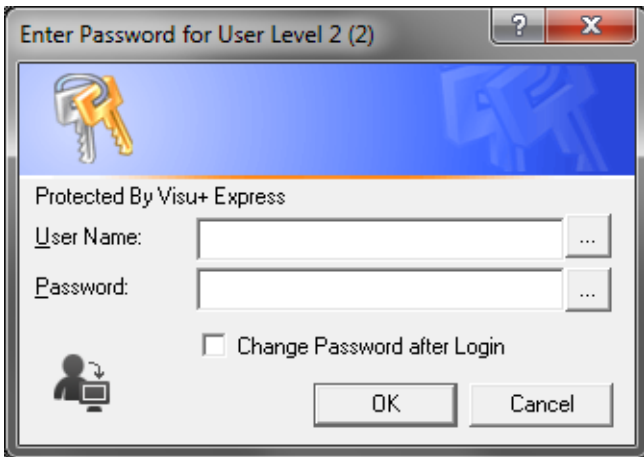


Figure 8 Password Screen

2. If HMI (Operator Panel) configuration parameters should be modified, power cycle the unit, interrupt the boot up process and enter either one of the following passwords:

+-+-

abc123

HMI menus will be accessible for making the required changes.

Help Screens

Useful screens for helping in system configuration, operation and communications

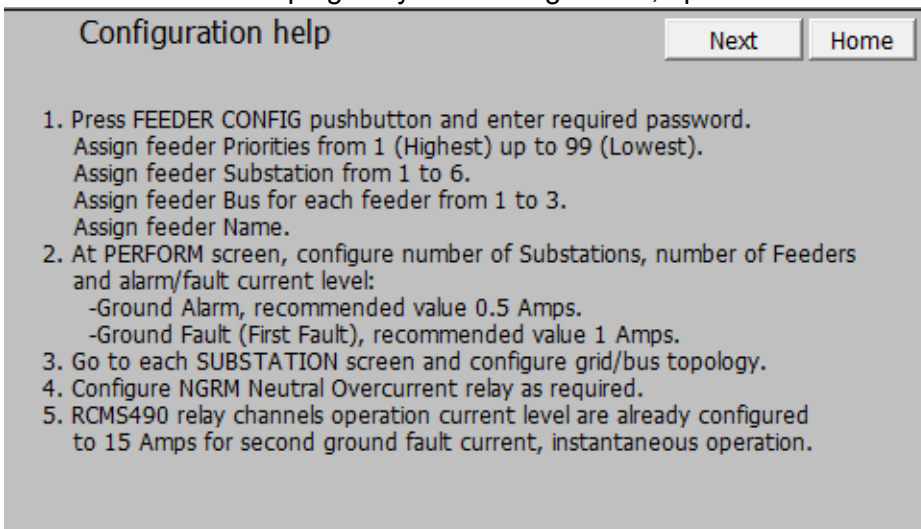


Figure 9 Configuration help Screen

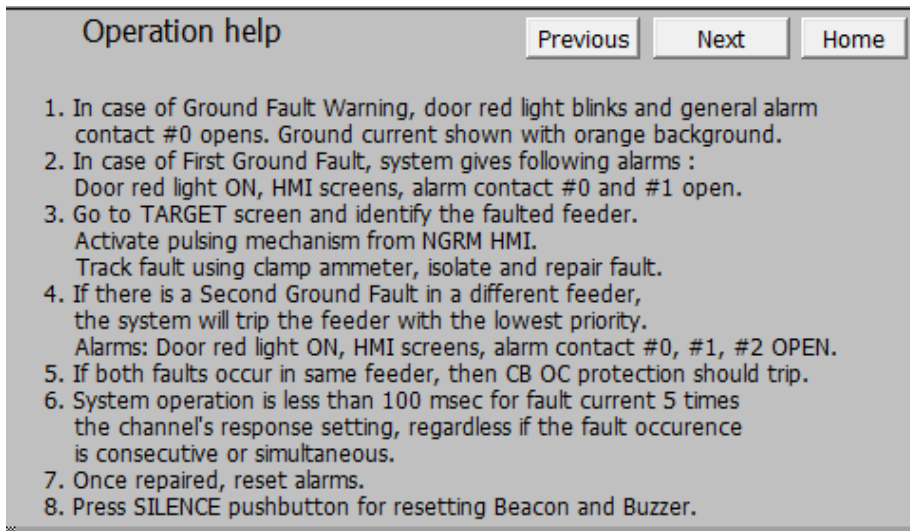


Figure 10 Operation help Screen

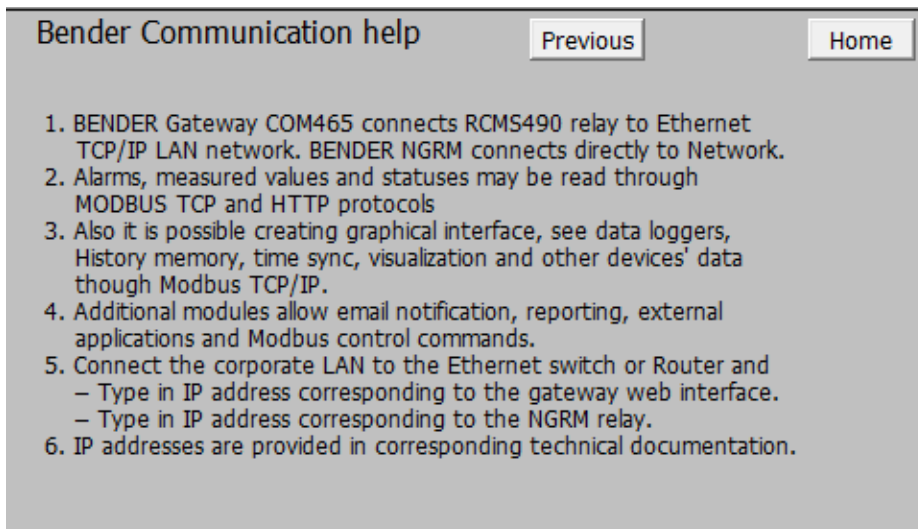


Figure 11 Bender Communicatio help Screen

Trendings Screens

All parameters in these screens are completely configurable by user according to their needs

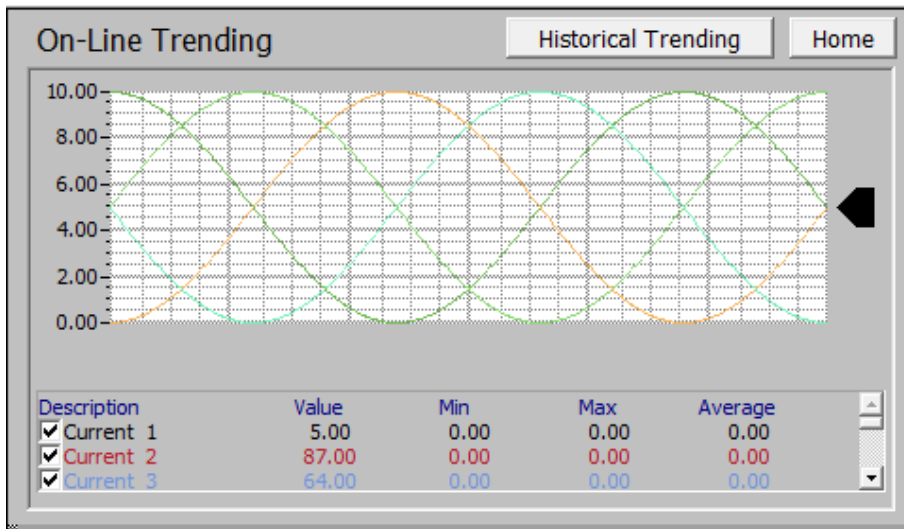


Figure 12 Trending Screen

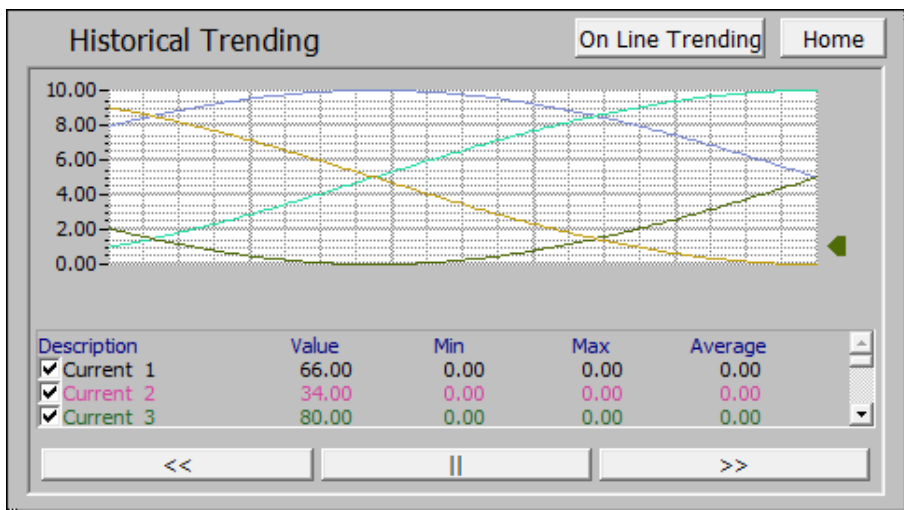


Figure 13 Historical Trending Screen

Substation Screens

SUBSTATIONS screens are accessed from the HOME screen and are used to:

1. Configure:
 - a. Power distribution network topology (password required)
 - b. Substation bus bar topology (password required)
2. Monitor:
 - a. Status of Ties/Circuit Breakers
 - b. Phase under-voltage relay operation
 - c. Occurrence of first ground fault (identifying faulted busbar and feeder)
 - d. Occurrence of neutral grounding resistor failure
3. Activate pulsing when using NGRM500 relay(s). When using NGRM700 relays pulsing is activated from the relay's FP200 interface.

Power System Configuration

For radial Power Systems there are two types of substations:

1. **Main Substation:** Connected directly to Utility or Auxiliary Generator. These substations may have one, two or three bus bars, each bus bar with its own NGR.
2. **Downstream Substation:** Connected to Main substation, involving only one bus bar and no NGR.

These two different Substation types are identified as follows (refer to SUBSTATION screens shown below):

1. Substation arrangement:
 - a. Each substation (Main or Downstream) is assigned a number from 1 to 6. Number 0 is used when the substation being configured has no upstream substation.
 - b. **Main Substations** do not have any upstream Substation from which to receive power from. So, at any Substation screen, entering the value 0 in the field named *Main Substat* makes this Substation as Main. Main bus value is ignored in this case.
 - c. **Downstream Substations** are identified by entering the number of the corresponding upstream Main substation station from 1 to 6, and bus bar from 1 to 3 in the fields named Main and Bus Bar. Downstream Substations require entering the Main substation number and its corresponding bus bar, regardless of any interposed substation that might be connected.
2. Number of Ties:
 - a. The only required value to enter in this field is the number of Bus Bar Ties (0, 1 or 2) for each substation.

Relay Configuration

All the relays in the system are factory configured for proper operation, requiring field adjustment only in case of simultaneous large inrush currents, for example when powering up large motors at the same time.

Example 1: One substation (Main) with a single bus bar

1. Main Substat = 0 (There is no upstream substation).
2. Main Bus = 1 (There is no Ties).

The status of Mains and Tie circuit breakers are displayed as follows:

1. Red: To indicate the circuit breaker is open.
2. Green: To indicate the circuit breaker is closed.

This convention can be modified according to customer needs.

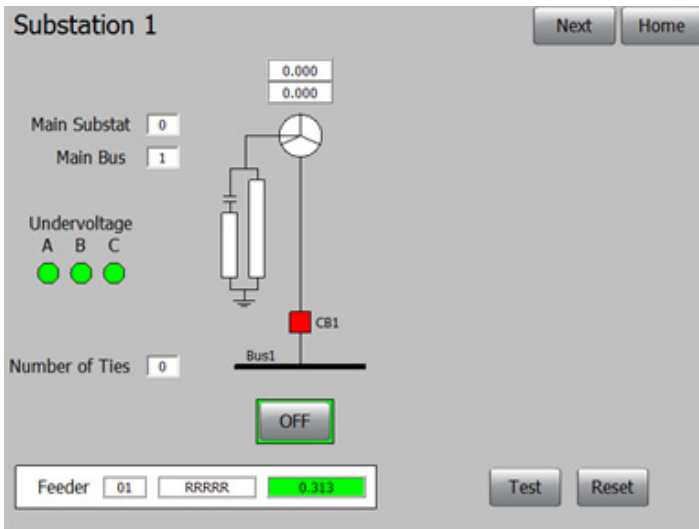


Figure 14 Example 1

Example 2: One substation (Main) with two bus bars

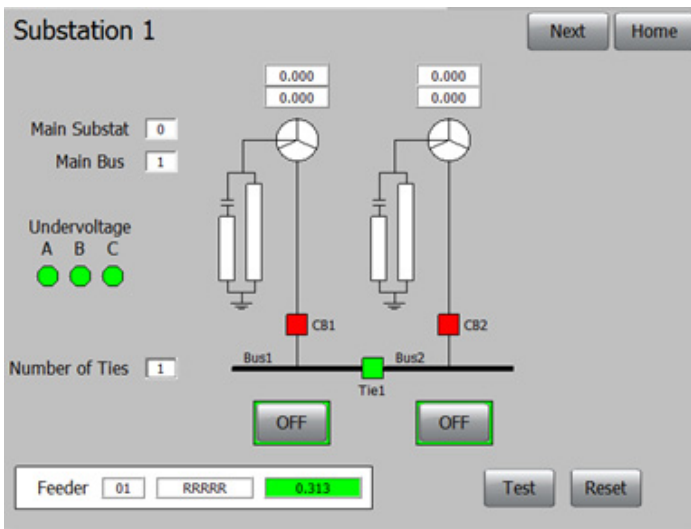


Figure 15 Example 2

When the Tie circuit breaker is closed, two important considerations apply:

1. For Generators or Transformers operating in parallel, proper interlocking must be provided between CB1, CB2 and Tie1.
2. The total unbalanced capacitive charging current will increase when Tie1 is closed. This condition must be taken into consideration when selecting ground-fault alarm and trip settings.

