Types REG 216 and REG 216 Compact

Generator protection

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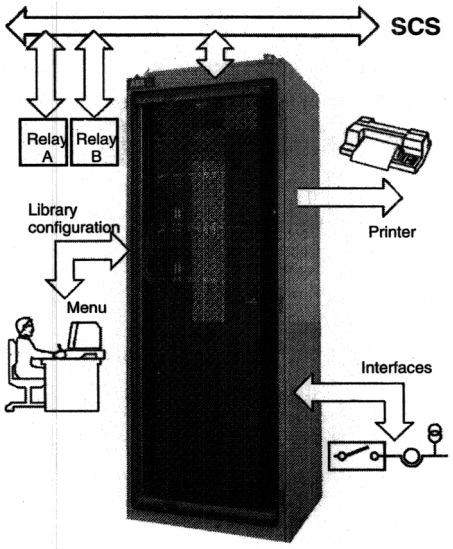
ABB Network Control
& Protection



Cubicle with the redundant REG 216 system

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**
- **Setting of parameters and recording of the settings by PC**
- **Display of measured values**
- **Display of events, their acknowledgement and printout**
- **Disturbance recording**
- **Self documentation**
- **Long term stability**
- **Communication and co–ordination with station control**
- **Two design versions available; extended version or compact version (with or without cubicle)**

Application

The REG 216 system is intended for 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 REG 216 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 for e.g. auxiliary supply units or the whole system.

Standard interfaces makes REG 216 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.

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 following table gives a survey of the most significant protection functions:

Application (cont'd)	Protection function	Description
	Generator differential	three–phase
	~~Power transformer differential~~	~~three–phase for 2– and 3–winding transformers~~
	Definite time overcurrent (undercurrent)	definite time delay, for phase and earth–fault, over– and undercurrent
	Overcurrent (or undercurrent) with peak value evaluation	instantaneous operation or with definite time delay, wide frequency range, over– and undercurrent
	Restriced earth fault	*overcurrent operation with definite time delay*
	Voltage controlled overcurrent	operation restrained by undervoltage
	Inverse time overcurrent	inverse current dependent time delay, for phase and earth fault
	Negative phase sequence current	negative phase sequence current with definite time delay *or inverse time delay with thermal replica*
	Definite time overvoltage (undervoltage)	definite time delay, over– and undervoltage. Applicable also for – stator E/F (95%) – rotor E/F – interturn fault protection
	Underimpedance	circular characteristic centered at origin of impedance plane
	Minimum reactance	circular characteristic for loss of excitation protection
	Power	any characteristic angle, over and underpower for: – active power – reactive power – reverse power protection – *minimum forward power*
	Overload	thermal replica with operating characteristic according to ASA–C50.13*) for : – standard stator current – rotor current
	Thermal overload	*thermal protection with precise thermal replica*
	Overtemperature	thermal protection with precise thermal replica
	Frequency Overexcitation	evaluation of voltage input voltage/frequency protection definite time delay *or inverse time delay*
	Voltage balance	*monitoring/comparing two groups of single- or three-phase voltage*
	Voltage peak value evaluation	*Instantaneous operation with definite time delay*
	Synchro check	*Supervision of phase angle frequency and voltage level of two systems*
	Logical functions	AND, OR, flip–flop, time delay, counter

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 processing unit
- 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.

Design

Hardware
The REG 216 equipment comprises two main assemblies, which are physically separated from each other and linked by standard pre–fabricated screened cables:

- Interfaces to the primary system (CT's, PT's and auxiliary relays), which provide dc isolation and a barrier to electromagnetic interference.
- Parallel bus and associated electronic units (e.g. analogue inputs and data processors) for signal conditioning and processing.

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

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.

A compact version of *REG 216C, with fewer process interfaces* is also available. The same number of electronic modules and the same microprocessor and bus capacity can be accommodated. The rack version is provided with screw terminals for user connections.

Other protection relays for functions, which are not part of the REG 216 system, may be installed in the cubicle and correspondingly interwired with REG 216.

