Numerical Line Protection

REL316*4

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Features

Application
- MV and HV systems with distance or longitudinal differential protection as main protection as well as combined in a terminal
- Overhead lines, cables and transformer feeders.

Distance protection
- Overcurrent or underimpedance starters with polygonal characteristic
- Five distance zones with polygonal impedance characteristic for forwards and reverse measurement
- Definite time-overcurrent back-up protection (short-zone protection)
- VT supervision
- Power swing blocking
- System logic
  - switch-onto-fault
  - overreach zone
- Teleprotection
  - The carrier-aided schemes include:
  - permissive underreaching transfer tripping
  - permissive overreaching transfer tripping
  - blocking scheme with echo and transient blocking functions
- Load-compensated measurement
  - fixed reactance slope
  - reactance slope dependent on load value and direction (<Z_{HV})
- Parallel line compensation
- Phase-selective tripping for single and three-pole autoreclosure
- Four independent, user-selectable setting groups
- Suitable for application with CVTs acc. to IEC 60044.

Longitudinal differential protection
- Independent measurement per phase
- Single-phase tripping (additional FUPLA logic available)
- Fast operation (typically 25 ms)
- Optical fiber data exchange between terminal equipment at 64 kBit/s
- Provision for transmitting 8 binary signals, e.g. for direct transfer tripping or blocking
- Continuous supervision of protection signal communication
- Provision for a power transformer in the zone of protection
  - phase compensation without interposing CTs
  - inrush restraint function.

Features (cont'd)

Earth fault protection
- Sensitive earth fault protection for ungrounded systems and systems with Petersen coils
- Directional comparison function for detecting high-resistance faults in neutral earthing systems
- Inverse time overcurrent function with four characteristics according to B.S. 142.

Current and voltage functions
- Definite time-overcurrent function with inrush detection
- Inverse time-overcurrent function with four characteristics according to B.S. 142 and one characteristic identical to the zero-sequence relay type RXIDG
- Directional inverse and definite time overcurrent protection
- Definite time overvoltage and undervoltage function
- Thermal overload function.

Control and monitoring functions
- Single and three-phase multi-shot autoreclosure
- Synchrocheck
- Breaker failure protection
- Metering
- Real and apparent power measurement
- 2 different measuring functions of voltage, current and frequency
- Fault location
- Sequence-of-events records
- Disturbance recorder
- Runtime supervision.

Distance protection for high-voltage lines (<Z_{HV})

(Identification code SN100 and SN300)

Application

- 220 kV and 380 kV high-voltage lines in grids with grounded star-points
- Overhead lines and cables.

Distance protection

- All six fault loops are measured simultaneously (6 systems) allowing the fast detection of evolving faults also in the case of double-circuit lines
- Fast operation, minimum 21 ms and typically 25 ms, see isochrones below
- Suitable for application with CVTs according to IEC 60044
- Polygonal underimpedance starter with stability against load encroachment
- Distance measurement with polygonal operating characteristic
- Two selectable criteria for the differentiation of short circuits with or without earth. Improved detection of the earth fault with application of I_2 compared with I_0
- The three distance zones responsible for the protection of the line are measured simultaneously and oprate without delay
  - 1 underreaching zone
  - 1 overreaching zone for comparison schemes
  - 1 reverse measuring zone for comparison schemes (echo and tripping logic at weak infeed, stabilization for double lines, resp. transmission of the blocking order for blocking systems)
- Load compensation of the reach of the first underreaching distance zone in order to avoid a possible overreach on the load exporting line-side even for high-resistance faults and double-end infeed
- Two time-delayed overreaching back-up zones
- Delayed back-up operation by the underimpedance starter, directional or nondirectional
- VT supervision
- Back-up overcurrent function
- The phase selection can be set directional and limited to the effective range of the overreach zone providing improved phase selection for single-pole autoreclosing

- Elimination of possible overreach in case of resistive phase-to-phase-to-earth faults
- Improved performance under high SIR
- Power swing blocking independent from the operating characteristic and from the place of installation of the distance relay
- System logic and carrier logic:
  - automatic switch-onto-fault protection
  - overreach zone, effective for all types of fault or for single-phase faults only, controlled by the autoreclosure function and current starter via external input or automatically in case of failure of the PLC channel
  - underreaching permissive transfer tripping with or without voltage criterion at weak infeed
  - overerreaching permissive transfer tripping with echo and tripping logic at weak infeed
  - overreaching system with blocking signal
  - stabilization of the overreaching systems at change of energy direction on parallel lines
- The distance protection function may be applied for capacitive voltage transformers.

<u>Back-up protection*</u>

- Non-directional overcurrent protection with definite time delay and/or inverse time
- Directional earth fault protection with signal comparison for selective detection of very high-resistance earth faults
- Multi-activation facility of the available function.

** also available in the distance protection function.*

Process supervision
- Sequence-of-events recorder (with fault indication)
- Disturbance recorder with analog and binary channels.

Functions for programming by the user
- Logic (AND, OR and S/R flip-flop)
- Timer/integrator.

Application-specific ancillary functions (optional)
- Graphical engineering of a logic to user specifications (CAP316). An editor and code compiler are used to generate data, which is loaded into the equipment via the HMI. This software allows signals from all functions to be interconnected and the realization of new functionalities if necessary.

Self-supervision
- Continuous self-supervision and diagnosis
- Test equipment for quantitative testing available
- Continuous supervision of the optical fiber link for the longitudinal differential function
- Plausibility check of the three-phase current and voltage inputs.

Operational control
- Multi-lingual menu-based operator program CAP2/316 based on Windows
- Four independent, user-selectable parameter sets able to be activated via binary input can be stored in REL316*4
- Multi-activation and allocation of functions.

Serial interfaces
- Frontplate interface for local connection of a personal computer
- Back plane interface for remote communication with a station control system: LON, IEC 60870-5-103, MVB (part of IEC 61375), SPA
- Back plane interface for process bus: MVB (part of IEC 61375).

Installation
- REL316*4 is suitable for semi-flush or surface mounting or installation in a rack.

Application

The fully numerical protection terminal REL316*4 is a compact line terminal. It is designed to provide high-speed selective protection in distribution, MV and HV transmission systems. It can be applied at all power system voltages and in solidly earthed, low-impedance grounded or ungrounded systems or in systems equipped with arc suppression (Petersen) coils.

REL316*4 can be used on overhead lines and cables, long feeders, short feeders, parallel circuit lines, heavily loaded lines, lines with weak infeeds and on ”short zone” lines. It detects all kinds of faults including close three-phase faults, cross-country faults, evolving faults and high-resistance ground faults.

The distance function for high-voltage lines ($<Z_{HV}$) essentially has identical starting and measuring characteristics.

The differences refer to their speciality for these lines. With regard to their settings this is especially noticeable during phase selection and the adaption to source-to-line impedance conditions. The relay detects evolving faults and follow-up faults. Also at follow-up faults between parallel lines, the probability of successful single-phase autoreclosure on both systems increases significantly. The reason for this is the limited phase selection within the reach.

Distance and longitudinal differential protection combined in one terminal allows a better protection concept. For example, distance protection as a backup in addition to the traditional overcurrent backup in case of a communication failure.

Another application may be longitudinal differential protection for transformer protection with distance protection as a backup.

REL316*4 also takes account of power swings and changes of energy direction. A switch-onto-fault condition is tripped instantaneously. The demands on CT and VT performance are moderate and the relay’s response is uninfluenced by their characteristics.

The distance protection function and the directional comparison function for high-resistance earth faults can communicate with the opposite end of the line by all the usual communication media as well as by the integrated direct optical connection used for the longitudinal differential protection. The communication between the terminals of the phase-segragated longitudinal differential protection can be performed using the integrated or separate optical fiber link.

Example

Autoreclosure for 1½ breaker scheme

Three-pole tripping and autoreclosing

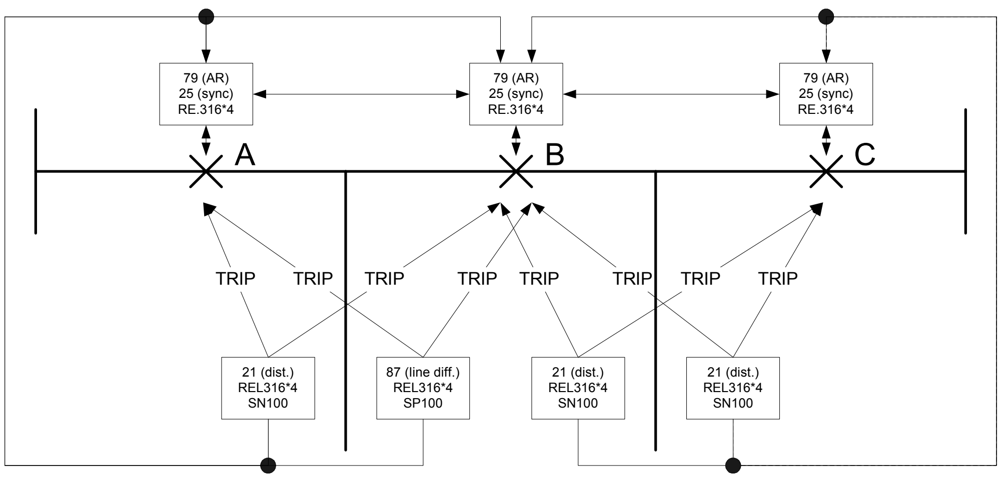


Fig. 1 Autoreclosing for 1½ breaker scheme (line-line diameter), three-pole application

The promoted solution for 1½ breaker scheme with three-pole tripping and autoreclosing is shown in Fig. 1.

- 21	Distance protection:	REL316*4 SN100
- 87	Line differential protection:	REL316*4 SP100
- 79/25	Autorecloser/synchrocheck:	REL316*4 SD050 or REC316*4.

Single-pole tripping and autoreclosing

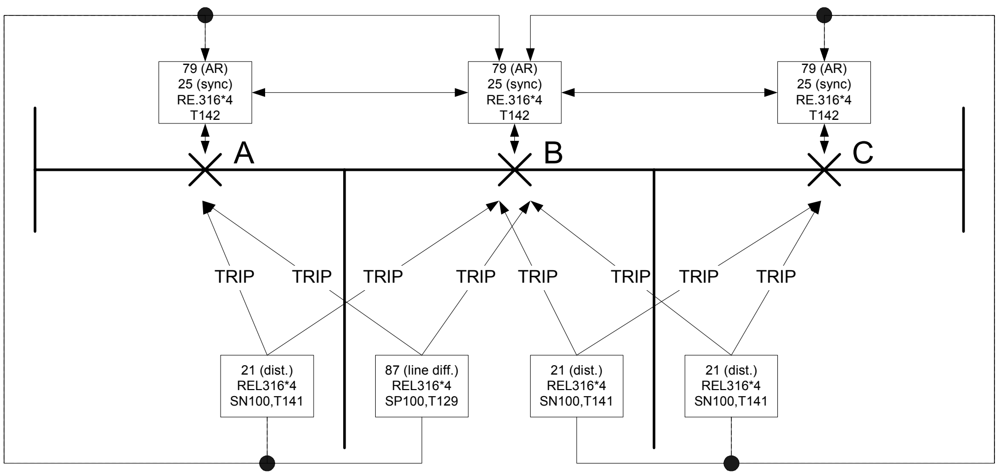


Fig. 2 Autoreclosing for 1½ breaker scheme (line-line diameter), single-pole application

The promoted solution for 1½ breaker scheme with single-pole tripping and autoreclosing is shown in Fig. 2.

- 21	Distance protection:	REL316*4 SN100, T141
- 87	Line differential protection:	REL316*4 SP100, T129
- 79/25	Autorecloser/synchrocheck:	REL316*4 SD050, T142 or REC316*4, T142.

In these figures two lines are connected to one diameter. Each line is protected by two REL316*4 relays. For the line on the right, the main relay is a distance protection relay (SN100), while the back-up relay is a line differential relay (SP100). The line on the right is protected with two distance protection relays (SN100). The autoreclosure functionality is achieved by one RE.316*4 relay per breaker (e.g. REL316*4 SD050).

For a single-pole application, the distance protection relay (SN100) is loaded with the supplementary FUPLA logic T141, the line differential relay (SP100) with the logic T129 and the autorecloser (e.g. SD050) with the logic T142.

The autoreclosure functions used for the bus breakers A and C are set as Masters and the one for the centre breaker B as Follower. Co-ordination is required between the autoreclosure functions. A synchrocheck function is also loaded in each relay to permit 3-pole autoreclosing.

Each line protection relay starts both bus and centre breakers for the concerned line. After a successful reclosure of the bus breaker, the centre breaker will be reclosed after a supplementary time delay. Should the bus CB autorecloser relay not be successful in its reclosing attempt, the centre CB autorecloser is blocked. If the bus CB is open or its autorecloser relay is not ready or out of service, the centre CB autorecloser will reclose the centre breaker after its own dead time without any supplementary time delay.