Example 3: One substation (Main) with three bus bars

This is a typical configuration used when an auxiliary generator is connected to Bus 2, providing power to bus 1 or bus 3 in case of need. Proper interlocking is required.

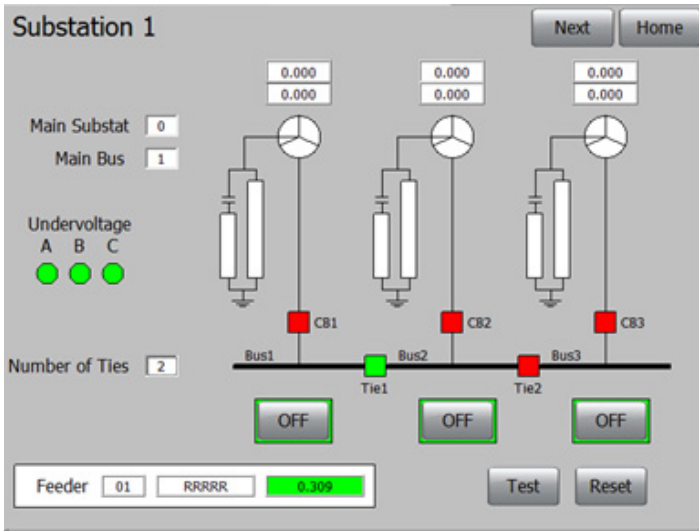


Figure 16 Example 3

Same screen, not including Phase Voltage Monitoring:

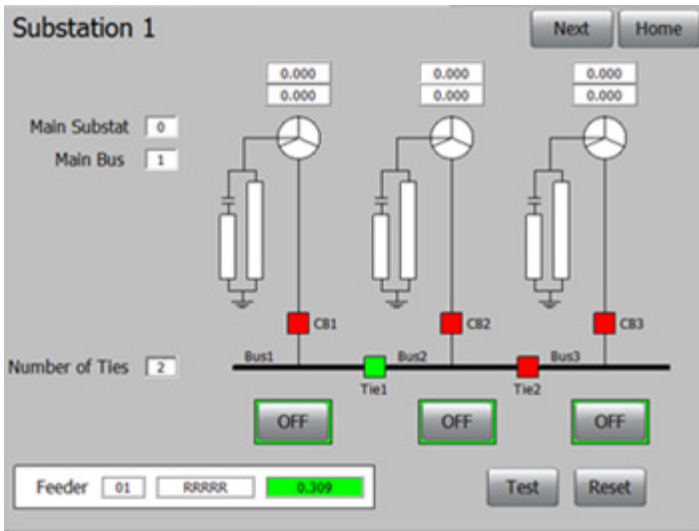


Figure 17 Example 3

Example 4: Adding downstream substations

Substation 2, 3, 4 (Downstream) are connected to Substation 1 (Main).

Downstream substations allow only one bus bar.

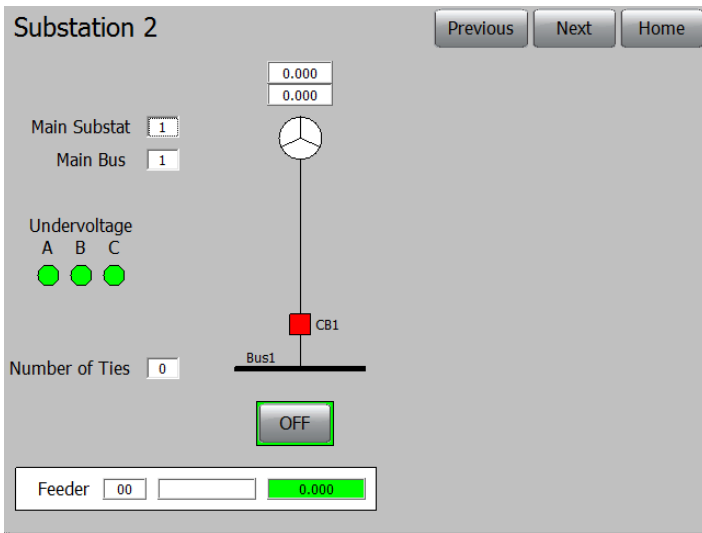


Figure 18 Example 4

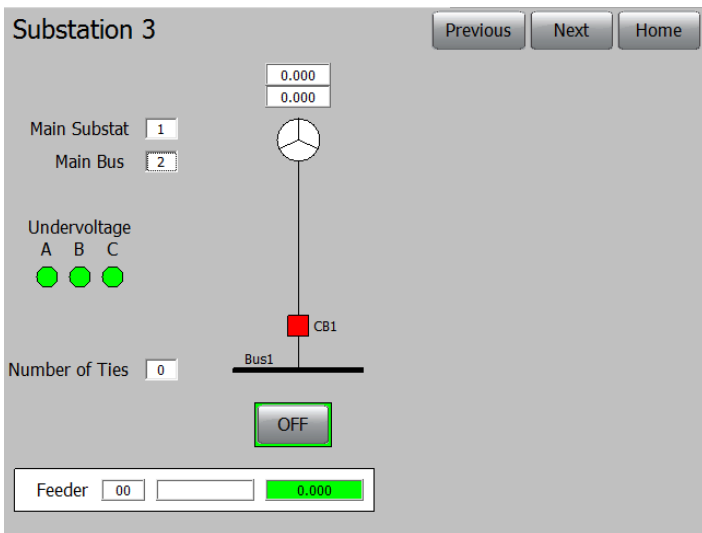


Figure 19 Example 4

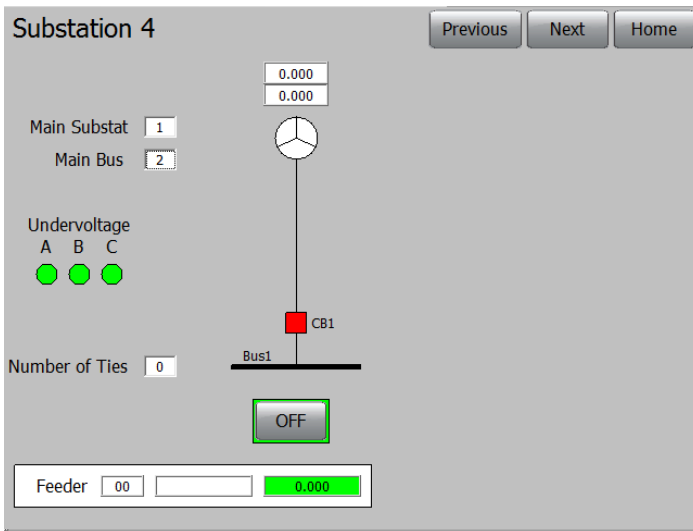


Figure 20 Example 4

System Conditions

Ground Current Alarm Condition

If any feeder ground current exceeds the alarm threshold configured in the HMI SYSTEM screen:

1. Ground Fault (Red) lamp on the front door will start blinking.
2. General Alarm relay will de-energize.
3. HOME, SUBSTATION and TARGET screens will display the corresponding condition.

First Ground Fault Condition

If neutral current exceeds the response value configured in the neutral relay:

1. Neutral relay will operate, changing over the corresponding auxiliary contact status.
2. Ground Fault (Red) lamp on the front door will turn steady ON.
3. Ground fault auxiliary relay will be de-energized.
4. General Alarm and First Ground Fault relays will de-energize.
5. HOME, SUBSTATION and TARGET screens will display the corresponding condition.
6. Close-command-permission auxiliary contacts for the TIE circuit breaker involved in the faulted zone will open if provided.
7. Feeder ground-fault channels will not trip in a first-fault condition since their response value is adjusted to Second Ground Fault current.

Second Ground Fault Condition

If ground current in two or more feeders exceeds the ground fault response configured in the Feeder Ground Fault Current Monitor (The neutral grounding resistor will not be in the path of a second ground fault):

1. Channels corresponding to faulted feeders will trip.

2. Feeders with lowest priorities will trip, while the faulted feeder(s) with the highest priority will remain on service, still at fault, returning the System to First Ground Fault Condition.
3. Ground Fault (Red) lamp on the front door will turn steady ON.
4. Second Ground Fault, First Ground Fault and General Alarm relays will de-energize.
5. HOME, SUBSTATION and TARGET screens will display the corresponding condition.

Neutral Overvoltage Condition

When the neutral voltage exceeds the setting of the Neutral Monitoring relay:

1. Ground Fault (Red) lamp on the front door will turn ON.
2. First Fault and General auxiliary relays will de-energize.
3. The corresponding SUBSTATION screens will show the neutral overvoltage condition.

Resistor Failure Condition

When the resistance path exceeds or declines to predefined limits:

1. Resistor Fault (Red) lamp on the front door will turn steady ON.
2. First Fault and General auxiliary relays will de-energize.
3. The corresponding SUBSTATION screens will display the resistor failure status.

Phase Undervoltage Condition

When there is undervoltage condition in any phase, HOME screen and the corresponding SUBSTATION screen will show it.

Coordination

Two coexistent protection systems may trip a feeder circuit breaker:

1. Circuit breakers' phase/ground overcurrent protection
2. Second Ground Fault protection

For proper selectivity, second ground fault protection must operate faster than phase overcurrent protection. (A circuit breaker's ground overcurrent protection is too slow for this application).

Second ground fault current is a line-to-line current flowing between two feeders through ground. The magnitude of this current is extremely variable in the range of tens to thousands of amps.

The tripping time of this Second Ground Fault Protection System is less than 100 ms, including shunt trip time, for fault current 5 times the response setting (e.g. if response current is set at 16 A, then for 80 A fault current operation time is less than 100 ms).

A typical coordination curve for a molded-case circuit breaker with the Second Ground Fault protection curve superimposed is shown below:

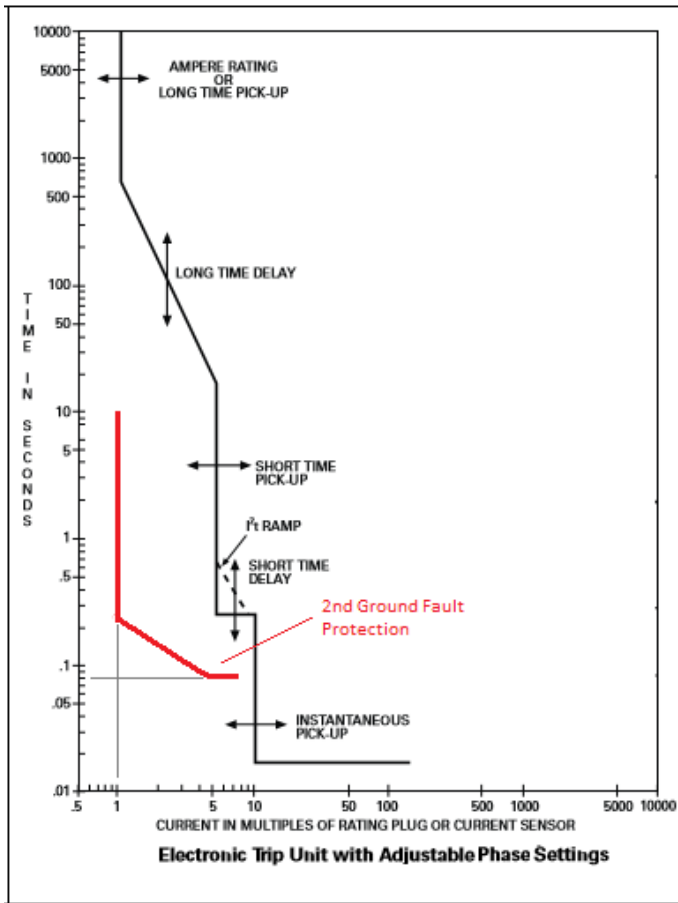


Figure 21 Coordination

Logic Diagrams

The main processes are shown below:

Alarm

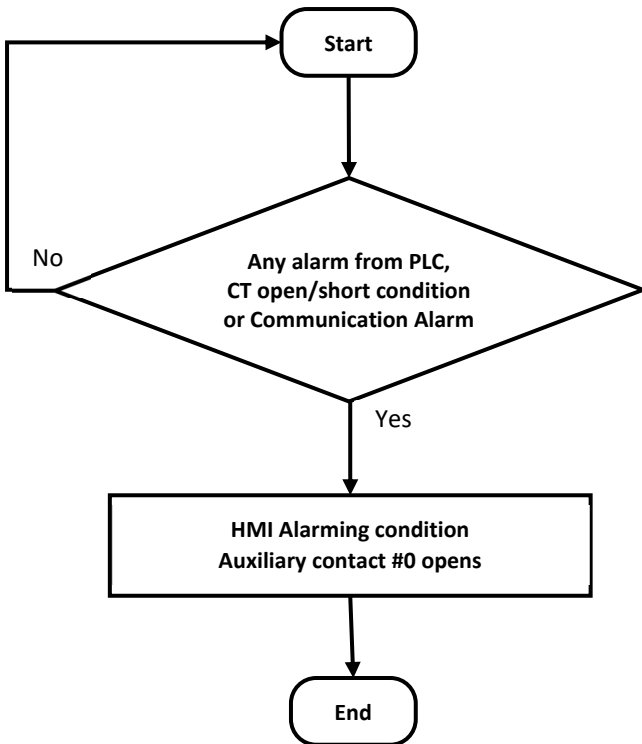


Figure 22 Alarm Condition

First fault

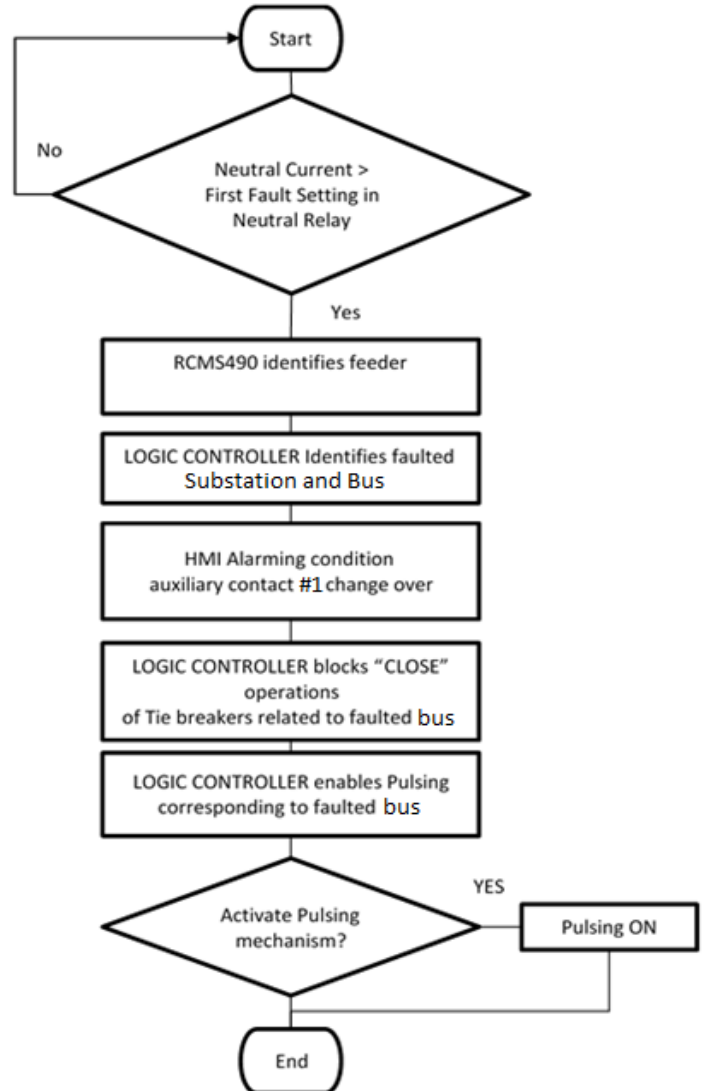
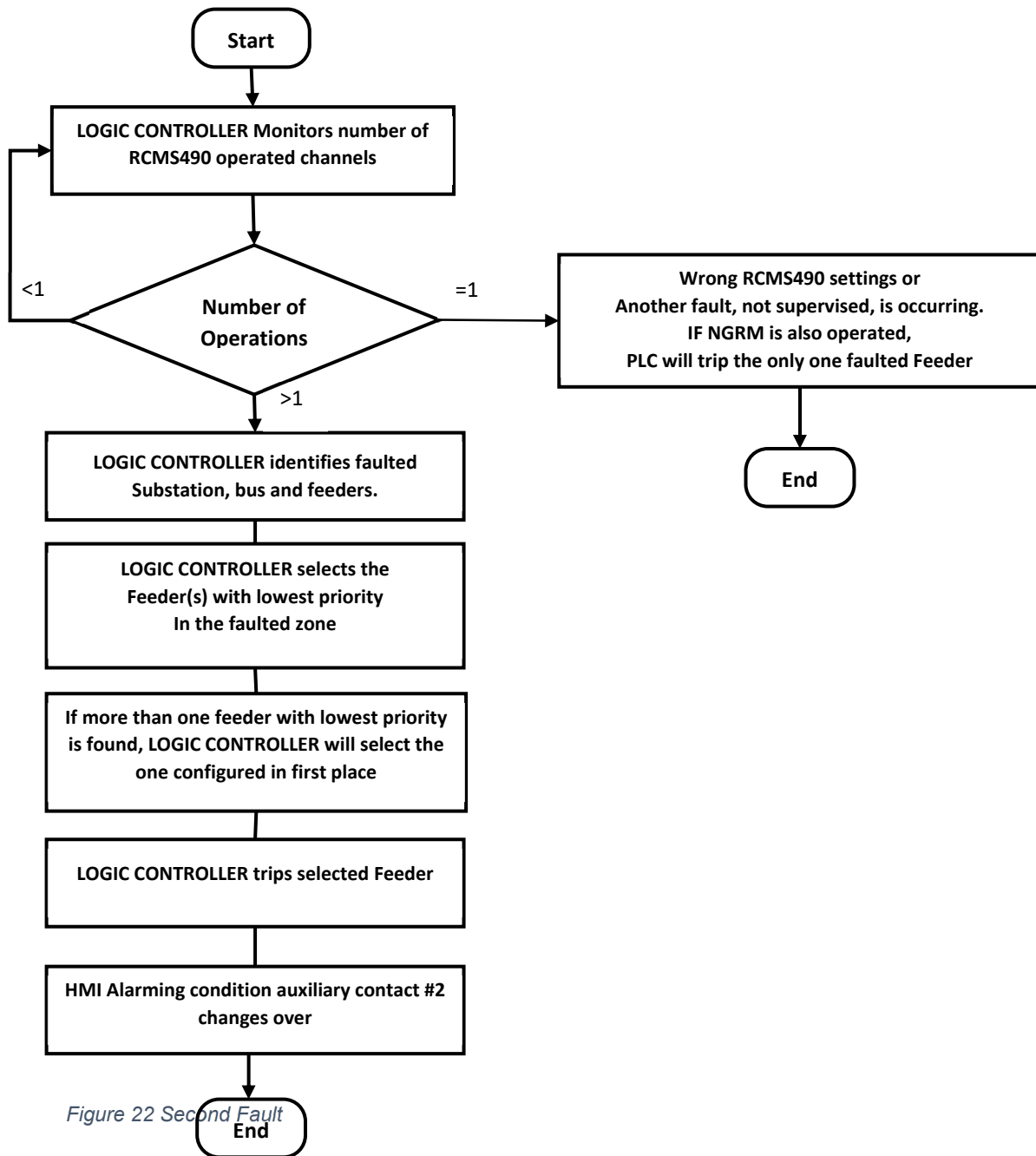


Figure 23 First Fault

Second Fault



NGR-2GFP Units

An NGR-2GFP Unit is a Neutral Grounding Resistor with the required control components to provide second ground fault protection in an industrial distribution system.

One NGR-2GFP Unit is required for each transformer and generator being protected. Some industrial distribution systems will have multiple transformers and generators and therefore require multiple NGR-2GFP units.

An NGR-2GFP Unit can be Standalone, Server or Remote. Server Units can control additional Remote Units to simplify maintenance and operation by having all the information concentrated in one central control point.

RCMS490 and NGRM settings

All of the **RCMS490** settings may be kept as the default values, except the followings:

General Settings

Start-up delay t setting: 5 s.

Channel Settings

Response value: 20A

Response delay: 0 to 20msec

CT monitor: on/off according to the installation requirements

Relay settings

Relay mode operation: N/O-T.

Alarm relay K1: N/C and Device Error: on

All of the **NGRM** should be set according to the installation requirements, with the precaution of considering the setting for the PLC First Fault response (page 15) same as in the NGRM relay.

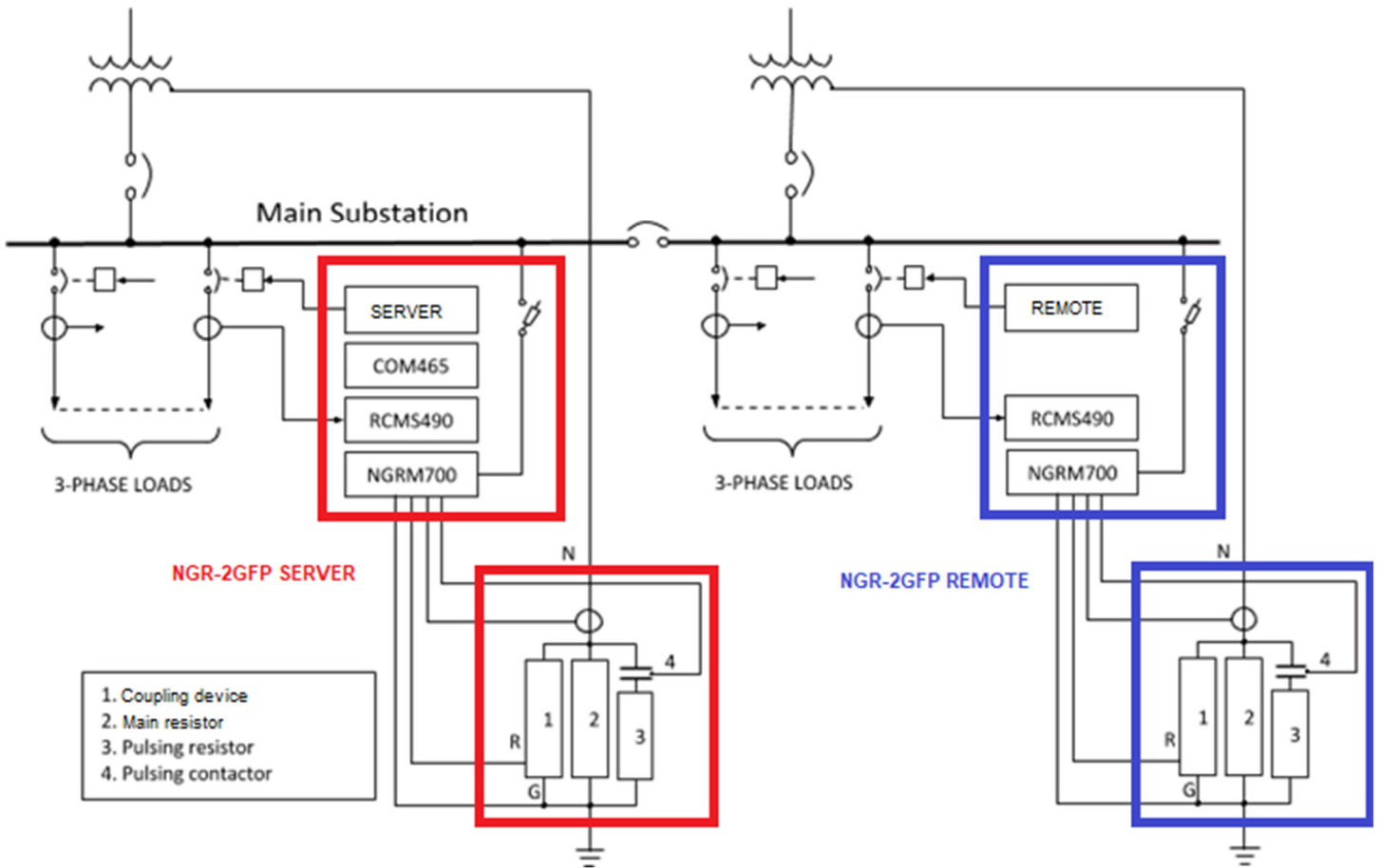


Figure 235 NGR-2GFP Server and Remote Units

Form Factors

Integrated System

A single enclosure with all the main system components except for the Feeder Ground Current Transformers. Optional components such as Zig-zag transformer, Disconnect Switch, Grounding Transformer and Touchscreen Operator Panel can sometimes be included in the same standard enclosure or in a larger enclosure.

Recommended for end users, system integrators and electrical-house manufacturers.

Easy to order, ship, install and maintain. Only available for low voltage systems. For medium voltage systems an NGR-2GFP Separated System is required.

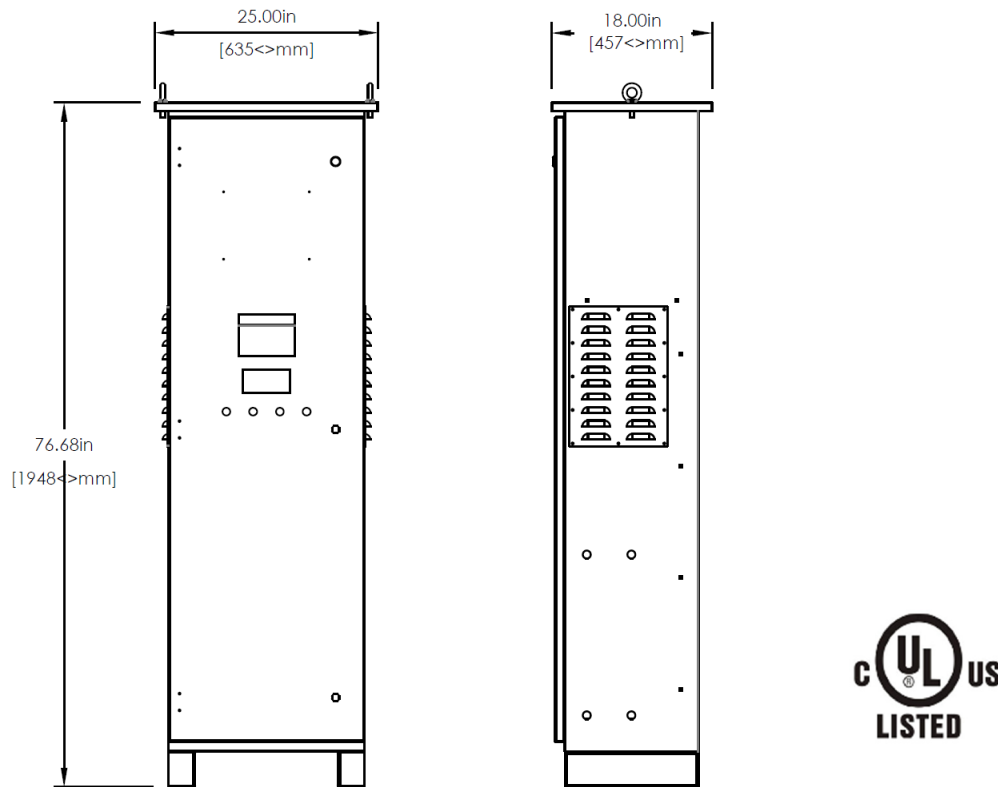


Figure 246 Integrated System HR4 Enclosure

Components

All standard units provide Second Ground Fault Protection, AC/DC Alarm, Communications, Harmonic Filtering, Pulsing System and Resistor Monitoring.

