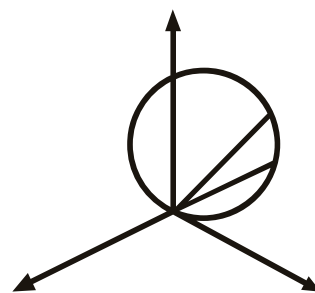


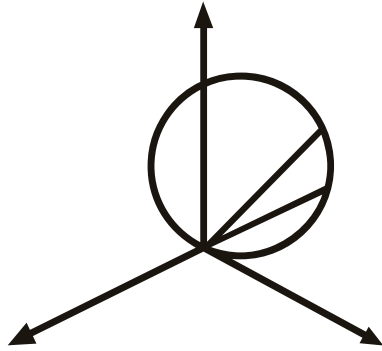
Swedish Neutral

Premium Power Protection



GROUND FAULT NEUTRALIZER EARTH FAULT PROTECTION SYSTEM





Premium protection for premium power

Swedish Neutrals mission is to supply products and solutions that help improve reliability and safety in high voltage grids.

Since our start in 1987 we have gained more than 25 years of experience of earth fault protection and neutral treatment.

Swedish Neutral has developed and is now providing everything from traditional equipment such as arc suppression coils and grounding transformers to the market leading Ground Fault Neutralizer.

Reliable and safe power supply is today more vital to society than ever and is becoming more and more important every day.

Swedish Neutrals cost-effective solutions provides a possibility for our customers to achieve the safest and most reliable power supply on the market and thus ensuring the highest possible gain to the end consumer.

Consisting of three main components — an Arc Suppression Coil, a RCC Inverter and a GFN Control Cabinet — the GFN system provides complete protection.

Best possible network reliability

Meeting the demands — protect your grid with the Ground Fault Neutralizer

The supply of electricity constitutes a vital part of society's infrastructure and the demand for reliable distribution of high-quality electricity is ever increasing. With the Ground Fault Neutralizer (GFN) you will be able to meet these demands while still guaranteeing highest possible safety.

Earth faults (single phase to ground faults) are the dominating type of fault in an electrical network. Therefore it is of utmost importance that these faults are handled in a satisfactory way. By injecting a phase-opposite current into the neutral, the GFN effectively cancels out

the fault current. This interception is exceptionally fast and has no impact on the conveyance of payload over the faulty feeder. Thus, earth faults can be handled without customer outage.

The GFN protects all parts of an interconnected grid — from the power transformer over the bus bar and the outgoing feeders down to the last corner of the grid — a truly comprehensive protection scheme. This overall action is accomplished in a very cost efficient way from one point — the neutral.

GFN bus bar and switchgear protection – faster than arc detection



Total earth fault compensation

The GFN — a paradigm shift in protection by smart neutral treatment

Protection is about safety and minimizing risks to people and property. The risk with an electrical fault is generally described as proportional to the energy injected into the fault site. Therefore the IEC standard defines the risk to be proportional to fault current and interception time — the well-known I^2t criteria.

Everybody understands — protection must be fast. But fault current levels included by their square are even more decisive to minimize consequential damages. The good news is — both fault current and interception time can be influenced through the neutral.

A benchmark for different types of system grounding and neutral treatment with respect to fault current levels and interception time clearly proves the superiority of the Ground Fault Neutralizer. Even better — almost all existing grids can be converted to GFN grounding. This conversion offers one of the most cost efficient investments in grid performance, improved SAIDI figures and last but not least safety.