Design

The REL316*4 belongs to the generation of fully numerical line protection terminals, i.e. analog-to-digital conversion of the input variables takes place immediately after the input transformers and all further processing of the resulting numerical signals is performed by microprocessors and controlled by programs.

Standard interfaces enable REL316*4 to communicate with other control systems. Provision is thus made for the exchange of data such as reactionless reporting of binary states, events, measurements and protection parameters or the activation of a different set of settings by higher level control systems.

Because of its compact design, the very few hardware units it needs, its modular software and the integrated continuous self-diagnosis and supervision functions, REL316*4 ideally fulfils the user's expectations of a modern protection terminal at a cost-effective price. The AVAILABILITY of a terminal, i.e. the ratio between its mean operating time in service without failure and its total life, is most certainly the most important characteristic required of protection equipment. As a consequence of the continuous supervision of its functions, this quotient in the case of REL316*4 is typically always close to 1.

The menu-based HMI (Human Machine Interface) and the REL316*4's small size makes the tasks of connection, configuration and setting simple. A maximum of FLEXIBILITY, i.e. the ability to adapt the protection for application in a particular power system or to coordinate with, or replace units in an existing protection scheme, is provided in REL316*4 by ancillary software functions and the assignment of input and output signals via the HMI.

REL316*4's RELIABILITY, SELECTIVITY and STABILITY are backed by decades of experience in the protection of lines and feeders in transmission and distribution systems. Numerical processing ensures consistent ACCURACY and SENSITIVITY throughout its operational life.

Hardware

The hardware concept for the REL316*4 line protection equipment comprises four different plug-in units, a connecting mother PCB and housing (Fig. 3):

- analog input unit
- central processing unit
- 1 to 4 binary input/output units
- power supply unit
- connecting mother PCB
- housing with connection terminals.

In the analog input unit an input transformer provides the electrical and static isolation between the analog input variables and the internal electronic circuits and adjusts the signals to a suitable level for processing. The input transformer unit can accommodate a maximum of nine input transformers (voltage-, protection current- or measuring transformer).

Every analog variable is passed through a first order R/C low-pass filter on the main CPU unit to eliminate what is referred to as the aliasing effect and to suppress HF interferences (Fig. 4). They are then sampled 12 times per period and converted to digital signals. The analog/digital conversion is performed by a 16 Bit converter.

A powerful digital signal processor (DSP) carries out part of the digital filtering and makes sure that the data for the protection algorithms are available in the memory to the main processor.

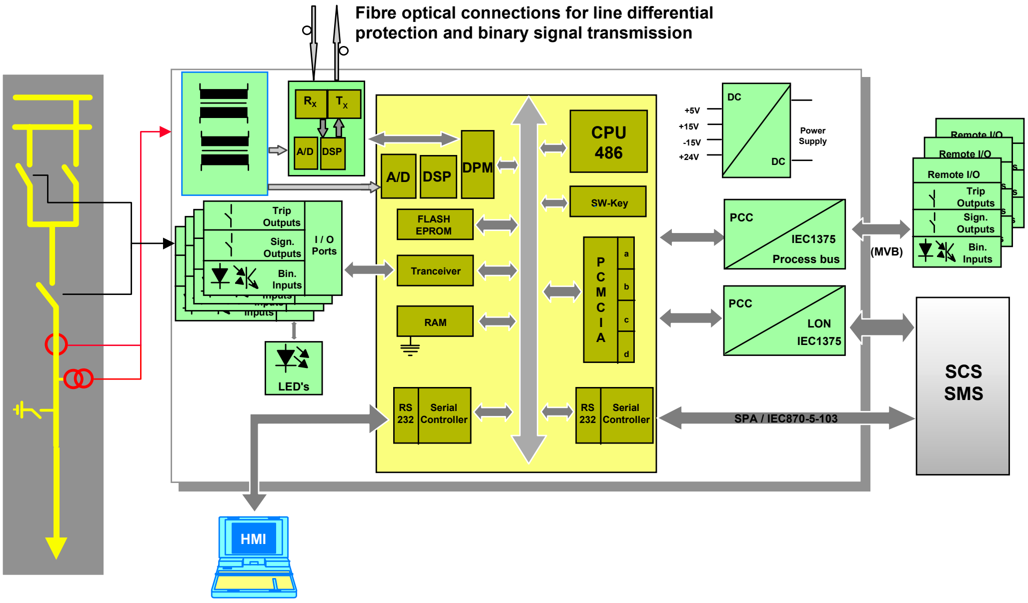


Fig. 3 Hardware platform overview (RE.316*4)

The processor core essentially comprises the main microprocessor (Intel 80486) for the protection algorithms and dual-ported memories (DPMs) for communication between the A/D converters and the main processor. The main processor performs the protection algorithms and controls the local HMI and the interfaces to the station control system. Binary signals from the main processor are relayed to the corresponding inputs of the I/O unit and thus control the auxiliary output relays and the light emitting diode (LED) signals. The main processor unit is equipped with an RS232C serial interface via which among other things the protection settings are made, events are read and the data from the disturbance recorder memory are transferred to a local or remote PC.

On this main processor unit there are two PCC slots and one RS232C interface. These serial interfaces provide remote communication to the station monitoring system (SMS) and station automation system (SAS) as well as to the remote I/Os.

REL316*4 can have one to four binary I/O units each. These units are available in three versions:

a) two tripping relays with two heavy-duty contacts, 8 optocoupler inputs and 6 signalling relays Type 316DB61.

b) two tripping relays with two heavy-duty contacts, 4 optocoupler inputs and 10 signalling relays Type 316DB62.

c) 14 optocoupler inputs and 8 signalling relays Type 316DB63.

When ordering REL316*4 with more than 2 I/O units, casing size N2 must be selected.

According to whether one or two I/O units are fitted, there are either 8 LEDs or 16 LEDs visible on the front of the REL316*4.

Software

Both analog and binary input signals are conditioned before being processed by the main processor: As described under hardware above, the analog signals pass through the sequence input transformers, shunt, low-pass filter (anti-aliasing filter), multiplexer and A/D converter stages and DSP. In their digital form, they are then separated by numerical filters into real and apparent components before being applied to the main processor. Binary signals from the optocoupler inputs go straight to the main processor. The actual processing of the signals in relation to the protection algorithms and logic then takes place.

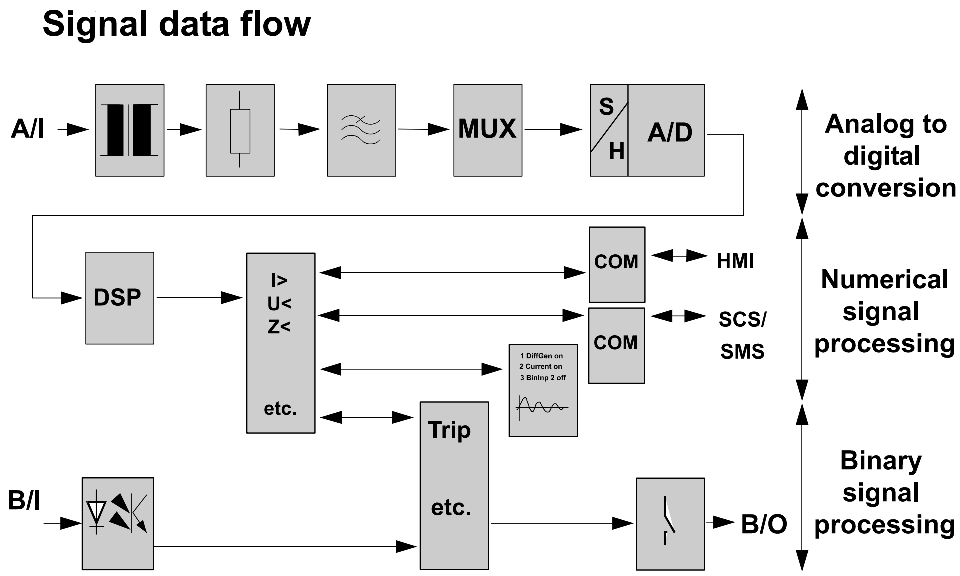


Fig. 4 Data flow

Graphical engineering tool

The graphical programming language used in the tool CAP316 makes CAP316 a powerful and user-friendly engineering tool for the engineering of the control and protection units RE.216/316*4. It is similar to IEC 1131. CAP316 permits the function blocks representing the application to be directly translated into an application program (FUPLA) capable of running on the processors of the control and protection units RE.316*4. The program packet contains an extensive library of function blocks. Up to 8 projects (FUPLA's created with CAP316) are able to run simultaneously on a RE.316*4.

List of functions

Binary functions:

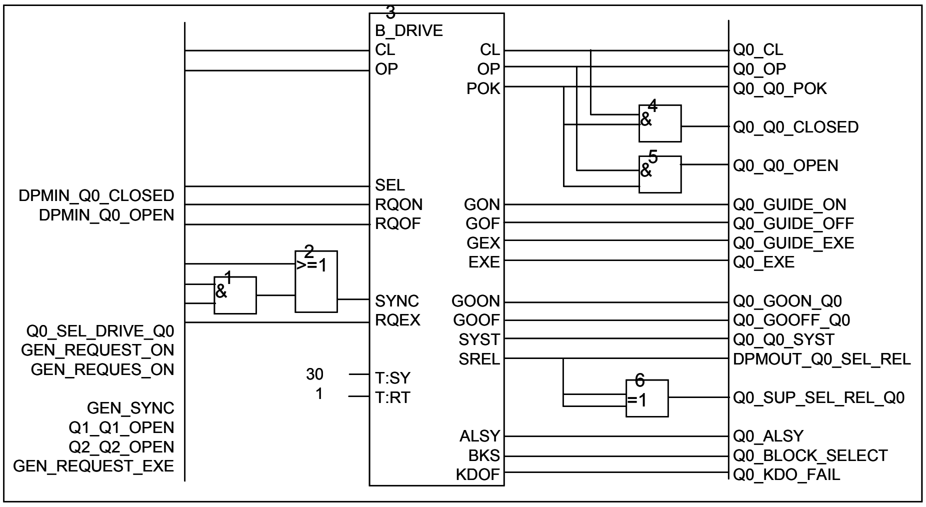
AND	AND gate
ASSB	Assign binary
B23	2-out-of-3 selector
B24	2-out-of-4 selector
BINEXTIN	External binary input
BINEXOUT	External binary output
COUNTX	Shift register
CNT	Counter
CNTD	Downwards counter
OR	OR gate
RSFF	RS flip-flop
SKIP	Skip segment
TFF	T flip-flop with reset
TMOC	Monostable constant
TMOCS, TMOCL	Monostable constant short, long
TMOI	Monostable constant with interrupt
TMOIS, TMOIL	Monostable constant with interrupt short, long
TOFF	Off delay
TOFFS, TOFFL	Off delay short, long
TON	On delay
TONS, TONL	On delay short, long
XOR	Exclusive OR gate

Analog functions:

ABS	Absolute value
ADD	Adder/subtracter
ADDL	Long integer adder/subtractor

ADMUL	Adder/multiplier	LIM	Limiter
CNVIL	Integer to long integer converter	LOADS	Load shedding function
		MAX	Maximum value detector
CNVLBCD	Long integer to BC converter	MIN	Minimum value detector
		MUL	Multiplier
CNVLI	Long integer to integer converter	MULL	Long integer multiplier
		NEGP	Percent negator
CNVLP	Long integer to percent converter	PACW	Pack binary signals into integer
CNVPL	Percentage to long integer converter	PDTS, PDTL	Differentiator
		PT1S, PT1L	Delayed approximation
DIV	Divider	SQRT	Square root
DIVL	Long integer divider	SWIP	Percent switch
FCTL	Linear function	THRLL	Lower limit threshold
FCTP	Polynomial function	THRUL	Upper limit threshold
FILT	Filter	TMUL	Time multiplier
INTS, INTL	Integrator	UPACW	Unpack binary signals from an integer.
KMUL	Factor multiplier		

Example:



Part of a FUPLA application (Q0: Control and interlocking logic for three objects Q0, Q1, Q2. B_DRIVE is a macro composed of binary function blocks)

Functions

The library of function modules for REL316*4 includes a variety of protection and ancillary functions from which the user can choose according to relay version (see ”Ordering data”). Within the constraints of the available processing capacity, the same function may be included several times. Four parameter sets may be selected via binary inputs. The individual functions are described below.

Distance protection

The distance protection function can have either overcurrent or underimpedance starters. They are equally suitable for use in solidly grounded, ungrounded or impedance grounded systems. In the case of ungrounded and impedance grounded systems, all the relays in the system have to have identically set phase-preference logics to maintain selectivity for cross-country faults. The following phase-preference schemes are available:

RTS	acyclic (R before T before S)
RST	acyclic (R before S before T)
TSR	acyclic (T before S before R)
TRS	acyclic (T before R before S)
SRT	acyclic (S before R before T)
STR	acyclic (S before T before R)
RTSR	cyclic (R bef. T, T bef. S, S bef. R)
TRST	cyclic (T bef. R, R bef. S, S bef. T).