Interfaces to the primary system
The following modular assemblies provide interfacing of REG 216 to the power system.

Input transformers assembly 216GW61
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 CT's 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 three assemblies can be used i.e. 36 inputs.*

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.

Facilities for different trip circuit supervision arrangements in conjunction with the output unit 216DB61 and the input auxiliary relay assembly 216GE61 (option) are also provided.

The tripping auxiliary relay assembly can be optionally fitted with a tripping logic diode matrix to enable direct coupling of external signals. REG 216 can also read and process external signals via digital inputs.

Auxiliary relay and optocoupler assembly 216GD61
This assembly is used in the compact version *REG 216C*. It provides six tripping relays, each with two powerful, potential–free tripping contacts (with surge circuits), 14 auxiliary relays and 16 optocoupler input circuits. *Two assemblies 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 dimensions 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.

Design (cont'd)

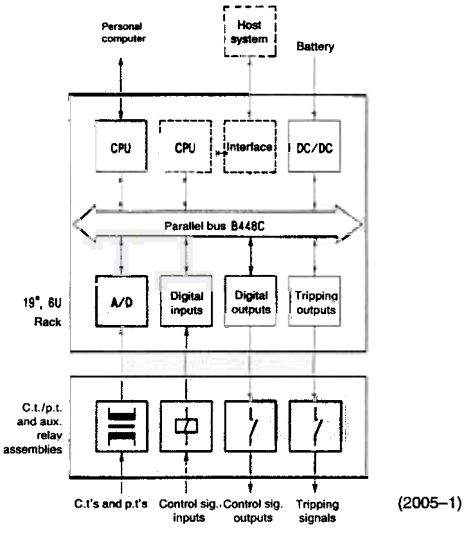


Fig. 1 Configuration of the REG 216 protection system

The protection system is based on a data bus with digital signal processing for most functions; signal conditioning, analogue 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 216MB61 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 masterunits having equal status actively accessing the bus
- Common internal 24 V auxiliary supply for all electronic units; redundant 24 V are possible.

Processing unit 216VE61
- *32 bit processor type 80386SX*
- Application software on (E) PROM
- Operating data on RAM
- Settings on non–volatile EEPROM2 potential–free RS–423 interfaces
- Space requirement: one rack division

Processing unit with object bus interface 216VC61 (OBI)
Additional to the 216VE61 normal tasks following extended functions can be performed:

- Connection to the station control with transmission of messages
- Time clock synchronizing for time tagging of events
- Event and disturbance memory with battery back up
- Space requirement: two rack divisions

Analogue input unit 216EA61
- 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 LED's for indication of activated relays
- Space requirement one rack division

Binary and analog output unit 216AC61
- *16 binary outputs for controlling of the output auxiliary relay assembly*
- *Short–circuit proof*
- *Front plate LED's for marking activated relays*
- *Eight analog outputs (0–20 mA with 0–500 Ω)*
- *Front space requirements: one rack division*

Binary input unit 216EB61
- *32 binary inputs used to connect ON or OFF signals to the REG 216 protection system from input relay assembly*
- *Front plate LED's marking activated relays*
- *Front space requirements: one rack division*

Tripping output unit 216DB61
- Eight 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 LED's
- Space requirement: one rack division

Auxiliary dc supply unit 216NG61, 216NG62, and 216NG63
- Versions for 36 to 312 V dc input
- Outputs 24 V dc , 150 W
- Short–circuit and overload proof outputs
- Parallel connection to increase rating
- Parallel connection for redundancy (two outputs)
- Space requirement: three rack divisions

All the REG 216 protection functions operate with sampled primary system voltages and currents. The sampling rate of the analogue 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 REG 216.

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 acknowledgement and print–out
- Disturbance recording (option)

Self–monitoring and testing facilities
The self–monitoring and testing routine philosophy 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, REG 216 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 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) Analogue inputs. The amplitudes, frequency and phase relationships of all the analogue 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 MMC "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.