The main components included in the standard HR4 enclosure are:

- REHR Neutral Resistor with Pulsing Resistor
- CD1000 Coupling Device
- NGRM700 or NGRM500 Neutral Ground Fault and Resistor Monitor
- CTUB103-CTBC35 Neutral Current Transformer
- RCMS490 Feeder Ground Fault Current Monitor
- ELCO-L12 Standalone System Controller 12 Feeders ILC 131 ETH System Controller
- COM465IP Communications Gateway
- HMI-6 Touchscreen Operator Panel

Other available components include:

- Feeder Ground Fault Current Transformers (One required for each feeder)
- Load-break Switch
- Zig-zag transformer (Required when the system neutral is not available)
- Disconnect Switch
- Grounding Transformer
- Handheld Pulse Detector
- Portable Ground Fault Location System

Item numbers

For systems with available neutral:

Voltage L/N	Current	With NGRM700			With NGRM500 ¹		
		Item number by number of feeders ²			Item number by number of feeders ²		
		12 AC	6 AC + 6 AC/DC	12 AC/DC	12 AC	6 AC + 6 AC/DC	12 AC/DC
277 Volts	5 Amps	140001	140004	140007	140010	140013	140016
	10 Amps	140002	140005	140008	140011	140014	140017
	1-5 Amps	140003	140006	140009	140012	140015	140018
347 Volts	5 Amps	140019	140022	140025	140028	140031	140034
	10 Amps	140020	140023	140026	140029	140032	140035
	1-5 Amps	140021	140024	140027	140030	140033	140036

¹Does not included phase voltage monitoring.

²Call factory for other ratings and additional required features.

Item numbers with zig-zag transformer

For systems with no available neutral:

Voltage L/N	Current	With NGRM700			With NGRM500 ¹		
		Item number by number of feeders ²			Item number by number of feeders ²		
		12 AC	6 AC + 6 AC/DC	12 AC/DC	12 AC	6 AC + 6 AC/DC	12 AC/DC
277 Volts	5 Amps	140037	140040	140043	140046	140049	140052
	10 Amps	140038	140041	140044	140047	140050	140053
	1-5 Amps	140039	140042	140045	140048	140051	140054

347 Volts	5 Amps	140055	140058	140061	140064	140067	140070
	10 Amps	140056	140059	140062	140065	140068	140071
	1-5 Amps	140057	140060	140063	140066	140069	140072

¹Does not include phase voltage monitoring.

²Call factory for other ratings and additional required features.

Separated System

Comes in two or more enclosures: One or more with the Resistive Elements, Coupling Device(s) and Neutral Current Transformer(s) and one or more one with the other components.

Recommended when the resistor cannot be installed in the same room as the control unit due to cooling or installation requirements.

Required for medium voltage systems due to the larger enclosure that is required for the Neutral Grounding Resistor. The control enclosure can be installed attached to a side of the Neutral Grounding Resistor or installed in a separate location.

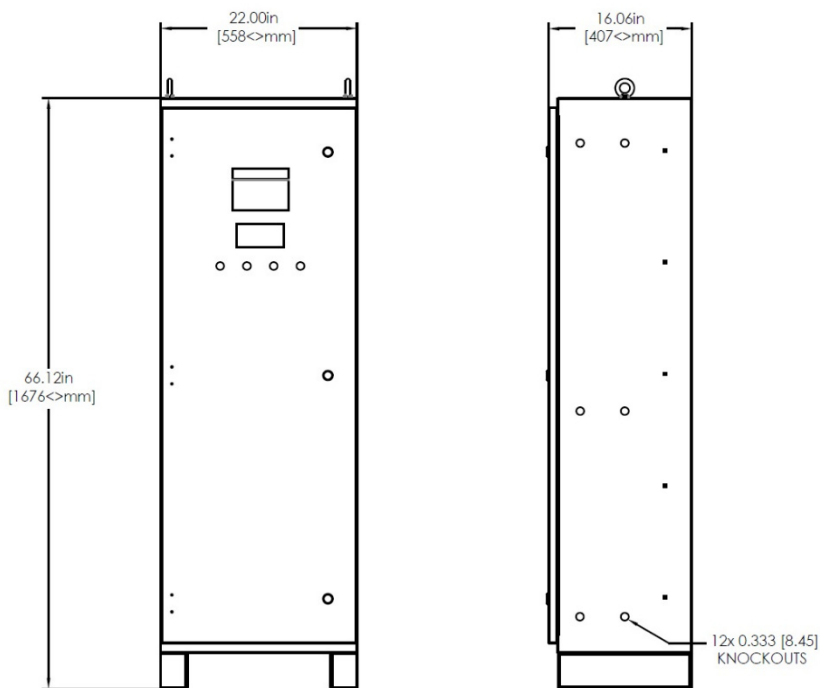


Figure 257 Separated System, HR3 Control Enclosure



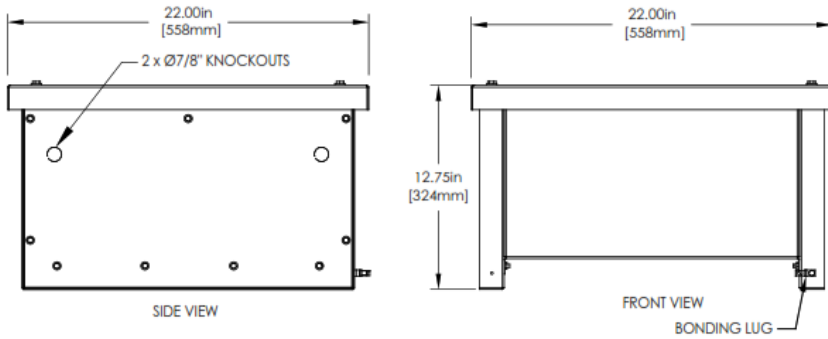


Figure 26 Separated System, N2 Low Voltage Resistor Enclosures

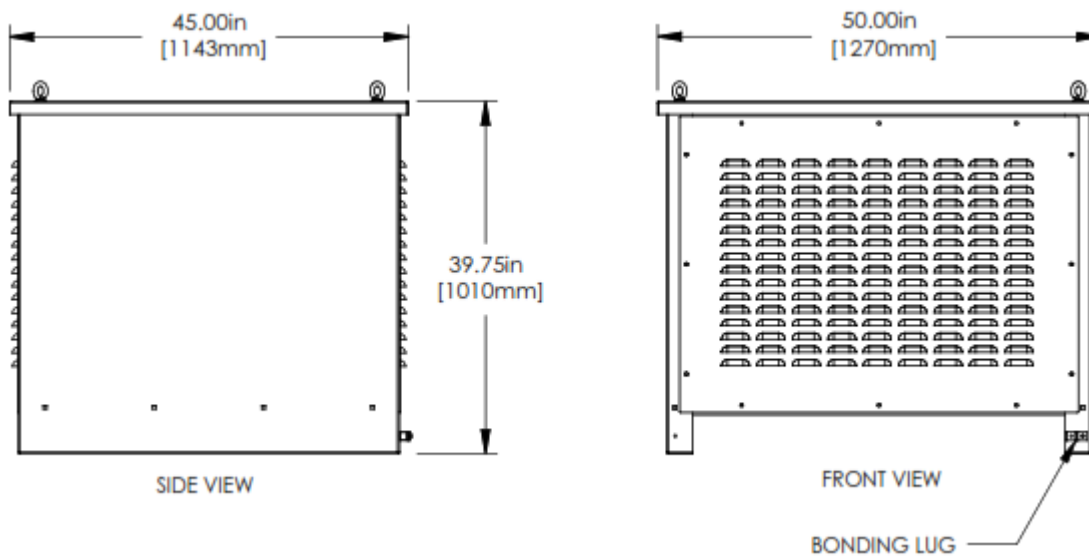


Figure 278 Separated System, N9A Medium Voltage Enclosure

The main components included in the standard HR3 control enclosure are:

- NGRM700 or NGRM500 Neutral Ground Fault and Resistor Monitor
- RCMS490 Feeder Ground Fault Current Monitor
- ELCO-L12 Standalone System Controller 12 Feeders
- COM465IP Communications Gateway
- HMI-6 Touchscreen Operator Panel

The main components included in the standard low voltage resistor N2 enclosure are:

- REHR Neutral Resistor with Pulsing Resistor
- CD1000 Coupling Device
- CTUB103-CTBC35 Neutral Current Transformer

The main components included in the standard medium voltage resistor N9A enclosure are:

- REMV Neutral Resistor with Pulsing Resistor
- CD5000 Coupling Device
- CTUB103-CTBC35 Neutral Current Transformer

When a Zig-zag transformer is required it is installed in the bottom compartment of a double N9A enclosure.

Other available components include:

- Feeder Ground Fault Current Transformers (One required for each feeder)
- Load-break Switch
- Disconnect Switch
- Grounding Transformer
- Handheld Pulse Detector
- Portable Ground Fault Location System

Item numbers

For systems with available neutral:

Voltage L/N	Current	With NGRM700			With NGRM500 ¹		
		Item number by number of feeders ²			Item number by number of feeders ²		
		12 AC	6 AC + 6 AC/DC	12 AC/DC	12 AC	6 AC + 6 AC/DC	12 AC/DC
277 Volts	5 Amps	140073	140076	140079	140082	140085	140088
	10 Amps	140074	140077	140080	140083	140086	140089
	1-5 Amps	140075	140078	140081	140084	140087	140090
347 Volts	5 Amps	140091	140094	140097	140100	140103	140106
	10 Amps	140092	140095	140098	140101	140104	140107
	1-5 Amps	140093	140096	140099	140102	140105	140108
1390 Volts	5 Amps	140109	140112	140115	140118	140121	140124
	10 Amps	140110	140113	140116	140119	140122	140125
	1-5 Amps	140111	140114	140117	140120	140123	140126
2400 Volts	5 Amps	140127	140130	140133	140136	140139	140142
	10 Amps	140128	140131	140134	140137	140140	140143
	1-5 Amps	140129	140132	140135	140138	140141	140144

¹Does not include phase voltage monitoring.

²Call factory for other ratings and additional required features.

Item numbers with zig-zag transformer

For systems with no available neutral:

Voltage L/N	Current	With NGRM700		With NGRM500 ¹	
		Item number by number of feeders ²		Item number by number of feeders ²	

		12 AC	6 AC + 6 AC/DC	12 AC/DC	12 AC	6 AC + 6 AC/DC	12 AC/DC
277 Volts	5 Amps	140145	140148	140151	140154	140157	140160
	10 Amps	140146	140149	140152	140155	140158	140161
	1-5 Amps	140147	140150	140153	140156	140159	140162
347 Volts	5 Amps	140163	140166	140169	140172	140175	140178
	10 Amps	140164	140167	140170	140173	140176	140179
	1-5 Amps	140165	140168	140171	140174	140177	140180
1390 Volts	5 Amps	140181	140184	140187	140190	140193	140196
	10 Amps	140182	140185	140188	140191	140194	140197
	1-5 Amps	140183	140186	140189	140192	140195	140198
2400 Volts	5 Amps	140199	140202	140205	140208	140211	140214
	10 Amps	140200	140203	140206	140209	140212	140215
	1-5 Amps	140201	140204	140207	140210	140213	140216

¹Does not include phase voltage monitoring.

²Call factory for other ratings and additional required features.

Rack System

One or more open frame plug-in module assemblies with one or more separate resistor units.

Recommended as direct replacement for the discontinued Federal Pioneer, IPC, I-Gard DSP MKII and DSA Ground Fault Protection Systems.

The main frame comes with:

- NGRM700 Neutral Ground Fault and Resistor Monitor
- RCMS490 Feeder Ground Fault Current Monitor
- ELCO-L12 Standalone System Controller 12 Feeders
- COM465IP Communications Gateway
- HMI-4 Touchscreen Operator Panel

The main components included in the standard low voltage resistor N3 enclosure are:

- REHR Neutral Resistor with Pulsing Resistor
- CD1000 Coupling Device
- CTUB103-CTBC35 Neutral Current Transformer

The main components included in the standard medium voltage resistor N9A enclosure are:

- REMV Neutral Resistor with Pulsing Resistor
- CD5000 Coupling Device
- CTUB103-CTBC35 Neutral Current Transformer

When a Zig-zag transformer is required it is installed in the bottom compartment of a double N9A enclosure.

Other available components include:

- Feeder Ground Fault Current Transformers (One required for each feeder)

- Load-break Switch
- Disconnect Switch
- Grounding Transformer
- Handheld Pulse Detector
- Portable Ground Fault Location System

Item numbers

For systems with available neutral:

Voltage L/N	Current	With NGRM700			With NGRM500 ¹		
		Item number by number of feeders ²			Item number by number of feeders ²		
		12 AC	6 AC + 6 AC/DC	12 AC/DC	12 AC	6 AC + 6 AC/DC	12 AC/DC
277 Volts	5 Amps	140217	140220	140223	140226	140229	140232
	10 Amps	140218	140221	140224	140227	140230	140233
	1-5 Amps	140219	140222	140225	140228	140231	140234
347 Volts	5 Amps	140235	140238	140241	140244	140247	140250
	10 Amps	140236	140239	140242	140245	140248	140251
	1-5 Amps	140237	140240	140243	140246	140249	140252
1390 Volts	5 Amps	140253	140256	140259	140262	140265	140268
	10 Amps	140254	140257	140260	140263	140266	140269
	1-5 Amps	140255	140258	140261	140264	140267	140270
2400 Volts	5 Amps	140271	140274	140277	140280	140283	140286
	10 Amps	140272	140275	140278	140281	140284	140287
	1-5 Amps	140273	140276	140279	140282	140285	140288

¹Does not include phase voltage monitoring.

²Call factory for other ratings and additional required features.