The relay detects ground faults on the basis of the neutral current and/or neutral voltage.

Distance measurement is performed in the first, overreach and reverse zones simultaneously. Every zone has a wide, completely independent setting range and an independent setting for the direction of measurement. Four directional zones are provided, the last of which can also be configured to be non-directional. Overreach and reverse measuring zones are for use in transfer tripping schemes. The distance measuring characteristic is a polygon with a slightly inclined reactance line which has proved to be an optimum in practice. Where the voltage measured by the relay for a fault is too low, the inclusion of a healthy phase voltage as reference, respectively the use of a memory feature (close three-phase faults) ensures the integrity of the directional decision. The mutual impedance on parallel circuit lines can be compensated by correspondingly setting the zero-sequence compensation factor (k_0) or by taking account of the neutral current of the parallel circuit.

A VT supervision function is also included which monitors the zero-sequence component ($U_0 \cdot I_0$) and/or the negative-sequence component ($U_2 \cdot I_2$), the latter being of advantage in ungrounded systems or systems with poor grounding.

An independent overcurrent back-up measurement is provided which becomes a short-zone scheme as soon as the feeder isolator is opened. When the back-up overcurrent measurement picks up, the distance relay is enabled in spite of any blocking signals (e.g. VT supervision or power swing blocking) which may be active. The power swing blocking feature included in the distance function is based on the evaluation of the variation of $U \cdot \cos\varphi$. This principle of detecting power swings is entirely independent of the operating characteristic and location of the distance relay. It covers the range 0.2 to 8 Hz.

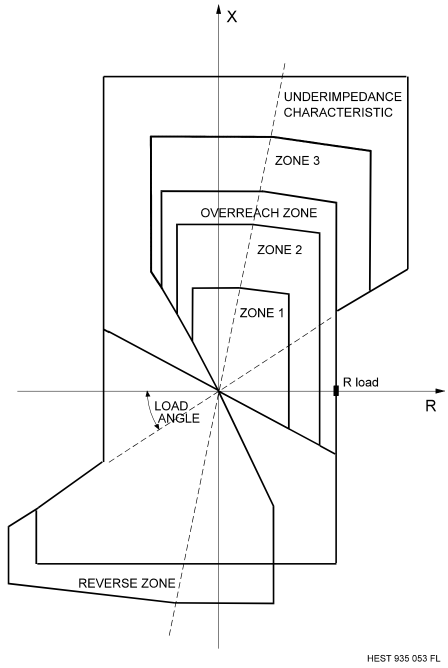


Fig. 5 Distance function characteristic

The tripping logic can be configured for all the usual transfer tripping schemes such as:

- overreaching (for autoreclosure with or without communications channel)
- permissive underreaching transfer tripping (including weak infeed logic)

- permissive overreaching transfer tripping (with echo tripping in the case of a weak-infeed and blocking logic for change of energy direction)
- blocking scheme (with blocking logic for change of energy direction).

The tripping logic provides access for the user to disable or enable a variety of functions such as the type communications channel, the switch-onto-fault logic, the overreaching zone, the VT supervision logic and whether tripping by the function should be single or three-phase.

Distance protection for high-voltage lines
The distance protection function ($<Z_{HV}$) is especially suited for 220 kV and 380 kV lines.

The "HV distance" function essentially has identical starting and measuring characteristics and the same setting parameters as the standard "distance" function.

The setting parameters for not effectively earthed networks have been omitted and a few new ones added, especially in connection with an improved phase selection.

The operating times for the "HV distance" function are shown in the form of isochrones. (see Section 'High-voltage distance protection function operating times'). All other functions remain unchanged.

Longitudinal differential protection
The longitudinal differential protection function included with REL316*4 is suitable for the protection of

- overhead lines
- cables
- transformer feeders.

It operates according to the proven transformer protection algorithm used in RET316*4 and exhibits the same outstanding characteristics with respect to through-fault stability and minimum CT performance.

The scheme is phase-selective and takes full advantage of the high data transfer rate of 64 kBit/s possible with an optical fiber link to sample the analog input variables at both ends of the line and transfers the corresponding values to the opposite station without almost any delay.

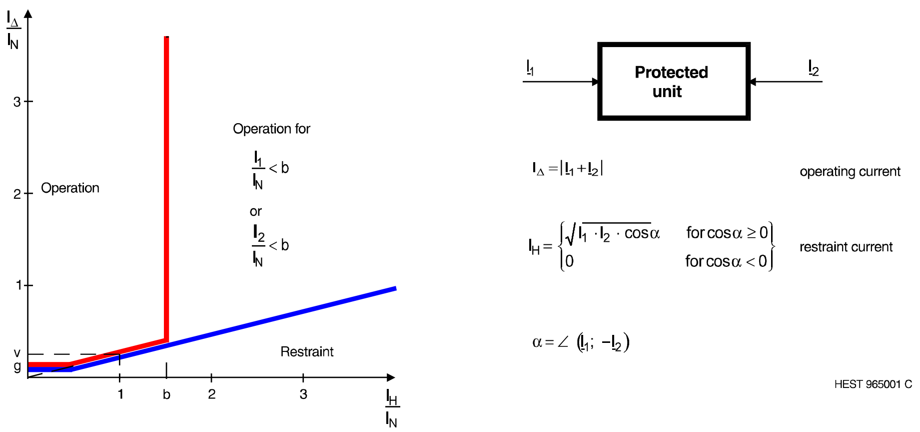


Fig. 6 Operating characteristic of the longitudinal differential function

Functions (cont'd)

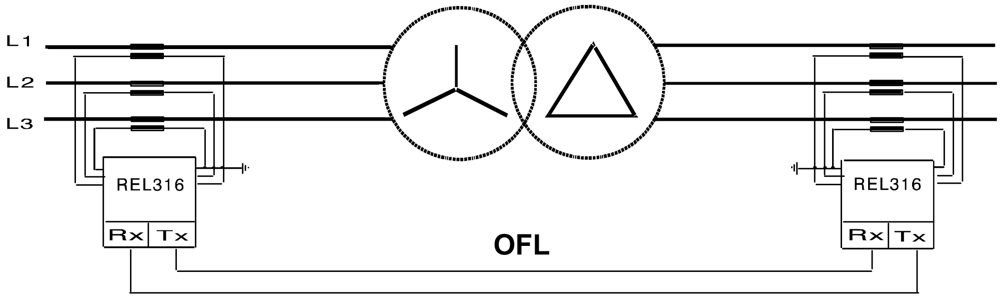


Fig. 7 Longitudinal differential protection with a power transformer in the protected zone

Tripping takes place should the comparison of the values in the terminal stations result in a differential current I_{Δ} above a given level (see operating characteristic in Fig. 6). The self-supervision function of the optical fiber link operates at such a speed that an additional enabling signal is not necessary.

Interposing CTs are not needed where the protected unit includes a power transformer (Fig. 7). The settings for the protection are made using a convenient control program running on a personal computer.

Provision is made for transmitting other signals via the optical fiber link in addition to those of the longitudinal differential function. These might be intertripping signals to the remote station generated by other internal protection functions or applied to the terminals binary inputs by some other external terminal. A ground fault comparison scheme can thus operate via the same optical fiber link. When the terminal equipment in one station is being tested, the equipment in the other station can be remotely blocked.

When the longitudinal protection function is in use, a maximum of six analog inputs is available, e.g. three current and three voltage measurements for main and back-up protections and for the disturbance recorder. Following analog-to-digital conversion, the signals branch in two directions. All six go to the main processor for evaluation for the local protection functions and the three corresponding to the local phase currents are additionally converted to light signals by an optical modem for transmission to the opposite station where they are evaluated in relation to the local current signals. Similarly the currents measured and digitized in the remote station are transferred to the local station and evaluated. A digital signal processor (DSP) ensures that the sampling and coordination of the signals in the two stations and also the transmission between the stations is properly synchronized. Thus there are two current signals available for the longitudinal differential comparison of each phase in both stations. Comparison is performed in the main processor according to the proven algorithm mentioned above.

As previously explained, the longitudinal differential function operates in conjunction with an optical fiber link between the stations at the ends of the transmission line. The signals are transmitted by a LED diode with a wavelength of 1300 nm and are coupled by a Type FC optical connector. Depending on the attenuation of the of the optical cable used, distances of up to 28 km can be covered. Repeaters have to be used for longer distances which in the case of FOX 6 Plus or Fox 20 enable transmission over distances up to 120 km (Fig. 8).

In REL316*4 units for longitudinal differential applications, the standard distance protection function can also be activated. The operation for single-pole autoreclosure is foreseen with the T129 logic. The other standard software of the line protection terminal is uninfluenced. Other optional functions from the software library are also provided (see Table of codes).

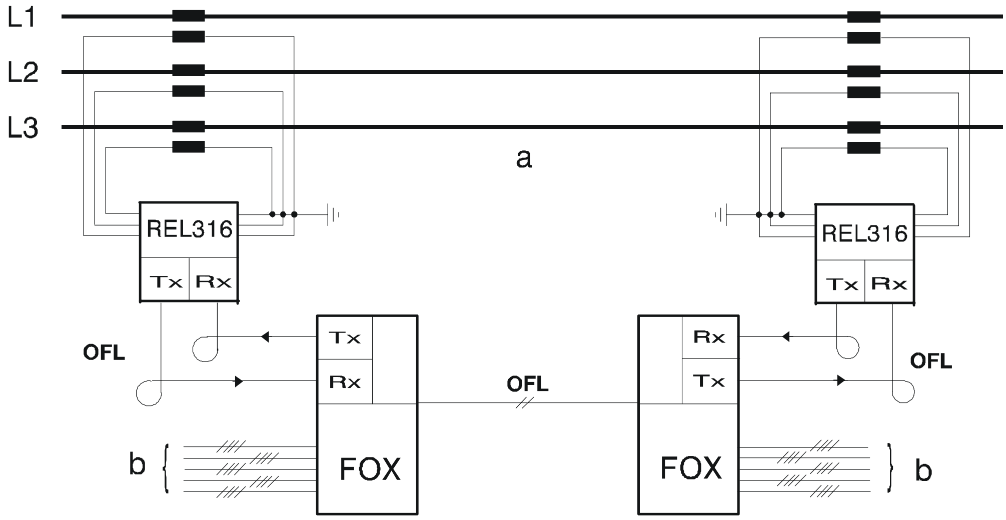


Fig. 8 Optical fiber link (OFL) using communications system Type FOX with a data transfer rate of 2 MBit/s

Autoreclosure
The autoreclosure function included in REL316*4 permits up to four three-phase reclosure cycles to be carried out, each with an independently adjustable dead time for fast and slow autoreclosure. Where single-phase reclosure is being applied, the first reclosure is the single-phase one and the others are three-phase.

The autoreclosure function can also be loaded several times in the same parameter set. This function also contains an integrated additional logic (FUPLA). This allows a customer-specific AR functionality. Both these possibilities have been used for the CH standard AR. Two AR functions are loaded for this: the first function with additional logic serves as fast autoreclosure and the second function as slow autoreclosure.

The integrated autoreclosure function for high-voltage lines (REL316*4/SN300) is employed on lines without local protection redundancy.

A separate autoreclosure unit is especially suitable for lines with redundant protection.

This unit enables practically all conventional and all modern line protection relays suitable for single-phase tripping to be connected to one system.

Synchrocheck
The synchrocheck function determines the difference between the amplitudes, phase angles and frequencies of two voltage vectors. Checks are also included to detect a dead line or busbar.

Thermal overload
The thermal overload function can be used for either cables or overhead lines. It is equipped with alarm and tripping stages and has a wide setting range for adjusting the time constant to match that of the protected unit.

Definite time voltage function
The voltage function can be set to operate on overvoltage or undervoltage with a definite time delay. Either single or three-phase measurements can be performed.

Definite time current function
The current function can be set to operate on overcurrent or undercurrent with a definite time delay. Either single or three-phase measurements can be performed.

Inverse time overcurrent function
The operating time of the inverse time overcurrent function reduces as the fault current increases and it can therefore achieve shorter operating times for fault locations closer to the source. Four different characteristics according to British Standard 142 designated normal inverse, very inverse, extremely inverse and long time inverse but with an extended setting range are provided. The function can be configured for single-phase mea-

Functions (cont'd)

surement or a combined three-phase measurement with detection of the highest phase current.

Directional overcurrent protection
The directional overcurrent protection function is available either with inverse time or definite time overcurrent characteristic. This function comprises a voltage memory for faults close to the relay location. The function response after the memory time has elapsed can be selected (trip or block).

