



Digital Distance Protection DD 2, DDS 2 and DDSE 2

1 Application

The DD 2, DDS 2, and DDSE 2 digital distance protection devices are preferably used as selective protectors for single- and double-fed lines (overhead lines and cables) in the medium-voltage or, respectively, the lower high-voltage range. They are suitable for all important system configurations (radial, ring, and meshed systems), methods of neutral-point connection (earthed with or without limiting resistance grounded, inductive, insulated) as well as for all positions of current transformer grounding (line or busbar end).

The most comprehensive type of the distance protectors, the DD 2, features - apart from the current starting - a sensitive impedance starting whose characteristic curves enable the user to differentiate - even in difficult cases - between load and short circuit.

The DDSE 2 is equipped with an internal, wattmetric directional earth-fault detection feature that enables it to be used preferably in compensated or insulated systems.

Other significant applications are

- back-up protection for transformers,
- both main and back-up protection for busbars as well as
- back-up protection for lines with phase comparison protection as the main protection.

2 Main characteristics

- Due to its compact design it can also be mounted into low-depth switchgear cells.
- The integration of other protective functions will mostly make it unnecessary to use additional protective equipment.

- A number of supplementary functions such as event and disturbance data logging as well as fault location guarantee a modern subsequent diagnosis and documentation of equipment operations and faults occurred in the system.
- Measures to increase the reliability and availability include - among other things - a comprehensive program of self-diagnostic functions as well as callable tests.
- The distance protectors are suitable for modern I&C¹ switchgears (substation control system interface) as well as for traditionally operated systems.
- Selection of rated current (1 or 5 A) is easy by terminal connection.
- Useful features in connection with AR and signalling of breaker tripping are integrated.
- The DDS 2 represents a very reasonably priced type of a distance protector.
- In the DDSE 2, the wattmetrical directional earth-fault detection supplies additional information on the reliability of direction.
- To simplify preparations for use, a delivery configuration was chosen (selection of protective functions and function assignment of optocoupler inputs, output relays and displays) which is directly suitable for a number of operations. Then, operator actions during the preparatory works are mainly limited to the entering of settings.

- Additionally, the setting and configuration options guarantee the adaptation to practical field conditions.

3 Design

The distance protectors are housed in a sheet-steel enclosure in the following designs:

- panel surface-mounting
- panel flush mounting.

For both versions, the low depth of 140 mm allows the installation into medium-voltage switchgear cells.

For panel surface mounting, the terminals can be accessed from the front panel, whereas for panel flush-mounted units they can be accessed from the rear side.

The front operator panels of both versions are equal. They include the membrane keyboard, a four-line LCD display of 20 characters per line, 12 LED's and a 9-pin Sub-D connector for plugging in a PC.

The optional IEC 60870-5-103 interface is available in two physical designs: optical fibre connection or RS485 twisted-pair wire. The optical fibre interface has two connectors for the transmission and reception direction. It is located in the upper level of the terminals. The alternative RS485 wire interface uses terminals.

4 Protective functions

4.1 Distance protection

4.1.1 Overcurrent starting

Overcurrent starting is phase-selective. With earth-fault current starting, stabilisation of the pickup value prevents faulty startings at the most sensitive setting.

¹ I&C: instrumentation and control for substations

4.1.2 Underimpedance starting in the DD 2

The characteristic of the underimpedance starting consists of three sub-areas.

1. circular area $Z < Z_{\text{setting}}$
2. starting sector in forward direction with the settings $X_f, \varphi_1, \varphi_2$
3. starting sector in reverse direction with the settings $X_r, \varphi_3, \varphi_4$

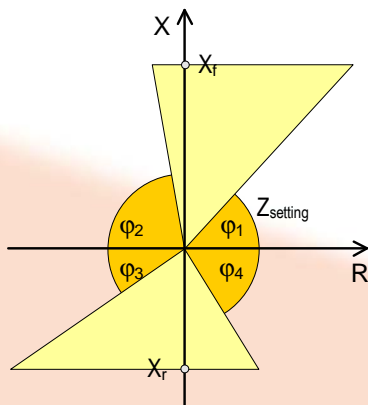


Fig. 1: Characteristic of underimpedance starting of the DD 2

Underimpedance starting is only available in the DD 2.

