Numerical Generator Protection

REG216 / REG216 Classic

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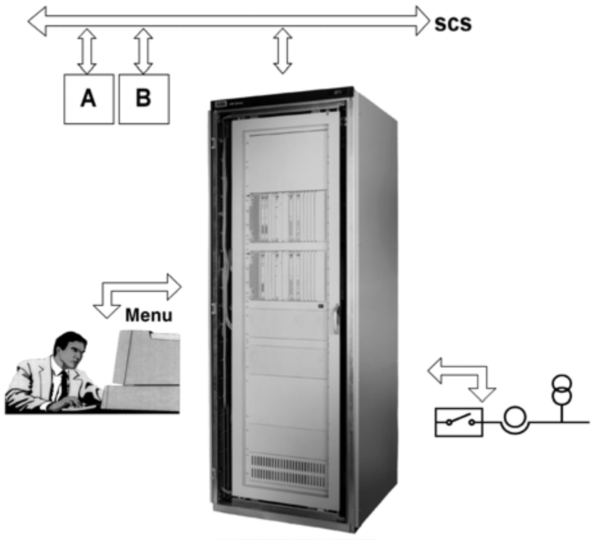
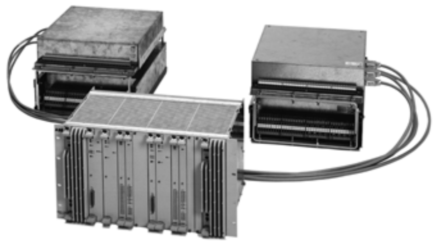


REG216 System



REG216

Features

- Modular hardware
- Selectable protection functions
- Multitude of applications
- Menu-assisted setting with PC
- Fully numerical signal processing
- Continuous self-monitoring of hardware
- Cyclical testing routines mostly performed by the software
- Setting of parameters and recording of the settings by PC
- Display of measured values
- Display of events, their acknowledgment and printout
- Disturbance recording
- Self-documentation
- Long-term stability
- Communication and coordination with station control
- Two design versions available; REG216 / REG216 Classic.

Application

The REG216 is intended for the protection of generators and block transformers.

The modular hardware and software design allows an extremely flexible installation. Simplicity of adaption to the size of the primary system and the desired protection schemes are achieved through the combination of a software library and hardware modules. Economic solutions can thus be achieved in the full range of applications for which it is intended.

The REG216 software system offers a library of protective functions. Functions suitable for generator and transformer protection are listed in the table below.

Different degrees of redundancy can be selected. Availability and reliability of the protection can be chosen to suit the application by duplicating e.g. auxiliary supply units of the whole system.

Standard interfaces make REG216 compatible with different process control systems. Data exchange with higher process control levels are possible, e.g. one-way reporting of digital states and events, measured values and protection parameters.

REG216 and REG216 Classic differ with regard to the binary process connection:

- REG216 uses the E/A-module 216GD61a.
- The REG216 Classic uses the modules 216GE61 / 216GA61 and 216GA62.

Application (cont´d)

Protection functions:	ANSI code	Description
Generator differential	87G	three-phase
Power transformer differential	87T	three-phase for 2- and 3-winding transformers
Definite time overcurrent (undercurrent)	51	definite time delay, for phase and earth-fault, over- and undercurrent
Overcurrent or undercurrent with peak value evaluation	50	instantaneous operation or with definite time delay, value evaluation wide frequency range, over- and undercurrent
Restricted earth fault	87N	overcurrent operation with definite time delay*
Voltage-controlled overcurrent	51/27	operation restrained by undervoltage
Inverse time overcurrent	51	inverse current dependent time delay, for phase and earth fault (51N)
Directional definite time overcurrent	67	definite time tripping
Directional inverse time overcurrent	67	inverse time tripping
Negative phase sequence current	46	negative phase sequence current with definite time delay or inverse time delay with thermal replica
Definite time overvoltage (undervoltage)	59 27 64	definite time delay, over- and undervoltage Applicable also for - stator E/F (95%) (59 G/N) - rotor E/F (64 R) ** - intertum fault protection
100% stator and rotor earth fault protection	64 S 64 R	based on the displacement principle calculation of the earth fault resistance. in addition the units REX010 and REX011 are required
Dead machine protection	50AE	
Underimpedance	21	circular characteristics centered at origin of impedance plane
Minimum reactance	40	circular characteristics for loss of excitation protection
Pole slip protection	78	detecting loss of synchronism of a generator as against the network
High-voltage distance protection	21Z<HV	6-system high-voltage protection
Distance protection	21Z<	distance protection with overcurrent or underimpedance starting
Power	32 37	any characteristic angle, over and underpower for: - active power - reactive power - reverse power protection - minimum forward power
Overload	49	thermal replica with operating characteristic according to ASA-C50.13*** for: - standard stator current (49 S) - rotor current (49 R)
Negative phase sequence current	46	evaluation of negative phase sequence of currents inverse time delay; with terminal replica
Overtemperature	49	thermal protection with precise thermal replica
Frequency	81	evaluation of voltage input
Rate-of-change of frequency	81	df/dt
Overexcitation	24	voltage/frequency protection (81/27) definite time delay or inverse time delay (81/27)
Voltage balance	60	monitoring/comparing two groups of single- or three-phase voltage
Voltage peak value evaluation	59/27	instantaneous operation with definite time delay
Synchro check	25	supervision of phase angle frequency and voltage level of two systems
Breaker failure protection	50BF	
Logical functions		AND, OR, flip-flop, time delay, counter

* with external hardware: stabilizing resistor, voltage-dependent resistor
** with external hardware: measuring bridge YWX111-..., coupling condensers
***ASA = American Standard Association

Aside from these typical generator protection functions the entire library of the RE.316*4 platform is also available (e.g. distance protection, autoreclosure, I_0 inverse, etc.). For more details see the Operating Instructions of REG216

Protection functions

All protection functions required for the stand-alone protection of generators, power transformers and feeders are available. The system therefore replaces several relays of a conventional protection scheme for such power system equipment. The table on page 2 gives a survey of the most significant protection functions.

The desired protection functions to suit the particular application can simply be selected from a comprehensive library using the personal computer. No knowledge of computer programming is required.

All setting ranges are extremely wide to make the protection functions suitable for a multitude of applications. The following main parameters can be set:

- Allocation of processing units
- Input channel or channels
- Pick-up setting
- Time delay
- Definition of the operating characteristic
- Tripping logic
- Control signal logic.

Setting a corresponding parameter enables the protection functions to be "connected" to particular input channels.

Digital input and output signals can also be internally combined logically:

- The tripping outputs of each protection function can be assigned to channels of the tripping auxiliary relay assembly in a manner corresponding to a matrix.
- The pick-up and tripping signals can be assigned to the channels of the signalling auxiliary relay assembly.
- Provision is available for blocking each protection function with a digital signal (e.g. digital inputs or by using the tripping signal of another protection function).
- External signals applied to the digital inputs can be processed in any desired fashion.
- Digital signals can be combined to perform logical functions e.g. external enabling or blocking signals with the output signals of an internal protection function and then used to block one of the other protection functions.

Remote in- and outputs (RIO580)

Using the process bus type MVB, remote in- and output units 500RIO11 can be connected to the REG216 terminals. The input and output channels can be extended to a large number by using the RIO580 remote input/output system. Installing 500RIO11 I/O units close to the process reduces the wiring dramatically, since they are accessible via fibre optic link from the REG216 terminals.

Analog signals can also be connected to the system via the 500AXM11 from the RIO580 family:

- DC current: 4...20 mA; 0...20 mA; -20...20 mA
- DC voltage: 0...10 V; -10...10 V
- Temp. sensor: Pt100, Pt250, Pt1000, Ni100, Ni250, Ni1000.

Construction

Hardware

The REG216 equipment comprises two main assemblies which are physically separated from each other and linked by standard prefabricated screened cables:

- Interfaces to the primary system (CTs, PTs and auxiliary relays), which provide DC isolation and a barrier to electromagnetic interference
- Parallel bus and associated electronic units (e.g. analog inputs and data processors/ for signal conditioning and processing.

The complete protection scheme comprises relatively few hardware modules allowing subsequent expansion of electronic units and the interfaces. 21 units of rack space is available per equipment frame.

Construction (cont´d)

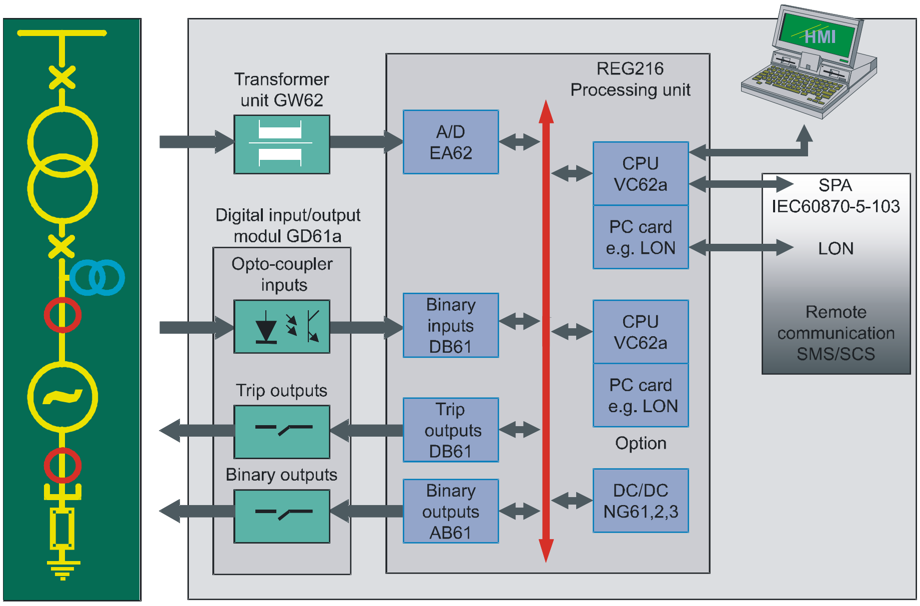


Fig. 1 Configuration of the REG216 protection system

Excellent electromagnetic compatibility has been achieved through careful attention to physical separation of the interfaces from the signal processing units

All hardware can be accommodated in one cubicle, which provides a further screen against induced interference and affords physical protection against dust, etc.

REG216 has 17 pre-defined rack configurations with a limited number of I/Os but equipped with the same SW library as the Classic system.

Other protection relays for functions which are not part of the REG216 may be installed in the cubicle and correspondingly interwired with REG216.

Interfaces to the primary system

The following modular assemblies provide interfacing of REG216 to the power system.

Input transformer assembly 216GW62
This assembly adjusts the signal levels and provides isolation between the primary system CT and PT circuits and the electronic circuits of the protection. One type of PT and two types of CTs are available, to meet different accuracy and dynamic performance requirements.

Space is available for up to 12 transformers, which are selected to suit the application. Up to four assemblies can be used, i.e. 48 inputs.

Auxiliary relay and optocoupler assembly 216GD61a
This assembly is used in the version of REG216. It provides eight tripping relays, each with powerful, potential-free tripping contacts (with surge circuits), 16 auxiliary relays and 16 optocoupler input circuits. Max. four assemblies can be provided.

Input auxiliary relay assembly 216GE61
Up to 16 auxiliary relays can be accommodated, providing complete potential separation of digital input signals.

Output auxiliary relay assembly 216GA61
Up to 16 auxiliary relays can be accommodated providing complete potential separation of digital output signals (two contacts per signal).

Tripping auxiliary relay assembly 216GA62
Up to eight powerful, potential-free tripping contacts and circuits, which provide high-speed operation (surge circuit) with reduced consumption after operation (economy circuit) are provided.

The tripping auxiliary relay assembly can be optionally fitted with a tripping logic diode matrix to enable direct coupling of external signals. REG216 can also read and process external signals via digital inputs.

Facilities for different trip circuit supervision arrangements in conjunction with the output unit 216DB61and the input auxiliary relay assembly 216GE61 can be provided.

Parallel bus and electronic units

The electronic units are of plug-in design and accommodated in an equipment rack with the standard dimension 19", 6U (1U = 44,45 mm). An equipment rack of this kind is divided into 21 standard divisions. The exchange of data via the parallel bus B448C is controlled and monitored by all units available.

The protection system is based on a data bus with digital signal processing for most functions; signal conditioning, analog and digital inputs, A/D conversion, processing and signal output.

The components of the system are:

- Static plug-in units, which exchange data via a powerful parallel bus
- Interfaces to the process (primary system, station equipment), which are isolated from the digital processing unit.

Equipment rack 216MB66/216MB68 and parallel bus B448C

The main features of the parallel bus B448C are:

- Specification based on IEEE P 896 (future bus)
- Time multiplexing of addresses and data (16 bit)
- Asynchronous data transmission with handshake
- Integrity checking of each data exchange.
- Up to 32 master units having equal status, actively accessing the bus
- Common internal 24 V auxiliary supply for all electronic units; redundant 24 V are possible.

Processing unit 216VC62a

- 32 bit processor type 80486DX-2
- Application software on Flash EPROM
- Operating data on RAM
- Settings on non-volatile Flash EPROM
- Potential-free RS-423 interface for PC operation
- Connection to the station control with transmission of messages
- Time clock synchronizing for time-tagging of events
- Non-volatile event and disturbance memory (gold capacitor buffered)
- Space requirement: two rack divisions.

Analog Input unit 216EA62

- 24 inputs sampled simultaneously in groups of six
- Sampling frequency 600 (720) Hz for a power frequency of 50 (60) Hz
- Space requirement: two rack divisions.

Digital output unit 216AB61

- 32 outputs for controlling the relays of the output auxiliary relay assembly
- Short-circuit proof
- Front plate LEDs for indication of activated relays
- Space requirement: one rack division.

Tripping output and binary input unit 216DB61

- 8 outputs for two-pole control of auxiliary tripping relays
- Monitored output amplifiers
- 16 digital inputs for the signals from the input auxiliary relay assembly (two each can be used to externally enable and block tripping respectively)
- Activated outputs and inputs indicated by LEDs
- Front space requirements: one rack division.

Auxiliary DC supply unit 216NG61, 216NG62 and 216NG63

- Versions for 36 to 312 V DC input
- Outputs 24V DC, 150 W
- Short-circuit and overload-proof outputs
- Parallel connection to increase rating
- Parallel connection for redundancy (2 outputs)
- Space requirement: 3 rack divisions.

All the REG216 protection functions operate with sampled primary system voltages and currents. The sampling rate of the analog

Construction (cont´d)

input units is 12 times per period at rated power system frequency with a dynamic range of 15 bits.

All further signal processing takes place digitally. The protection functions are therefore universally applicable, highly accurate and have excellent long-time stability.