Inverse time ground fault overcurrent function
The inverse time ground fault overcurrent function monitors the neutral current of the system which is either measured via a neutral current input transformer or derived internally in the terminal from the three-phase currents. Four different characteristics according to British Standard 142 designated normal inverse, very inverse, extremely inverse and long time inverse but with an extended setting range are provided.

Directional ground fault function for ungrounded systems or systems with Petersen coils
The sensitive ground fault protection function for ungrounded systems and systems with Petersen coils can be set for either forwards or reverse measurement. The characteristic angle is set to ±90° ($U_0 \bullet I_0 \bullet \sin\varphi$) in ungrounded systems and to 0° or 180° ($U_0 \bullet I_0 \bullet \cos\varphi$) for systems with Petersen coils. The neutral current is always used for measurement in the case of systems with Petersen coils, but in ungrounded systems its use is determined by the value of the capacitive current and measurement is performed by a core-balance CT to achieve the required sensitivity.

Directional ground fault function for grounded systems
A sensitive directional ground fault function based on the measurement of neutral current and voltage is provided for the detection of high-resistance ground faults in solidly or low-resistance grounded systems. The scheme operates either in a permissive or blocking mode and can be used in conjunction with an inverse time ground fault overcurrent function. In both cases the neutral current and voltage can be derived either externally or internally.

Frequency function
The frequency function is based on the measurement of one voltage. This function is able to be configured as maximum or minimum function and is applied as protection function and for load shedding. By multiple configuration of this function almost any number of stages can be realized.

Rate-of-change of frequency
This function offers alternatively an enabling by absolute frequency. It contains an undervoltage blocking facility. Repeated configuration of this function ensures a multi-step setup.

Measuring
Both measuring functions measure the single-phase rms values of voltage, current, frequency, real power and apparent power for display on the local HMI or transfer to the station control system. A choice can be made between phase-to-neutral and phase-to-phase voltages.

Ancillary functions
Ancillary functions such as a logic and a delay/integrator enable the user to create logical combinations of signals and pick-up and reset delays.

A runtime supervision feature enables checking the opening and closing of all kinds of breakers (circuit-breakers, isolators, ground switches...). Failure of a breaker to open or close within an adjustable time results in the creation of a corresponding signal for further processing.

Plausibility check
The current and voltage plausibility functions facilitate the detection of system asymmetries, e.g. in the secondary circuits of CTs and VTs.

Sequence-of-events recorder
The event recorder function provides capacity for up to 256 binary signals including time marker with a resolution in the order of milliseconds and gives the distance to a fault expressed as a percentage of a specified reference reactance, e.g. the reactance of the protected line.

Disturbance recorder
The disturbance recorder monitors up to 9 analog inputs, up to 16 binary inputs and internal results of protection functions. The capacity for recording disturbances depends on the duration of a disturbance as deter-

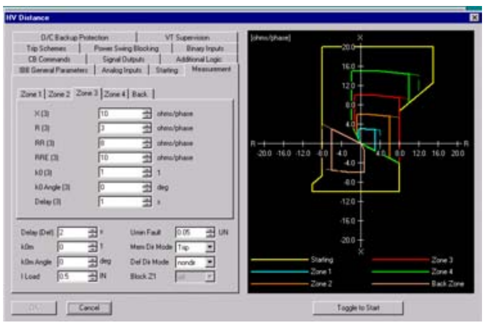
mined by its pre-disturbance history and the duration of the disturbance itself. The total recording time is approximately 5 s.

Human Machine Interface (HMI) - CAP2/316
For local communication with REL316*4, there is the setting software CAP2/316 available which is based on Windows. This software runs under the following operating systems:

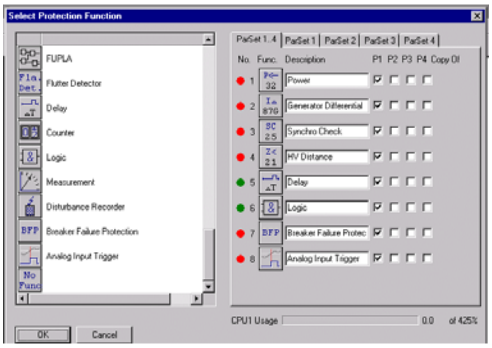
- Windows NT 4.0
- Windows 2000.

This optimal programming tool is available for engineering, testing, commissioning and operation. The software can be used either ON-LINE or OFF-LINE and furthermore contains a DEMO mode.

For each protection function a tripping characteristic is displayed. Apart from the basic understanding of the protection functions, the graphical display of these functions also makes the setting of the parameters clearer.



Any desired protection function can be selected from the software library of all released protection functions by means of the drag-and-drop feature.



Built-in HMI
The front HMI unit serves primarily for the signalling of actual events, measurands and diagnostic data. Settings are not displayed.

Features:

- Measurand display
  - Amplitude, angle, frequency of analog channels
  - Functional measurands
  - Binary signals
- Event list
- Operating instructions
- Disturbance recorder information
- Distance to fault indication
- Diagnostic information
- Acknowledgment functions
  - Resetting LEDs
  - Resetting latched outputs
  - Event erasing
  - Warm start.

Remote communication
REL316*4 is able to communicate with a station monitoring and evaluation system (SMS) or a station automation system (SAS) via an optical fiber link. The corresponding serial interface permits events, measurements, disturbance recorder data and protection settings to be read and sets of parameter settings to be switched.

Functions (cont'd)

Using the LON bus permits in addition the exchange of binary information between the individual bay controllers, e.g. signals for station interlocking.

Remote in- and outputs (RIO580)
Using the process bus type MVB remote in- and output units (500RIO11) can be connected to the RE.316*4 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 close to the process reduces the wiring dramatically, since they are accessible via fiberoptic link from the RE.316*4 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.

Self-diagnosis and supervision
RE.316*4's self-diagnosis and supervision functions ensure maximum availability not only of the protection terminal itself, but also of the power system it is protecting. Hardware failures are immediately signalled by an alarm contact. In particular, the external and internal auxiliary supplies are continuously supervised. The correct function and tolerance of the A/D converter are tested by cyclically converting two reference voltages. Special algorithms regularly check the processor's memories (background functions). A watchdog supervises the execution of the programs.

The program execution itself is monitored by a watchdog function for each processor.

An important advantage of the extensive self-diagnosis and supervision functions is that periodic routine maintenance and testing are reduced.

The optical fiber link is also supervised on terminal equipped with the longitudinal differential function. For this purpose test data are transmitted in addition to the protection signals to test the integrity of the communications channel. The supervision function also detects the failure of the auxiliary supply in one terminal station. In the event that the optical fiber link should fail, the back-up protection functions remain operational.

Supporting software
The operator program facilitates configuration and setting of the protection, listing parameters, reading events and listing the various internal diagnostic data.

The evaluation programs REVAL and E_wineve (Windows NT/Windows 2000) are available for viewing and evaluating the disturbances stored by the disturbance recorder. Where the disturbance data are transferred via the communications system to the disturbance recorder evaluation station, the file transfer program WinCom (Windows NT/Windows 2000) is also used.

The program XSCON is available for conversion of the RE.316*4 disturbance recorder data to ABB's test set XS92b format. This offers reproduction of electrical quantities recorded during a fault.

Technical data hardware

Table 1: Analog input variables

Number of inputs according to version, max. 9 analog inputs (voltages and currents, 4 mm^2 terminals)	
Rated frequency f_N	50 Hz or 60 Hz
Rated current I_N	1 A, 2 A or 5 A
Thermal rating of current circuit continuous for 10 s for 1 s dynamic (half period)	 4 x I_N 30 x I_N 100 x I_N 250 x I_N (peak)
Rated voltage U_N	100 V or 200 V
Thermal rating of voltage circuit continuous during 10 s	 1.3 x U_N 2 x U_N
Burden per phase current inputs at I_N = 1 A at I_N = 5 A voltage inputs at U_N	 <0.1 VA <0.3 VA <0.25 VA
VT fuse characteristic	Z acc. to DIN/VDE 0660 or equivalent

Table 2: Contact data

Tripping relays	
No. of contacts	2 relays per I/O unit 316DB61 or 316DB62 with 2 N/O contacts each, 1.5 mm^2 terminals
Max. operating voltage	300 V AC or V DC
Continuous rating	5 A
Make and carry for 0.5 s	30 A
Surge for 30 ms	250 A
Making power at 110 V DC	3300 W
Breaking capacity for L/R = 40 ms Breaking current with 1 contact at U <50 V DC at U <120 V DC at U <250 V DC	 1.5 A 0.3 A 0.1 A
Breaking current with 2 contacts in series at U <50 V DC at U <120 V DC at U <250 V DC	 5 A 1 A 0.3 A
Signalling contacts	
No. of contacts	6, 10 or 8 acc. to I/O unit (316DB61, 316DB62 or 316DB63), 1 contact per sig. relay with 1.5 mm^2 terminals Each interface unit equipped with 1 C/O contact and the all others N/O contacts
Max. operating voltage	250 V AC or V DC
Continuous rating	5 A
Make and carry for 0.5 s	15 A
Surge for 30 ms	100 A
Making power at 110 V DC	550 W
Breaking current for L/R = 40 ms at U <50 V DC at U <120 V DC at U <250 V DC	 0.5 A 0.1 A 0.04 A
The user can assign tripping and signalling contacts to protection functions	

Technical data hardware (cont'd)

Table 3: Optocoupler inputs

No. of optocouplers	8, 4 or 14 acc. to I/O unit (316DB61, 316DB62 or 316DB63)
Input voltage	18 to 36 V DC / 36 to 75 V DC / 82 to 312 V DC /175 to 312 V DC
Threshold voltage	10 to 17 V DC / 20 to 34 V DC / 40 to 65 V DC / 140 to 175 V DC
Max. input current	<12 mA
Operating time	1 ms
The user can assign the inputs to protection functions.	

Table 4: Light-emitting diodes

Choice of display modes:	
• Accumulates each new disturbance • Latching with reset by next pick-up • Latching only if protection trips with reset by next pick-up • Signalling without latching	
Colors	1 green (standby) 1 red (trip) 6 or 14 yellow (all other signals)
The user can assign the LEDs to protection functions.	

Table 5: Configuration and settings

Local via the communication interface on the front port connector using an IBM-compatible PC with Windows NT 4.0 or Windows 2000. The operator program can also be operated by remote control via a modem.	
Operator program	in English or German

Table 6: Remote communication

RS232C interface Data transfer rate Protocol Electrical/optical converter (optional)	9 pin Sub-D female 9600 Bit/s SPA or IEC 60870-5-103 316BM61b
PCC interface Number	 2 plug-in sockets for type III cards
PCC (optional) Interbay bus protocol Process bus protocol (interbay and process bus can be used concurrently) LON bus Data transfer rate	 LON or MVB (part of IEC 61375) MVB (part of IEC 61375) PCC with fiber-optical port, ST connectors 1.25 MBit/s
MVB bus Data transfer rate	PCC with redundant fiber-optical port, ST connectors 1.5 Mbit/s
Event memory Capacity Time marker resolution	 256 events 1 ms
Time deviation without remote synchronizing	<10 s per day
Engineering interface	integrated software interface for signal engineering with SigTOOL

Table 7: Auxiliary supply

Supply voltage	
Voltage range	36 to 312 V DC
Voltage interruption bridging time	>50 ms
Fuse rating	≥4 A
Load on station battery at normal operation (1 relay energized) during a fault (all relays energized) with 1 I/O unit with 2 I/O units with 3 I/O units with 4 I/O units	 <20 W <22 W <27 W <32 W <37 W
Additional load of the options line differential protection (code SPxxx) SPA, IEC 60870-5-103 or LON interface MVB interface	 7.5 W 1.5 W 2.5 W
Buffer time of the event list and fault recorder data at loss of auxiliary supply	>2 days (typ. 1 month)

Table 8: 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	5 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 1 kV across open contacts	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.

Technical data hardware (cont'd)

Table 9: Mechanical design

Weight Size N1 casing Size N2 casing	 approx. 10 kg approx. 12 kg
Methods of mounting	semi-flush with terminals at rear surface with terminals at rear 19" rack mounting, height 6U, width N1: 225.2 mm (1/2 19" rack). Width N2: 271 mm.
Enclosure Protection Class	IP 50 (IP 20 if MVB PC cards are used) IPXXB for terminals.