Injection testing
A 100% test of system can be carried out by injecting test voltages and currents using, for example, a test set type XS92a or FREJA. Provision is made for injection testing with a test set at the terminals of the input transformer assembly 216GW61. The terminals enable primary system PT circuits to be interrupted and CT's to be short–circuited.

Technical data

Input circuit

Rated current	I_N	1 A, 2 A or 5 A
Rated voltage	U_N	100 V/110 V or 200 V/ 220 V
Rated frequency	f_N	50/60 Hz
Thermal ratings:		
continuous		4 x I_N
for 10 s		30 x I_N
for 1 s		100 x I_N
surge (half–cycle)		250 x I_N peak
Burden of the current inputs		< 0.2 VA/input at I_N
Burden of the voltage inputs		<0.4 VA/input at U_N
Input signals		
ac		24 V to 220 V
dc		24 V to 250 V

Protection Functions
Generator differential

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 $I\Delta > 2\ I_N$	≤ 30 ms
– for $I\Delta \leq 2\ I_N$	≤ 50 ms
Accuracy of pick–up value of g	+5% I_N (at f_N)

Transformer differential

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	0.2 to 0.5 I_N (in steps of 0.05)
v–setting	0.25, 0.5
b–setting	1.25–2.5 (0.25 step)
Max. trip time (protected transformer loaded)	
– For $I\Delta > 2\ I_N$	≤ 30 ms
– For $I\Delta \leq 2\ I_N$	≤ 50 ms
Accuracy of pick–up value	+5% I_N (at f_N)

Characteristic

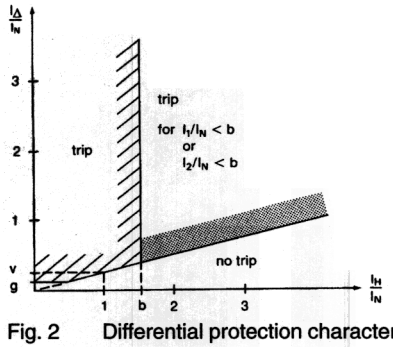
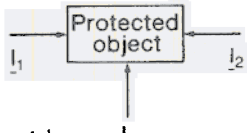


Fig. 2 Differential protection characteristic (2005–4)

Differential protection definitions:



$$I_\Delta = |\underline{I}_1 + \underline{I}_2| \qquad \underline{I}_3$$

$$I_H = \begin{cases} \sqrt{I_1 \cdot I_2 \cos\alpha} & \text{for } \cos\alpha > 0 \\ 0 & \text{for } \cos\alpha < 0 \end{cases}$$

$$\alpha = \sphericalangle\,(\underline{I}_1; -\underline{I}_2)$$

2–winding: $\underline{I}_1' = \underline{I}_1$, $\underline{I}_2' = \underline{I}_2$, $\underline{I}_3$

3–winding: $\underline{I}_1' = \text{MAX}\,(\underline{I}_1, \underline{I}_2, \underline{I}_3)$
$\underline{I}_2' = \underline{I}_1 + \underline{I}_2 + \underline{I}_3 - \underline{I}_1'$
$\alpha = \sphericalangle(\underline{I}_1, -\underline{I}_2)$

Definite time overcurrent
(optionally used as restricted earth fault relay by additional external hardware)

Features:
- Maximum or minimum function (over– and undercurrent)
- Single- or three–phase measurement
- Highest or lowest phase value evaluation for three–phase function

Settings:

Current	0.02 to 20 I_N (in steps of 0.01)
Delay	0.02 to 60 s (in steps of 0.01 s)
Accuracy of pick–up value	±5% (at f_N)
Reset ratio	95% (for max. function) 105% (for min. function)
Max. trip time with no delay	≤ 50 ms

Instantaneous overcurrent

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)
Reset ratio	95% (for max. function) 105% (for min. function)
Max. trip time with no delay	≤ 30 ms (at f_N)