DC components and harmonic contents are efficiently suppressed by digital filters to avoid disturbance. The tripping logic for the internal protection functions (earlier a diode matrix), is software-controlled in REG216.

Setting and control

The protection system is set and controlled using a personal computer connected to it via a serial interface.

Operation of the console is menu-assisted and permits:

- Setting of parameters and recording of the settings
- Display of measured values
- Display of events, their acknowledgment and printout
- Disturbance recording.

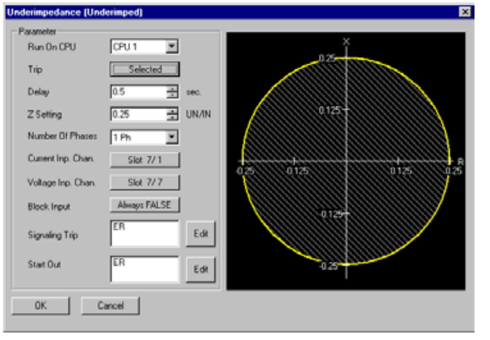
Windows HMI

A new Windows-based setting tool CAP2/316 is available since the Firmware version V5.2. This Software runs only under the following operating systems:

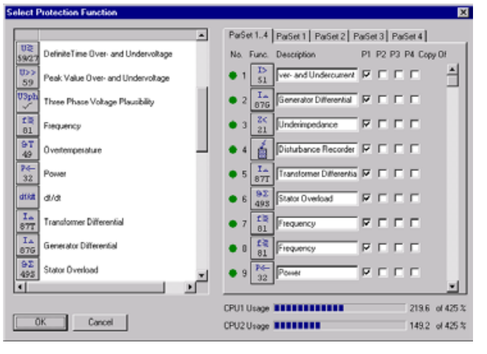
- WINDOWS NT 4.0
- WINDOWS 2000
- WINDOWS XP ≥6.0

The perfect tool for engineering, testing, commissioning and maintenance personnel can be used for ON-LINE or OFF-LINE programming.

For each protection function a visible tripping characteristic is displayed depending on the setting values, e.g. the underimpedance function shown below.



There is a library with all protection functions necessary for generator and transformer protection. Easy activation of a protective function by “drag & drop” technology.



Self-monitoring and testing facilities

The self-monitoring and testing routine philosophy of the REG216 can be divided into following sections:

- Self-monitoring
- Parameter viewing facilities
- Injection testing with separate test equipment.

Self-monitoring

The self-monitoring and testing routine philosophy is quite different from conventional testing techniques. Whilst the previous practice in protection was to maintain availability through comprehensive periodic testing. REG216 does this continuously by taking full advantage of digital and data bus technology.

The self-monitoring functions have two elements:

- Continuous self-monitoring by hardware
- Cyclically executed testing routines, mainly by software.

Testing

Viewing protection measurements

One feature of the REG216 is the provision to view various operating measurements. This together with the self-monitoring functions replaces the periodic injection testing necessary with conventional protection equipment. The following data can be viewed:

a) The system values as measured by all protection functions. The corresponding functions do not have to have picked up for this purpose.

b) Analog inputs. The amplitudes, frequency and phase relationships of all the analog inputs can be viewed without jeopardizing the operation of the protection functions.

c) Digital input and output signals. The status of each signal can be viewed.

Apart from the self-monitoring routines, the fact that the measurement data can be viewed all the way from the input transformers to the digital signals also confirms the correct functioning of the digital processors and the data bus.

Using software HMI „Test functions"

The desired protective function may be selected from the list of available active functions. The test operation is based on simulated numerical values. One or more channels may be selected for testing the tripping or signalling outputs. The test function is mainly used for commissioning purposes when the system is out of service.

Redundancy

Hardware and software redundancy is adapted to the functional requirements. Two independent groups of protection functions are accommodated in either two separate hardware racks or in only one rack, but with two completely independent hardware groups.

Injection testing

A 100% test of the system can be carried out by injecting test voltages and currents using, for example, a test set type OMICRON. Provision is made for injection testing with a test set at the terminals of the input transformer assembly 216GW62. The terminals enable primary system PT circuits to be interrupted and CTs to be short-circuited.

Technical data

Table 1: Input circuits

Rated current I_N	1 A, 2 A or 5 A
Rated voltage U_N	100 V or 200 V
Rated frequency f_N	50/60 Hz
Thermal ratings: continuous for 10 s for 1 s surge (half-cycle)	 4 x I_N 30 x I_N 100 x I_N 250 x I_N (peak)
Thermal rating of voltage circuit: continuous during 10 s	 2.25 x U_N 4 x U_N
Burden of the current inputs Burden of the voltage inputs	<0.2 VA/input at I_N <0.4 VA/input at U_N
Input signals REG216 Classic (216GE61) REG216 (216GD61a)	 24 to 220 V AC or 24 to 250 V DC 20 to 30 V DC, 36 to 75 V DC, 82 to 312 V DC or 175 to 312 V DC

Table 2: Generator differential (87G)

Features: • Three-phase function • Current-adaptive characteristic • High stability for external faults and current transformer saturation	
Settings:	
g-setting (basic sensitivity)	0.1 to 0.5 I_N in steps of 0.05 I_N
v-setting (slope)	0.25; 0.5
Max. trip time - for $I_\Delta > 2\ I_N$ - for $I_\Delta \leq 2\ I_N$	 ≤30 ms ≤50 ms
Accuracy of pick-up value of g	±5% I_N (at f_N)

Table 3: Transformer differential (87T)

Features: • For two- and three-winding transformers • Three-phase function • Current-adaptive characteristic • High stability for external faults and current transformer saturation • No auxiliary transformers necessary because of vector group and CT ratio compensation • Inrush restraint using 2nd harmonic	
Settings:	
g-setting	0.1 to 0.5 I_N in steps of 0.1 I_N
v-setting	0.25, 0.5
b-setting	1.25 to 5 in steps of 0.25
Max. trip time (protected transformer loaded) - for $I_\Delta > 2\ I_N$ - for $I_\Delta \leq 2\ I_N$	 ≤30 ms ≤50 ms

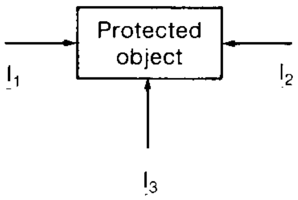
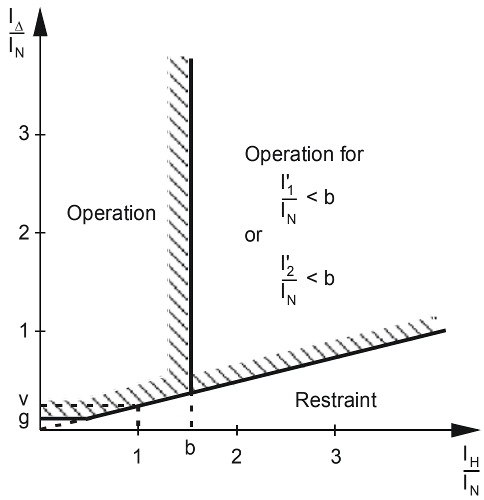
Accuracy of pick-up value	±5% I_N (at f_N)
Reset conditions	I_Δ <0.8 g-setting
Differential protection definitions:  $I_\Delta = \lvert \underline{I}_1 + \underline{I}_2 + \underline{I}_3 \rvert$ $I_H = \begin{cases} \sqrt{I_1' \times I_2' \times \cos\alpha} & \text{for } \cos\alpha \ge 0 \\ 0 & \text{for } \cos\alpha < 0 \end{cases}$ $\alpha = \arg(\underline{I}'_1 ; -\underline{I}'_2)$ 2-winding: $\underline{I}'_1 = \underline{I}_1$, $\underline{I}'_2 = \underline{I}_2$ 3-winding: $\underline{I}'_1 = \text{MAX}(\underline{I}_1, \underline{I}_2, \underline{I}_3)$ $I'_2 = \underline{I}_1 + \underline{I}_2 + \underline{I}_3 - \underline{I}'_1$	 Fig. 2 Differential protection characteristic

Table 4: Definite time current function (51 DT)

Features: • Over and undercurrent detection • Single- or three-phase measurement with detection of the highest, respectively lowest phase current • 2nd. harmonic restraint for high inrush currents	
Settings:	
Pick-up current	0.02 to 20 I_N in steps of 0.01 I_N
Delay	0.02 to 60 s in steps of 0.01 s
Accuracy of the pick-up setting (at f_N)	±5% or ±0.02 I_N
Reset ratio overcurrent undercurrent	 >94 % (for max. function) <106 % (for min. function)
Max. operating time without intentional delay	60 ms
Inrush restraint pick-up setting reset ratio	optional 0.1 I_{2h}/I_{1h} 0.8

Technical data (cont´d)

Table 5: Instantaneous overcurrent (50)

Features: • Maximum or minimum function (over- and undercurrent) • Single- or three-phase measurements • Wide frequency range (0.04 to 1.2 f_N) • Peak value evaluation	
Settings:	
Current	0.1 to 20 I_N in steps of 0.1 I_N
Delay	0 to 60 s in steps of 0.01 s
Accuracy of pick-up value (at 0.08 to 1.1 f_N)	±5% or ±0.02 I_N
Reset ratio	>90% (for max. function) <110% (for min. function)
Max. trip time with no delay (at f_N)	≤30 ms (for max. function) ≤60 ms (for min. function)

Table 6: Voltage-controlled overcurrent (51/27)

Features: • Maximum current value memorized after start • Reset of function after voltage return or after trip • Single- or three-phase measurement for current • Positive-sequence voltage evaluation	
Settings:	
Current	0.5 to 20 I_N in steps of 0.1 I_N
Voltage	0.4 to 1.1 U_N in steps of 0.01 U_N
Delay	0.5 to 60 s in steps of 0.01 s
Hold time	0.1 to 10 s in steps of 0.02 s
Accuracy of pick-up value	±5% (at f_N)
Reset ratio	>93%
Starting time	≤80 ms

Table 7: Inverse time-overcurrent function (51)

• Single- or three-phase measurement with detection of the highest phase current • Stable response to transients	
Inverse time characteristic (acc. to B.S. 142 with extended setting range) normal inverse very inverse extremely inverse long time earth fault	$t = k_1 / ((I/I_B)^C - 1)$ c = 0.02 c = 1 c = 2 c = 1
or RXIDG characteristic	$t = 5.8 - 1.35 \cdot \ln (I/I_B)$
Settings:	
Number of phases	1 or 3
Base current I_B	0.04 to 2.5 I_N in steps of 0.01 I_N
Pick-up current	1 to 4 I_B in steps of 0.01 I_B
Min. time setting	0 to 10 s in steps of 0.1 s
k_1 setting	0.01 to 200 s in steps of 0.01 s
Accuracy classes for the operating time according to BritishStandard 142 RXIDG characteristic	 E 5.0 ±4% (1 - I/80 I_B)
Reset ratio	>94%

Table 8: Directional definite time overcurrent protection (67)

• Directional overcurrent protection with detection of the power direction • Back-up protection for distance protection scheme	
• Three-phase measurement • Suppression of DC- and high-frequency components • Definite time characteristic • Voltage memory feature for close faults	
Settings:	
Current	0.02 to 20 I_N in steps of 0.01 I_N
Angle	-180° to +180° in steps of 15°
Delay	0.02 s to 60 s in steps of 0.01 s
tWait	0.02 s to 20 s in steps of 0.01 s
Memory duration	0.2 s to 60 s in steps of 0.01 s
Accuracy of pick-up setting (at f_N) Reset ratio Accuracy of angle measurement (at 0.94 to 1.06 f_N)	±5% or ±0.02 I_N >94% ±5°
Voltage input range Voltage memory range Accuracy of angle measurement at voltage memory Frequency dependence of angle measurement at voltage memory Max. response time without delay	0.005 to 2 U_N <0.005 U_N ±20° ±0.5°/Hz 60 ms

Table 9: Directional inverse time overcurrent function (67)

• Directional overcurrent protection with detection of the power direction • Back-up protection for distance protection scheme	
• Three-phase measurement • Suppression of DC- and high-frequency components • Inverse time characteristic • Voltage memory feature for close faults	
Settings:	
Current I_{Start}	1…4 I_B in steps of 0.01 I_B
Angle	-180°…+180° in steps of 15°
Inverse time characteristic (acc. to B.S. 142 with extended setting range) normal inverse very inverse extremely inverse long-time earth fault	$t = k_1 / ((I/I_B)^C - 1)$ c = 0,02 c = 1 c = 2 c = 1
k_1-setting	0.01 to 200 s in steps of 0.01 s
t-min	0 to 10 s in steps of 0.1 s
IB-value	0.04 to 2.5 I_N in steps of 0.01 I_N
tWait	0.02 s to 20 s in steps of 0.01 s

Technical data (cont´d)

Memory duration	0.2 s to 60 s in steps of 0.01 s
Accuracy of pick-up setting (at f_N) Reset ratio Accuracy of angle measurement (at 0.94 to 1.06 f_N) Accuracy class of the operating time acc. to British Standard 142	±5% >94% ±5° E 10
Voltage input range Voltage memory range Accuracy of angle measurement at voltage memory Frequency dependence of angle measurement at voltage memory Max. response time without delay	0.005 to 2 U_N <0.005 U_N ±20° ±0.5°/Hz 60 ms

Table 10: Negative phase-sequence current (46)

Features: • Protection against unbalanced load • Definite time delay • Three-phase measurement	
Settings:	
Negative phase-sequence current (I_2)	0.02 to 0.5 I_N in steps of 0.01 I_N
Delay	0.5 to 60 s in steps of 0.01 s
Accuracy of pick-up value	±2% I_N (at f_N, I ≤I_N with measuring transformers)
Reset ratio I_2 ≥0.2 I_N I_2 <0.2 I_N	 >94% >90%
Starting time	≤80 ms

Table 11: Definite time overvoltage (59, 27)

Features: • Maximum or minimum function • Single- or three-phase measurement • Highest or lowest phase value evaluation for three-phase function • Also applicable as – Stator earth fault (95%) (59G/N) – Rotor earth fault* (64R) – Interturn fault	
Settings:	
Voltage	0.01 to 2.0 U_N in steps of 0.002 U_N
Delay	0.02 to 60 s in steps of 0.01 s
Accuracy of pick-up value (at $f_{N)}$	±2% or ±0.005 U_N
Reset ratio	>96% (for max. function) <104% (for min. function)
Response time without delay	≤60 ms

*requires ext. hardware: measuring bridge YWX111-... and coupling condensers.