Technical data functions

Table 10: Distance and high-voltage distance protection (21)

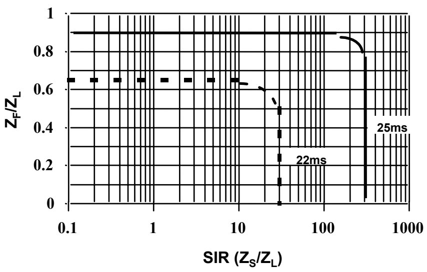
All values of settings referred to the secondaries, every zone can be set independently of the others, 4 independent files for sets of settings.	
Impedance measurement	-300 to 300 Ω/ph in steps of 0.01 Ω/ph (I_N = 1 A or 2 A) -30 to 30 Ω/ph in steps of 0.001 Ω/ph (I_N = 5 A)
Zero-sequence current compensation	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 (not included in the high-voltage distance protection function $<Z_{HV}$)	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 0.01U_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%
Operating times of the high-voltage distance protection function $<Z_{HV}$ (including tripping relay) minimum typical (see also isochrones) all permitted additional functions activated The operating times of the (standard-) distance functions are higher by 5 to 10 ms	 21 ms 25 ms 4 ms in addition
Typical reset time	30 ms
VT-MCB auxiliary contact requirements Operating time	 <15 ms

Technical data functions (cont'd)

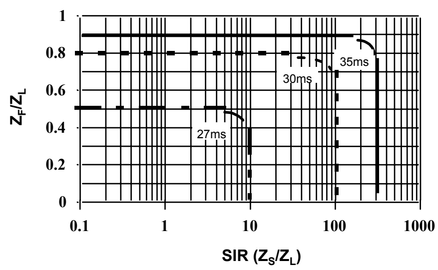
High-voltage distance protection function operating times (Versions SN 100 and SN 300)

Isochrones

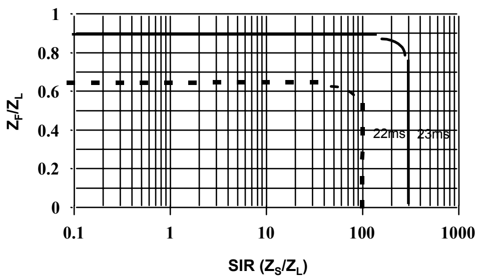
Single phase fault (min)



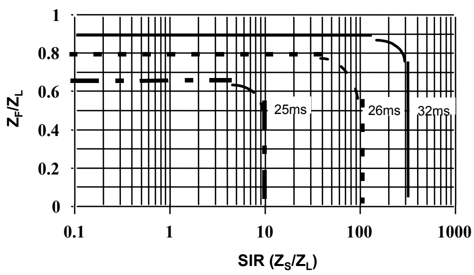
Single phase fault (max)



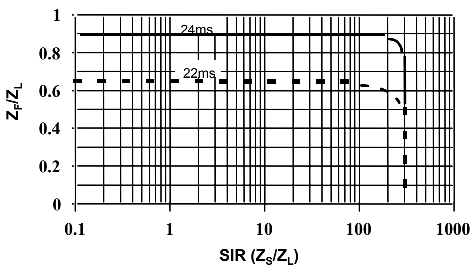
Two phase fault (min)



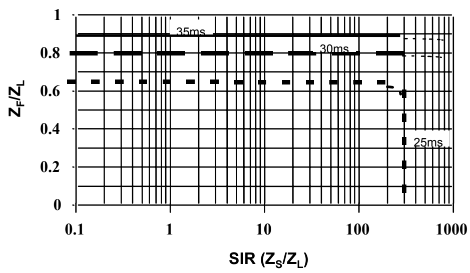
Two phase fault (max)



Three phase fault (min)



Three phase fault (max)



Abbreviations:
Z_S = source impedance
Z_F = fault impedance
Z_L = zone 1 impedance setting

Table 11: Longitudinal differential protection function (87)

• Three-phase measurement with current comparison per phase • Adaptive current characteristic • Provision for two-winding power transformer in protection zone - compensation of group of connection - compensation of differing CT ratios - 2nd harmonic inrush restraint	
Settings:	
Basic setting	g = 0.1 to 0.5 I_N in steps of 0.1 I_N
Pick-up ratio	v = 0.25 / 0.5
Restraint criterion	b = 1.25 to 5 in steps of 0.25
Typical operating time (incl. tripping relay)	25 ms
Pick-up accuracy of g	±5% I_N (at f_N)
Condition for resetting	I_Δ <0.8 setting for g
Communications link to the remote station	Two optical fiber connectors for transmit (Tx) and receive (Rx)
Data transfer rate	64 kBit/s
Optical fiber conductors	multi-mode MM (50/25 μm) single-mode SM (9/125 μm)
Max. attenuation of link	MM 18 dB, SM 14 dB
Optical connectors	Type FC
Operating wave length	1300 nm
Max. permissible transmission time per direction	11.5 ms at f_N = 50 Hz 9.5 ms at f_N = 60 Hz
Range MM SM	 <18 km (1 dB/km incl. splice) <28 km (0.5 dB/km incl. splice)
Long distance range using FOX20	<87 km (0.5 dB/km incl. splice for SM, 1300 nm) <124 km (0.35 dB/km incl. splice for SM, 1550 nm)

Table 12: Binary signal transmission function

Transmission of binary signals via the optical fiber link of 316EA63 (link used for the longitudinal protection function)	
Max. 8 binary signals of which the first 4 are assignable to the tripping logic	
Typical transmission time for 1 binary signal	18 ms (13 to 25 ms)

Table 13: Autoreclosure (79)

• Single and three-phase autoreclosure. • Operation in conjunction with distance, longitudinal differential, overcurrent and synchrocheck functions and also with external protection and synchrocheck relays. • Logic for 1st and 2nd main protections, duplex and master/follower schemes. • Up to four fast or slow reclosure shots. The autoreclosure function may also be loaded several times in the same parameter set. • Detection of evolving faults.	
Settings:	
1st reclosure	none 1P fault - 1P reclosure 1P fault - 3P reclosure 1P/3P fault - 3P reclosure 1P/3P fault - 1P/3P reclosure

Technical data functions (cont'd)

2nd to 4th reclosure	none two reclosure cycles three reclosure cycles four reclosure cycles
Single-phase dead time	0.05 to 300 s
Three-phase dead time	0.05 to 300 s
Dead time extension by ext. signal	0.05 to 300 s
Dead times for 2nd, 3rd and 4th reclosures	0.05 to 300 s
Fault duration time	0.05 to 300 s
Reclaim time	0.05 to 300 s
Blocking time	0.05 to 300 s
Single and three-phase discrimination times	0.1 to 300 s
	All settings in steps of 0.01 s

Table 14: Synchrocheck function (25)

• Determination of synchronism - Single-phase measurement. The differences between the amplitudes, phase angles and frequencies of two voltage vectors are determined. • Voltage supervision - Single or three-phase measurement - Evaluation of instantaneous values and therefore wider frequency range - Determination of maximum and minimum values in the case of three-phase inputs • Phase selection for voltage inputs • Provision for switching to a different voltage input (double busbar systems) • Remote selection of operating mode	
Settings:	
Max. voltage difference	0.05 to 0.4 U_N in steps of 0.05 U_N
Max. phase difference	5 to 80° in steps of 5°
Max. frequency difference	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
Resetting time	0 to 1 s in steps of 0.05 s
Accuracy Voltage difference Phase difference Frequency difference	for 0.9 to 1.1 f_N ±5% U_N ±5° ±0.05 Hz

Table 15: Thermal overload function (49)

• Thermal image for the 1st order model. • Single or three-phase measurement with detection of maximum phase value.	
Settings:	
Base current I_B	0.5 to 2.5 I_N in steps of 0.01 I_N
Alarm 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	2 to 500 min in steps of 0.1 min
Accuracy of the thermal image	±5% ϑ_N (at f_N) with protection CTs ±2% ϑ_N (at f_N) with metering CTs

Table 16: Definite time current function (51DT)

• 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%
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

Table 17: Definite time voltage function (27/59)

• Over and undervoltage detection • Single or three-phase measurement with detection of the highest, respectively lowest phase voltage	
Settings:	
Pick-up 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 the pick-up setting (at f_N)	±2% or ±0.005 U_N
Reset ratio ($U \geq 0.1\ U_N$) overvoltage undervoltage	 >96% (for max. function) <104% (for min. function)
Max. operating time without intentional delay	60 ms

Table 18: 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 inverse	$t = k_1 / ((I/I_B)^C - 1)$ 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 I_{start}	1 to 4 I_B in steps of 0.01 I_B
Min. time setting t_{min}	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 British Standard 142 RXIDG characteristic	 E 5.0 ±4% (1 - I/80 I_B)
Reset ratio	>94%

Technical data functions (cont'd)

Table 19: Inverse time ground fault overcurrent function (51N)

• Neutral current measurement (derived externally or internally) • Stable response to transients	
Inverse time characteristic (acc. to B.S. 142 with extended setting range) normal inverse very inverse extremely inverse long time inverse	$t = k_1 / ((I/I_B)^C - 1)$ 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 I_{start}	1 to 4 I_B in steps of 0.01 I_B
Min. time setting t_{min}	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 British Standard 142 RXIDG characteristic	 E 5.0 ±4% (1 - I/80 I_B)
Reset ratio	>94%

Table 20: Directional definite time overcurrent protection (67)

• Directional overcurrent protection	
• 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 21: 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
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 22: Directional ground fault function for ungrounded systems and systems with Petersen coils (32N)

Determination of real or apparent power from neutral current and voltage	
Settings:	
Pick-up power	0.005 to 0.1 S_N in steps of 0.001 S_N
Reference value of the power S_N	0.5 to 2.5 $U_N \cdot I_N$ in steps of 0.001 $U_N \cdot I_N$
Characteristic angle	-180° to +180° in steps of 0.01°
Phase error compensation of current input	-5° to +5° in steps of 0.01°
Delay	0.05 to 60 s in steps of 0.01 s
Reset ratio	30 to 95% in steps of 1%
Accuracy of the pick-up setting	±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

Technical data functions (cont'd)

Table 23: Directional ground fault function for grounded systems (67N)

• Detection of high-resistance ground faults • Current enabling setting $3I_0$ • Direction determined on basis of neutral variables (derived externally or internally) • Permissive or blocking directional comparison scheme • Echo logic for weak infeeds • Logic for change of energy direction	
Settings:	
Current pick-up setting	0.1 to 1.0 I_N in steps of 0.01 I_N
Voltage pick-up setting	0.003 to 1 U_N in steps of 0.001 U_N
Characteristic angle	-90° to +90° in steps of 5°
Delay	0 to 1 s in steps of 0.001 s
Accuracy of the current pick-up setting	±10% of setting

Table 24: 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 25: 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 three-phase measurement and 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 26: Power function (32)

• Measurement of real or apparent power • Protection function based on either real or apparent power measurement • Reverse power protection • Over and underpower • Single, two or three-phase measurement • Suppression of DC components and harmonics in current and voltage • Compensation of phase errors in main and input CTs and VTs	
Settings:	
Power pick-up	-0.1 to 1.2 S_N in steps of 0.005 S_N
Characteristic angle	-180° to +180° in steps of 5°
Delay	0.05 to 60 s in steps of 0.01 s
Phase error compensation	-5° to +5° in steps of 0.1°
Rated power S_N	0.5 to 2.5 $U_N \bullet I_N$ in steps of 0.001 $U_N \bullet I_N$
Reset ratio	30% to 170% in steps of 1%
Accuracy of the pick-up setting	±10% of setting or 2% $U_N \bullet I_N$ (for protection CTs) ±3% of setting or 0.5% $U_N \bullet I_N$ (for core-balance CTs)
Max. operating time without intentional delay	70 ms

Table 27: 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 current operating time (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)

Technical data functions (cont'd)

Table 28: Disturbance recorder

• Max. 9 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, 1.3 x U_N
Resolution	12 bits
Settings:	
Recording periods Pre-event Event Post-event	 40 to 400 ms in steps of 20 ms 100 to 3000 ms in steps of 50 ms 40 to 400 ms in steps of 20 ms

Ancillary functions

Table 29: Logic

Logic for 4 binary inputs with the following 3 configurations: 1. OR gate 2. AND gate 3. Bistable flip-flop with 2 set and 2 reset inputs (both OR gates), resetting takes priority
All configurations have an additional blocking input. Provision for inverting all inputs.