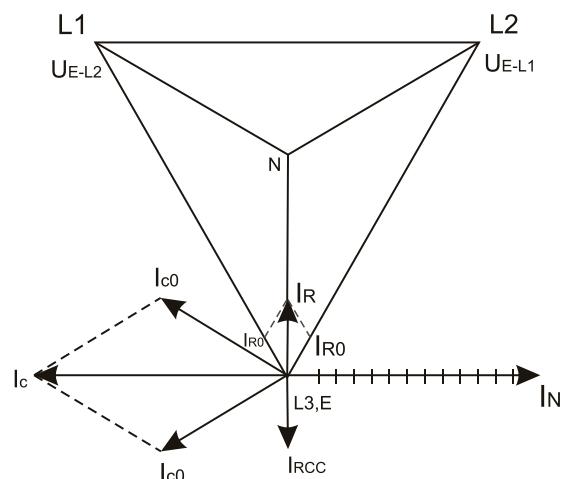
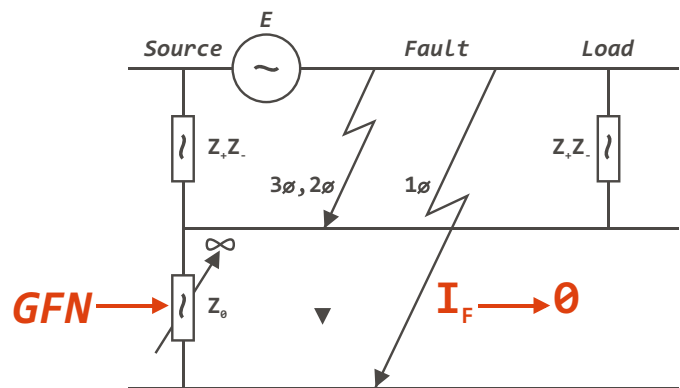
In utilizing the inherent — but generally unused — zero sequence properties of the 3-phase system, the GFN Ground Fault Neutralizer elevates grid protection to new levels of performance and achieves all the benchmarks of good protection — namely speed, sensitivity and last but not least selectivity.

Moreover, the GFN action is smart in the way that voltage injection and fault current can be cancelled out completely without interrupting the power supply — truly a smart grid solution. Instead of feeder tripping “fault amputation” with lots of outages, the GFN now offers “smart medication”. The “antidote” — a current equal but opposite to the fault current — is simply injected into the neutral. No immediate interruption of any power supply is required.

IEC 60479 — General risk assessment

RISK $f(t, I^2)$

NEUTRAL TREATMENT	EARTH FAULT CURRENT	SPEED OF PROTECTION
SOLID GROUNDING	10kA	0.1-1.0s
NER GROUNDING	1kA	0.1-1.0s
UNGROUNDING	100A	0.1-1.0s
RESONANCE GROUNDING	10A	1.0-[∞]s
GROUND FAULT NEUTRALIZER	0A (<50mA)	<60ms



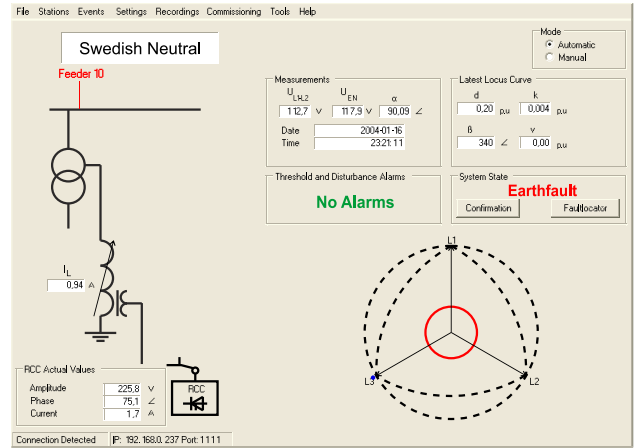
Speed — ultra fast earth fault interception