Table 12: Instantaneous overvoltage protection function (59, 27) with peak value evaluation

Features: • Evaluation of instantaneous values, therefore extremely fast and frequency-independent on a wide scale • Storing of the highest instantaneous value after start • No suppression of DC components • No suppression of harmonics • Single- or three-phase • Maximum value detection for multi-phase functions • Variable lower limiting frequency f_{min}	
Settings:	
Voltage	0.01 to 2.0 U_N in steps of 0.01 U_N
Delay	0.00 to 60 s in steps of 0.01 s
Limiting f_{min}	25 to 50 Hz in steps of 1 Hz
Accuracy of pick-up value (at 0.08 to 1.1 f_N)	±3% or 0.005 U_N
Reset ratio	>90% (for max. function) <110% (for min. function)
Max. trip time at no delay (at f_N)	<30 ms (for max. function) <50 ms (for min. function)

Table 13: Distance protection (21)

• All values of settings referred to the secondaries, every zone can be set independently of the others • 4 independent files for sets of settings.	
Impedance measurement	-300 to 300 Ω/ph in steps of 0.01 Ω/ph (I_N = 1 A or 2 A) -30 to 30 Ω/ph in steps of 0.001 Ω/ph (I_N = 5 A)
Zero-sequence current compensation	0 to 8 in steps of 0.01, -180° to +90° in steps of 1°
Mutual impedance for parallel circuit lines	0 to 8 in steps of 0.01, -90° to +90° in steps of 1°
Time step setting range	0 to 10 s in steps of 0.01 s
Underimpedance starters	-999 to 999 Ω/ph in steps of 0.1 Ω/ph (I_N = 1 A or 2 A) -99.9 to 99.9 Ω/ph in steps of 0.01 Ω/ph (I_N = 5 A)
Overcurrent starters	0.5 to 10 I_N in steps of 0.01 I_N
Min. operating current	0.1 to 2 I_N in steps of 0.01 I_N
Back-up overcurrent	0 to 10 I_N in steps of 0.01 I_N
Neutral current criterion	0.1 to 2 I_N in steps of 0.01 I_N
Neutral voltage criterion	0 to 2 U_N in steps of 0.01 U_N
Low voltage criterion for detecting, for example, a weak infeed	0 to 2 U_N in steps of 0.01 U_N
VT supervision NPS/neutral voltage criterion NPS/neutral current criterion	 0.01 to 0.5 U_N in steps of 0.01 U_N 0.01 to 0.5 I_N in steps of 0.01 I_N
Accuracy (applicable for current time constants between 40 and 150 ms) amplitude error phase error Supplementary error for - frequency fluctuations of ±10 - 10 % third harmonic - 10 % fifth harmonic	 ±5% for U/U_N >0.1 ±2° for U/U_N >0.1 ±5% ±10% ±10%
Minimum operating time (incl. tripping relay):	21 ms
Typical operating time (incl. tripping relay): Basic distance protection function With ancillary functions activated	 30 ms +8 ms
Typical reset time	45 ms

Technical data (cont´d)

Table 14: Underimpedance (21)

Features:
- Detection of two- and three-phase short circuits (back-up protection)
- Single- or three-phase measurement
- Circular characteristic centered at origin of R-X diagram
- Lowest phase value evaluation for three-phase measurement

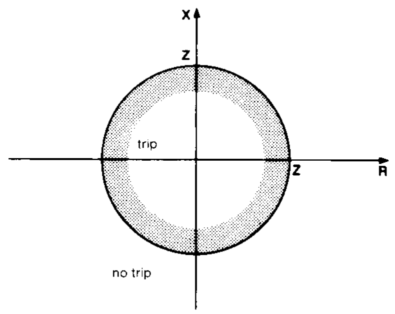


Fig. 3 Underimpedance protection function characteristics

Settings:	
Impedance	0.025 to 2.5 U_N/I_N in steps of 0.001 U_N/I_N
Delay	0.2 to 60 s in steps of 0.01 s
Reset ratio	<107%
Starting time	<80 ms (at f_N)

Table 15: Minimum reactance (40)

Features:
- Detection of loss-of-excitation failure of synchronous machines
- Single- or three-phase measurement
- Out-of-step detection with additional time delay or count logic
- Circular characteristic
- Tripping possible inside or outside of the circle

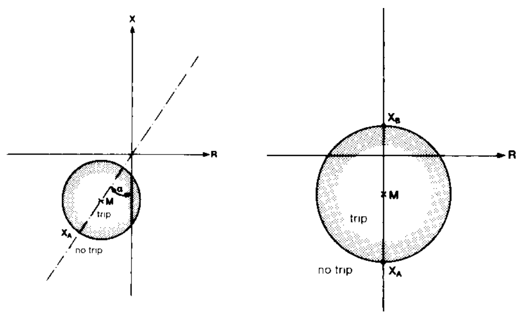


Fig. 4 Minimum reactance protection function characteristics

Settings:	
Reactance X_A	-5 to 0 U_N/I_N in steps of 0.01 U_N/I_N
Reactance X_B	-2.5 to + 2.5 U_N/I_N in steps of 0.01 U_N/I_N
Delay	0.2 to 60 s in steps of 0.01 s
Angle	-180° to +180° in steps of 5°
Accuracy of pick-up values	±5% of highest absolute value of X_A, X_B (at f_N)
Reset ratio	(related to origin of circle), 105% for min. function 95% for max. function
Starting time	≤80 ms

Table 16: Power (32)

Features: • Applicable for – active power protection – reverse power protection – reactive power protection • Maximum and minimum function • Single- or two- or three-phase measurement • Adjustable compensation angle for input transformer errors	
Settings:	
Power	-0.1 to 1.2 P_N in steps of 0.005 P_N
Minimum setting:	- 0.005 P_N (with measuring CT) - 0.02 P_N (with protection CT)
Angle	-180° to +180° in steps of 5°
Delay	0.05 to 60 s in steps of 0.01 s
Compensation angle	-5° to +5° in steps of 0.l°
Nominal power P_N	0.5 to 2.5 $U_N \cdot I_N$ in steps of 0.001 $U_N \cdot I_N$
Reset ratio	30% to 170% in steps of 1%
Accuracy	±10% of setting or 2% $U_N \cdot I_N$ (for protection CTs) ±3% of setting or 0.5% $U_N \cdot I_N$ (for core-balance CTs)
Max. operating time without intentional delay	70 ms

Table 17: Stator overload (49 S)

Features: • Single- or three-phase measurement • Operating characteristics according to ASA-C50.13 • Highest phase value for three-phase measurement • Wide time multiplier setting.	

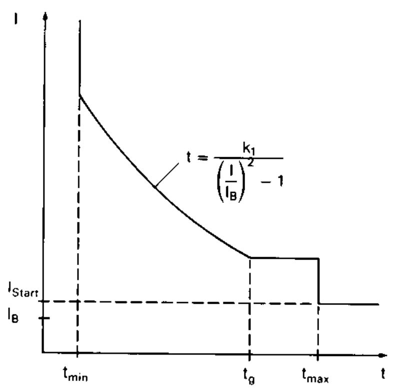


Fig. 5 Stator overload protection function characteristics

Settings:	
Base current (I_B)	0.5 to 2.5 I_N in steps of 0.01 I_N
Time multiplier k_1	1 to 120 s in steps of 0.1 s
Pick-up current (I_{start})	1.0 to 1.6 I_B in steps of 0.01 I_B
t_{min}	1 to 120 s in steps of 0.1 s
t_g	10 to 2000 s in steps of 10 s
t_{max}	100 to 2000 s in steps of 10 s
t_{reset}	10 to 2000 s in steps of 10 s
Accuracy of current measurement	±5% (at f_N), ±2% (at f_N) with measuring transformer
Starting time	≤80 ms

Technical data (cont´d)

Table 18: Rotor overload (49 R)

Features: Same as stator overload function, but three-phase measurement
Settings: Same as for stator overload function

Table 19: Inverse time negative phase sequence current (46)

Features:
- Protection against unbalanced load
- Inverse time delay
- Three-phase measurement

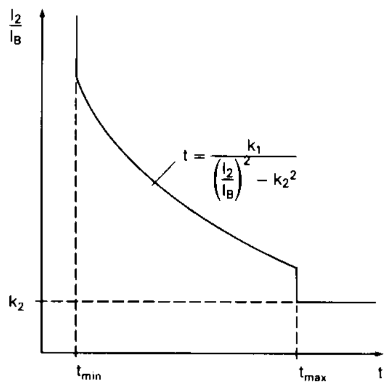


Fig. 6 Inverse time negative phase sequence current protection function characteristics

Settings:	
Base current (I_B)	0.5 to 2.5 I_N in steps of 0.01 I_N
Time multiplier k_1	5 to 60 s in steps of 0.1 s
Factor k_2 (pick-up)	0.02 to 0.20 in steps of 0.01
t_{min}	1 to 120 s in steps of 0.1 s
t_{max}	500 to 2000 s in steps of 1 s
t_{reset}	5 to 2000 s in steps of 1 s
Accuracy of NPS current (I_2) measurement	+2% (at f_N) with measuring transformers
Starting time	≤80 ms

Table 20: Overtemperature (49)

Features:
- Thermal replica for system of first order or general thermal system response
- Single- or three-phase current measurement
- Highest phase value for three-phase measurement

Settings:	
Base current I_B	0.5 to 2.5 I_N in steps of 0.01 I_N
Warning stage	50 to 200% ϑ_N in steps of 1% ϑ_N
Tripping stage	50 to 200% ϑ_N in steps of 1% ϑ_N
Thermal time constant	0.0 to 500 min in steps of 0.1 min
Accuracy of current measurement	±2% (at f_N) with measuring transformers
Accuracy of the thermal image	±5%

Table 21: Frequency (81)

Features: • Maximum or minimum function (over-, underfrequency) • Minimum voltage blocking	
Settings:	
Frequency	40 to 65 Hz in steps of 0.01 Hz
Delay	0.1 to 60 s in steps of 0.01 s
Minimum voltage	0.2 to 0.8 U_N in steps of 0.1 U_N
Accuracy of pick-up value	±30 mHz (at U_N and f_N)
Reset ratio	<106%
Starting time	<135 ms

Table 22: Rate-of-change of frequency df/dt (81)

Features: • Combined pick-up with frequency criterion possible • Blocking by undervoltage	
Settings:	
df/dt	-10 to +10 Hz/s in steps of 0.1 Hz/s
Frequency	40 to 55 Hz in steps of 0.01 Hz at f_N = 50 Hz 50 to 65 Hz in steps of 0.01 Hz at f_N = 60 Hz
Delay	0.1 to 60 s in steps of 0.01 s
Minimum voltage	0.2 to 0.8 U_N in steps of 0.1 U_N
Accuracy of df/dt (at 0.9 to 1.05 f_N)	±0.1 Hz/s
Accuracy of frequency (at 0.9 to 1.05 f_N)	±30 mHz
Reset ratio df/dt	95% for max. function 105% for min. function

Table 23: Overexcitation (24)

Features: • U/f measurement • Minimum voltage blocking	
Settings:	
Pick-up value	0.2 to 2 U_N/f_N in steps of 0.01 U_N/f_N
Delay	0.1 to 60 s in steps of 0.01 s
Frequency range	0.5 to 1.2 f_N
Accuracy (at f_N)	±3% or ±0.01 U_N/f_N
Reset ratio	>97% (max.), < 103% (min.)
Starting time	≤120 ms

Technical data (cont´d)

Table 24: Overexcitation function with inverse time delay (24)

Features: • Single-phase measurement • inverse time delay • According to IEEE Guide C37.91-1985, setting made by help of table settings	
Settings:	
Table settings	U/f values: (1.05; 1.10 to 1.50) U_N/f_N
Start value U/f	1.05 to 1.20 U_N/f_N in steps of 0.01 U_N/f_N
t_{min}	0.01 to 2 min in steps of 0.01 min
t_{max}	5 to 100 min in steps of 0.1 min
Reset time	0.2 to 100 min in steps of 0.1 min
Reference voltage	0.8 to 1.2 U_N in steps of 0.01 U_N
Accuracy of pick-up value	±3% U_N/f_N (at f_N)
Frequency range	0.5 to 1.2 f_N
Reset ratio	100%
Starting time	<120 ms

Table 25: Voltage balance function (60)

Features:

- Comparing of the voltage amplitudes of two groups of voltage inputs (line 1, line 2)
- Single- or three-phase voltage measurement
- Signalling of the group having the lower voltage
- Evaluation of the voltage differences per phase for the 3-phase function and logic OR connection for the tripping decision
- Variable tripping and reset delay
- Suppression of DC components
- Suppression of harmonics

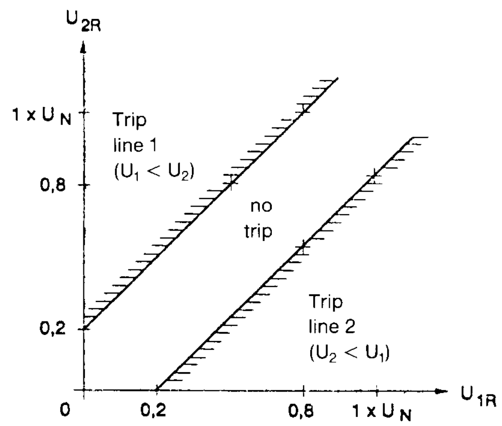


Fig. 7 Tripping characteristic Voltage comparison (shown for the phases R and the setting value volt. diff. = $0.2 \cdot U_N$)

Settings:	
Voltage difference	0.1 to 0.5 U_N in steps of 0.05 U_N
Trip delay	0.00 to 1.0 s in steps of 0.01 s
Reset delay	0.1 to 2.0 s in steps of 0.01 s
Numbers of phases	1 or 3
Maximum tripping time without delay	≤50 ms
U_{1R}: U_{2R}:	phase R voltage amplitude voltage channel 1 (line 1) phase R voltage amplitude voltage channel 2 (line 2)

For 3-phase function: the characteristic is valid accordingly for the phases S and T

Technical data (cont´d)

Table 26: Dead machine protection (51, 27)

Features: • Quick separation from network at accidental energization of generator (e.g. at standstill or on turning gear) • Instant overcurrent measurement • Voltage-controlled overcurrent function e.g. blocked at voltage values >0.85 U_N This function does not exist in the library, it must be combined from the voltage current and time function	
Settings:	
Voltage	0.01 to 2 U_N in steps of 0.002 U_N
Reset delay	0 to 60 s in steps of 0.01 s
Current	0.02 to 20 I_N in steps of 0.02 I_N
Delay	0.02 to 60 s in steps of 0.01 s

Table 27: 100% Stator earth fault protection (64 S)

Features: • Protection of the entire stator winding, including star points, even at standstill. Works also for most of the operating conditions. • Also suitable when 2 earthings (groundings) are in the protection zone • Continuous supervision of the insulation level of the stator • Based on the earth (ground) voltage displacement principle and calculation of the earth (ground) fault resistance • Alarm and tripping values are entered, resp. measured and displayed in kΩ	
• Type of earthings (groundings): - star point earthing with resistors (requires REX011) - star point earthing with grounding transformer (requires REX011-1) - earthing transformers on generator terminals (requires REX011-2)	
Settings:	
Alarm stage	100 Ω to 20 kΩ
Delay	0.2 s to 60 s
Tripping stage	100 Ω to 20 kΩ
Delay	0.2 s to 60 s
R_{ES}	400 Ω to 5 kΩ
Number of star points	2
R_{ES}-2. starpoint	900 Ω to 30 kΩ
Reset ratio	110% for setting values of ≤10 kΩ 120% for setting values of >10 kΩ
Accuracy	0.1 kΩ to 10 kΩ: <±10% 0 to 100 Ω, 10 kΩ to 20 kΩ: <±20%
Starting time	1.5 s
Functional requirements:	
- max. earthing current	I_0 <20 A (recommended I_0 = 5A)
- stator earthing capacity	0.5 µF to 6 µF
- stator earthing resistance R_{PS}	75 Ω to 500 Ω
- stator earthing resistance R_{ES}	250 Ω to 5 kΩ (≥4.5 x R_{PS})
(All values are based on the starpoint side)	
The actual earthing resistances R_{ES} + R_{PS} have to be calculated in accordance with the Operating Instructions: The 100% stator earth fault protection function always requires an injection unit type REX010, an injection transformer block type REX011 and a 95% stator earth fault protection function.	