Table 30: Delay/integrator

• For delaying pick-up or reset or for integrating 1 binary signal • Provision for inverting the input	
Settings:	
Pick-up or reset time	0 to 300 s in steps of 0.01 s
Integration	yes/no

Table 31: Plausibility check

A plausibility check function is provided for each three-phase current and three-phase voltage input which performs the following: • Determination of the sum and phase sequence of the three-phase currents or voltages • Provision for comparison of the sum of the phase values with a corresponding current or voltage sum applied to an input • Function blocks for currents exceeding 2 x I_N, respectively voltages exceeding 1.2 U_N	
Accuracy of the pick-up setting at rated frequency	±2% I_N in the range 0.2 to 1.2 I_N ±2% U_N in the range 0.2 to 1.2 U_N
Reset ratio	≥90% whole range >95% (at U >0.1 U_N or I >0.1 I_N)
Current plausibility settings: Pick-up differential for sum of internal summation current or between internal and external summation currents	 0.05 to 1.00 I_N in steps of 0.05 I_N
Amplitude compensation for summation CT	-2.00 to +2.00 in steps of 0.01
Delay	0.1 to 60 s in steps of 0.1 s

Voltage plausibility settings: Pick-up differential for sum of internal summation voltage or between internal and external summation voltages	0.05 to 1.2 U_N in steps of 0.05 U_N
Amplitude compensation for summation VT	-2.00 to +2.00 in steps of 0.01
Delay	0.1 to 60 s in steps of 0.1 s

Table 32: Runtime supervision

The runtime supervision feature enables checking the opening and closing of all kinds of breakers (circuit-breakers, isolators, ground switches...). Failure of a breaker to open or close within an adjustable time results in the creation of a corresponding signal for further processing.	
Settings	
Setting time	0 to 60 s in steps of 0.01 s
Accuracy of runtime supervision	±2 ms

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)

Connection diagram

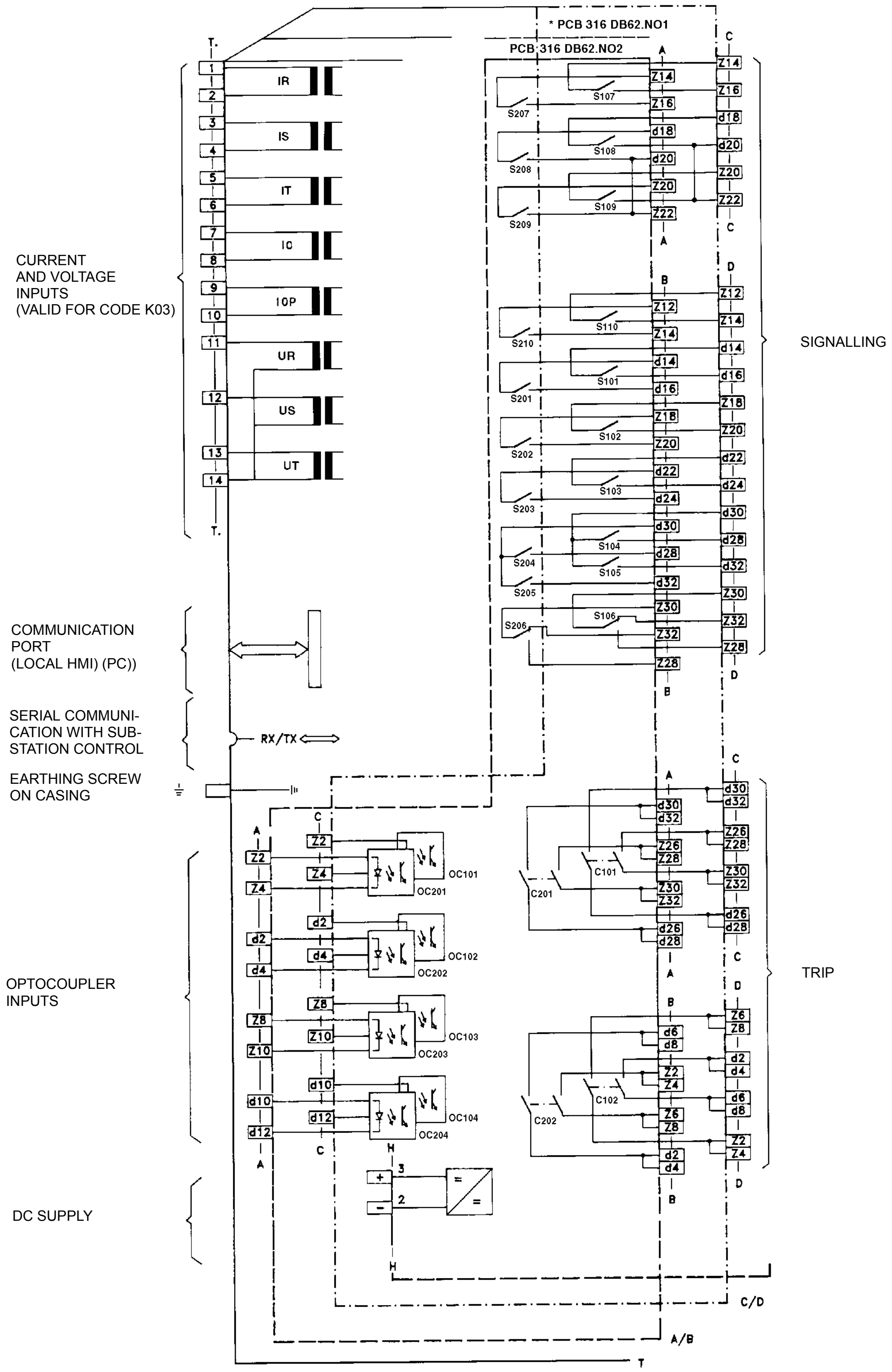


Fig. 9 Typical wiring diagram of REL316*4 in size N1 casing with two input/output units 316DB62

Ordering

Please specify:

- Quantity
- Ordering number
- ADE code + key

The following basic versions can be ordered:

Stand-alone units REL316*4 with built-in HMI (see table below) HESG448750M0001

Table 34: REL316*4 basic versions

	Relay ID code		<Z	$<Z_{HV}$	E/Fungnd	E/Fgnd	AR	SC	Long. diff	BST	Basic-SW
Order No. HESG448750M0001	A*B0U*K01E*I*F0J0 Q0V0R0W0Y*N*M*	SA010 T***	X								
	A*B0U*K01E*I*F0J0 Q0V0R0W0Y*N*M*	SA100 T***	X								X
	A*B0U*K03E*I*F*J* Q*V*R*W*Y* N*M*	SE010 T***	X								
	A*B0U*K03E*I*F*J* Q*V*R*W*Y* N*M*	SE100 T***	X								X
	A*B*U*K04E*I*F*J* Q*V*R*W*Y* N*M*	SG100 T***	X		X						X
	A*B*U*K04E*I*F*J* Q*V*R*W*Y* N*M*	SH100 T***	X		X		X				X
	A*B*U*K09E*I*F*J* Q*V*R*W*Y* N*M*	SH300 T***	X		X		X	X			X
	A*B0U*K03E*I*F*J* Q*V*R*W*Y* N*M*	SK100 T***	X				X				X
	A*B0U*K05E*I*F*J* Q*V*R*W*Y* N*M*	SK300 T***	X				X	X			X
	A*B0U*K05E*I*F*J* Q*V*R*W*Y* N*M*	SL100 T***	X			X					X
	A*B0U*K05E*I*F*J* Q*V*R*W*Y* N*M*	SM100 T***	X			X	X				X
	A*B0U*K08E*I*F*J* Q*V*R*W*Y* N*M*	SM300 T***	X			X	X	X			X
	A*B0U*K01E*I*F0J0 Q0V0R0W0Y*N*M*	SA020 T***									X
	A*B0U*K03E*I*F*J* Q*V*R*W*Y* N*M*	SC020 T***									X
	A*B0U*K05E*I*F*J* Q*V*R*W*Y* N*M*	SC050 T***						X			X
	A*B0U*K03E*I*F*J* Q*V*R*W*Y* N*M*	SD020 T***					X				X
	A*B0U*K05E*I*F*J* Q*V*R*W*Y* N*M*	SD050 T***					X	X			X
	A*B*U*K04E*I*F0J0 Q0V0R0W0Y*N*M*	SG020 T***			X						X
	A*B*U*K04E*I*F*J* Q*V*R*W*Y* N*M*	SH020 T***			X		X				X
	A*B*U*K09E*I*F*J* Q*V*R*W*Y* N*M*	SH050 T***			X		X	X			X
	A*B0U*K16E*I*F*J*Q*V*R*W*Y*N*M*	SP100 T***	X				X		X	X	X
	A*B0U*K16E*I*F*J*Q*V*R*W*Y*N*M*	SP200 T***	X			X	X		X	X	X
	A*B*U*K17E*I*F*J*Q*V*R*W*Y*N*M*	SP300 T***			X		X	X	X	X	X
	A*B0U0K15E*I*F*J* Q*V*R*W*Y*N*M*	SP400 T***					X		X	X	X
	A*B0U*K16E*I*F*J*Q*V*R*W*Y*N*M*	SP400 T***					X		X	X	X
	A*B*U*K17E*I*F*J*Q*V*R*W*Y*N*M*	SP400 T***					X		X	X	X
	A*B0U*K16E*I*F*J*Q*V*R*W*Y*N*M*	SP500 T***				X	X		X	X	X
	A*B0U*K05E*I*F*J*Q*V*R*W*Y*N2M*	SN100 T***		X		X					X
	A*B0U*K05E*I*F*J*Q*V*R*W*Y*N2M*	SN300 T***		X		X	X	X			X
	A*B0U*K08E*I*F*J*Q*V*R*W*Y*N2M*	SN300 T***		X		X	X	X			X

T0129 is to be ordered additionally in case that single-pole autoreclosure for line differential protection is required.

Ordering (cont'd)

Legend:

*	required sub-code in Table 35
<Z	distance protection
$<Z_{HV}$	high-voltage distance protection
E/Fungnd	direction ground fault function for ungrounded systems or systems with Petersen coils
E/Fgnd	direction ground fault function for grounded systems
AR	autoreclosure
SC	synchrocheck
Long. diff.	longitudinal differential function
BST	binary signal transmission

Basic SW		Basic software including the following functions:
	OCDT	definite time overcurrent
	OCDT Dir	directional definite time overcurrent protection
	OCDT Inv Dir	directional inverse time overcurrent protection
	VTDT	definite time voltage function
	TH	thermal overload
	Power	power function
	OCInv	inverse definite minimum time-overcurrent
	Ucheck	voltage plausibility
	Icheck	current plausibility
	UIfPQ	metering
	MeasMod	three-phase measuring module
	Delay	delay/integrator
	Logic	AND gate, OR gate or bistable flip-flop
	FUPLA	project-specific logic
	DRec	disturbance recorder
	I0inv	inverse time ground fault overcurrent function
	BFP	breaker failure protection
	RTS	runtime supervision

All the functions of the basic versions can be applied in any combination providing the maximum capacity of the processor and the number of analog channels is not exceeded.

The basic versions with the longitudinal differential function include the additional 316EA62 board and another back plate.

Table 35: Definitions of the relay ID codes in Table 34

Sub code		Significance	Description	Remarks
A-	A0 A1 A2 A5	none 1 A 2 A 5 A	rated current	state
B-	B0 B1 B2 B5	none 1 A 2 A 5 A	rated current	state
C-	C0 C1 C2 C5	none 1 A 2 A 5 A	rated current	state
D-	D0 D1 D2 D5	none 1 A 2 A 5 A	rated current	state
U-	U0 U1 U2	none 100 V AC 200 V AC	rated voltage	state
K-	K01	3 VTs (3ph star Code U-) 3 CTs (3ph Code A-)	VT, CT and MT combination in input transformer unit type 316GW61	see previous table
	K03	3 VTs (3ph star Code U-) 3 CTs (3ph Code A-) 1 CT (1ph Code A-) 1 CT (1ph Code A-)	CT = current transformer VT = voltage transformer MT = metering transformer	
	K04	3 VTs (3ph star Code U-) 1 VT (1ph Code U-) 3 CTs (3ph Code A-) 1 CT (1ph Code A-) 1 MT (1ph Code B-)	K01 to K14: without differential function K15 to K20: with differential function	
	K05	3 VTs (3ph star Code U-) 1 VT (1ph Code U-) 3 CTs (3ph Code A-) 1 CT (1ph Code A-) 1 CT (1ph Code A-)		
	K08	3 VTs (3ph star Code U-) 1 VT (1ph Code U-) 1 VT (1ph Code U-) 3 CTs (3ph Code A-) 1 CT (1ph Code A-)		
	K09	3 VTs (3ph star Code U-) 1 VT (1ph Code U-) 1 VT (1ph Code U-) 3 CTs (3ph Code A-) 1 MT (1ph Code B-)		
	K15	3 CTs (3ph Code A-) 3 not defined 3 remote CTs	optical link to the remote station	
	K16	3 CTs (3ph Code A-) 3 VTs (3ph star Code U-) 3 remote CTs	optical link to the remote station	

Ordering (cont'd)