4.1.3 Loop selection

Some principles:

- Overcurrent starting has priority over underimpedance starting (DD 2).
- The phase-to-earth loop is selected in the following cases
 - in compensated and insulated systems with earth-fault current starting,
 - in grounded systems with earth-fault current or residual voltage starting.
- It may be chosen whether, in the event of multi-pole starting, the loop is selected according to the lowest voltage, or according to a fixed selection program, where in turn several options are available.
- It may be chosen whether, in the event of single-pole starting, the loop should be generated with either the leading or the lagging phase.
- In the as-delivered configuration (adjusted to compensated/ insulated systems), in the event of multiple starting, a fixed selected program is run with the acyclic phase priority L3 before L1 before L2, and, in the event of single-pole phase-current starting, the cyclically following phase is started additionally.

4.1.4 Distance and direction decision

The direction decision is based on 90° switching, in which the phase-to-phase loop selection is based on the difference of the other two phase-to-phase voltages.

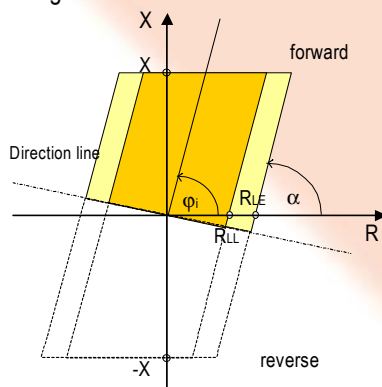


Fig. 2: Characteristic of distance stage

In case of the triple-pole, short-line fault (3-pole $I >$ and 3-pole $U_{LL} < U_{min}$) the direction decision is made by use of the voltage memory U_{23}, U_{31} and the current I_{12} .

Fig. 2 shows the characteristic of the distance stage, where the following adjustments are possible:

- angle α , common to all stages,
- R_{LL}, R_{LE} , separately for each stage,
- forward or reverse direction, separately for each stage.
- characteristic angle φ_i perpendicular on direction line.

Time grading stages are provided as follows:

- the impedance stages $Z_{11} t_{11}, Z_{12} t_{12}, Z_2 t_2, Z_3 t_3, Z_4 t_4$,
- the directional time limit stage t_5 ,
- the non-directional back-up time stage t_6 ,
- the impedance stages $Z_{11} t_{11}$ and $Z_{12} t_{12}$ can be operated as overreaching stages with the overreach factors f_{11} or f_{12} .

The overreaching stages are provided for the combined operation with the functions "auto-reclose", "signal comparison" and, if applicable, "switch-on-to-fault protection".

The as-delivered configuration uses the overreaching stage $Z_{11} t_{11}$ with f_{11} jointly for auto-reclose and signal comparison. $Z_{12} t_{12}$ (f_{12}) has to be configured, if needed.

4.2 Auto-reclose AR (Option)

The as-delivered configuration includes a one-time automatic reclose with a short open time.

With reconfiguring the number of reclosure attempts can be increased to $n=5$. The first open time can either be "short (Rapid Reclose)" or "long (Delayed Reclose)". All following open times are always long.

To adapt to traditional switchgears, the break contact of an output relay in the as-delivered configuration is used to interrupt the breaker-tripping signal in the event of the "non-final trip command". Another relay contact closes for short periods, if the intended "CLOSE command" is not issued, for example, due to auto-reclosure blocking in the meantime. As a result, the previously suppressed breaker tripping impulse can be simulated afterwards.

Furthermore and with the appropriate setting, it is possible to run an AR selectively on a mixed line of an open line sector (cable and overhead line sector). The protective function "AR" may be switched on or off by I&C-telegram or by using optocoupler inputs (DDS(E)2).