Table 28: Rotor earth fault protection (64 R)

Features: • Continuous supervision of the insulation level and calculation of the earthing (grounding) resistance • Alarm and tripping values are entered resp. measured and displayed in kΩ	
Settings:	
Alarm stage	100 Ω to 25 kΩ
Delay	0.2 s to 60 s
Tripping stage	100 Ω to 25 kΩ
Delay	0.2 s to 60 s
R_{ER}	900 Ω to 5 kΩ
Coupling capacity	2 µF to 10 µF
Reset ratio	110%
Accuracy	0.1 kΩ to 10 kΩ <±10% 0 to 100 Ω, 10 kΩ to 25 kΩ <±20%
Starting time	1.5 s
Functional requirements:	
- total rotor earthing capacity	200 nF to 1µF
- rotor earthing resistance R_{PR}	100 Ω to 500 Ω
- rotor earthing resistance R_{ER}	900 Ω to 5 kΩ
- coupling capacity	2 µF to 10 µ F
- time constant	$\tau = R_{ER} \times C$ = 3...10 ms
The actual earthing resistance $R_{ER} + R_{PR}$ have to be calculated in accordance with the Operating Instructions. The 100% rotor earth fault protection function always requires an injection unit type REX010 and an injection transformer block type REX011 which are connected to the plant via coupling capacities.	

Technical data (cont´d)

Table 29: Pole slip protection (78)

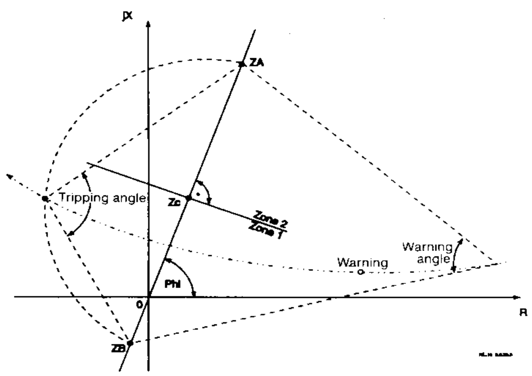
Features: • Recording the pole wheel movements from 0.2 Hz to 8 Hz • Differentiation of the pendulum center inside or outside of the generator-transformer block zone by two independent tripping stages • Adjustable warning angle for pole wheel movements • Number of slips adjustable before tripping	
 Fig. 8 Characteristic of the function	
Settings:	
ZA (system impedance)	0 to 5.0 U_N/I_N
ZB (generator impedance)	-5.0 to 0 U_N/I_N
ZC (impedance step 1)	0 to 5.0 U_N/I_N
Phi	60° to 270°
warning angle	0° to 180°
tripping angle	0° to 180°
n1	0 to 20
n2	0 to 20
t-reset	0.5 to 25 s

Table 30: Synchrocheck (25)

Features: • Supervision of synchronism. Single-phase measurement. The differences of the amplitudes, phase angles and frequencies of two voltage vectors are checked • Voltage supervision: Single- or three-phase voltage measurement. Evaluation of instantaneous values and therefore a large frequency range. Detection of maximum and minimum values in case of three-phase input • Phase selection of the voltage inputs • External switchover to another voltage input is possible (for double busbar systems) • External selection of the mode	
Settings:	
Max. voltage diff.	0.05 to 0.4 U_N in steps of 0.05 U_N
Max. phase diff.	5 to 80 deg. in steps of 5.0 deg.
Max. frequency diff.	0.05 to 0.4 Hz in steps of 0.05 Hz
Min. voltage	0.6 to 1 U_N in steps of 0.05 U_N
Max. voltage	0.1 to 1 U_N in steps of 0.05 U_N
Supervision time	0.05 to 5 s in steps of 0.05 s
Reset time	0 to 1 s in steps of 0.05 s

Table 31: Metering function UIfPQ

• Single-phase measurement of voltage, current, frequency, real power and apparent power • Choice of measuring phase-to-ground or phase-to-phase voltages • Suppression of DC components and harmonics in current and voltage • Compensation of phase errors in main and input CTs and VTs	
Settings:	
Phase-angle	-180° to +180° in steps of 0.1°
Reference value of the power S_N	0.2 to 2.5 S_N in steps of 0.001 S_N

Refer to Table 33 for accuracy.

Table 32: Three-phase measuring module

• Three-phase measurement of voltage (star or delta), current, frequency, real and apparent power and power factor • Two independent impulse counter inputs for calculation of interval and accumulated energy • The impulse counters can be used independently and may also be disabled • This function may be configured four times	
Settings:	
Angle	-180° to +180° in steps of 0.1°
Reference value for power	0.2 to 2.5 S_N in steps of 0.001 S_N
t1-Interval	1 min., 2 min., 5 min., 10 min., 15 min., 20 min., 30 min., 60 min. or 120 min.
Scale factor of power	0.0001 to 1
Max. impulse frequency	25 Hz
Min. impulse duration Accuracy of time interval	10 ms ±100 ms

See Table 33 for accuracy

Table 33: Accuracy of the metering function UIfPQ and three-phase measuring module (including input voltage and input current CT)

Input variable	Accuracy		Conditions
	Core balance CTs with error compensation	Protection CTs without error compensation	
Voltage	±0.5% U_N	±1% U_N	0.2 to 1.2 U_N $f = f_N$
Current	±0.5% I_N	±2% I_N	0.2 to 1.2 I_N $f = f_N$
Real power	±0.5% S_N	±3% S_N	0.2 to 1.2 S_N 0.2 to 1.2 U_N 0.2 to 1.2 I_N $f = f_N$
Apparent power	±0.5% S_N	±3% S_N	
Power factor	±0.01	±0.03	$S = S_N$, $f = f_N$
Frequency	±0.1% f_N	±0.1% f_N	0.9 to 1.1 f_N 0.8 to 1.2 U_N

$S_N = \sqrt{3} \cdot U_N \cdot I_N$ (three-phase)

$S_N = 1/3 \cdot \sqrt{3} \cdot U_N \cdot I_N$ (single-phase)

Technical data (cont´d)

Table 34: Breaker-failure protection (50BF)

Features • Individual phase current recognition • Single- or three-phase operation • External blocking input • Two independent time steps • Remote tripping adjustable simultaneously with retripping or back-up tripping • Possibility of segregated activating/deactivating each trip (Redundant trip, retrip, back-up trip and remote trip).	
Settings:	
Current	0.2 to 5 I_N in steps of 0.01 I_N
Delay t1 (repeated trip)	0.02 to 60 s in steps of 0.01 s
Delay t2 (back-up trip)	0.02 to 60 s in steps of 0.01 s
Delay tEFS (End fault protection)	0.02 to 60 s in steps of 0.01 s
Reset time for retrip	0.02 to 60 s in steps of 0.01 s
Reset time for back-up trip	0.02 to 60 s in steps of 0.01 s
Pulse time for remote trip	0.02 to 60 s in steps of 0.01 s
Number of phases	1 or 3
Accuracy of pick-up current (at f_N) Reset ratio of current measurement	±15% >85%
Reset time (for power system time constants up to 300 ms and short-circuit currents up to 40 • I_N)	≤28 ms (with main CTs TPX) ≤28 ms (with main CTs TPY and current setting ≥1.2 I_N) ≤38 ms (with main CTs TPY and current setting ≥0.4 I_N)

Table 35: Disturbance recorder

• Max. 12 CT/VT channels • Max. 16 binary channels • Max. 12 analog channels of internal measurement values • 12 samples per period (sampling frequency 600 or 720 Hz at a rated frequency of 50/60 Hz) • Available recording time for 9 CT/VT- and 8 binary signals approximately 5 s • Recording initiated by any binary signal, e.g. the general trip signal.	
Data format	EVE
Dynamic range	70 x I_N, 2.2 x U_N
Resolution	12 bits
Settings:	
Recording periods Pre-event Event Post-event	 40...400 ms in steps of 20 ms 100...3000 ms in steps of 50 ms 40...400 ms in steps of 20 ms

Table 36: Logic functions

Delay function: - Adjustable trip delay and drop delay - Two time integration modes - Input invertible	0 to 300 s in steps of 0.01 s
Counting function: - Adjustable trip counting threshold and drop delay - Input invertible	1 to 100 in steps of 1
AND function - Maximum of four inputs - All inputs invertible - Trip with additional delay or counting function	
OR-function - Maximum of four inputs - All inputs invertible - Trip with additional delay or counting function	
FLIP-FLOP function - Two set- and two reset inputs - All inputs invertible - Trip with additional delay or counting function	

Table 37: Configuration and Settings

Locally via the comm. port on the front-plate using an IBM AT or compatible PC
User interface program CAP2/316 in English, German or French on a CD

Table 38: Remote communication

RS232C interface Data transfer rate Protocol Electrical/optical converter (optional)	 9600 Bit/s SPA or IEC 60870-5-103 216BM61b
PC-Card interface Number	 2 plug-in sockets for type 3 cards (for 2 processing units 216VC62a)
PC-Cards (optional) interbay bus protocol process bus protocol (interbay and process bus can be used concurrently) LON bus Data transfer rate IEC 61375 bus Data transfer rate	 LON or MVB (part of IEC 61375) MVB (part of IEC 61375) PC-Card with fibreoptic port, ST connectors 1.25 MBit/s PC-Card with redundant fibreoptic port, ST connectors 1.5 MBit/s
Event memory Capacity Time marker resolution	 256 events 1 ms
Time deviation without remote synchronization	<10 s per day
Engineering interface	integrated software interface for signal engineering with SigTOOL

Technical data (cont´d)

Table 39: Contact data

Tripping:	
Max. operating voltage	250 V_{AC} or V_{DC}
Make and carry for 0.5 s	30 A_{AC} or A_{DC}
Continuous current	10 A_{AC} or A_{DC}
Making power	2500 VA
Rupture current with two contacts in series and L/R = 40 ms at U $\leq$50 V_{DC} at U $\leq$120 V_{DC} at U $\leq$250 V_{DC}	 5 A 1 A 0,3 A
Signalling stand by No. of contacts (216GA61) No. of contacts (216GD61a)	 2 break contacts per signalling channel 1 make contact per signalling channel 4 signalling channels with 1 break contact
Max. operating voltage	250 V_{AC} or V_{DC}
Make and carry for 0.5 s	10 A_{AC} or A_{DC}
Continuous current	5 A_{AC} or A_{DC}
Making power	1250 VA_{AC} 60 W_{DC}

Table 40: Auxiliary supply

Max. installed rating per cubicle	400 W
Supply interruption bridging time at min input voltage and full load at rated input voltage and 70% load	 >10 ms >50 ms

Table 41: General data

Temperature range operation storage	 -10° C to +55° C -40° C to +85° C	 EN 60255-6 (1994), IEC 60255-6 (1988)
Humidity	93%, 40° C, 4 days	IEC 60068-2-3 (1969)
Seismic test	2 g, 30 s, 1 to 33 Hz (1 octave/min)	IEC 60255-21-3 (1995), IEEE 344 (1987)
Leakage resistance	>100 MΩ, 500 V DC	EN 60255-5 (2001), IEC 60255-5 (2000)
Insulation test	2 kV, 50 Hz, 1 min 2.2 kV, 50 Hz, 1 s 2.85 kV, DC, 1 min 3.2 kV, DC, 1 s 1 kV across open contacts Second test multiplication x 0.75 (Voltage)	EN 60255-5 (2001), IEC 60255-5 (2000), EN 60950 (1995)
Surge voltage test	5 kV, 1.2/50 µs	EN 60255-5 (2001), IEC 60255-5 (2000) *
1 MHz burst disturbance test	1.0/2.5 kV, Cl. 3; 1MHz, 400 Hz rep.freq.	IEC 60255-22-1 (1988), ANSI/IEEE C37.90.1 (1989)
Fast transient test	2/4 kV, Cl. 4	EN 61000-4-4 (1995), IEC 61000-4-4 (1995)

Electrostatic discharge test (ESD)	6/8 kV (10 shots), Cl. 3	EN 61000-4-2 (1996), IEC 61000-4-2 (2001)
Immunity to magnetic interference at power system frequencies	300 A/m; 1000 A/m; 50/60 Hz	EN 61000-4-8 (1993), IEC 61000-4-8 (1993)
Radio frequency interference test (RFI)	• 0.15-80 MHz, 80% amplitude modulated 10 V, Cl. 3 • 80-1000 MHz, 80% amplitude modulated 10 V/m, Cl. 3 • 900 MHz, puls modulated 10 V/m, Cl. 3	EN 61000-4-6 (1996), EN 61000-4-6 (1996), EN 61000-4-3 (1996), IEC 61000-4-3 (1996), ENV 50204 (1995)
Emission	Cl. A	EN 61000-6-2 (2001), EN 55011 (1998), CISPR 11 (1990)
* Reduced values apply for repeat tests according to IEC publication 255-5, Clauses 6.6 and 8.6.		

Table 42: Mechanical design

Terminals CT and PT circuits	10 mm^2, Type Phoenix URTK/S
Tripping and signalling circuits	4 mm^2, Type Phoenix UKK5-MT KD-P/P (GKOS for 216GD61a)
Aux. DC supply and remaining aux. circuits	10 mm^2, Type Phoenix UK4 (GKOS for 216GD61a)
Cubicle wiring CT and PT circuits	directly mounted terminals
Aux. DC supply (IK62)	0.5 mm^2
Tripping and signalling circuits (IK64)	1 - 1.5 mm^2
System cables (IK61)	0.14 mm^2
Cubicle design	ABB Type RESP (see Data Sheet 1MRB520115-Ben)
Cubicle dimensions (w x d x h)	800 x 800 x 2200 mm
Total weight (with all aux. relays and units inserted)	200 to 400 kg

Ordering

In order to configure the generator protection system type REG216 the ABB-Engineering group needs the information from the Questionnaire 1MRB520026-Ken.