Voltage controlled *overcurrent*

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	95%
Start time	≤ 80 ms

Inverse time overcurrent

Features:
- Single- or three–phase measurement
- Operating characteristics according to British Standard 142
- *Normal inverse*
- Very inverse and long time earth–fault
- Extremely inverse
- Wide multiplier setting
- Good transient performance

Settings:

Base current (I_B)	0.5 to 2.5 I_N (in steps of 0.01 I_N)
Pick–up current (I_a)	1 to 2 I_N (in steps of 0.01 I_B)
Time multiplier k_1	1 to 200 s (in steps of 0.1 s)

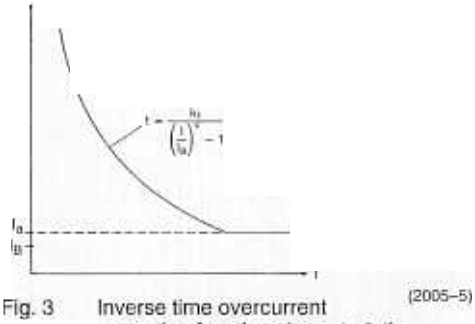


Fig. 3 Inverse time overcurrent protection function characteristics (2005–5)

Permissible variation of the trip time according to British standard 142

Class E 7.5	(for *normal inverse*, extremely inverse and long time earth–fault)
Class E 5.0	(for very inverse)
Reset ratio	95%

Negative phase sequence current

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, $I \leq I_N$ with measuring transformers)
Reset ratio	100%
Start time	≤ 80 ms

Definite time overvoltage

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%)
  - rotor earth fault
  - interturn fault

Settings:

Voltage	0.01 to 2.0 U_N (steps of 0.002 U_N)
Delay	0.02 to 60 s (in steps of 0.01 s)
Accuracy of pick–up value	±3% (at f_N, $U > U_N$)
Reset ratio	98% (for max. function) 102% (for min. function)
Max. trip time	≤ 60 ms

Voltage peak value evaluation

Features:
- *Maximum or minimum function*
- *Single- or three–phase measurement*
- *Peak value evaluation settings:*

Voltage	*0.01 to 2.0 U_N (steps of 0.01 U_N)*
Delay	*0–60 s (steps of 0.01 s)*
Accuracy of pick–up value	*±5% I_N (at 0.08–1.1 f_N)*
Reset ratio	*95% (for max functions) 105% (for min functions)*
Max. trip time at no delay	*< 30 ms (at f_N)*

Underimpedance

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

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)

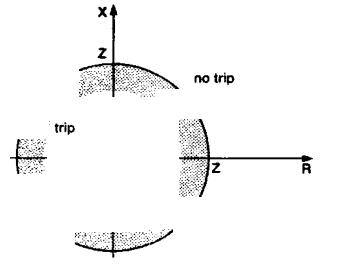


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Fig. 4 Underimpedance protection function characteristics

Minimum reactance

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

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	α	–180° to +180° (in steps of 30°)
Accuracy of pick–up values		±5% of highest absolute value of X_A, X_B (at f_N)
Reset ratio		105% (related to origin of circle)
Start time		≤ 80 ms

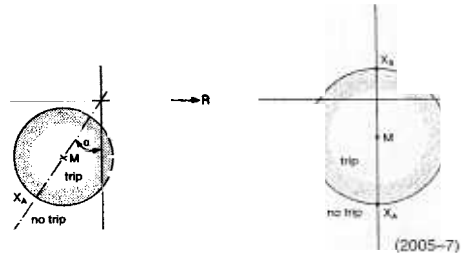

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Fig. 5 Minimum reactance protection function characteristics

Power

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)
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 0.1°)
Nominal power P_N	0.5 to 2.5 U_N x I_N (in steps of 0.001 U_N x I_N)
Drop ratio	30% to 170% (in steps of 1%)

Stator overload

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

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 50 s (in steps of 0,.1 s)
Pick–up current (I_a)	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
Start time	≤ 80 ms