Item numbers with zig-zag transformer

For systems with no available neutral:

Voltage L/N	Current	With NGRM700			With NGRM500 ¹		
		Item number by number of feeders ²			Item number by number of feeders ²		
		12 AC	6 AC + 6 AC/DC	12 AC/DC	12 AC	6 AC + 6 AC/DC	12 AC/DC
277 Volts	5 Amps	140289	140292	140295	140298	140301	140304
	10 Amps	140290	140293	140296	140299	140302	140305
	1-5 Amps	140291	140294	140297	140300	140303	140306
347 Volts	5 Amps	140307	140310	140313	140316	140319	140322
	10 Amps	140308	140311	140314	140317	140320	140323
	1-5 Amps	140309	140312	140315	140318	140321	140324
1390 Volts	5 Amps	140325	140328	140331	140334	140337	140340
	10 Amps	140326	140329	140332	140335	140338	140341
	1-5 Amps	140327	140330	140333	140336	140339	140342
2400 Volts	5 Amps	140343	140346	140349	140352	140355	140358
	10 Amps	140344	140347	140350	140353	140356	140359

	1-5 Amps	140345	140348	140351	140354	140357	140360
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¹Does not include phase voltage monitoring.

²Call factory for other ratings and additional required features.

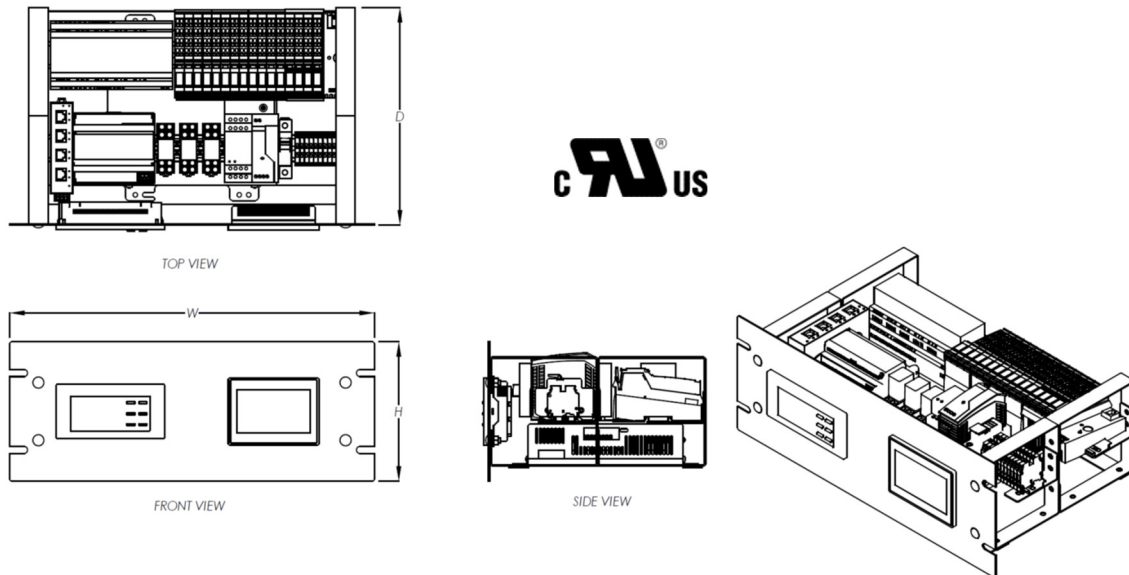


Figure 289 Rack System, Main Frame

Extender frames are available to increase the number of feeders in multiples of 12 or 24. Both main and extender frames come in a 19" (483 mm) rack enclosure to allow direct replacement of installed DSP MKII and DSA Systems.

A separate resistor unit with the Neutral Resistor, Pulsing Resistor, Coupling Device and Neutral Current Transformer is included.

Two current-transformer options are available for retrofitting applications:

- 1) Replacing the existing TXA* current transformers with Bender W or CTBC series current transformers. This will add monitoring of the connection cables for open or short circuit. The use of CTBC current transformers will allow detection of faults from DC to 1.9 kHz.
- 2) Leave existing TXA* current transformers installed and add a Bender W or CTAC current transformer cascaded with five primary turns from the TXA-secondary terminals to provide the correct ratio for the RCMS relay.

*Legacy TXA (Type T Series A) current transformers manufactured by Federal Pioneer, IPC and I-Gard including models T2A, T3A, T3A-S, T6A, T6A-S, T9A, R7-13A, R14-17A and R8-26A are supported. DC Ground Fault Monitoring is not supported by TXA Sensors. If DC to 1.9 kHz ground fault monitoring is required, TXA Sensors must be replaced with Bender CTBC current transformers.

For cascading, Bender W or CTAC current transformers including models W1-S35, W0-S20, CTAC20 and CTAC35 can be used.

Existing cables connecting TXA current transformers to DSP / DSA systems can be used to connect W or CTAC current transformers.

Cascade current transformers can be installed beside the existing T sensors, to allow monitoring of the connection cables for open or short circuit, or beside the Rack System in the control enclosure.

To use cascaded current transformers:

- 1) Pass five wraps of the existing current transformer secondary leads through the window of the W or CTAC current transformer to reduce the transformation ratio five times from 1000:1 to 200:1 (See Figure 28 below)
- 2) Enter 200 in the field Factor of the corresponding channel setting of the RCMS90 relay

Type T Series A
current transformer
X = 1000 A / 1 A

Bender measuring
current transformer
with 5 primary turns

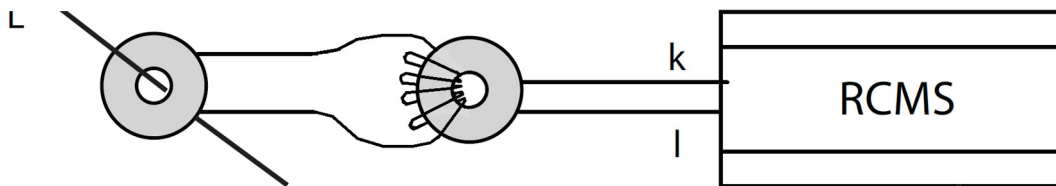


Figure 30 Cascading CTs

Plate System

Open Frame Plates: Back Plates and Front Plates combination with separate resistor enclosures.

Generally used by electrical houses manufacturers to be integrated into their own panels for large projects involving multiple units.

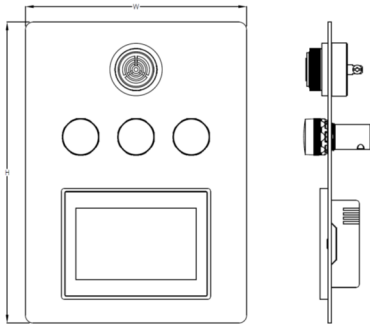


Figure 31 Plate System, Front Plate

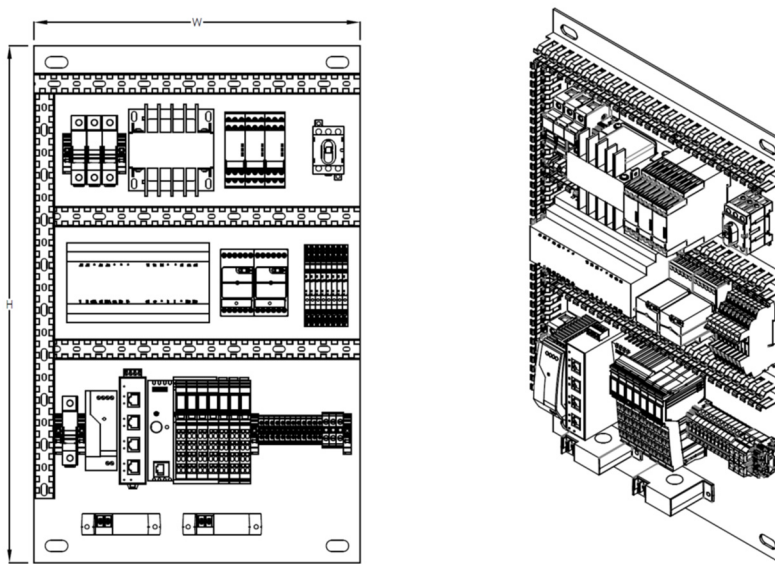


Figure 32 Plate System, Back Plate

The main components included in the back plate are:

- NGRM700 Neutral Ground Fault and Resistor Monitor
- RCMS490 Feeder Ground Fault Current Monitor
- ELCO-L12 Standalone System Controller 12 Feeders
- COM465IP Communications Gateway

The main components included in the front plate are:

- HMI-4 Touchscreen Operator Panel

The main components included in the standard resistor enclosure are:

- REHR Neutral Resistor with Pulsing Resistor
- CD1000 or CD5000 Coupling Device
- CTUB103-CTBC35 Neutral Current Transformer

Other available components include:

- Feeder Ground Fault Current Transformers (One required for each feeder)
- Load-break Switch
- Zig-zag transformer (Required when the system neutral is not available)
- Disconnect Switch
- Grounding Transformer
- Handheld Pulse Detector
- Portable Ground Fault Location System

When a Zig-zag transformer is required it is installed in the bottom compartment of a double N9A enclosure.

Other available components include:

- Feeder Ground Fault Current Transformers (One required for each feeder)
- Load-break Switch
- Disconnect Switch
- Grounding Transformer
- Handheld Pulse Detector
- Portable Ground Fault Location System

Item numbers

For systems with available neutral:

Voltage L/N	Current	With NGRM700			With NGRM500 ¹		
		Item number by number of feeders ²			Item number by number of feeders ²		
		12 AC	6 AC + 6 AC/DC	12 AC/DC	12 AC	6 AC + 6 AC/DC	12 AC/DC
277 Volts	5 Amps	140361	140364	140367	140370	140373	140376
	10 Amps	140362	140365	140368	140371	140374	140377
	1-5 Amps	140363	140366	140369	140372	140375	140378
347 Volts	5 Amps	140379	140382	140385	140388	140391	140394
	10 Amps	140380	140383	140386	140389	140392	140395
	1-5 Amps	140381	140384	140387	140390	140393	140396
1390 Volts	5 Amps	140397	140400	140403	140406	140409	140412
	10 Amps	140398	140401	140404	140407	140410	140413
	1-5 Amps	140399	140402	140405	140408	140411	140414
2400 Volts	5 Amps	140415	140418	140421	140424	140427	140430
	10 Amps	140416	140419	140422	140425	140428	140431
	1-5 Amps	140417	140420	140423	140426	140429	140432

¹Does not include phase voltage monitoring.

²Call factory for other ratings and additional required features.

Item numbers with zig-zag transformer

For systems with no available neutral:

Voltage L/N	Current	With NGRM700			With NGRM500 ¹		
		Item number by number of feeders ²			Item number by number of feeders ²		
		12 AC	6 AC + 6 AC/DC	12 AC/DC	12 AC	6 AC + 6 AC/DC	12 AC/DC
277 Volts	5 Amps	140433	140436	140439	140442	140445	140448
	10 Amps	140434	140437	140440	140443	140446	140449
	1-5 Amps	140435	140438	140441	140444	140447	140450
347 Volts	5 Amps	140451	140454	140457	140460	140463	140466
	10 Amps	140452	140455	140458	140461	140464	140467
	1-5 Amps	140453	140456	140459	140462	140465	140468
1390 Volts	5 Amps	140469	140472	140475	140478	140481	140484
	10 Amps	140470	140473	140476	140479	140482	140485
	1-5 Amps	140471	140474	140477	140480	140483	140486
2400 Volts	5 Amps	140487	140490	140493	140496	140499	140502
	10 Amps	140488	140491	140494	140497	140500	140503
	1-5 Amps	140489	140492	140495	140498	140501	140504

¹Does not include phase voltage monitoring.

²Call factory for other ratings and additional required features.

Loose Components System

The main components are shipped loose to be integrated into an OEM enclosure.

Generally used by switchgear manufactures to be integrated with other components for large projects involving multiple units.

The main components required are:

- NGRM700 Neutral Ground Fault and Resistor Monitor
- RCMS490 Feeder Ground Fault Current Monitor
- ELCO-L12 Standalone System Controller 12 Feeders
- COM465IP Communications Gateway
- HMI-4 Touchscreen Operator Panel

And a separate neutral grounding resistor with

- CD1000 or CD5000 Coupling Device
- CTUB103-CTBC35 Neutral Current Transformer

Other available components include:

- Feeder Ground Fault Current Transformers (One required for each feeder)
- Load-break Switch
- Zig-zag transformer (Required when the system neutral is not available)
- Disconnect Switch
- Grounding Transformer
- Handheld Pulse Detector
- Portable Ground Fault Location System

Main Components

Resistive Elements

Used to limit the ground fault current to a safe value while at the same time letting enough current flow to operate the protective relays that will alarm or clear the fault. While the disturbance lasts the resistor must be capable of absorbing and dissipating the energy generated without exceeding the temperature limits established by international standards. In this way the fault is safely limited, isolated, and the power system is protected against transient over-voltages.

Resistive elements are generally manufactured using special stainless steel alloys mounted in porcelain insulators, supported by stainless steel rods, connected with stainless steel or copper shunts and attached using galvanized steel brackets.

Multiple taps are available, as an option, to allow for future changes in system design that require a change of ground fault current. Pulsing and testing sections can also be added to the resistive elements configuration to allow for added functionality.

The insulation, spacing and protection of resistive elements require careful consideration to meet voltage and current ratings and to provide adequate cooling.

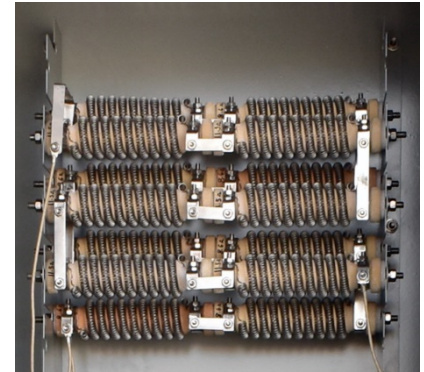


Figure 293 Resistive Elements

Coupling Device

Used to monitor the neutral path from the transformer X0 to the Neutral Grounding Resistor.