When ordering the REG216 version the following has to be stated:

- Rated current
- Rated voltage
- Optocoupler voltage
- Quantity of different units (electronic part) and interfaces.

1) 216GW62 Input transformer assembly
2) 216GD61a Interface unit consisting of:
   8 tripping relays
   16 signalling relays
   16 optocouplers
   3 cables 216IK61.

NOTE:
For customizing the REG216 version, please contact an ABB sales representative.

Table 43: Subcodes

Subcodes	Explanation	Description	Remarks for ordering
M- M1	Single system 1*rack 216MB66 consisting of 1*NG6x, 1*EA62, 1*AB61, 1*DB61, 1*VC62a		
	1*GW62 1*GD61a	Code K- Code I-	
M- M2	Single system 1*rack 216MB66 consisting of 1*NG6x, 1*EA62, 1*AB61, 2*DB61, 1*VC62a		
	2*GW62 2*GD61a	Code K-/L- Code I-	
M- M3	Single system 1*rack 216MB66 consisting of 1*NG6x, 1*EA62, 1*AB61, 1*DB61, 1*VC62a		
	2*GW62 1*GD61a	Code K-/L- Code I-	
M- M4	Single system 1*rack 216MB66 consisting of 1*NG6x, 1*EA62, 1*AB61, 2*DB61, 1*VC62a		
	1*GW62 2*GD61a	Code K- Code I-	
M- M5	Single system 1*rack 216MB66 consisting of 1*NG6x, 2*EA62, 1*AB61, 2*DB61, 1*VC62a		
	3*GW62 2*GD61a	Code K-/L-/N- Code I-	
M- M6	Single system 1*rack 216MB66 consisting of 1*NG6x, 2*EA62, 1*AB61, 2*DB61, 1*VC62a		
	4*GW62 2*GD61a	Code K-/L-/N-/O- Code I-	
M- M11	Redundant system 1*rack 216MB68 consisting of 1*NG6x, 1*EA62, 1*AB61, 1*DB61, 1*VC62a per system		
	2*GW62 2*GD61a	Code K-/L- Code I-	common for both systems
M- M12	Redundant system 1*rack 216MB68 consisting of 1*NG6x, 1*EA62, 1*AB61, 2*DB61, 1*VC62a per system		
	2*GW62 4*GD61a	Code K-/L- Code I-	common for both systems

Subcodes		Explanation	Description	Remarks for ordering
M-	M13	Redundant system 1*rack 216MB68 consisting of 1*NG6x, 1*EA62, 1*AB61, 1*DB61, 1*VC62a per system		
		1*GW62	Code K-	for system A
		1*GW62	Code L-	common for both systems
		1*GW62	Code N-	for system B
		2*GD61a	Code I-	
M-	M14	Redundant system 1*rack 216MB68 consisting of 1*NG6x, 1*EA62, 1*AB61, 2*DB61, 1*VC62a per system		
		1*GW62	Code K-	for system A
		1*GW62	Code L-	common for both systems
		1*GW62	Code N-	for system B
		4*GD61a	Code I-	
M-	M15	Redundant system 1*rack 216MB68 consisting of 1*NG6x, 1*EA62, 1*AB61, 1*DB61, 1*VC62a per system		
		2*GW62	Code K-/L-	for system A
		2*GW62	Code N-/O-	for system B
		2*GD61a	Code I-	
M-	M16	Redundant system 1*rack 216MB68 consisting of 1*NG6x, 1*EA62, 1*AB61, 2*DB61, 1*VC62a per system		
		2*GW62	Code K-/L-	for system A
		2*GW62	Code N-/O-	for system B
		4*GD61a	Code I-	

M-	M21	Double system 2*racks 216MB66 consisting of 1*NG6x, 1*EA62, 1*AB61, 2*DB61, 1*VC62a per rack		
		1*GW62	Code K-	for system A
		1*GW62	Code L-	common for both systems
		1*GW62	Code N-	for system B
		4*GD61a	Code I-	
M-	M22	Double system 2*racks 216MB66 consisting of 1*NG6x, 2*EA62, 1*AB61, 2*DB61, 1*VC62a per rack		
		1*GW62	Code K-	for system A
		2*GW62	Code L-/N-	common for both systems
		1*GW62	Code O-	for system B
		4*GD61a	Code I-	
M-	M23	Double system 2*racks 216MB66 consisting of 1*NG6x, 2*EA62, 1*AB61, 2*DB61, 1*VC62a per rack		
		4*GW62	Code K-/L-/N-/O-	common for both systems
		4*GD61a	Code I-	
M-	M24	Double system 2*racks 216MB66 consisting of 1*NG6x, 2*EA62, 1*AB61, 2*DB61, 1*VC62a per rack		
		1*GW62	Code K-	for system A
		3*GW62	Code L-/N-/O-	common for both systems
		1*GW62	Code P-	for system B
		4*GD61a	Code I-	
M-	M25	Double system 2*racks 216MB66 consisting of 1*NG6x, 2*EA62, 1*AB61, 2*DB61, 1*VC62a per rack		
		2*GW62	Code K-/L-	for system A
		2*GW62	Code N-/O-	common for both systems
		2*GW62	Code P-/Q-	for system B
		4*GD61a	Code I-	

Ordering (cont´d)

Subcodes		Explanation	Description	Remarks for ordering
A-	A0	none	rated current	for protection transformers
	A1	1 A		
	A5	5 A		
B-	B0	none	rated current	for measurement transfomers
	B1	1 A		
	B5	5 A		
U-	U0	none	rated voltage	
	U1	100 V AC		
	U2	200 V AC		
K-/L-	K01	6 CTs (3ph	Code A-)	VT, CT and MT arrangements of
N-/O-	L01	1 MT (1ph	Code B-)	analog input transformer unit
P-/Q-	N01	2 VTs (1ph	Code U-)	
	O01	3 VTs (3ph delta	Code U-)	
	P01			
	Q01			
K-/L-	K02	6 CTs (3ph	Code A-)	Typ 216GW62
N-/O-	L02	3 MTs (3ph	Code B-)	Explanation:
P-/Q-	N02	3 VTs (3ph delta	Code U-)	CT = current transformer protection core
	O02			MT = current transformer measurement core
	P02			VT = voltage transformer
	Q02			
K-/L-	K03	6 CTs (3ph	Code A-)	
N-/O-	L03	3 VTs (3ph delta	Code U-)	
P-/Q-	N03	3 VTs (3ph delta	Code U-)	
	O03			
	P03			
	Q03			
K-/L-	K04	6 CTs (3ph	Code A-)	
N-/O-	L04	1 CT (1ph	Code A-)	
P-/Q-	N04	1 MT (1ph	Code B-)	
	O04	1 VTs (1ph	Code U-)	
	P04	3 VTs (3ph delta	Code U-)	
	Q04			
K-/L-	K05	9 CTs (3ph	Code A-)	
N-/O-	L05	1 MT (1ph	Code B-)	
P-/Q-	N05	2 VTs (1ph	Code U-)	
	O05			
	P05			
	Q05			
K-/L-	K06	9 CTs (3ph	Code A-)	
N-/O-	L06	3 VTs (3ph delta	Code U-)	
P-/Q-	N06			
	O06			
	P06			
	Q06			
K-/L-	K07	12 CTs (3ph	Code A-)	
N-/O-	L07			
P-/Q-	N07			
	O07			
	P07			
	Q07			

Subcodes		Explanation	Description	Remarks for ordering
K-/L-	K08	9 CTs (3ph	Code A-)	
N-/O-	L08	3 MTs (3ph	Code B-)	
P-/Q-	N08			
	O08			
	P08			
	Q08			
K-/L-	K09	3 CTs (3ph	Code A-)	
N-/O-	L09	3 MTs (3ph	Code B-)	
P-/Q-	N09	3 VTs (3ph delta	Code U-)	
	O09	2 VTs (1ph	Code U-)	
	P09	1 MT (1ph	Code B-)	
	Q09			
K-/L-	K10	6 CTs (3ph	Code A-)	
N-/O-	L10	3 VTs (3ph delta	Code U-)	
P-/Q-	N10	3 VTs (1ph	Code U-)	
	O10			
	P10			
	Q10			
K-/L-	K11	9 CTs (3ph	Code A-)	
N-/O-	L11	3 VTs (3ph star	Code U-)	
P-/Q-	N11			
	O11			
	P11			
	Q11			
K-/L-	K12	3 CTs (3ph	Code A-)	
N-/O-	L12	3 VTs (3ph delta	Code U-)	
P-/Q-	N12	1 VT (1ph	Code U-)	
	O12	1 MT (1ph	Code B-)	
	P12	1 VT (1ph		95% Stator earth fault protection
	Q12	3 VTs (special)		100% Stator + Rotor earth fault protection
K-/L-	K13	6 CTs (3ph	Code A-)	
N-/O-	L13	3 VTs (3ph delta	Code U-)	
P-/Q-	N13	1 VT (1ph		95% Stator earth fault protection
	O13	2 VTs (special)		100% Stator earth fault protection
	P13			
	Q13			
K-/L-	K14	3 CTs (3ph	Code A-)	
N-/O-	L14	3 VTs (3ph delta	Code U-)	
P-/Q-	N14	1 MT (1ph	Code B-)	
	O14	1 CT (1ph	Code A-)	
	P14	1 MT (1ph	Code B-)	
	Q14	3 VTs (3ph delta	Code U-)	
K-/L-	K15	2 VTs (1ph	Code U-)	
N-/O-	L15	1 CT (1ph	Code A-)	
P-/Q-	N15	9 CT (3ph	Code A-)	
	O15			
	P15			
	Q15			

Ordering (cont´d)

Subcodes		Explanation	Description	Remarks for ordering
K-/L-	K16	2 VTs (special)		100% Stator earth fault protection
N-/O-	L16	1 CT (1ph	Code A-)	
P-/Q-	N16	9 CT (3ph	Code A-)	
	O16			
	P16			
	Q16			
K-/L-	K18	6 CTs (3ph	Code A-)	
N-/O-	L18	1 CT (1ph	Code A-)	
P-/Q-	N18	1 MT (1ph	Code B-)	
	O18	1 CT (1ph	Code A-)	
	P18	3 VTs (3ph delta	Code U-)	
	Q18			
K-/L-	K19	3 VTs (3pn delta	Code U-)	
N-/O-	L19	3 VTs (3ph delta	Code U-)	
P-/Q-	N19	1 CT (1ph	Code A-)	
	O19	1 MT (1ph	Code B-)	
	P19	1 CT (1ph	Code A-)	
	Q19	1 VT (1ph		95% Stator earth fault protection
		2 VTs (special)		100% Stator earth fault protection

The above mentioned devices are included in the code Mx.
The number and types of CPUs, power supply, system
cable length and protocol must be specified by the code

G-	G1	165..312 V DC	1. DC/DC converter	System A
	G2	82....156 V DC	supply voltage	
	G4	36.....75 V DC		
H-	H0	none	2. DC/DC converter	System A
	H1	165..312 V DC	supply voltage	for variants M1-M6 and M21-M25 optional
	H2	82....156 V DC		redundant DC/DC converter can be used
	H4	36.....75 V DC		
E-	E0	none	1. DC/DC converter	System B
	E1	165..312 V DC	supply voltage	for variants M11-M16 and M21-M25 only
	E2	82....156 V DC		
	E4	36.....75 V DC		
F-	F0	none	2. DC/DC converter	System B
	F1	165..312 V DC	supply voltage	for variants M21-M25 optional
	F2	82....156 V DC		redundant DC/DC converter can be used
	F4	36.....75 V DC		
I-	I1	82....312 V DC		
	I2	36.....75 V DC	Binary input/output unit GD61a optocoupler input voltage	
	I3	20.....30 V DC		
	I9	175..312 V DC	This variant to be used with 220 or 250 V DC	

Subcodes		Explanation	Description	Remarks for ordering
S-	S1	SPA	Interbay bus protocol	
	S2	IEC 60870-5-103		only available >= Version 6.5c
	S3	LON		
W-	W0	not equipped	Additional CPU	only valid for M1-M6 and M21-M25
	W5	System A		maximum are two CPUs per system
	W6	System B		
	W7	System A + B		
C-	C1	IK61*2.5 m	System cable	Cable length GW62a modules --> System A
	C2	IK61*4.0 m		
D-	D1	IK61*2.5 m	System cable	Cable length GD61a modules --> System A
	D2	IK61*4.0 m		
Y-	Y0	not equipped	System cable	Cable length GW62 modules --> System B
	Y1	IK61*2.5 m		
	Y2	IK61*4.0 m		
Z-	Z0	none	System cable	Cable length GD61a modules --> System B
	Z1	IK61*2.5 m		
	Z2	IK61*4.0 m		
R-	R0	none	Reset unit	
	R1	System A		
	R2	System B		
	R3	System A + B		

Ordering (cont´d)

Table 44: Accessories

Type					Order No.
DC filter for REG216 power supply module (one per module required)					HEST402042P0307
PCC card interface					
Type	Protocol	Connector	Optical fibre*	Gauge **	Order No.
For interbay bus: PCCLON2 SET	LON	ST (bajonet)	G/G	62,5/125	HESG 448766R0001
For process bus: 500PCC02	MVB	ST (bajonet)	G/G	62,5/125	HESG 448735R0232
RS232C interbay bus interface					
Type	Protocol	Connector	Optical fibre*	Gauge **	Order No.
216BM61b	SPA	ST (bajonet)	G/G	62,5/125	HESG448267R1021
216BM61b	IEC 60870-5-103	SMA (screw)	G/G	62,5/125	HESG448267R1022
* receiver Rx / transmitter Tx, G = glass, P = plastic **optical fibre conductor gauge in µm					
Human machine interface					
Type		Description			Order No.
CAP2/316 *		Installation CD	German/English		1MRB260030M0001
* Unless expressly specified the latest version is supplied.					
Optical fibre PC connecting cable					
Type					Order No.
YX216a-1 (4 m)					HESG448522R1
YX216a-1 (10 m)					HESG448522R2
YX216a-1 (30 m)					HESG448522R3
Disturbance recorder evaluation program PSM505					
Description		SW variant	Licence type		Order No.
Software installation key		all variants	all types		1MRB260035R1099
Licence key		RelView	single-user		1MRB260035R1001
		Professional	single-user		1MRB260035R1011
		Professional	multi-user		1MRB260035R1012
		Expert	single-user		1MRB260035R1021
		Expert	multi-user		1MRB260035R1022
30-day trial licence key		Expert	single-user		On request: sa-t.supportline@se.abb.com

Accessories (optional)
These may also be obtained elsewhere, however correct operation of the overall system is crucial and the following details must be considered.