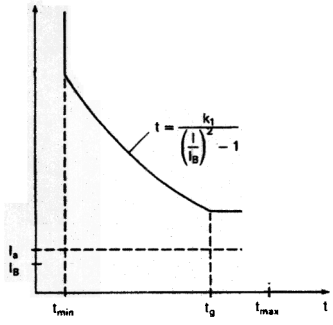

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Fig. 6 Stator overload protection function characteristics

Rotor overload

Features:
Same as stator overload function, but three–phase measurement

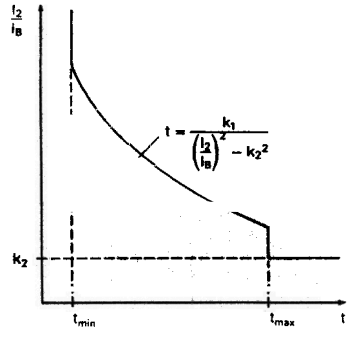
Settings:
Same as for stator overload function

Inverse time negative phase sequence current

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

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 30 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 step of 0.1 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
Start time	≤ 80 ms



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Inverse time negative phase sequence current protection function characteristics

Overtemperature

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:

Warning stage	50 to 200% θ_N (in steps of 1% θ_N)
Trip stage	50 to 200% θ_N (in steps of 1% θ_N)
Thermal time constant	0.5 to 500 min (in steps of 0.1 min)
Accuracy of current measurement	±2% (at f_N) with measuring transformers ±2% (at f_N) with measuring transformers
Accuracy of thermal replica	±5%

Frequency

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	100%
Start time	≤ 120 ms

Overexcitation

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	+3% (at f_N)
Reset ratio	98%
Start time	≤ 120 ms

Overexcitation protection function with inverse time delay

Features:
- *One-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, 1.10–1.50) U_N/f_N*
Delay	*0.1–100 min (in steps of 0.1 min)*
Start value U/f	*1.05–1.20 U_N/f_N (in steps of 0.01 U_N/f_N)*
t_{min}	*0.01–2 min (in steps of 0.01 min)*
t_{max}	*5–100 min (in steps of 0.01 min)*
Reset time	*0.2–100 min (in steps of 0.01 min)*
Reference voltage	*0.8–1.2 U_N (in steps of 0.01 U_N)*
Accuracy of pick–up value	*±3% U_N/f_N(at f_N)*
Frequency range	*0.5–1.2 f_N*
Drop ratio	*100%*
Start time	*< 120 ms*

Voltage balance function

Features:
- *Comparing of two groups of voltage inputs*
- *Single- or three-phase voltage detection*
- *Indication of a group with the lower voltage*

Settings:

Voltage unbalance	*0.1–0.5 U_N (in steps of 0.05)*
Delay	*0–1 s (in steps of 0.01)*
t_{reset}	*0.1–3 s (in steps of 0.01)*
Reset ratio	*90%*
Max. trip time with no delay	*≤ 50 ms (at f_N)*

Dead machine protection

Features:
- *Quick separation from network at accidental energization of generator (e.g. at stand–still or on turning-gear)*
- *Instant overcurrent measurement*
- *Voltage controlled overcurrent function e.g. blocked at voltage values > 0.85 U_N*

Settings:

Voltage	*0.01–2 I_N (in steps of 0.002)*
Reset delay	*0–60 s (in steps of 0.01 s)*
Current	*0.02–20 I_N (in steps of 0.02 I_N)*
Delay	*0.02–60 s (in steps of 0.01 s)*

Synchrocheck

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 switch over to another voltage input is possible (for double busbar systems)*
- *External selection of the mode*

Settings:

Max. voltage diff.	*0.05–0.4 U_N (in steps of 0.05 U_N)*
Max. phase diff.	*5–80 deg (in steps of 5.0 deg)*
Max. frequence diff.	*0.05–0.4 Hz (in steps of 0.05 Hz)*
Min. voltage	*0.6–1 U_N (in steps of 0.05 U_N)*
Max. voltage	*0.1–1 U_N (in steps of 0.05 U_N)*
Supervision time	*0.05–5 s (in steps of 0.05 s)*
Reset time	*0–1 s (in steps of 0.05 s)*