Models:

CD1000 for up to 1000 V L/L (577 V L/N)

CD5000 for up to 5kV L/L (2887 V L/N)



Figure 34 CD1000



Figure 305 CD5000

Neutral Ground Fault and Resistor Monitor

Two available models: NGRM500 and NGRM700.

This relay is used to monitor neutral current, harmonics, and voltage in addition to monitor NGR resistance. Model NGRM700 can also monitor phase voltages.

Main features:

1. Alarm or trip on ground fault
2. Continuous monitoring of NGR resistance value, open/short detection



Figure 316 NGRM500

3. AC/DC Monitoring of NGR current (fundamental and harmonics)
4. Monitoring of NGR voltage
5. Pulsing timer and output
6. Modbus RTU and TCP/IP communication, and web server
7. Fault/History memory
8. Detachable user interface for door mounting
9. Phase-to-Phase and Phase-to-Ground voltage indication (NGRM700)



Figure 33 W Series

Neutral Current Transformers

One Bender current transformer series W1-S35 systems. It can be replaced with a CTUB102-Monitoring is required.



Figure 327 NGRM700

is included in all standard CTBC35 if AC/DC Ground Fault

Feeder Ground Current Transformers

One Bender current transformer series W, WR, CTAC or CTUBC is required per feeder.

A series CTUB102-CTBC with the corresponding 24V power supply must be used if AC/DC Ground Fault Monitoring is required.



Figure 35 WR Series

W Series	Window diameter
W0-S20	20 mm
W1-S35	35 mm
W2-S70	70 mm
W3-S105	105 mm
W4-S140	140 mm
W5-S210	210 mm



Figure 34 CTAC Series

R Series	Window size
WR70x175S	70 x 175 mm
WR115x305S	115 x 305 mm
WR115x350S	115 x 350 mm
WR200x500S	200 x 500 mm

CTAC Series*	Window diameter
--------------	-----------------

CTAC20	20 mm
CTAC35	35 mm
CTAC60	60 mm
CTAC120	120 mm
CTAC210	210 mm

CTUB Series*	Window diameter
CTUB102-CTBC20	20 mm
CTUB102-CTBC35	35 mm
CTUB102-CTBC60	60 mm
CTUB102-CTBC120	120 mm
CTUB102-CTBC210	210 mm

Feeder Ground Fault Current Monitor

The Bender RCMS490 relay is a residual current monitor for twelve channels providing values, alarms and tripping functions. Its main features include:

1. Twelve measuring current channels, from 6mA to 20A
2. Option to measure true RMS value, or filtered 50Hz or 60Hz
3. Adjustable ground current scale factors
4. Adjustable time delays
5. Password protection for device setting
6. CT monitoring (open CT or short CT alarms, if configured per channel)
7. Bender CTs should be used
8. Logging and historical records for the last 300 events
9. Total Harmonic Distortion and Harmonics per channel
10. Network communications capable



Figure 37 RCMS

Communications Gateway

The Bender COM465IP is a communication Gateway/Front End Processor used for transferring data from RCMS490 devices to other devices via Modbus over TCP/IP protocol.



Figure 36 CTUB Series

Its main features include:

1. RCMS490/RCMS460 relays monitoring
2. Modbus slave driver
3. Time synchronization for the BMS bus system
4. Diagnostics functions
5. Password-protected device menu



Figure 38 COM465 IT

System Controller

Used for second ground fault protection logic, pulsing, interlocking, HMI and SCADA functionalities.

Main features:

1. Server and Remote units with Profinet protocol
2. Ethernet Switches, unmanaged
3. Interposing relays for tripping and alarming purposes
4. Testing terminal blocks
5. Surge protection for Ethernet network (if necessary)
6. VISU+ SCADA software for monitoring and control
7. System integration through Modbus TCP/IP
8. Models: ELCO-L12 (Standalone 12 feeders), ELCO-S12 (Server 12 feeders), ELCO-R12 (Remote, 12 feeders). Other models are available for multiples of 12 feeders.



Figure 39 System Controller

Touchscreen Display

Touchscreen operator panel (HMI) used for system configuration and monitoring.

Main features:

1. Color
2. 5.7" or 4.3" graphics-capable TFT display,
3. 640 x 480 or 480 x 272 pixels respectively
4. 1 x Ethernet,
5. 1 x Serial RS 232
6. 2 x USB
7. Models: HMI-6 (5.7") or HMI-4 (4.3")



Figure 40 Touchscreen

Handheld Pulse Detector (Optional)

Used to trace the pulse waveform generated by the Resistor Unit to locate phase-to-ground faults while the system remains in operation.

Main features:

1. Analog Ammeter
2. Multi-range switch
3. Shorting switch
4. Carrying case
5. Low voltage models*: HPD6 (6"-152mm window) and HPD9 (9"-229mm window)
6. Medium voltage models: HPD6-5kV (6"-152mm window) and HPD9-5kV (9"-229mm window)



*Ask factory for medium voltage models

Figure 41 HPD6

Portable Ground Fault Location System (Optional)

Used to locate ground faults in de-energized systems.

Main features:

1. Backlit LC display, 3 x 16 characters
2. Measuring clamps 0.75"-20mm window and 2"-52mm window (Optional 4.5"-115mm)
3. Carrying case
4. Series EDS3090*

*Ask factory for required models according to the available control power.



Application Examples

Second Ground Fault Protection Systems can be used in industrial power distribution systems with different bus arrangements.

One Substation, Single Source, Single Bar

A basic configuration using a Separated NGR-2GFP unit.

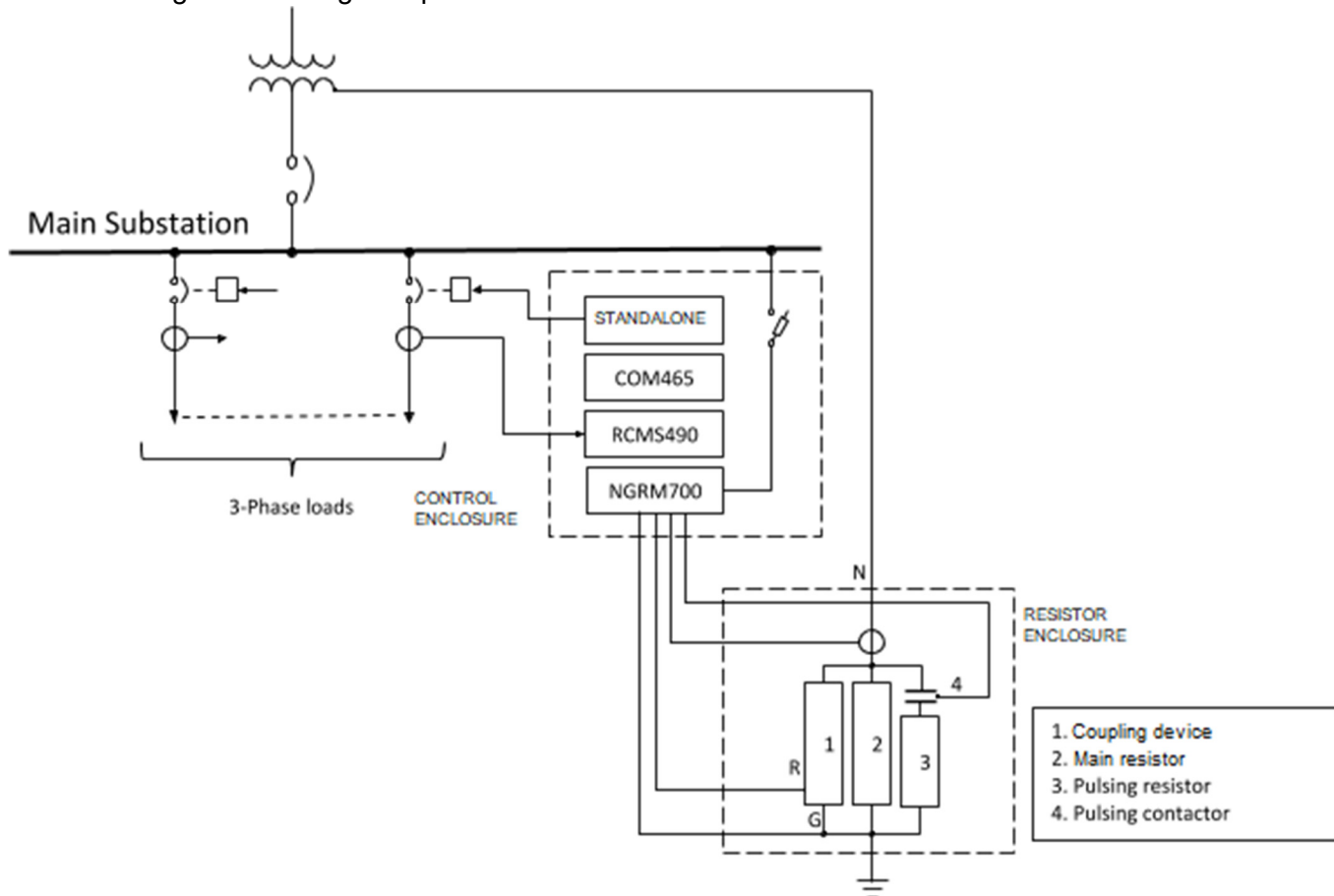


Figure 42 One Station, Single Source, Single Bar

The corresponding schematic is:

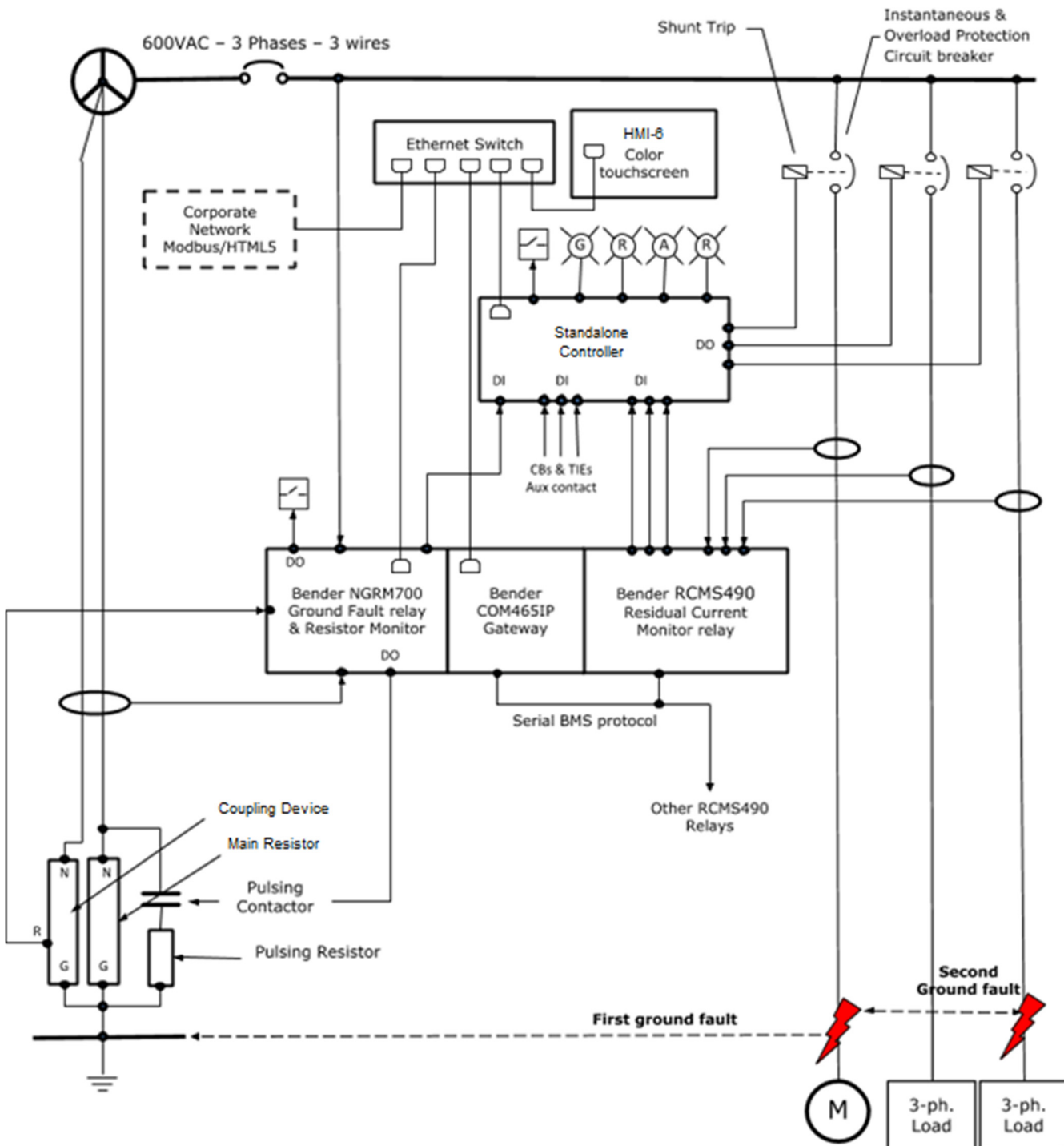


Figure 43 One Station, Single source, Single Bar, Schematic

One Substation, Multiple Sources, Single Bus Bar with Zig-Zag

The bus is grounded using a zig-zag transformer to create an artificial neutral point.