Sub code		Significance	Description	Remarks
	K17	3 CTs (3ph Code A-) 1 VT (1ph Code U-) 1 VT (1ph Code U-) 1 MT (1ph Code B-) 3 remote CTs	optical link to the remote station	
E-	E1	8 optocoupler 6 signal. relays 2 command relays 8 LEDs	1. binary input/output unit Type 316DB61	see previous table
	E2	4 optocoupler 10 signal. relays 2 command relays 8 LEDs	1.binary input/output unit Type 316DB62	
	E3	14 optocoupler 8 signal. relays 8 LEDs	1.binary input/output unit Type 316DB63	
I-	I3 I4 I5 I9	82 to 312 V DC 36 to 75 V DC 18 to 36 V DC 175 to 312 V DC	1. binary input/output unit optocoupler input voltage	state
F-	F0	none		
	F1	8 optocoupler 6 signal. relays 2 command relays 8 LEDs	2. binary input/output unit Type 316DB61	see previous table
	F2	4 optocoupler 10 signal. relays 2 command relays 8 LEDs	2. binary input/output unit Type 316DB62	
	F3	14 optocoupler 8 signal. relays 8 LEDs	2. binary input/output unit Type 316DB63	
J-	J0 J3 J4 J5 J9	none 82 to 312 V DC 36 to 75 V DC 18 to 36 V DC 175 to 312 V DC	2. binary input/output unit optocoupler input voltage	state
Q-	Q0	none		
	Q1	8 optocoupler 6 signal. relays 2 command relays	3. binary input/output unit Type 316DB61	see previous table
	Q2	4 optocoupler 10 signal. relays 2 command relays	3. binary input/output unit Type 316DB62	
	Q3	14 optocoupler 8 signal. relays	3. binary input/output unit Type 316DB63	
V-	V0 V3 V4 V5 V9	none 82 to 312 V DC 36 to 75 V DC 18 to 36 V DC 175 to 312 V DC	3. binary input/output unit optocoupler input voltage	state

Sub code		Significance	Description	Remarks
R-	R0	none		
	R1	8 optocoupler 6 signal. relays 2 command relays	4. binary input/output unit Type 316DB61	see previous table
	R2	4 optocoupler 10 signal. relays 2 command relays	4. binary input/output unit Type 316DB62	
	R3	14 optocoupler 8 signal. relays	4. binary input/output unit Type 316DB63	
W-	W0 W3 W4 W5 W9	none 82 to 312 V DC 36 to 75 V DC 18 to 36 V DC 175 to 312 V DC	4. binary input/output unit optocoupler input voltage	state
Y-	Y0 Y1 Y2 Y3 Y4 1)	no comm. protocol SPA IEC 60870-5-103 LON MVB (part of IEC 61375)	Interbay bus protocol	
N-	N1 N2	casing width 225.2 mm casing width 271 mm		see previous table
M-	M1 M5 1)	Semi-flush mounting Surface mounting, standard terminals		Order M1 and separate assembly kit for 19" rack mounting
S-	SA000 to SO990	basic versions REL316*4 without differential function	Different versions of functions	see previous table
	SP000 to SQ990	basic versions REL316*4 with differential function		
	SZ990	order not acc. to Data Sheet		
T-	T000 T001x to T999x	without FUPLA logic FUPLA logic	Customer-specific logic x = version of the FUPLA logic	Defined by ABB Switzerland Ltd
	T129x	Logic for single-phase autoreclosure for line differential protection		
	T141x	Logic for single-phase autoreclosure for the distance protection with a 1½-breaker scheme		
	T142x	Logic for single-phase autoreclosure for a reclosure unit with a 1½-breaker scheme		

1) MVB interface (for interbay or process bus) not applicable for surface-mounted version.

The order number has been defined for the basic version as above and the required accessories can be ordered according to the following Table.

Ordering (cont'd)

Table 36: Accessories

Assembly kits

Item	Description	Order No.
	19"-mounting plate for hinged frames, light-beige for use with:	
1	1 REL316*4 (size 1 casing)	HESG324310P1
2	2 REL316*4 (size 1 casing)	HESG324310P2
3	1 REL316*4 (size 2 casing)	HESG324351P1
4	1 REL316*4 and 1 test socket block XX93, Test adapter and accessories:	HESG324310P3
5	Semi-flush test socket block for Item 4	XX93/HESG112823R1
6	Test kit including 19" mounting plate to fit 1 REL316*4 in a hinged frame	316TSS01/HESG448342R1
7	Test kit[1] for semi-flush panel mounting	316TSS01/HESG448342R3
8	Test kit[1] for surface mounting	316TSS01/HESG448342R11
9	Test socket block for surface mounting	XX93/HESG112823R2
10	Connecting cable XX93/XS92b for use with Items 5 and 9	YX91-4/HESG216587R4
11	Test plug with 4 mm terminals for use with test set 316TSS01	RTXH24/RK926016-AA
12	Connecting cable for XS92b with 4 mm terminals for use with test plug RTXH24	YX91-7/HESG216587R7
13	1 REL316*4 size 1, surface mounting kit	HESG448532R0001
14	1 REL316*4 size 2, surface mounting kit	HESG448532R0002

[1] A test kit Type 316TSS01 comprises:
- casing for semi-flush or surface mounting
- test socket block RTXP24.

PCC card interface

Type	Protocol	Connector	Optical fiber*	Gauge **	Order No.
For interbay bus: PCCLON1 SET	LON	ST (bajonet)	G/G	62,5/125	HESG 448614R0001
500PCC02	MVB	ST (bajonet)	G/G	62,5/125	HESG 448735R0231
For process bus: 500PCC02	MVB	ST (bajonet)	G/G	62,5/125	HESG 448735R0232

RS232C interbay bus interface

Type	Protocol	Connector	Optical fiber*	Gauge **	Order No.
316BM61b	SPA	ST (bajonet)	G/G	62,5/125	HESG448267R401
316BM61b	IEC 60870-5-103	SMA (screw)	G/G	62,5/125	HESG448267R402
316BM61b	SPA	Plug/plug	P/P		HESG448267R431

* receiver Rx / transmitter Tx, G = glass, P = plastic **optical fiber 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.

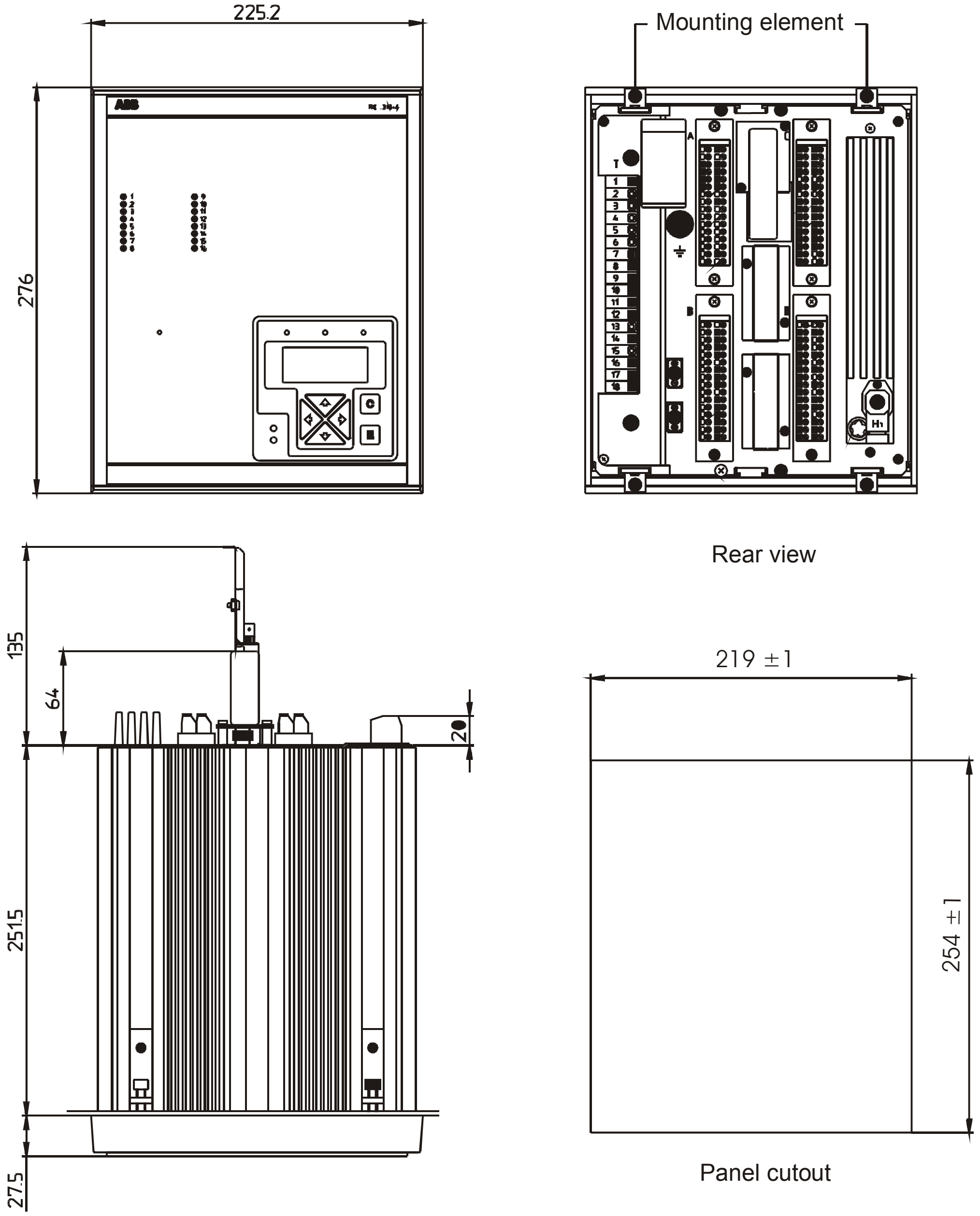
Optical fiber PC connecting cable

Type	Order No.
500OCC02 communication cable for device with LDU.	1MRB380084-R1

Disturbance recorder evaluation program

Type, description				Order No.
REVAL English	3½"-Disk			1MRK000078-A
REVAL German	3½"-Disk			1MRK000078-D
E_wineve	English/German	(Professional)	Single-licence	1MRB260034R0011
E_wineve	English/German	(Expert)	Single-licence	1MRB260034R0021
E_wineve	English/German	(Professional)	Multy-licence	1MRB260034R0012
E_wineve	English/German	(Expert)	Multy-licence	1MRB260034R0022

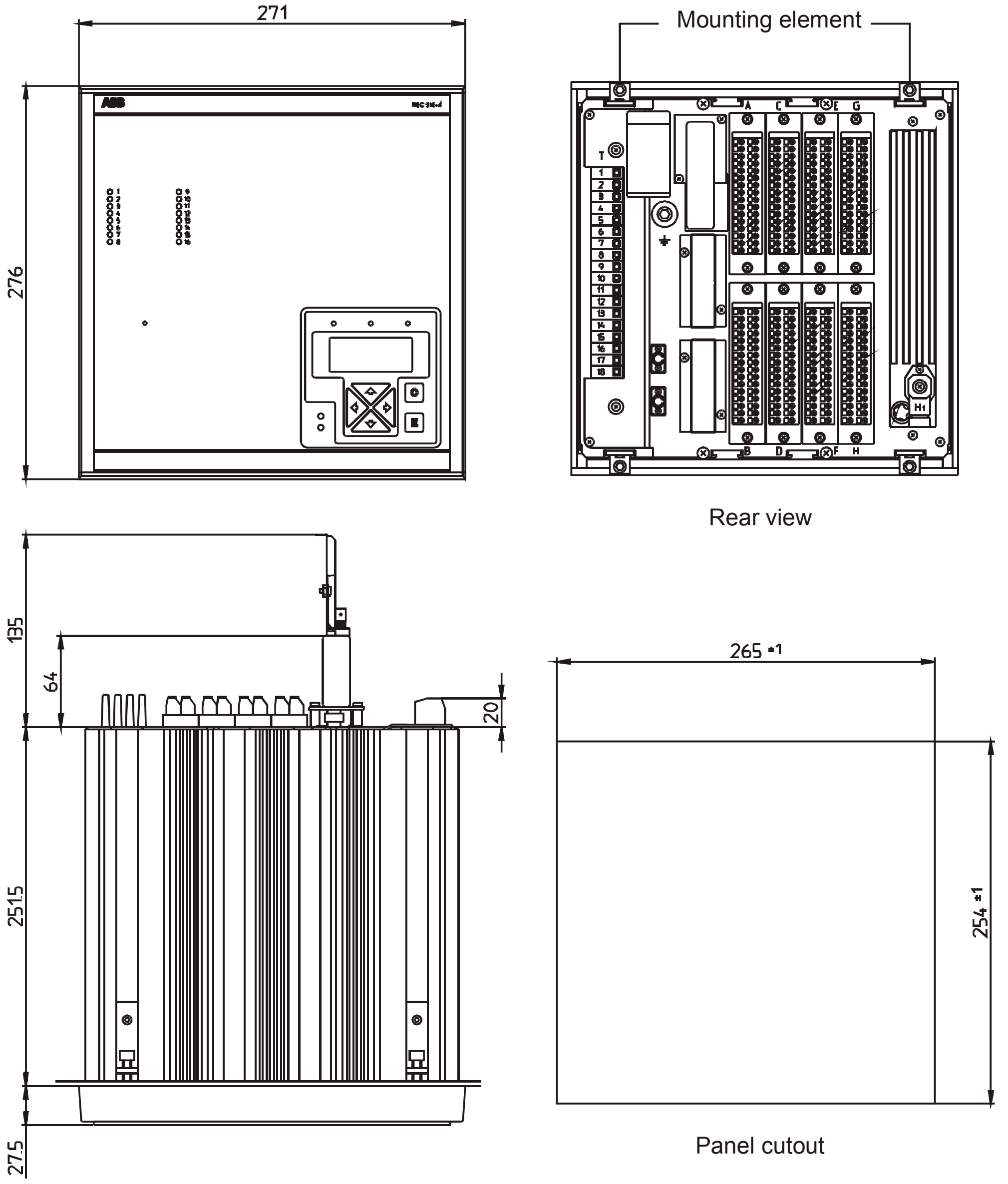
Dimensioned drawings



T = Instr. transformer inputs
cross section = 4 mm^2
A to D = Commands, input and output signals
cross section = 1.5 mm^2
H1 = Auxiliary voltage

Fig. 10 Semi-flush mounting, rear connections. Size N1 casing.