4.3 Teleprotection method

In the as-delivered configuration, the protectors enable a signal comparison with the remote station through a two-wire-signal loop, which is supplied by a battery voltage of a station where the break contacts of the transmitting relays and the optocoupler inputs of both distance relays are arranged in series.

Reconfiguration enables the adjustments indicated below:

- Reverse interlock, i.e., shortened TRIP command time, if the response of protective devices on the relative outgoing feeders is missing.
- When applying teleprotection devices, there are different options:
 - unidirectional operation,
 - permissive overreach protection
 - and blocking overreach protection.
- Intertripping in weak infeeds.
- With the optional coupling to the substation control system, the "teleprotection" protective function may be switched on or off by use of a telegram.

4.4 Switch-on-to-fault protection

This protective function guarantees the quickest final trip command, if a short-circuit should occur in the event of a "manual CLOSE" of the assigned circuit breaker. It may be chosen whether just "general starting" or, in addition, a distance condition should be fulfilled.

4.5 Earth-fault detection

4.5.1 Phase-selective earth-fault detection

In the as-delivered configuration, the distance protector is prepared to be used in compensated or insulated systems, and therefore, a stage for phase-selective earth-fault detection is activated.

4.5.2 DDSE 2 earth-fault direction

The DDSE 2 detects the active and the reactive power and therefrom, depending on the type of system (insulated or compensated), the earth-fault direction. It is a new feature of each DDSE 2 that it can adapt its sensitivity to an optimum value depending on the earth-fault location and the earth-fault resistance. To do so, the power operate value is increased or decreased by a variable factor. A direction decision is taken, if the given power P is higher than the setting $P >$ divided by the factor. This results in a very high reliability of the direction decision also.

4.5.3 Solution for earth-fault direction in the DD 2 and DDS 2

For directional-selective earth-fault detection in the DD(S) 2 it is recommended to use the affordable and high-performance directional earth-fault relay ERER 3 of EAW Relaisstechnik GmbH. The direction decision of ERER 3 is to be supplied through its "forward" and "reverse" output contacts to two enabled DD(S) 2 optocoupler inputs. Further processing concerning the decision on the directional earth-fault (event logging, information on control systems) is then given within the scope of a homogeneous internal function group.

4.6 Directional zero power time protection

In earthed-neutral systems, especially in such with earth-current limits, the directional zero power protection is often used. In the DDx 2 this protective function is available and runs with an exclusive starting of the earth current and displacement voltage.

4.7 Emergency overcurrent time protection

This protective function is automatically activated, if

- the monitoring of measured quantities detects a malfunction in the voltage path,
- a fuse failure in voltage path, or
- all of the distance stages are switched off by manual activation.

The emergency overcurrent time protection includes the overcurrent time stages for the three phase currents and for the earth current that can be separately adjusted. It is available in the as-delivered configuration.

4.8 Input signal processing

The input signals wanted for the different protective and additional functions are freely programmable; several inputs for one function may be used. Processing the optocoupler input signals, the logic functions negation (NOT), AND, OR are available. As a result, there are logical input signals for internal processing in the protector.

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4.9 Pulse shaper stage

This stage is preferably used to perform the following special tasks:

- in and output coupling: activation of a selectable visual display or an output relay through an input signal which can be modified optionally in time characteristics (also latching see Fig. 3), or can be extracted from the logic operation of several input signals.
- Blocking of protective functions.

The pulse shaper stage has two ports functioning independently of each other. For instance, the pulse shaper stage may be used for building a simple power swing blocking.

In the as-delivered configuration the pulse shaper stage is not activated.

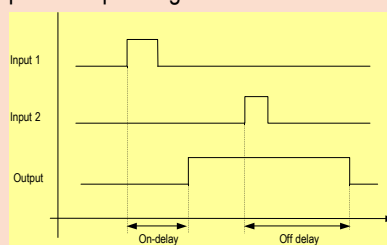


Fig. 3 Example for one effect of the pulse shaper stage

4.10 Change of characteristic sets

Three characteristic sets may be entered. The respectively active set can be selected by an operator action or by

command from the substation control system. Changing the configuration allows to switch between the characteristic sets using the optocouplers.