Instantaneous fault compensation without tripping the feeder

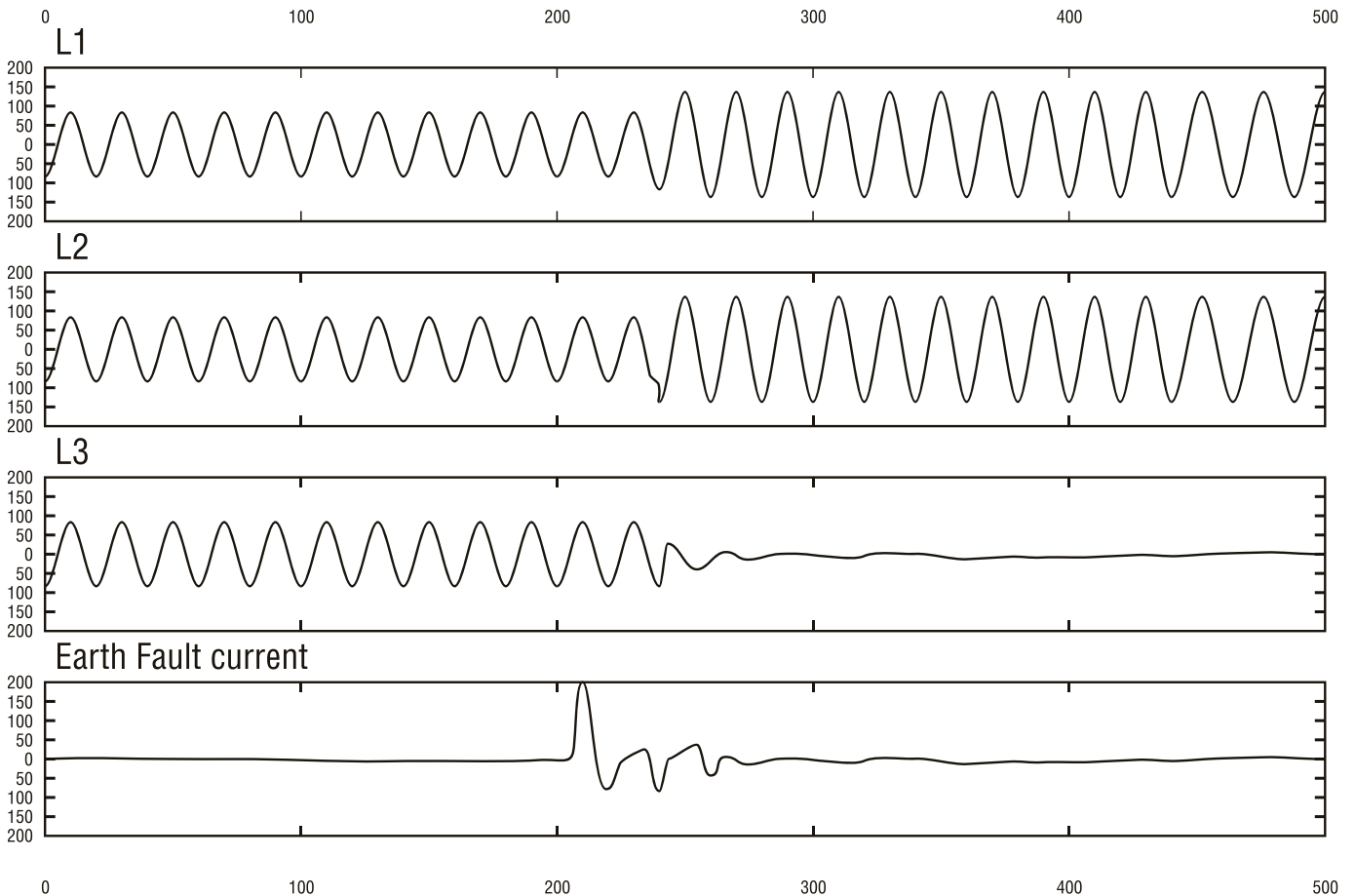
As injury statistics clearly indicate, speed is the most essential aspect of protection. With a total response time of less than 60ms (three cycles) the GFN is substantially faster than traditional protection schemes, independent of the actual fault location.

Instead of tripping the faulty feeder the GFN brings the fault current down to practically zero making it possible to maintain safe operation without disturbing power supply to customers. This unique feature can be guaranteed both during transient and sustained earth faults. Installed in the substation and connected to the transformer neutral, the GFN protects the entire network from one point.