Dimensioned drawings (cont'd)



T = Instr. transformer inputs
cross section = 4 mm^2
A to H = Commands, input and output signals
cross section = 1.5 mm^2
H1 = Auxiliary voltage

Fig. 11 Semi-flush mounting, rear connections. Size N2 casing

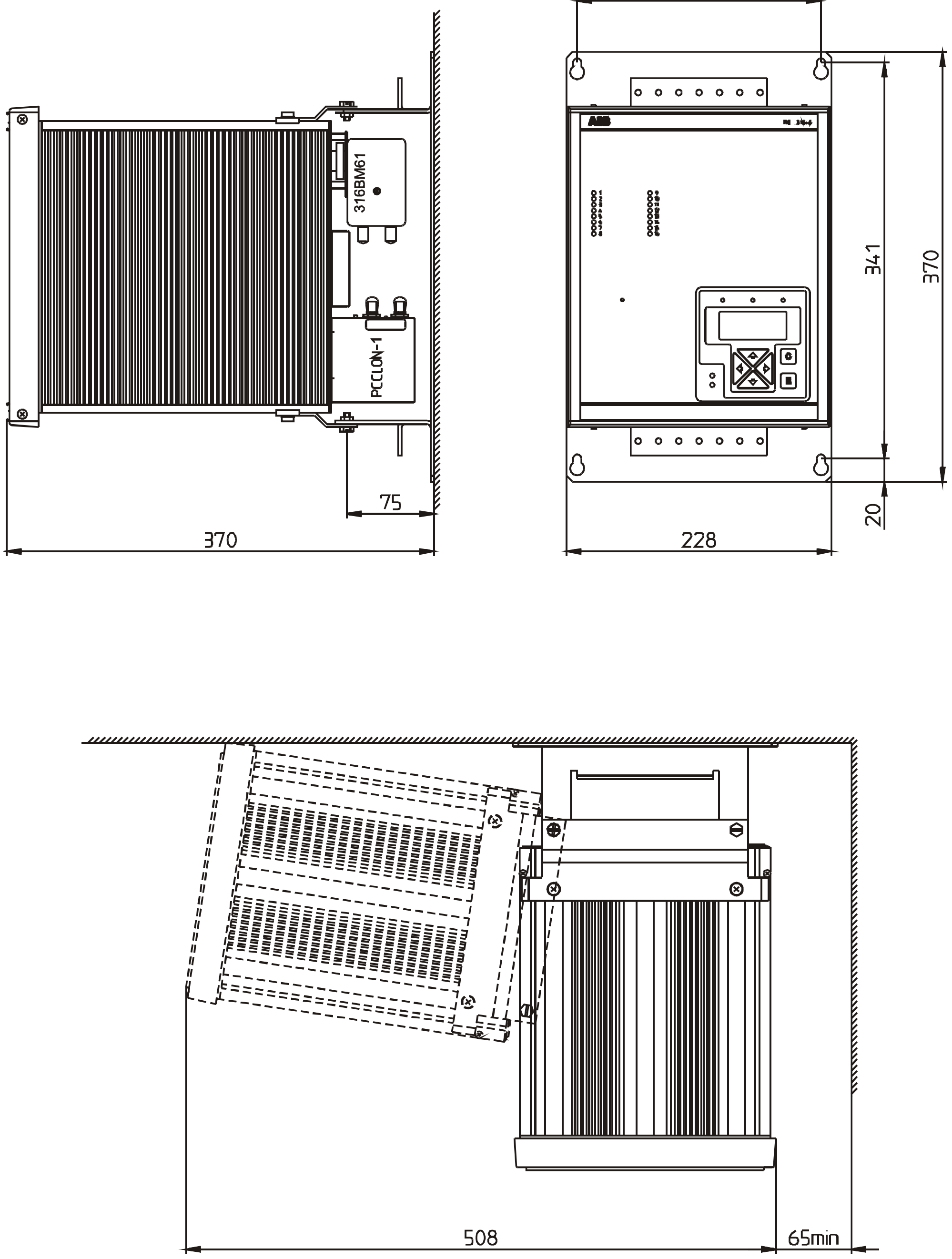


Fig. 12 Surface mounting, casing able to swing to the left, rear connections. Size N1 casing

Dimensioned drawings (cont'd)

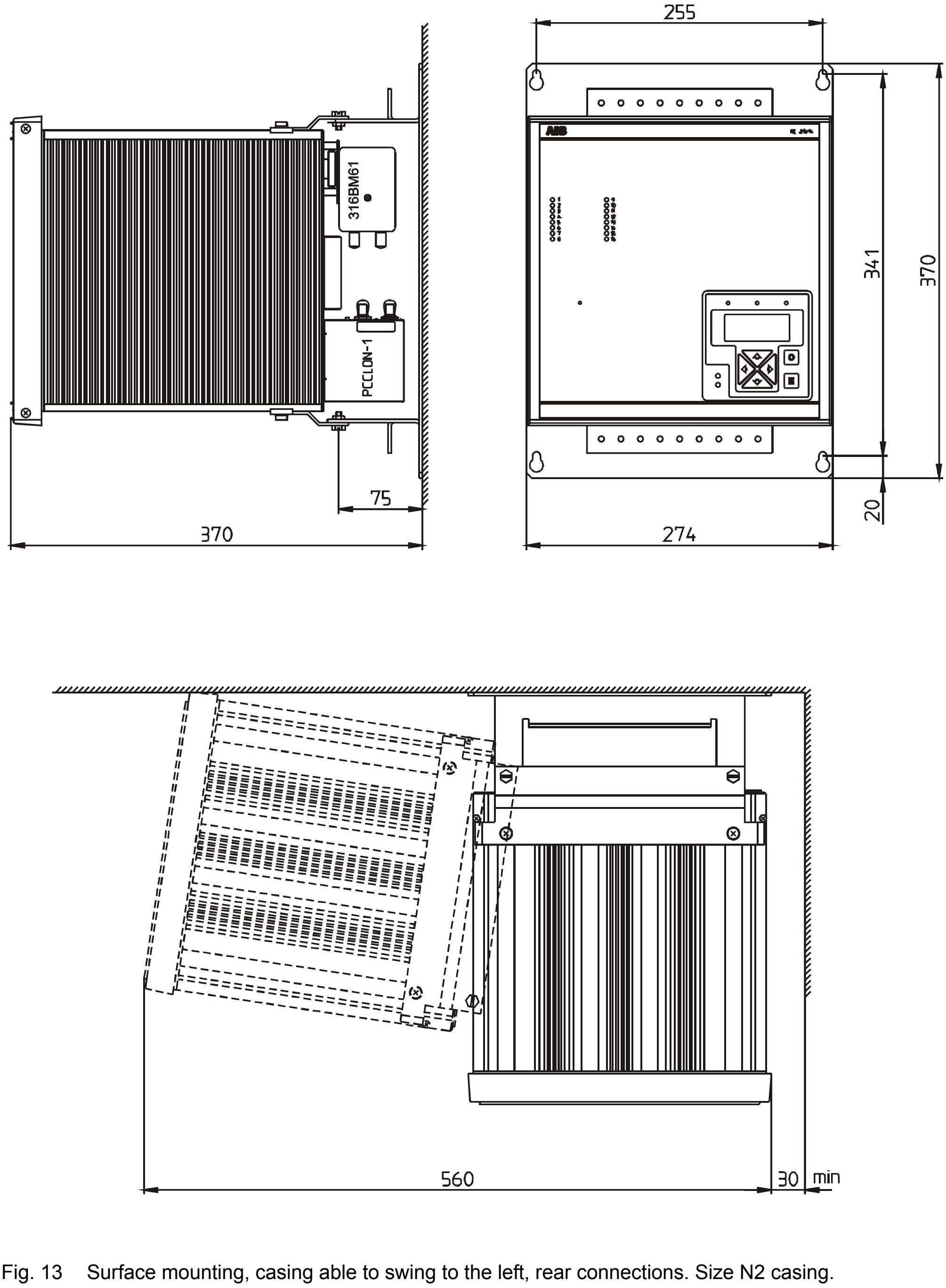


Fig. 13 Surface mounting, casing able to swing to the left, rear connections. Size N2 casing.

Example of an order

- Rated current 1 A, rated voltage 100 V AC
- 3-phase voltages, 3-phase currents, 1 neutral current
- 110 V DC aux. supply
- 4 heavy duty relays (3 tripping, 1 CB closing), 20 signalling relays
- 8 optocoupler inputs (110 V DC)
- 1 relay for 19" rack mounting
- Distance protection function (Z starters with provision for all transfer tripping schemes)
- Autoreclosure
- Communication with the station control system (e.g. LON)
- Operator program on CD.

The corresponding order is as follows:

- 1 REL316*4, HESG448750M0001
- 110 V DC aux. supply
- Optocoupler input voltage 110 V DC
- Rated current 1 A
- Rated voltage 100 V AC
- 1 mounting kit HESG324310P1
- 1 electro-optical converter HESG448267R401
- 1 CD RE.216 / RE.316*4 1MRB260030M0001
- 1 PC connecting cable (if not already available) 1MRB380084-R1.

Alternatively, the relay ID code may be given instead. In this case the order would be:

- 1 REL316*4, A1B0U1K03E2I3F2 J3Y1N1M1SK100T0
- 1 mounting kit HESG324310P1
- 1 CD RE.216 / RE.316*4 1MRB260030M0001
- 1 electro-optical converter HESG448267R401
- 1 PC connecting cable (if not already available) 1MRB380084-R1.

Relay ID codes are marked on all relays. The significance of the sub-codes can be seen from Table 35.

Example of a specification

Numerical line protection terminal with extensive self-supervision of the internal functions and A/D conversion of all input variables. The terminal shall be suitable for the protection of single and double-circuit lines and cables in solidly or low-impedance grounded systems, ungrounded systems and systems with Petersen coils. It shall be capable of detecting all kinds of power system faults including close three-phase faults, cross-country faults (in ungrounded systems or systems with Petersen coils), evolving faults and high-resistance ground faults. Due account shall be taken of power swings and changes in the direction of energy flow.

The distance protection terminal shall have at least three distance zones with independent settings and in addition zones of measurement for all the usual transfer tripping schemes. Provision shall be made for compensating the mutual impedance in the case of parallel circuit lines using the neutral current of the parallel circuit to obtain a correct setting. The integrity of the VT circuit shall be supervised.

The longitudinal differential protection terminal shall measure the three phases independently and permit other protection signals to be transmitted via the same communications channel. Provision shall be made for the combination with a distance protection scheme, a directional ground fault scheme and back-up functions.

The protection functions shall be in the form of software such that additional or different functions, i.e. power swing blocking, sensitive ground fault, overcurrent, thermal overload, single or three-phase autoreclosure, application-specific logics etc., can be readily implemented without changes to the existing hardware. All configuration and setting operations shall be made using a menu-based operator program running on a PC connected locally to the terminal for the purpose.

The assignment of input and output signals to the protection functions shall be possible largely without restrictions. An event recorder with fault locator function shall be provided.

The data exchange between the control system and the station control system shall be ensured via a communication interface. The data connection itself shall be able to be designed with fiberoptic conductors.

Other relevant documents

Operating Instructions REL316*4 (printed)	1MRB520050-Uen
Operating Instructions REL316*4 (CD)	1MRB260030M0001
Operating Instructions Testing program using XS92b	CH-ES 86-11.52 E
Data Sheet CAP316	1MRB520167-Ben
Data Sheet Test Set XS92b	1MRB520006-Ben
Reference List REL316*4	1MRB520212-Ren
Description Current transformer requirements	CH-ES 45-12.30 E
Data Sheet SigTOOL	1MRB520158-Ben
Data Sheet RIO580	1MRB520176-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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