Measuring functions (U, I, P, Q, f)

Features:
- *Single–phase measurement*
- *Minimum one measurement per second*
- *Dc and harmonics suppression in current and voltage*
- *Compensation of measuring phase error*
- *High accuracy in range 0.9 to 1.1 f_N*

Settings:		*Accuracy*
Voltage U_N	*0–1.2 U_N*	*0.5–2%*
Current I_N	*0–20 U_N*	*1–3%*
Active reactive power P, G P_N–U_N x I_N	*0.2–2.5 P_N*	*0.5–2%*
Frequency Hz	*0.9–1.1 f_N*	*max. 50 mHz*
Phase angle correction	*–180° to +180° (in steps of 0.1)*	

Logic functions

Delay function:

– Adjustable trip delay and drop delay	0 to *300 s* (in steps of 0.01 s)
– Two time integration modes	
– Input invertable	

Counting function:

– Adjustable trip counting threshold and drop delay	1 to 100 (in steps of 1)
– Input invertable	

AND function:

- Maximum of four inputs
- All inputs invertable
- Trip with additional delay or counting function

OR function:

- Maximum of four inputs
- All inputs invertable
- 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

Contact data

Tripping:	
max. operating voltage	250 V ac or dc
make and carry for 0.5	30 A ac or dc
scontinuous current	10 A ac or dc
making power	2500 VA
rupture current with two contacts in series and L/R = 40 ms	
at U ≤ 50 V dc	5 A
at U ≤ 120 V dc	1 A
at U ≤ 250 V dc	0.3 A
Signalling:	
stand by	
No. of contacts	2 break contact per signalling channel
(216 GA 61)	
(216 GD 61)	1 make contact per signalling channel, 4 signalling channels with 1 break contact
max. operating voltage	250 V ac or dc
make and carry for 0.5	10 A ac or dc
scontinuous current	5 A ac or dc
making power	1250 VA ac 60 W dc

Auxiliary supply

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

General data

Ambient conditions	(IEC–TC65A (sec) 68, VDE 0160) [1]
temperature ranges	
in operation	–10 to +55°C (rack ambient)
storage and transport	–40 to +85°C
relative humidity	93%, 40°C, 4 days (IEC 68–2/3)
seismic test (for equipment)	5 g, 30 s, 0.5 to 35 Hz (1 oct/min)
Insulation test	
all terminals to earth and to each other [2]	2 kV, 50 Hz, 1 min [3] (IEC 255–4)
across open contacts	1 kV, 50 Hz, 1 min [3]
Electromagnetic compatibility (type test)	
surge test	5 kV, 1.2/50 µs (IEC 255–4/–5)
interference test	2.5 kV, 1 MHz (IEC 255–22–1)
fast transient test	2 kV [4]
electrostatic discharge test	8 kV [5]
radio interference suppression	Class A (VDE 871/6.78)
permissible electromagnetic field strength	≤ 10 V/m [6]

Mechanical design

Terminals	
CT and PT circuits	10 mm², Phoenix URTK/S
tripping and signalling circuits	4 mm², Phoenix MKT–P/P (GKOS for 216 GD 61)
aux. dc supply and remaining aux. circuits	4 mm², Phoenix UK4 (GKOS for 216 GD 61)
Cubicle wiring	
CT and PT circuits	directly mounted terminals
aux. dc supply	1.5 mm²
tripping and signalling circuits	0.5 mm²
standard pre–made cables	0.25 mm²
Cubicle design	
Cubicle dimensions (wxdxh)	800 x 800 x 2200 mm
Total weight (with all aux. relays and units inserted)	200–400 kg
Compact version	See Fig. 10
[1] draft document	(IEEE 344)
[2] serial interface leakage resistance	500 V, 50 Hz, 1 min ≥ 100 MΩ, 500 V dc