GFN operation - terminal program



GFN response time less than 60ms



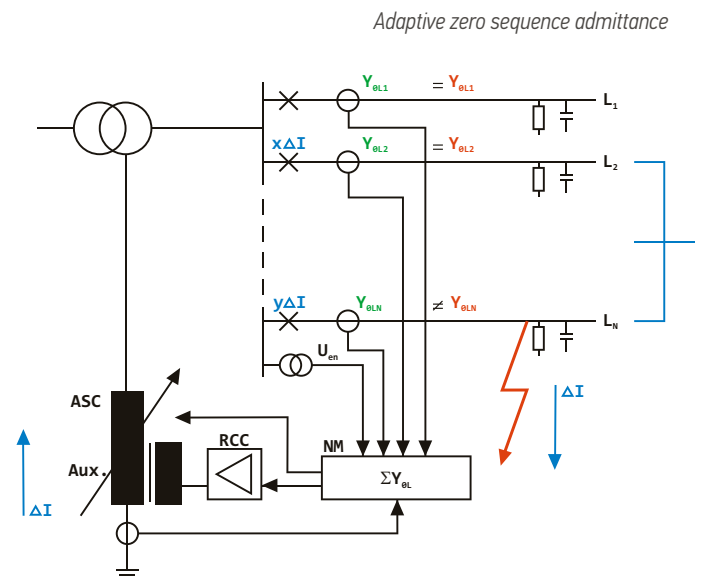
Sensitivity — fast and sensitive earth fault detection

Sophisticated and robust fault finding algorithms

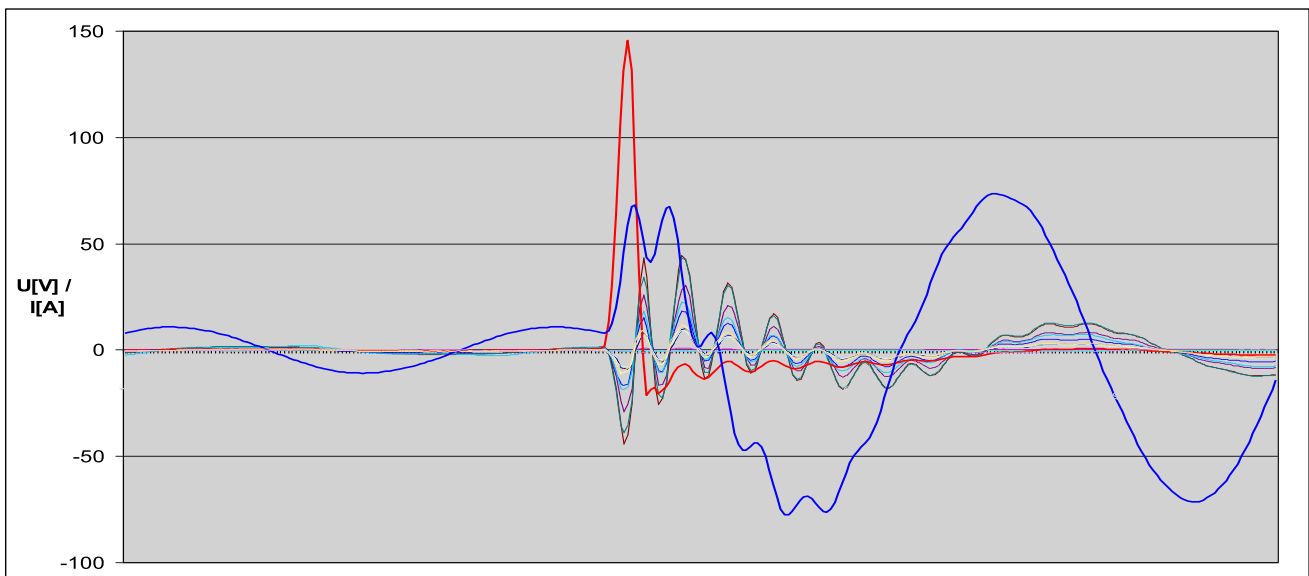
The Ground Fault Neutralizer includes fast, reliable and highly sensitive algorithms for earth faults detection. Common for the algorithms is the use of neutral voltage (UEN) and feeder summation currents as detection criteria.

The fastest algorithm for earth fault detection is the Initial Transient Detection Scheme. The faulty feeder can be identified instantly at the start of the earth fault. The detection scheme is very fast and robust, and therefore especially suitable for re-striking cable faults.

To provide the highest possible detection level a second scheme — based on an adaptive zero sequence admittance measurement is employed. Two subsequent admittance measurements are taken and compared — before and after switching of a capacitor element in the arc suppression coil. As the scheme employs a differential algorithm, the errors in the CT:s and VT:s can be eliminated. This allows for a very sensitive setting, suitable for instance for the detection of high impedance mid-span faults on overhead lines.