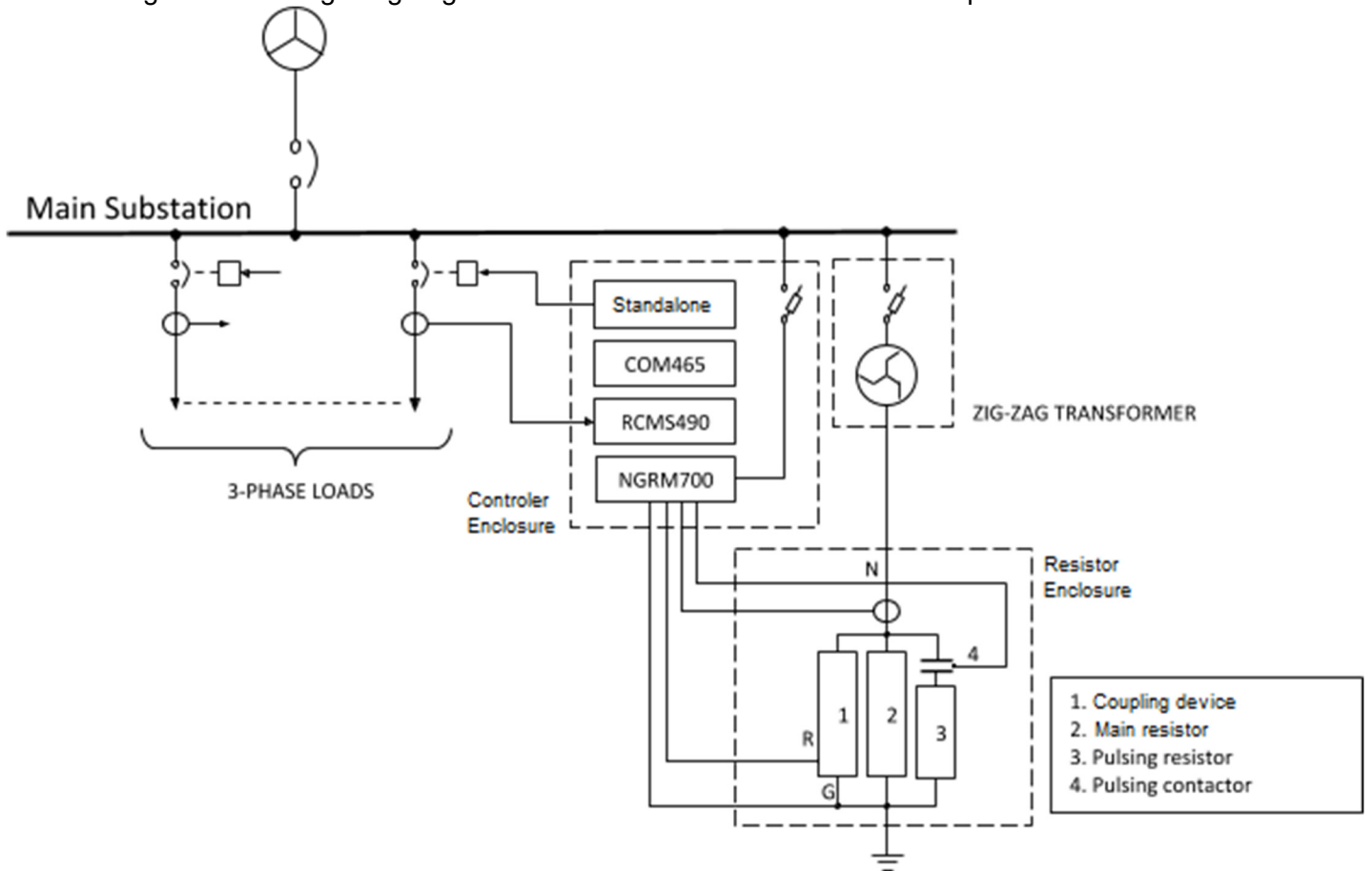


Figure 44 One Substation, Multiple Sources, Single Bus Bar with Zig-zag

One Substation, Two Sources, Two Bars

This case shows a substation involving two bus bars, using one controller Unit with Remote Unit.

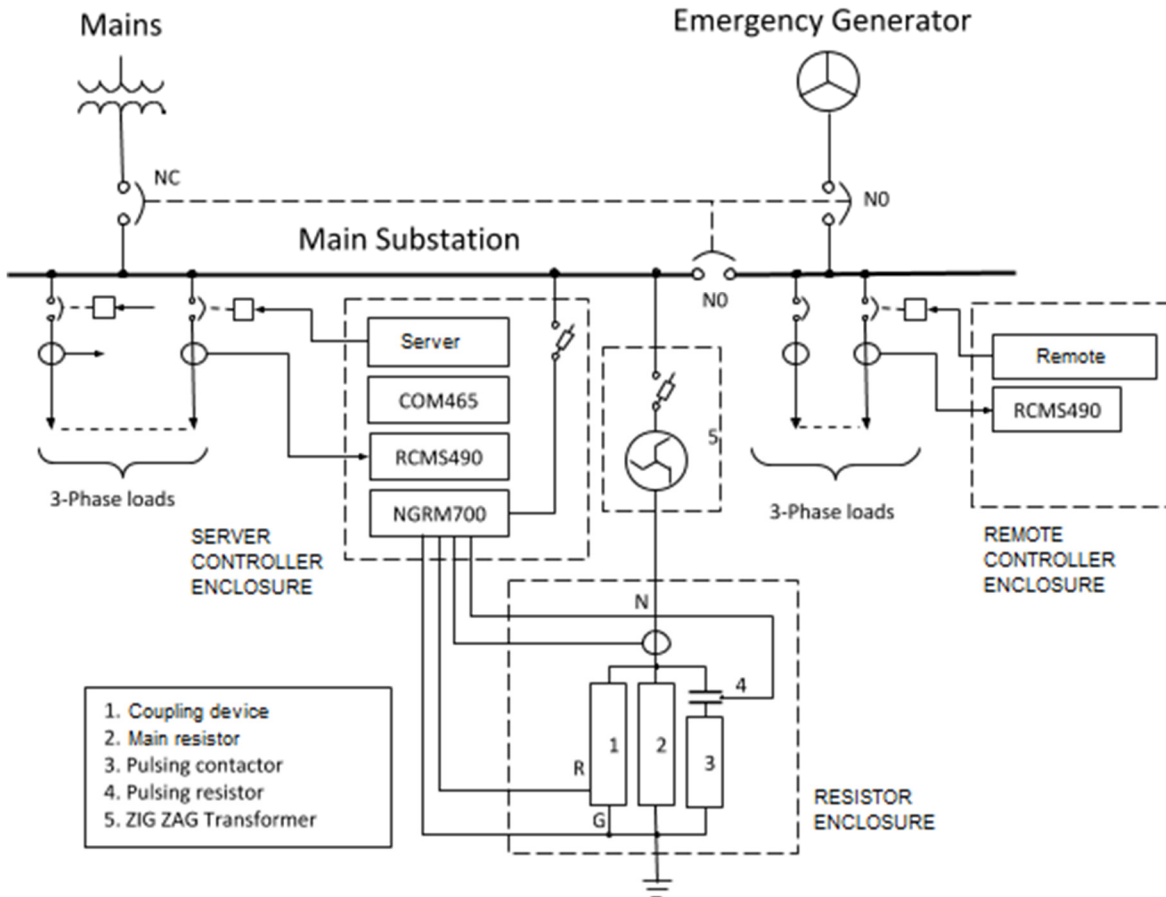


Figure 45 One Substation, Two Sources, Two Bars

One Substation, Two Sources, Mains and Emergency

The following example presents two sources, Mains and Emergency Generator, and grounded bus bar, using one Controller Unit and one Remote Unit.

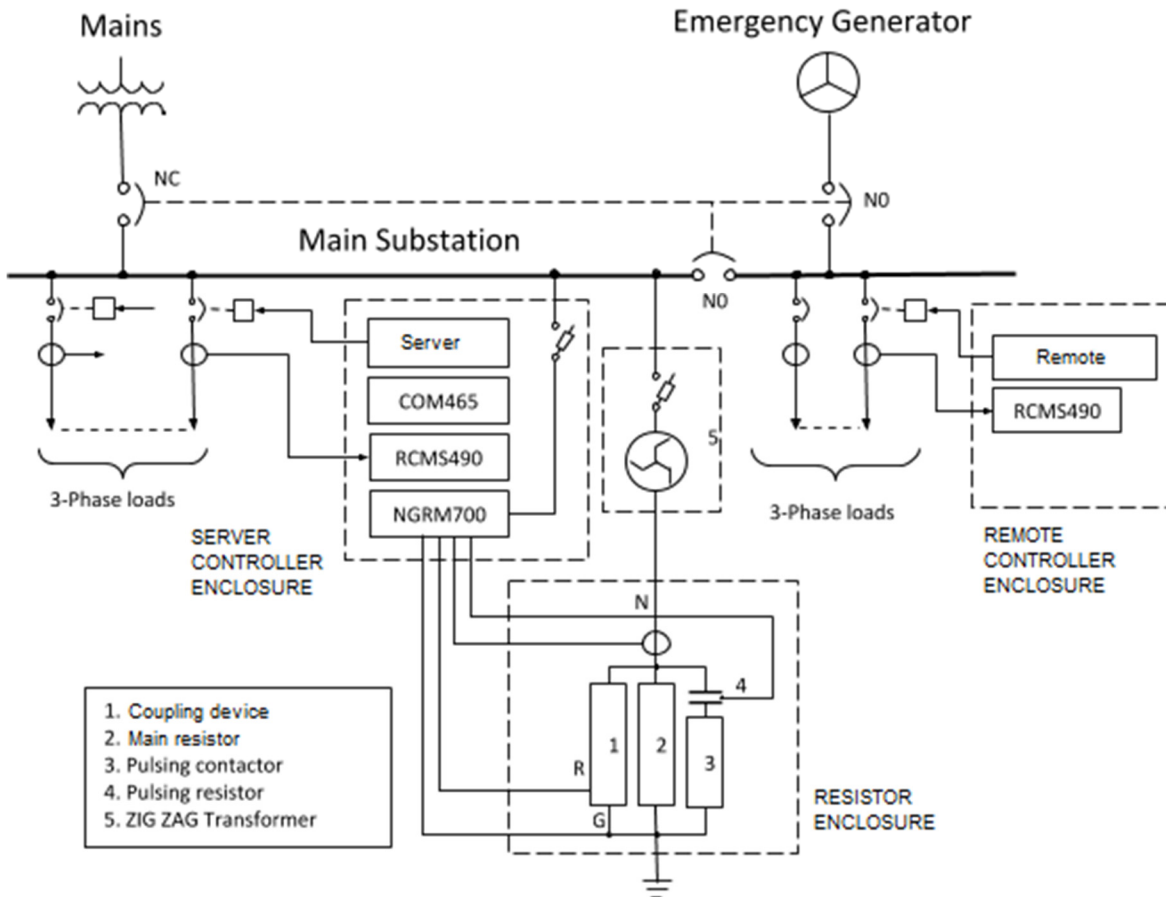


Figure 46 One Substation, Two Sources, Mains and Emergency

Four Substations, Two Sources, Five Bars

This example presents a radial topology with three downstream substations.

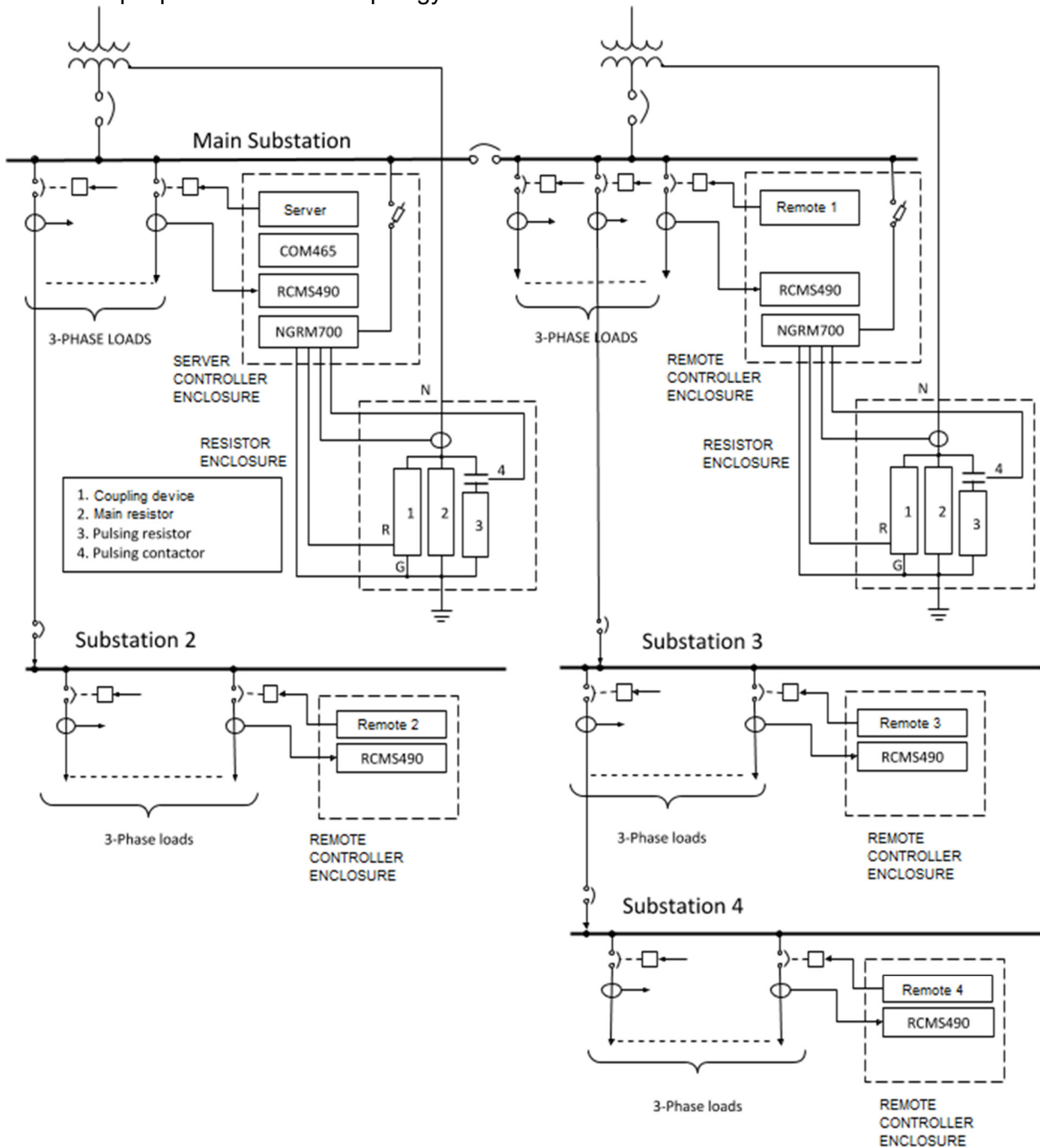


Figure 47 Four Substations, Two Sources, Five Bars

Network Architecture

The following example shows the network architecture for the system shown in figure 52 (with Server unit):