[3] test voltages must be reduced if tests are repeated, in accordance with IEC Publ. 255–5

[4] based on IEC801–4
[5] based on IEC801–1 (cubicle closed)
[6] based on IEC801–3

Diagram

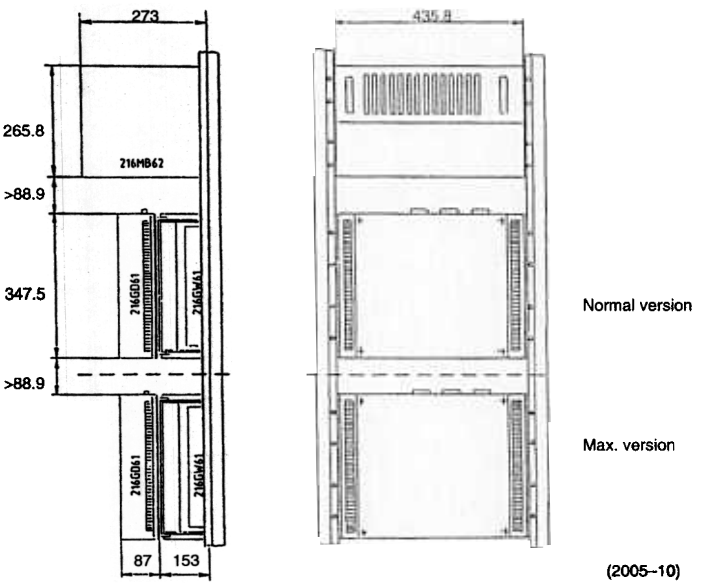

Fig. 10 Compact version *REG 216C* (rear view)

Ordering

In order to configure the generator protection system type REG 216 the ABB–engineering group needs the information from the Questionnaire CH–ES 56–30.11 E.

When ordering the compact version, the following has to be stated:

- Rated current
- Rated voltage
- Optocoupler voltage
- Quantity of different units (electronic part) and interfaces
  1)216 GW62 Input transformer assembly
  2)216 GD61 Interface unit consisting of:
  6 aux. tripping relays
  14 signalling relays
  16 optocouplers
  3 cables 216 IK61

NOTE:
The compact version in addition requires configuration and final testing, which is normally not included. For customizing the compact version, please contact an ABB Relays sales representative.

Ordering (cont'd)

Compact version – Codes for ordering

	No. of GW62*		No of GD61*		Code
1) Version with corresp. Ident. no.	1	2	1	2	
HESG 112 815 M1	X		X		M1
		X		X	M2
		X	X		M3
	X			X	M4
*all necessary cables included					

GW62–First Unit transforming combination	6 CT 1 MT 5 PT	6 CT 3 MT 3 PT	6 CT 6 PT	7 CT 1 MT 4 PT	9 CT 1 MT 2 PT	9 CT 3 PT	12 CT	9 CT 3 MT	*3 CT 4 MT 5 PT*
Code	K1	K2	K3	K4	K5	K6	K7	K8	K9

GW62 – Second transformer unit

GW62–Second Unit transforming combinations	6 CT 1 MT 5 PT	6 CT 3 MT 3 PT	other on request						
Code	L1	L2	L3	L4	L5	L6	L7	L8	L9

Characteristic protection and/or				*measuring transformer rating*		
Rated current	1 A	2 A	5 A	1 A	2 A	5 A
Code	A1	A2	A5	B1	B2	B5

Rated voltage	100–130 V	200–230 V
Code	U1	U2

First interface 216 GD61

	dc voltage–optocoupler		
	82–312 V	36–75 V	20–30 V
Code	I1	I2	I3
Mark corresp.			