Initial charging transient



Selectivity — high accuracy earth fault localization

GFN fault finding — a matter of minutes

Even though the GFN immediately eliminates voltage injection and fault current — independent of the location of the fault — the actual fault site must be located for further inspection or repair.

The integrated GFN fault locating is based on two superior detection schemes — a very fast transient detection mainly for re-striking cable faults and a highly sensitive adaptive zero sequence admittance scheme to detect both low and high impedance faults on overhead lines and cables.

In urban grids distribution feeders are normally arranged in open rings with ring main units to provide safe power supply. For these grids the GFN works with its well proven distance-to-fault scheme. After closing the NOP — normally-open-point — the fault site can be pin pointed with high accuracy.

Rural distributions generally have radial structures with many lateral spurs. Earth fault locating in these grids is rather difficult and

often based on either time consuming trial-and-error methods or simple overcurrent fault passing indicators with insufficient sensitivity. The new GFN Fault Passing Indicator (GFN FPI) working with access to modern internet communication technology provides a substantial improvement. Due to its adaptive scheme, the GFN FPI can detect much more sensitively than traditional FPI's. This is an important step ahead, as many of the line faults in overhead grids are high impedance mid-span faults with poor ground contact and high risks for fire ignition.

The GFN FPI can be combined with any type of sectionalizing equipment. All fault confirmation and sectionalizing controls are available at the central GFN control cabinet, but can also be transmitted to a dispatch center or a handheld field monitor.

GFN Loop Measurement for cable grids

The screenshot shows a software interface for 'GFN Loop Measurement for cable grids'. It features a 'Measurements' section on the left with input fields for 'Measurement No.' (1), 'Distribution' (56.4 / 43.5), 'Distance from beginning' (43.5), 'Number of measurements' (1), 'Mean (Ratio)' (56.4), 'Deviation (Ratio)' (0.00), 'Mean (km)' (43.5), and 'Deviation (km)' (0.00). A central diagram shows a circular loop with a red dot indicating a fault location, labeled 'TestLoop' and 'Length 1000 km'. Below the diagram are 'Begin' and 'End' labels, and 'Feeder 5' and 'Feeder 10' labels. A 'Calibrations' table is at the bottom with columns for Name, Km, Radio L1, Radio L2, Radio L3, and Calibrated. Buttons for 'Measure', 'Clear', 'Add', 'Edit', 'Delete', and 'Ok' are also visible.

Sensitive GFN Fault Passing Indicator for radial feeders

The screenshot shows a software interface for the 'Sensitive GFN Fault Passing Indicator for radial feeders'. The title is 'Stockholm'. It features a 'Measurements' section with input fields for $U_{L1,2}$ (100.0), U_{EN} (110.0), α (330.0), 'Date' (2013-06-13), and 'Time' (10:00:57). A 'Latest Locus Curve' section shows 'd' (0.00 pu), 'k' (0.000 pu), ' β ' (0), and ' γ ' (0.00 pu). A 'Threshold and Disturbance Alarms' section displays 'No Alarms'. A 'System State' section shows 'Earthfault' with 'Confirmation' and 'Faultlocator' buttons. A diagram on the left shows a radial feeder structure with a 'Bus bar' and 'Feeder 8'. A diagram on the right shows a circular fault locus with a red circle and dashed lines, labeled 'L1', 'L2', and 'L3'. A 'Confirmation' button is also present.