Personal computer
Various PCs having a RS232 and working with the operating systems Windows NT 4.0, Windows 2000 or Windows XP ≥6.0 can be used.

This PC type can also be used in the future in the probable event that the software functions increase (graphic display, etc.). Following requirements should be met:

64 MByte RAM
1 CD-ROM drive
1 hard disk minimum 500 MB
1 serial interface (RS 232 C)
2nd serial interface as option.

Variant M1 (single system, 1 rack)

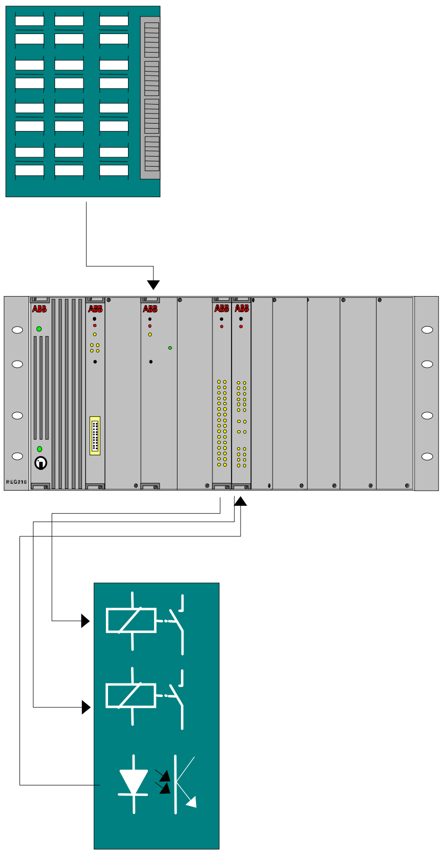
Configuration:

- 1*216NG6x		Code G
- 1*216VC62a		
- 1*216EA62		
- 1*216AB61		
- 1*216DB61		
- 12 Input transformers	(1*216GW62)	Code K
- 8 Tripping relays - 16 Signaling relays - 16 Binary inputs	(1*216GD61a)	Code I

Options:

- Additional CPU type 216VC62a	Code W5
- Redundant power supply 216NG6x	Code H

Ordering example for M1:
HESG324510M1001
Code: M1K*A*B*U*G*H*I*S*W*C*D*R*



Ordering (cont´d)

Variant M2 (single system, 1 rack)

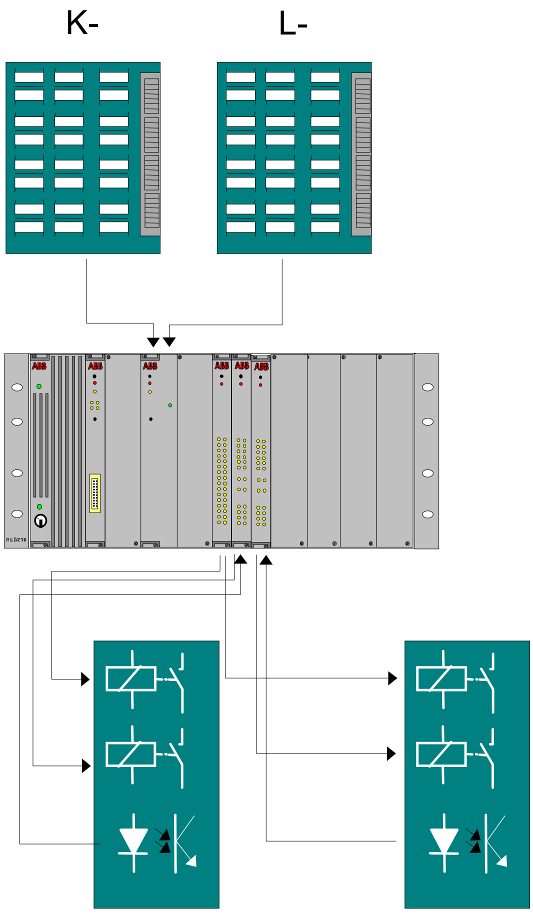
Configuration:

- 1*216NG6x		Code G
- 1*216VC62a		
- 1*216EA62		
- 1*216AB61		
- 2*216DB61		
- 24 input transformers	(2*216GW62)	Code K/L
- 16 tripping relays		
- 32 signaling relays	(2*216GD61a)	Code I
- 32 binary inputs		

Options:

- Additional CPU type 216VC62a	Code W5
- Redundant power supply 216NG6x	Code H

Ordering example for M2:
HESG324510M1001
Code: M2K*L*A*B*U*G*H*I*S*W*C*D*R*



Variant M3 (single system, 1 rack)

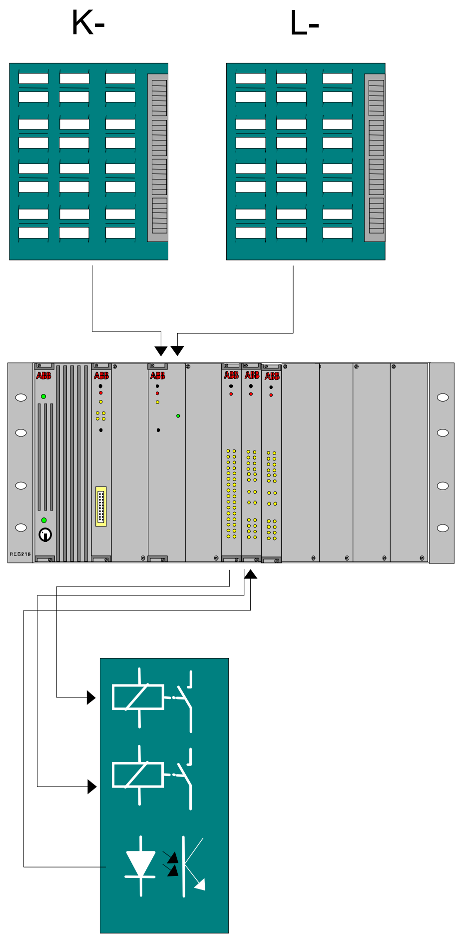
Configuration:

- 1*216NG6x		Code G
- 1*216VC62a		
- 1*216EA62		
- 1*216AB61		
- 1*216DB61		
- 24 input transformers	(2*216GW62)	Code K/L
- 8 tripping relays		
- 16 signaling relays	(1*216GD61a)	Code I
- 16 binary inputs		

Options:

- Additional CPU type 216VC62a	Code W5
- Redundant power supply 216NG6x	Code H

Ordering example for M3:
HESG324510M1001
Code: M3K*L*A*B*U*G*H*I*S*W*C*D*R*



Ordering (cont´d)

Variant M4 (single system, 1 rack)

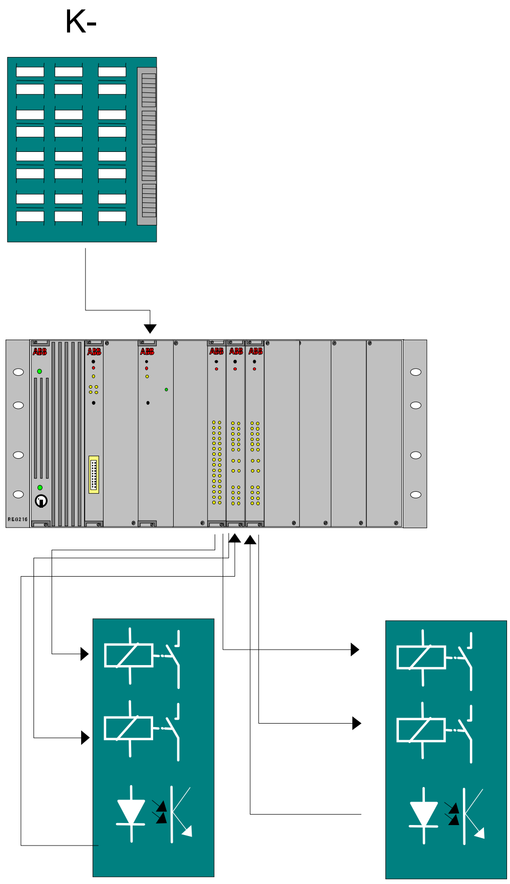
Configuration:

- 1*216NG6x		Code G
- 1*216VC62a		
- 1*216EA62		
- 1*216AB61		
- 2*216DB61		
- 12 input transformers	(1*216GW62)	Code K
- 16 tripping relays - 32 signaling relays - 32 binary inputs	(2*216GD61a)	Code I

Options:

- Additional CPU type 216VC62a	Code W5
- Redundant power supply 216NG6x	Code H

Ordering example for M4:
HESG324510M1001
Code: M4K*A*B*U*G*H*I*S*W*C*D*R*



Variant M5 (single system, 1 rack)

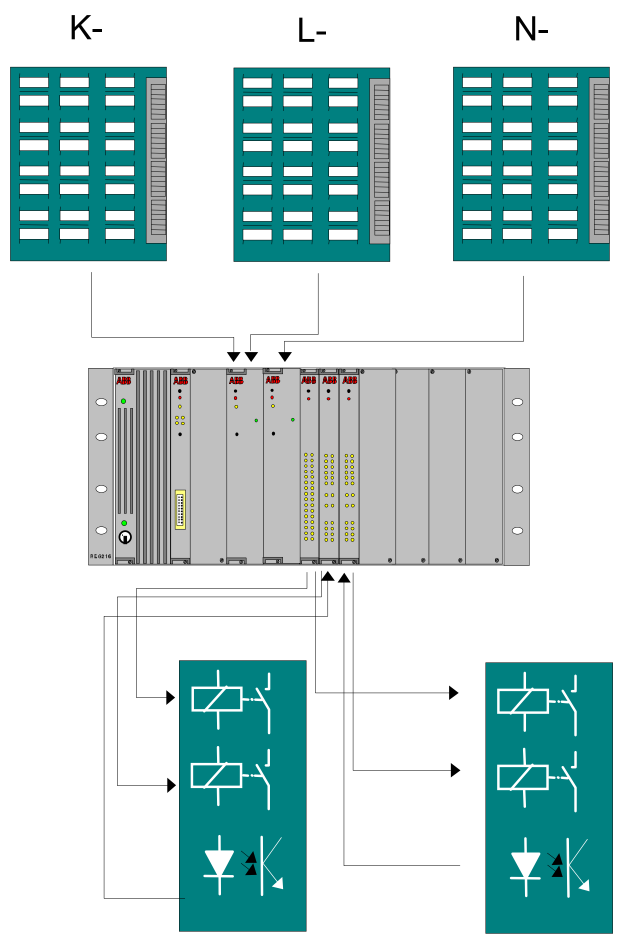
Configuration:

- 1*216NG6x		Code G
- 1*216VC62a		
- 2*216EA62		
- 1*216AB61		
- 2*216DB61		
- 36 input transformers	(3*216GW62)	Code K/L/N
- 16 tripping relays - 32 signaling relays - 32 binary inputs	(2*216GD61a)	Code I

Options:

- Additional CPU type 216VC62a	Code W5
- Redundant power supply 216NG6x	Code H

Ordering example for M5:
HESG324510M1001
Code: M5K*L*N*A*B*U*G*H*I*S*W*C*D*R*



Variant M6 (single system, 1 rack)

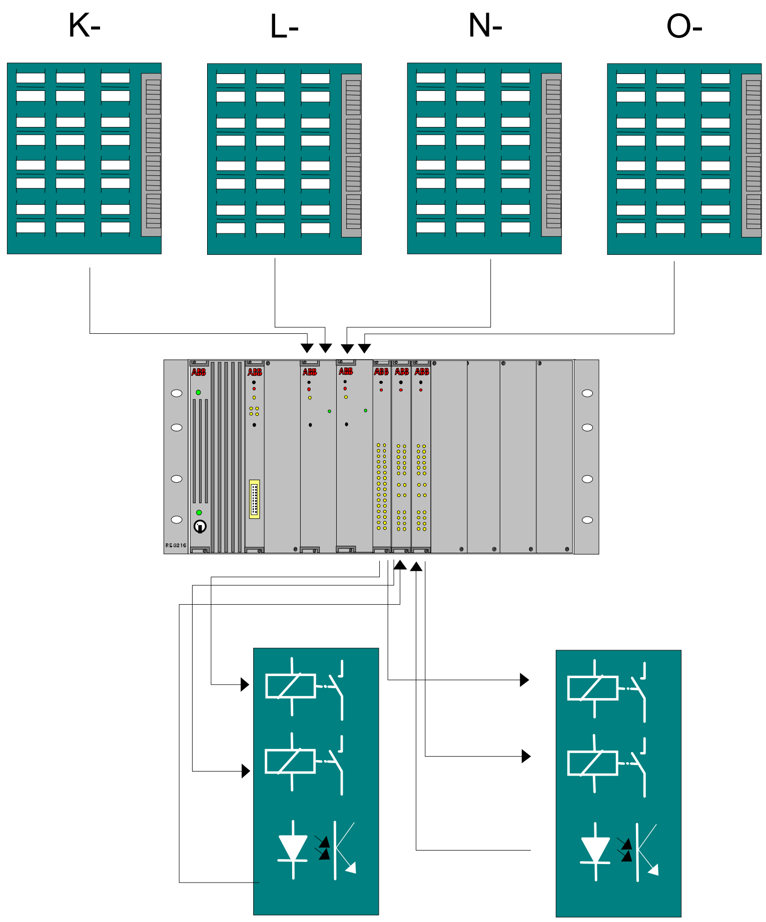
Configuration:

- 1*216NG6x		Code G
- 1*216VC62a		
- 2*216EA62		
- 1*216AB61		
- 2*216DB61		
- 48 input transformers	(4*216GW62)	Code K/L/N/O
- 16 tripping relays - 32 signaling relays - 32 binary inputs	(2*216GD61a)	Code I

Options:

- Additional CPU type 216VC62a	Code W5
- Redundant power supply 216NG6x	Code H

Ordering example for M6:
HESG324510M1001
Code: M6K*L*N*O*A*B*U*G*H*I*S*W*C*D*R*



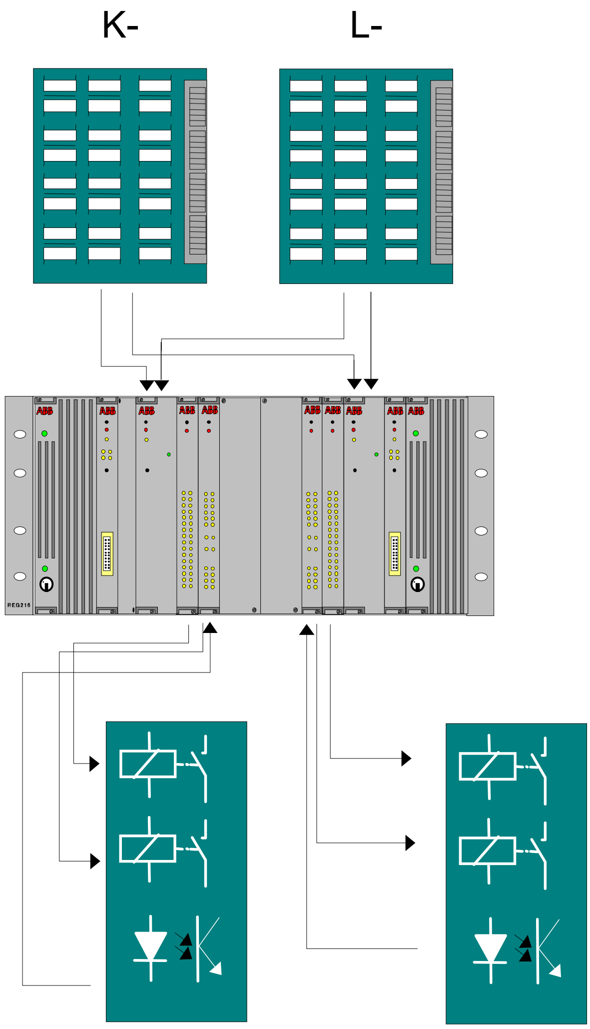
Variant M11 (redundant system, 1 rack)

Configuration as per system:

- 1*216NG6x		Code G/E
- 1*216VC62A		
- 1*216EA62		
- 1*216AB61		
- 1*216DB61		
- 8 tripping relays - 16 signaling relays - 16 binary inputs	(1*216GD61a)	Code I
Common use for both systems:		
- 24 input transformers	(2*216GW62)	Code K/L

Options:
- none

Ordering example for M11:
HESG324510M1001
Code: M11K*L*A*B*U*G*E*I*S*C*D*Y*Z*R*



Variant M12 (redundant system, 1 rack)

Configuration as per system:

- 1*216NG6x		Code G/E
- 1*216VC62a		
- 1*216EA62		
- 1*216AB61		
- 2*216DB61		
- 16 tripping relays	(2*216GD61a)	Code I
- 32 signaling relays		
- 32 binary inputs		
Common use for both systems:		
- 24 input transformers	(2*216GW62)	Code K/L

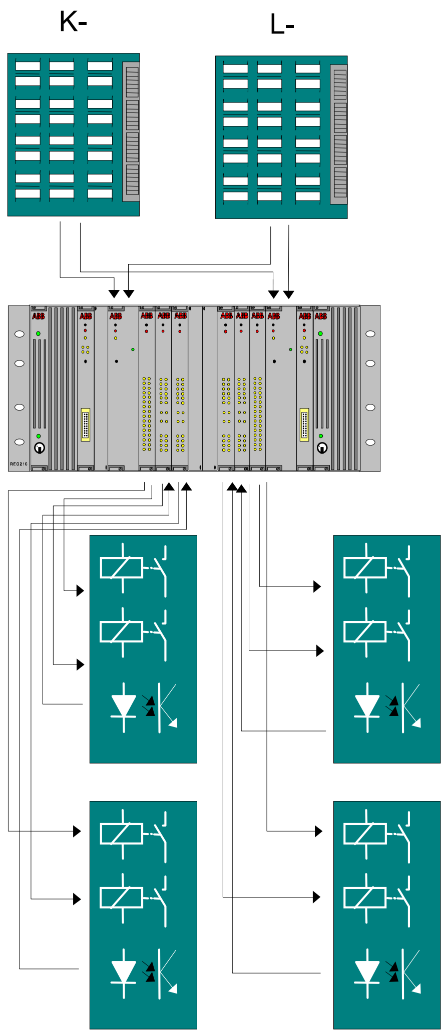
Options:

- none

Ordering example for M12:

HESG324510M1001

Code: M12K*L*A*B*U*G*E*I*S*C*D*Y*Z*R*



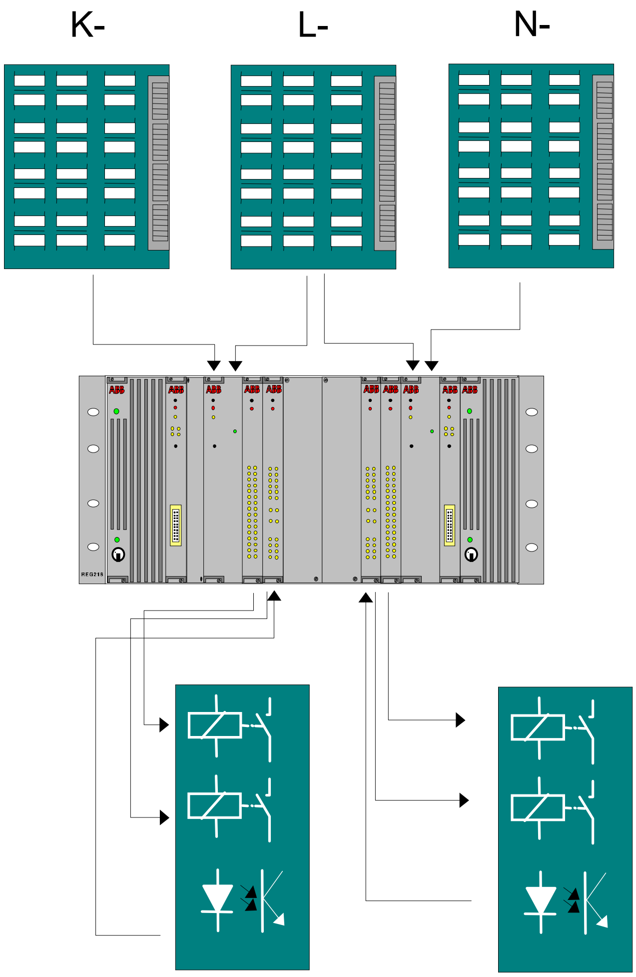
Variant M13 (redundant system, 1 rack)

Configuration as per system:

- 1*216NG6x		Code G/E
- 1*216VC62a		
- 1*216EA62		
- 1*216AB61		
- 1*216DB61		
- 8 tripping relays	(1*216GD61a)	Code I
- 16 signaling relays		
- 16 binary inputs		
- 12 input transformers	(1*216GW62)	Code K/N
Common use for both systems:		
- 12 input transformers	(1*216GW62)	Code L

Options:
- none

Ordering example for M13:
HESG324510M1001
Code: M13K*L*N*A*B*U*G*E*I*S*C*D*Y*Z*R*



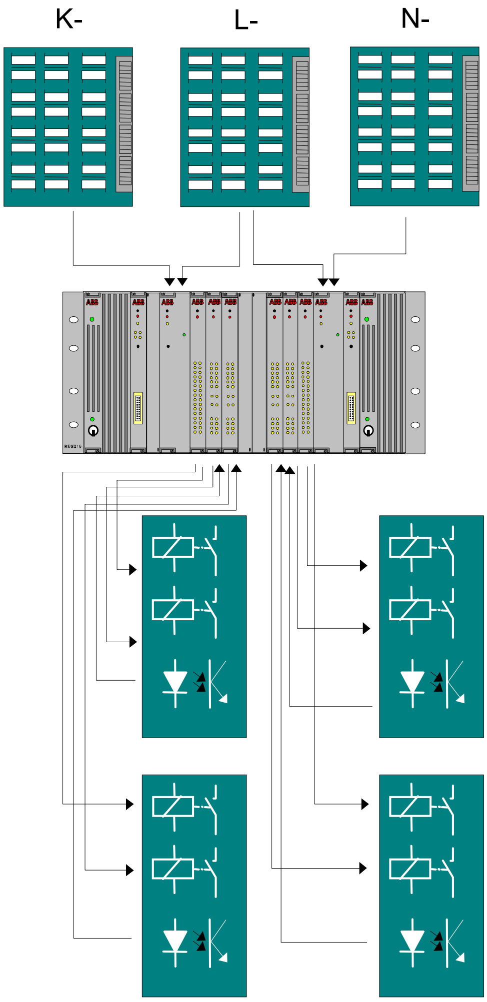
Variant M14 (redundant system, 1 rack)

Configuration as per system:

- 1*216NG6x		Code G/E
- 1*216VC62a		
- 1*216EA62		
- 1*216AB61		
- 2*216DB61		
- 16 tripping relays		
- 32 signaling relays	(2*216GD61a)	Code I
- 32 binary inputs		
- 12 input transformers	(1*216GW62)	Code K/N
Common use for both systems:		
- 12 input transformers	(1*216GW62)	Code L

Options:
- none

Ordering example for M14:
HESG324510M1001
Code: M14K*L*N*A*B*U*G*E*I*S*C*D*Y*Z*R*



Variant M15 (redundant system, 1 rack)

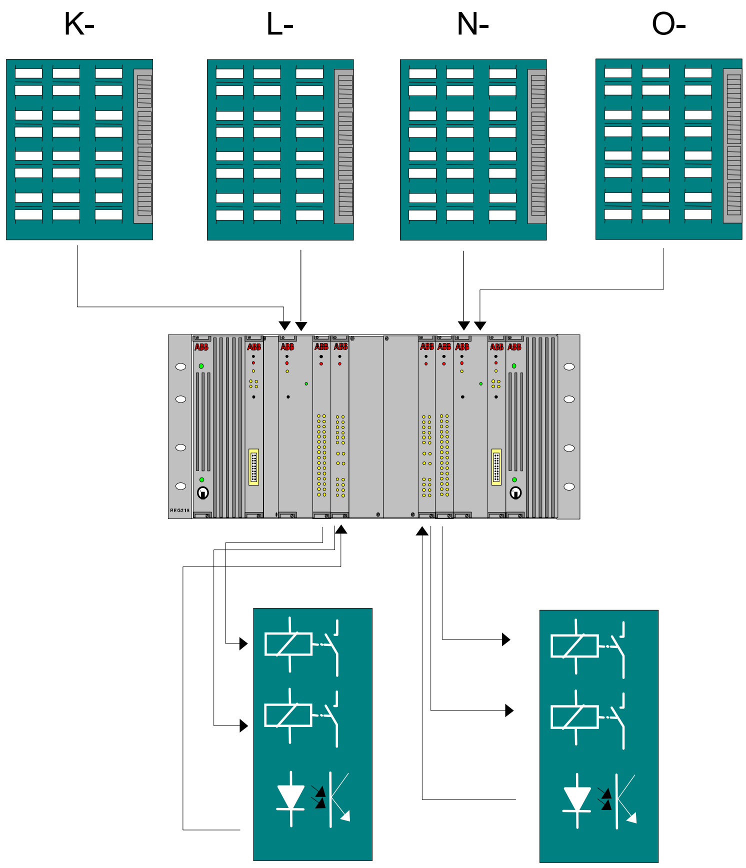
Configuration as per system:

- 1*216NG6x		Code G/E
- 1*216VC62a		
- 1*216EA62		
- 1*216AB61		
- 1*216DB61		
- 8 tripping relays - 16 signaling relays - 16 binary inputs	(1*216GD61a)	Code I
- 24 input transformers	(2*216GW62)	Code K/L/N/O

Common use for both systems:
- none

Options:
- none

Ordering example for M15:
HESG324510M1001
Code: M15K*L*N*O*A*B*U*G*E*I*S*C*D*Y*Z*R*



Variant M16 (redundant system, 1 rack)

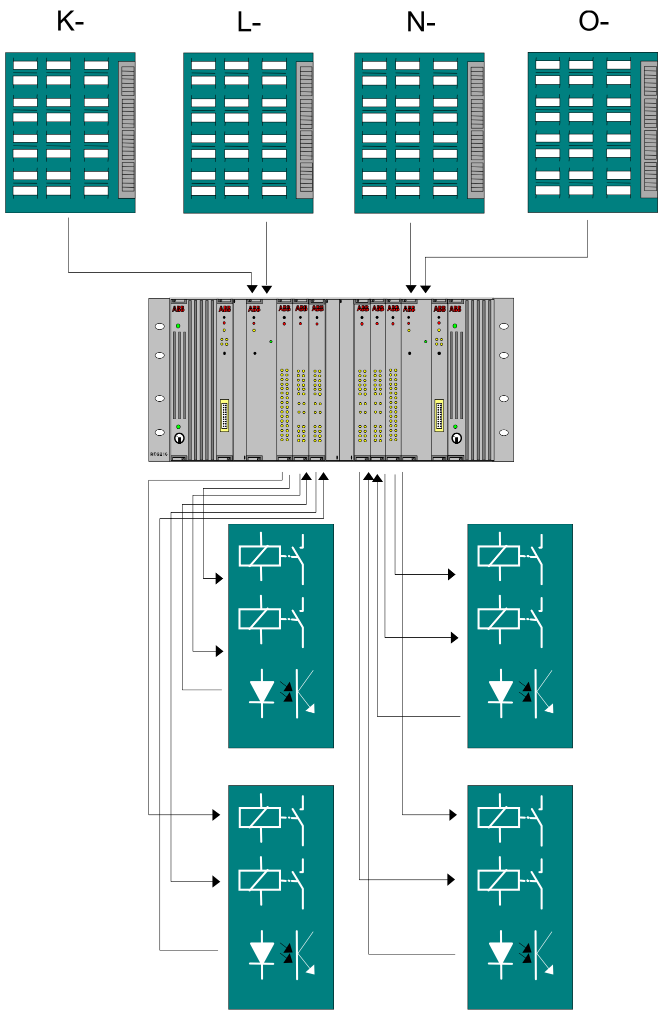
Configuration as per system:

- 1*216NG6x		Code G/E
- 1*216VC62a		
- 1*216EA62		
- 1*216AB61		
- 2*216DB61		
- 16 tripping relays - 32 signaling relays - 32 binary inputs	(2*216GD61a)	Code I
- 24 input transformers	(2*216GW62)	Code K/L/N/O

Common use for both systems:
- none

Options:
- none

Ordering example for M16:
HESG324510M1001
Code: M16K*L*N*O*A*B*U*G*E*I*S*C*D*Y*Z*R*



Variant M21 (double system, 2 racks)