Second interface 216 GD61

	dc voltage–optocoupler		
	82–312 V	36–75 V	20–30 V
Code	J1	J2	J3

Rack 216 MB62 is normally equipped with:
One 216 VE6101 one 216 VC, one 216 EA61, one 216 AB61, one DB61 and one NG6.
Additional units need additional codes

CPU selection

	216 VE	*216 VC**
Code	*W1*	*W2*

** needs two plug–in units space and the second 216 VE fall off.*
Please consider also the corresponding codes for library and protocol

Additional CPU unit 216 VE61a

	Total No. of units		
	2	3	4
Code	X1	Y1	Z1

Code	*Q21*	*Q30*
Protocol	*SPA*	*VDEW*
Code	*S1*	*S2*

Analogue input unit 216 EA61:
One 216 EA61a suitable for one or two GW62

Additional
Tripping output unit 216 DB61a

Total No. of units	2*
Code	F1

* have to be used at two GW62

Aux. dc supply unit 216 NG6–a

	48–60 V		110 V		220 V	
	NG61		NG62		NG63	
No. of dc units	1	2	1	2	1	2
Code	G4	H4	G2	H2	G1	H1

Battery	*Lithium*	*Nickel–Cadmium*
Code	*T6*	*T7*

Rest button	*Code*
	R1

Diskette for PC	German	English	French	Spanish	$3^1/_2$" 720 kB	$5^1/_4$" 360 kB
Code	PD	PE	PF	PS	D3	D5

Example:	**Code:**
REG 216 –version M1	
fitted with one GW62, one GD61 and one MB62	
– Rated current I_N = 5 A, rated voltage U_N = 100–130 V	M1
– dc supply: 220 V dc, optocoupler supply: 82–312 V dc	
1) Equipment rack type 216 MB62 consisting of:	
1 processing unit 216 VE61	
1 analogue input unit 216 EA61	
1 digital output unit 216 AB61	
1 tripping output unit 216 DB61 and	
● 1 aux. dc supply unit 216 NG6... (220 V)	G1
2) Interface unit 216 GD61 consisting of:	
6 aux. tripping relays	
14 signalling relays	
16 optocouplers and U_{opt} = 82–312 V	
● 3 cables 216 IK61	I1
3) Input transformer assembly 216 GW62 consisting of:	
6 CT's, 5 PT's and I_N = 5 A, U_N = 100–130 V	
1 measuring transformer I_N = 5 A	K1–A–B5
● 1 cable 216 IK61	5–U1
● Please state when ordering	
The ordering text is: Compact version REG 216, version M1	
Ordering code: M1 – K1 – A5 – B5 – U1 – G1 – I1	
Consisting for one (216 GW62) input transformer assembly, one (216 GD61) interface unit and one (216 MB62) rack.	
Addtional: one diskette for PC in German and $3^1/_2$"	*PD–D3*

Ordering (cont'd)

Accessories (optional)
This may also be obtained elsewhere, however correct operation of the overall system is crucial.

Supplementary interface RS232 will be necessary to connect the printer to the protection system.
Printer to be connected to the PC.
EPSON type FX800 must possess a parallel Centronics interface.

Personal computer
Various PC's having a RS232 and working with the operating system MS-*PC DOS 3.x can be used.* We are in a position to supply a Toshiba T1600 *or other suitable PCs.*

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:

80286 processor
640 kB Ram
Diskette drive 3.5", I 1.44 MB or
1 Diskette drive 5.25", 1.2 MB
1 Hard disk min. 20 MB
1 Parallel interface (Centronics)
1 serial interface (RS–232C)
2nd serial interface as option
A monochrome screen controller able to show block graphics (640 x 200 points or better)

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 MMI 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 numbers of signal and tripping relays.

This flexibility resulting from the modular hardware will enable the equipment configuration to be easily catered to 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 the 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 analogue 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 done easily using only a few push–button commands on a personal computer (PC) *via a serial RS232 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

- Relay mounting systems — 1MDB14004–EN
- Operating and Commissioning Instructions REG 216 Numerical Bus–orientated Protection System — CH–ES 83–30.11 E
- Description Generator Protection with the digital REG 216 — CH–ES 56–30.11 E
- Reference List — CH–ES 69–30.10 D/E