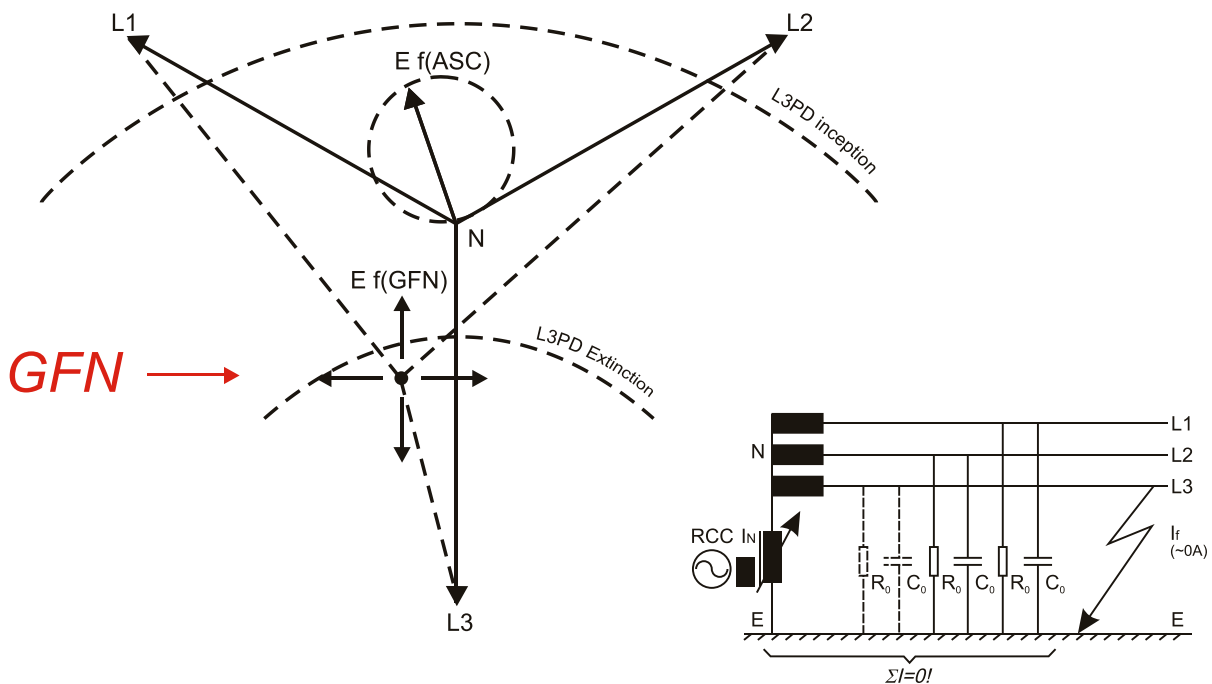
Enhanced network condition monitoring

GFN PD monitoring & control — the next step in grid protection

The GFN Ground Fault Neutralizer, originally developed to solve the problem with re-striking cable faults in resonant grounded networks, offers combined with state of the art on-line PD measurement a new powerful tool for grid insulation monitoring and pre-fault protection. By means of voltage/current injection into the neutral, the GFN controls all phase-to-ground voltages and — if necessary — quickly quenches discharge activities by lowering the voltage in the suspected phase, thus preventing further development into a full dielectric breakdown.

Furthermore the full control of phase-to-ground voltages during plant operation also admits for new online PD testing methods at levels above normal operating voltages, thus enabling systematic forechecking strategies for the early detection of defective components. This is done without affecting the power supply to end users.

Distribution network owners and operators looking for new and cost efficient means to monitor the condition of their aging cable grids may benefit from this novel tool to support their ongoing CBM activities. The GFN enhanced monitoring works on all type of plants — rotating machines as well as transformers, switchgears and cable feeders. The method can also be used before, during and after commissioning of a new plant to verify the quality of workmanship on cable joints and terminations.



Network quality analysis

GFN Harmonic Monitor & Compensation Concept — Improving power quality

Modern electrical equipment demands voltage stability and power quality. High voltage networks have to be free from harmonics and other electrical disturbances. The GFN Harmonic Monitor & Compensation will allow you to maintain adequate power quality in your high voltage network by monitoring the harmonic content in your network, compensating for the harmonic current in addition to the fundamental (50Hz) current in

the case of an earth fault and presenting trend analysis of your networks harmonic content. A harmonic free network also imposes much less strain on equipment and lengthens its life span. This means lower maintenance cost and lower cost for replacing worn-out equipment.