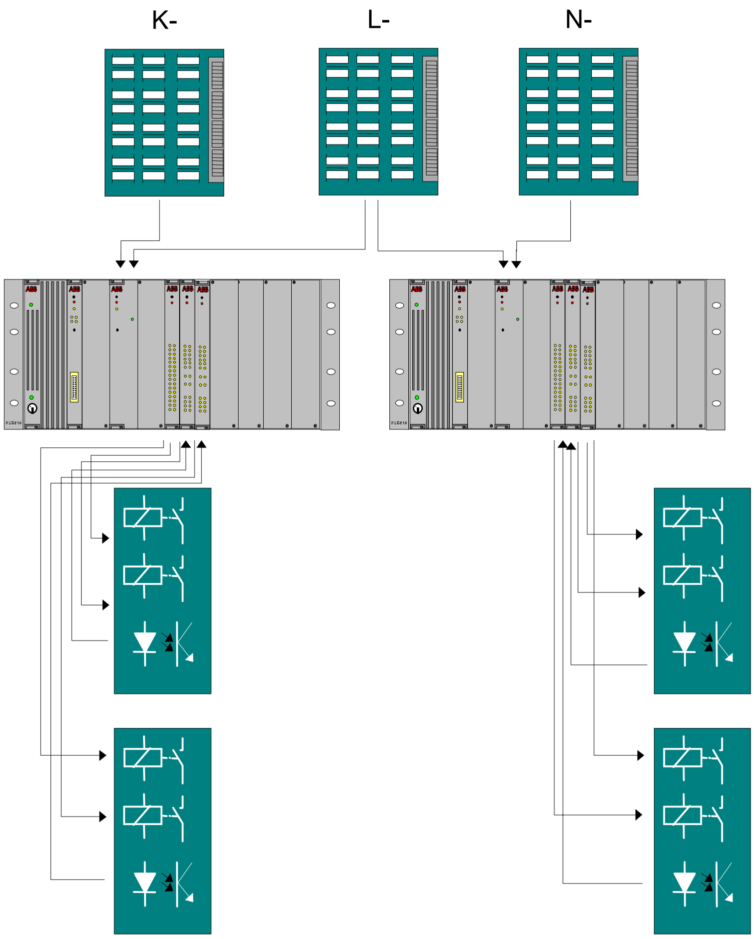
Configuration as per system:

- 1*216NG6x		Code G/E
- 1*216VC62a		
- 1*216EA62		
- 1*216AB61		
- 2*216DB61		
- 16 tripping relays		
- 32 signaling relays	(2*216GD61a)	Code I
- 32 binary inputs		
- 12 input transformers	(1*216GW62)	Code K/N
Common use for both systems:		
- 12 input transformers	(1*216GW62)	Code L

Options:

- Additional CPU board per system	Code W
- 2nd power supply (A)	Code H
- 2nd power supply (B)	Code F

Ordering example for M21:
HESG324510M1001
Code: M21K*L*N*A*B*U*G*H*E*F*I*S*W*C*D*Y*Z*R*



Variant M22 (double system, 2 racks)

Configuration as per system:

- 1*216NG6x		Code G/E
- 1*216VC62a		
- 2*216EA62		
- 1*216AB61		
- 2*216DB61		
- 16 tripping relays - 32 signaling relays - 32 binary inputs	(2*216GD61a)	Code I
- 12 input transformers	(1*216GW62)	Code K/O
Common use for both systems:		
- 24 input transformers	(2*216GW62)	Code L/N

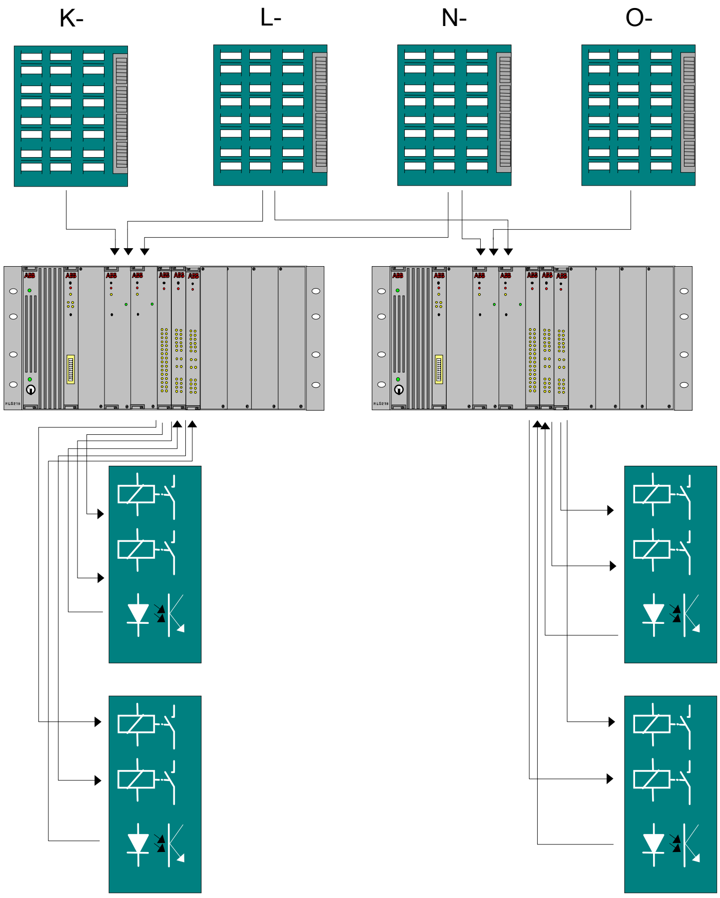
Options:

- Additional CPU board per system	Code W
- 2nd power supply (A)	Code H
- 2nd power supply (B)	Code F

Ordering example for M22:

HESG324510M1001

Code: M22K*L*N*O*A*B*U*G*H*E*F*I*S*W*C*D*Y*Z*R*



Variant M23 (double system, 2 racks)

Configuration as per system:

- 1*216NG6x		Code G/E
- 1*216VC62a		
- 2*216EA62		
- 1*216AB61		
- 2*216DB61		
- 16 tripping relays - 32 signaling relays - 32 binary inputs	(2*216GD61a)	Code I
Common use for both systems:		
- 48 input transformers	(4*216GW62)	Code K/L/N/O

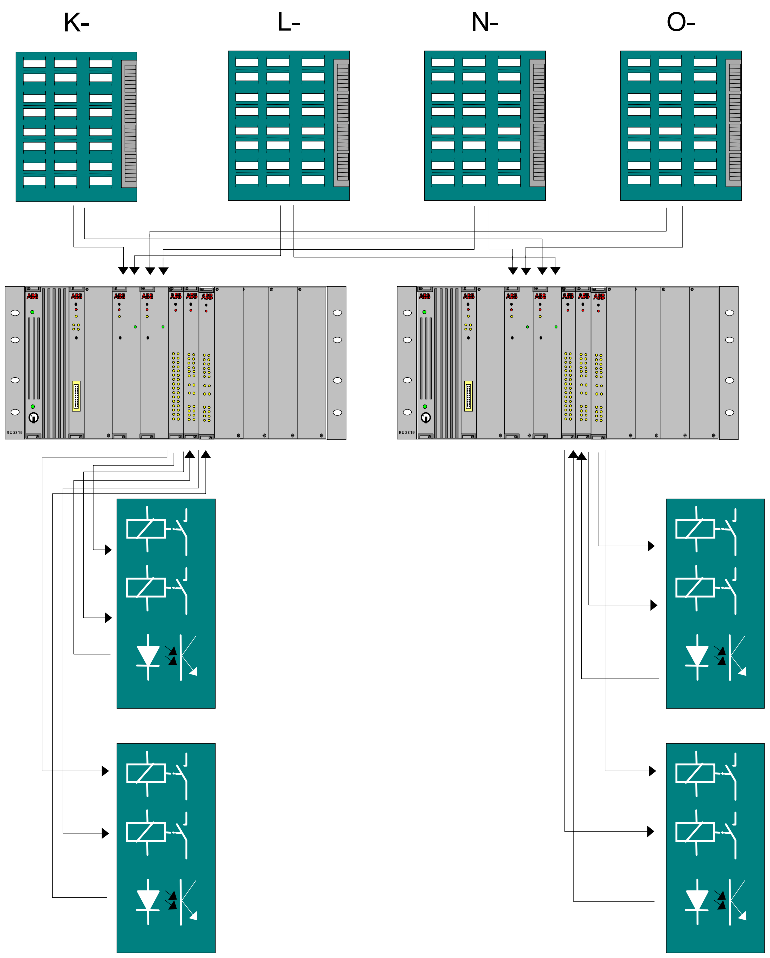
Options:

- Additional CPU board per system	Code W
- 2nd power supply (A)	Code H
- 2nd power supply (B)	Code F

Ordering example for M23:

HESG324510M1001

Code: M23K*L*N*O*A*B*U*G*H*E*F*I*S*W*C*D*Y*Z*R*



Variant M24 (double system, 2 racks)

Configuration as per system:

- 1*216NG6x		Code G/E
- 1*216VC62a		
- 2*216EA62		
- 1*216AB61		
- 2*216DB61E		
- 16 tripping relays - 32 signaling relays - 32 binary inputs	(2*216GD61a)	Code I
- 12 input transformers	(1*216GW62)	Code K/P
Common use for both systems:		
- 36 input transformers	(3*216GW62)	Code L/N/O

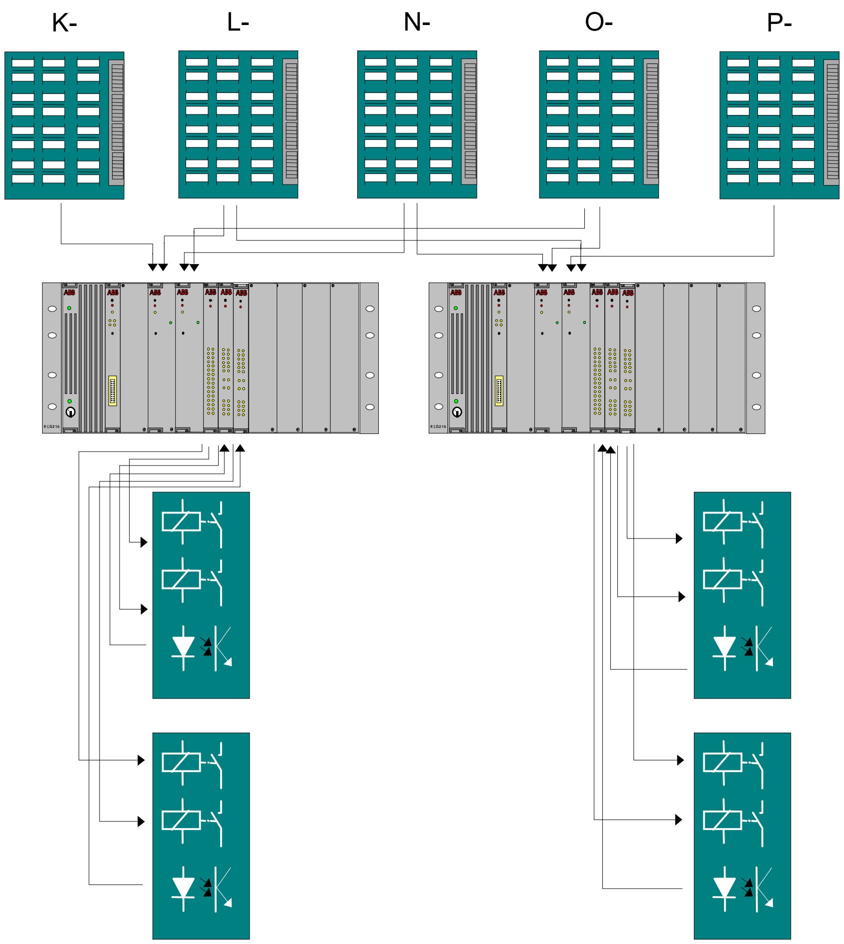
Options:

- Additional CPU board per system	Code W
- 2nd power supply (A)	Code H
- 2nd power supply (B)	Code F

Ordering example for M24:

HESG324510M1001

Code: M24K*L*N*O*P*A*B*U*G*H*E*F*I*S*W*C*D*Y*Z*R*



Variant M25 (double system, 2 racks)

Configuration as per system:

- 1*216NG6x		Code G/E
- 1*216VC62a		
- 2*216EA62		
- 1*216AB61		
- 2*216DB61		
- 16 tripping relays - 32 signaling relays - 32 binary inputs	(2*216GD61a)	Code I
- 24 input transformers	(2*216GW62)	Code K/L/P/Q
Common use for both systems:		
- 24 input transformers	(2*216GW62)	Code N/O

Options:

- Additional CPU board per system	Code W
- 2nd power supply (A)	Code H
- 2nd power supply (B)	Code F

Ordering example for M25:

HESG324510M1001

Code: M25K*L*N*O*P*Q*A*B*U*G*H*E*F*I*S*W*C*D*Y*Z*R*

Sample specification

Numerical protection equipment used for generator and block transformer protection.

It will be a stand-alone system but closely involved in the process. Parameters, signals, measured values as well as remote parameter regulation commands will be exchanged via appropriate interfaces and a serial communications channel to central process control equipment.

The system will be supported by a software library of diverse protection functions. A menu-driven HMI (human machine interface) will allow users to activate functions which are provided in the protection function library.

The entire protective system will consist of a relatively small number of hardware components. This applies not only to the electronic units, but also to the process interfaces, such as current and voltage inputs as well as the numbers of signal and tripping relays.

This flexibility resulting from the modular hardware will enable the equipment configuration to be easily adapted for installations of different sizes and the desired scope of protection.

The system will permit various degrees of redundancy. The user can specify the desired configuration:

- duplicating power supply unit
- duplicating the whole system.

Additional benefits considered are wide setting ranges, excellent long-term stability and few setting steps. The numerical system should offer a library of the available protective functions. These functions will then be selected by the user by the simple assignment of parameters.

All protection functions should operate from sampled primary system voltages and currents. The sampling rate of the analog input units should be 12 times per period at rated power system frequency with a dynamic range of 15 bit.

The man-machine communication should be performed easily using only a few push button commands on a personal computer (PC) via a serial RS 232 interface. No prior knowledge of programming should be necessary. For all functions the user is guided with the aid of screen menus and windows. All different languages for texts could be supplied. Any text change is accommodated easily.

All the hardware components should be packaged in a single cabinet. This cubicle can also accommodate other protection relays with external functions, for example 100% stator earth fault protection, Buchholz relay or some thermal sensors.

References

Data Sheet RESP 97 - Cubicles for Electronic Installations	1MRB520115-Ben
Operating Instructions REG216 (printed)	1 MDU02005-EN / 1KHA000951-UEN
Operating Instructions REG216 (CD)	1MRB260030M0001
Reference List REG216	1MRB520011-Ren
Data Sheet REX010/011	1MRB520123-Ben

ABB Switzerland Ltd
Power Technology Systems
Brown-Boveri-Strasse 6
CH-5400 Baden/Switzerland
Tel. +41 58 585 77 44
Fax +41 58 585 55 77
E-mail: substation.automation@ch.abb.com

www.abb.com/substationautomation

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