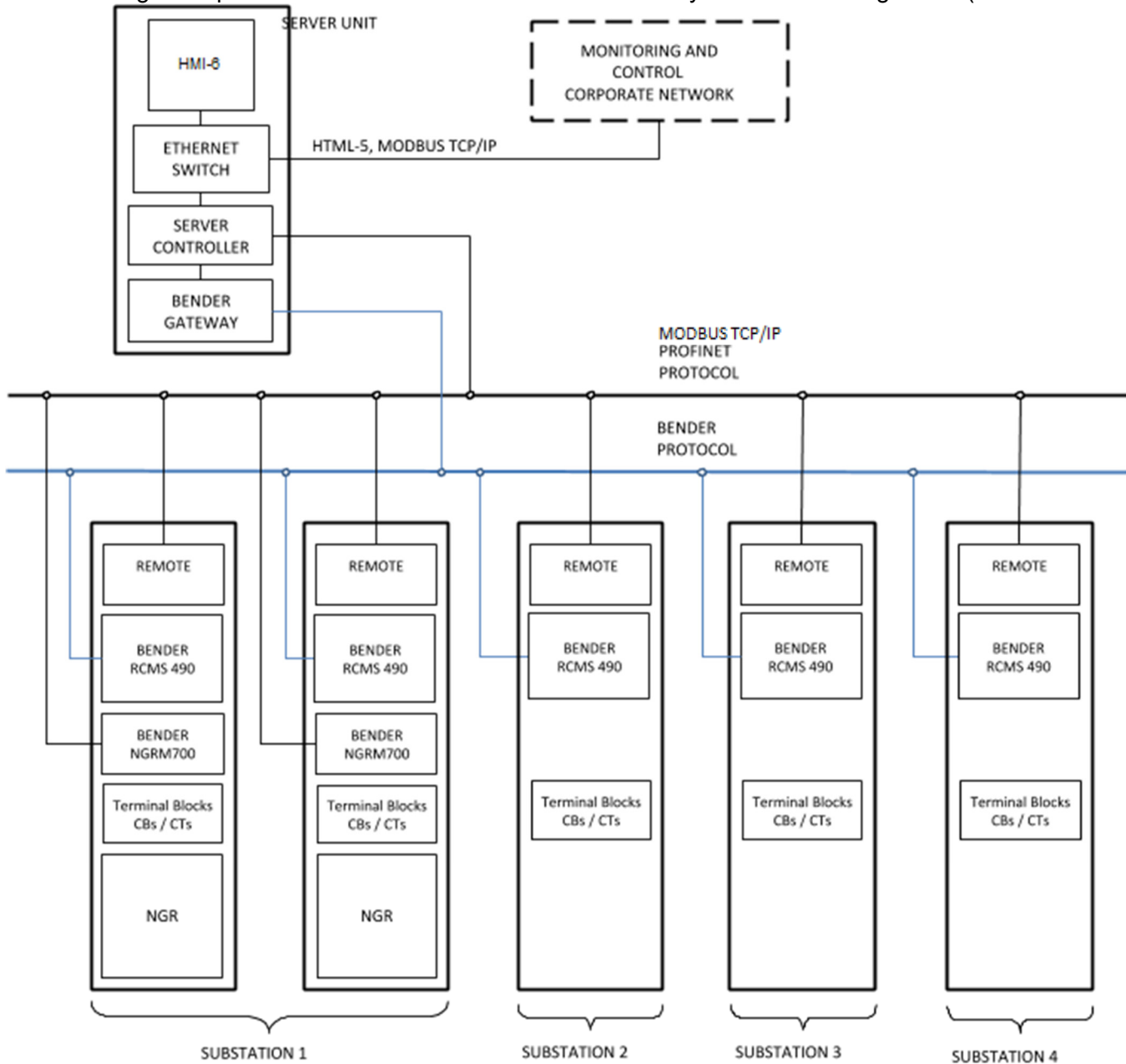


Figure 48 Network Architecture

1. Substation 1: Two bus bar
2. Substation 2: Downstream substation, one bus bar, no NGR, no Neutral relay
3. Substation 3: Downstream substation, one bus bar, no NGR, no Neutral relay
4. Substation 4: Downstream substation, one bus bar, no NGR, no Neutral relay.

Modbus Communication

Standard Modbus TCP/IP and HTLM5 communication are provided by the NGRM700 or the NGRM500 relay and COM465IP gateway.

Information related to Neutral and Feeder current and alarms can be obtained.

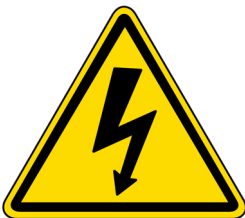
Refer to their manuals for their implementation.

For legacy systems, integration through MODBUS serial RS485 is available on request.

Specifications

1. System voltage: 480 to 5000 VAC
2. Supply voltage: 120-220 VAC, 50-60Hz, 48 VDC, 125 VDC
3. Standard / Maximum number of feeders: 12 / 120
4. Second Ground Fault current setting: 15 to 20 Amps per channel
5. Trip time on Second Ground Fault: Less than 100 milliseconds
6. Highest/Lowest Priority: 1 / 99
7. Neutral Grounding current: 1, 1 to 5 or 10 Amps
8. Pulse duration: 0.5 to 3 seconds
9. Ethernet switch, unmanaged: 5 ports, 1 port available for user
10. Protocols: TCP / IP, SMTP, NTP, Modbus TCP/IP, HTML
11. Operator panel: Color Touchscreen 4.3" or 6"
12. Operating temperature (excluding operator panel): -20 to +55 degree centigrade

Maintenance and Testing:



Hazard of electric shock!

Please ensure the equipment is properly grounded before applying power. Prior to performing any maintenance, remove power and wait thirty (30) minutes for the resistor to cool down.



Hazard of fire or burn!

Neutral grounding resistors have the potential to reach high temperatures. Protection, such as a mechanical housing around the resistor assembly, should be provided by the installer to prevent injury to personnel that may come into proximity to the installation and prevent contact with material that could be combustible due to these temperatures. Do not allow combustible or metallic matter into the NGR; otherwise, fire or accident could occur.

After the 2GFP system is installed, and with the electrical system to be protected out of service:

1. Activate test function on NGRM relay
2. The Touchscreen Operator Panel or the remote computer via Modbus or HTML5 will display ground fault and resistor fault conditions
3. Reset NGRM relay
4. Inject primary current in two Feeder Current Transformers
5. Increase the current in both channels to simulate a second ground fault
6. The lower priority feeder should trip
7. Repeat steps 4 to 6 until all feeders are tested except the feeder with the highest priority
8. To test the feeder with the highest priority:
 - a. Activate test function on NGRM relay
 - b. Inject primary current in the highest priority Feeder Current Transformer
 - c. Increase the current to simulate a second ground fault
 - d. The highest priority feeder should trip
 - e. Reset NGRM relay

Inspect the 2GFP system periodically as follows:

1. Disable breaker shunt trips to prevent tripping the electrical system (There will be no second ground fault protection during testing. The system will still be high resistance grounded)
2. De-energize the 2GFP system and remove the required covers to allow for visual inspection of the internal components
3. Make sure that all connections and fasteners are tight, that no insulators are cracked and that there are no signs of damage from heat, vibration, etc.
4. Clean the units for excessive dust
5. Replace all covers
6. Energize the 2GFP System
7. Activate test function on NGRM relay
8. The Touchscreen Operator Panel or the remote computer via Modbus or HTML5 will display ground fault and resistor fault conditions
9. Reset NGRM relay
10. Use two power supplies to inject primary current in two Feeder Current Transformers
11. Increase the current in both channels to simulate a second ground fault
12. The lower priority feeder should trip
13. Repeat steps 4 to 6 until all feeders are tested except the feeder with the highest priority
14. To test the feeder with the highest priority:
 - a. Activate test function on NGRM relay
 - b. Use a power supply to inject primary current in the highest priority Feeder Current Transformer
 - c. Increase the current to simulate a second ground fault
 - d. The highest priority feeder should trip
 - e. Reset NGRM relay

Internal errors in the controller or the main relays will be displayed in the Touchscreen Operator Panel or the remote computer via Modbus or HTML5

For installations with multiple units and for OEMs and Integrators the Second Ground Fault Protection Test Set (2GFPT) can help speed up the testing process and test for additional variables such as trip response time.

The 2GFPT testing unit is specifically designed for performing operational tests on Second Ground Fault Protection Systems involving multiple feeders and is capable of testing up to 12 feeders at a time.

In addition, it may be used for testing single function overcurrent relays and calibrate resistor monitor relays using 20 k Ω and 100 k Ω coupling devices.

It includes 0-120VAC/0-130VDC/24VDC power outputs for supplying power to other equipment e.g. relay, command panels.



Figure 49 2GFPT Test Set

Storage, returns, and warranty

Warranty

Bender is not responsible for products delivered in good condition to the courier that arrive damaged to the destination (unless otherwise stated) but we will help you make a claim to the courier if required.

All claims must be made within 30 days of delivery.

Bender warrants the products to be free from defects under proper use, maintenance and installation for two years from the date of delivery unless otherwise stated.

This warranty is limited to repair or replacement of the defective part or product according to our judgment and will not include installation, removal, transportation expenses or losses due to equipment failure.

We must be informed of the claim by the purchaser as soon as the problem is observed.

Defective products should not be sent to our location unless authorized in writing by one of our employees.

Bender shall not be liable for any claims arising from special, indirect or consequential damages nor from any loss of production or other losses resulting from the failure of any equipment.

All warranty and product returns inquiries should be directed to sales@benderinc.com.

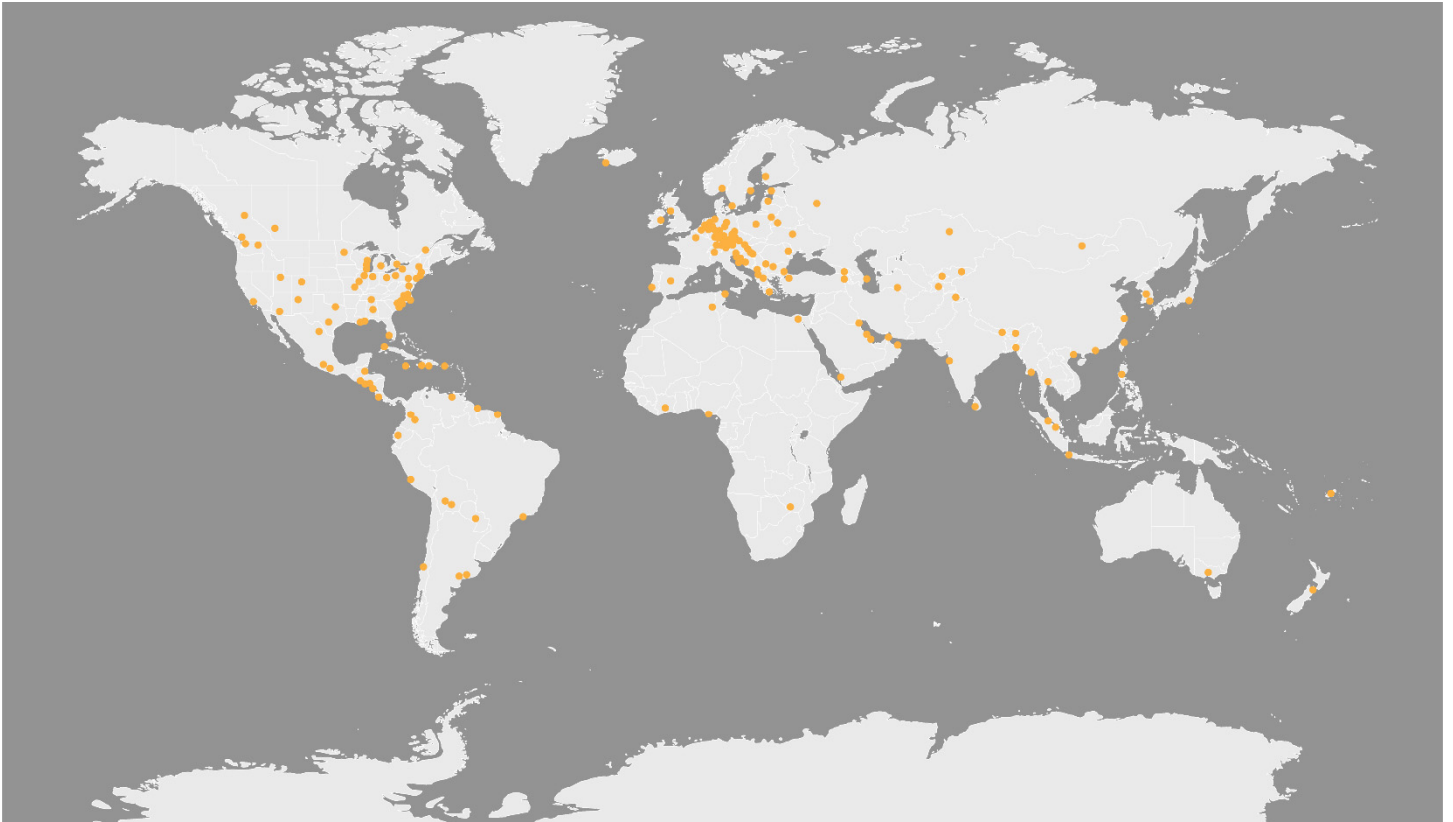
Appendix A – Relay manuals

[NGRM500/550](#)

[NGRM700/750](#)

[RCMS460-490](#)

Notes:



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