	Fundamental		3rd		5th		7th	
	Amp	Phs	Amp	Phs	Amp	Phs	Amp	Phs
L1	64,2 V	325,4 <	0,6 V	4,5 <	0,4 V	53,6 <	0,3 V	40,2 <
			1,0 %		0,6 %		0,5 %	
L2	65,2 V	206,1 <	0,7 V	119,6 <	0,4 V	3,9 <	0,3 V	24,6 <
			1,1 %		0,7 %		0,5 %	
L3	64,3 V	86,1 <	0,7 V	3,2 <	0,5 V	29,7 <	0,4 V	7,6 <
			1,1 %		0,8 %		0,6 %	

No file selected

Close

Harmonic Monitor

The Harmonic Monitor measures and records harmonic components up to and including 7th harmonic. Real time results are presented in the terminal software (NMTerm). The 3rd, 5th, and 7th harmonics are displayed in volts, angles and as in percent of the fundamental.

Harmonic Compensation

The Harmonic Compensation compensates for the harmonic content during an earth fault.

Harmonic Trend Analysis

Historical results are presented in NMTerm. The fundamental, 3rd, 5th, and 7th harmonics phase to ground voltage and angle is stored for L1, L2 and L3. The logging interval and buffer size is adjustable.

Applicable in all types of HV networks

Premium power protection
for everyone



Total earth fault current compensation

Total earth fault current compensation
(capacitive + active + harmonics)

Ultra fast earth fault compensation

Total earth fault current compensation within 60ms
(three cycles)

Best possible network reliability

No feeder tripping necessary (fault site is safe)

Ultra sensitive earth fault detection

Differential measurement with highest sensitivity
(independent of current transformer accuracy)

High accuracy earth fault location

Distance to earth fault (loop measurement)

Enhanced network condition monitoring

Enhanced on-line partial discharge monitoring

Network quality analysis

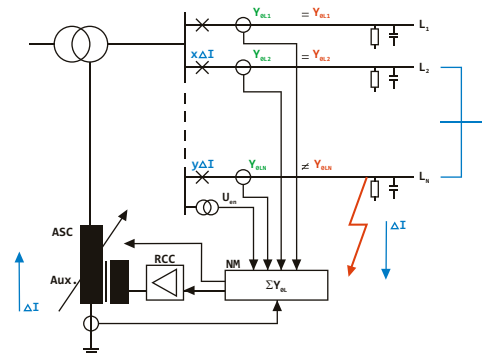
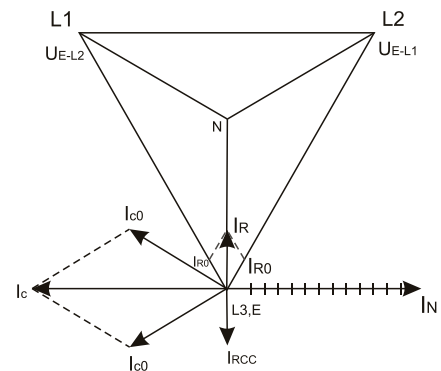
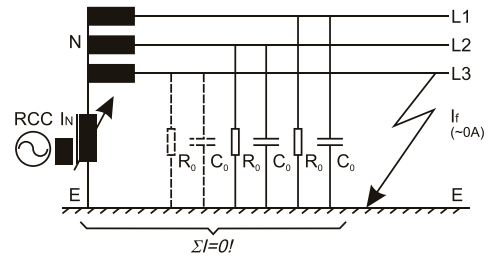
Harmonic monitor and alarm

Applicable in all types of hv networks

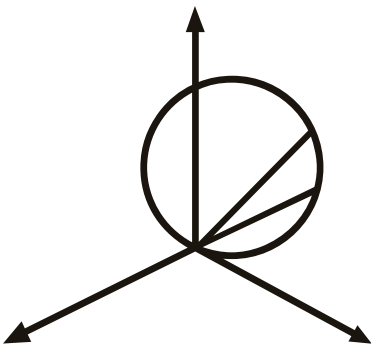
Applicable in overhead / cable / mixed hv networks
(6kV - 110kV)

Premium power protection for everybody

Power plants – transmission – distribution
Industries – mines – railways
Marine – offshore – distributed generation



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SOLID GROUNDING	10kA	0.1-1.0s
NER GROUNDING	1kA	0.1-1.0s
UNGROUNDING	100A	0.1-1.0s
RESONANCE GROUNDING	10A	1.0-[∞]s
GROUND FAULT NEUTRALIZER	0A (<50mA)	<60ms



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