4.11 Circuit-breaker failure protection

This protective function is not included in the as-delivered configuration of the distance protector, but it can be selected. This protective function contains two subfunctions:

- Failure detection of its own assigned circuit breaker. The trip command starts the time stage t_{CBF} . During its running time the current in all phases must be below the minimum value. If this is not the case, an output relay to be configured will be started, preferably controlling a contactor whose main contact is able to break the trip coil circuit of the assigned circuit breaker. The additional contactor contacts are needed for output of the breaking command to the protective relays located in the incoming feeders.
- Trip demand in the protective relays of the incoming feeders by arrival of the above mentioned signal. There, additional conditions may still be set to realise the trip command.

5 Additional functions

5.1 Display of operating values

Three programs to display the operating values can be selected:

1. The three phase currents and the three phase-to-phase voltages.
2. The three phase currents and the three earth-to-phase voltages.
3. The three-phase active, reactive and apparent power.

The selection of the operating value range comprises:

- as primary quantities in kA, kV, MW or MVA_r,
- as secondary quantities referred to the secondary nominal value.

The current and voltage values will be updated about every 2 s, the power values about every 5 s.



5.2 Visual display of system faults

For a first short information concerning a system fault, 12 light emitting diodes (LED's) and a four-line display with 20 characters each per line are available.

The LED display may be shown either in steady light or flashing light, while the flashing light dominates.

The LED display as delivered in the standard configuration is shown in Table 1. As an output command can be derived practically from each sub-function of the DDx 2, the LED assignment can be changed within wide limits by changing the configuration.

The four-line LCD text display shown after a "final TRIP" command includes the following information:

- tripping reason, expressed by short symbols,
- period of fault (relative time until TRIP command),
- loop selected for distance measurement,
- r.m.s. value of current in the individual phases at the time of the TRIP command output,
- fault location in km

It should be considered that this LCD report is only used as first information after a "final TRIP". Information that is more detailed can be found in the event and disturbance data memories of all relays started.

LED	steady light		flashing light
green G	protection available	u	—
red R	alarm	l t	malfunction t
yellow 0	TRIP non-final	l	TRIP final t
yellow 1	$I_1 >$	l	$I_1 >_{OTP}$
yellow 2	$I_2 >$	l	$I_2 >_{OTP}$
yellow 3	$I_3 >$	l	$I_3 >_{OTP}$
yellow 4	$I_E >$	l	$I_E >_{OTP}$
yellow 5	current on	u	—
yellow 6	AR: cycle on	u	switch-on-to-fault protection
yellow 7	forward	l	earth-fault forward
yellow 8	reverse	l	earth-fault reverse
yellow 9	earth-fault	u	—

Table 1: LED assignment on delivery for DDSE 2

(abbreviations are as follows:

- u: updating l: latching
t: additional indication on LCD)

5.3 Event logging

Event logging is used to make a follow-up analysis of what happened in the protective object and in the protective relays.

To achieve a better survey, the events are divided into the following groups:

- system faults,
- indications,
- operator actions and
- internal malfunctions and alarms.

Moreover, it can be seen whether the events occurred during

- normal, or
- test operation.

The division into

- main and
- subevents

supports the temporal classification.

Main events are numbered and time-stamped. Subevents contain the time in ms relative to the assigned main event. The event memory is a shift memory whose oldest events are overwritten.

The content of the event memory can be selected and displayed on the front panel without using a PC.

The installed back-up battery preserves the event memory content even if the supply voltage fails.

Distance protectors using a serial interface as connection to the system control satisfy the IEC 60870-5-103 requirements concerning event logging.

If displayed in PC operating program, disturbance data related to the main event "system faults" can be detected from the event memory.

5.4 Disturbance data logging

Disturbance data logging includes the storage of the digital instantaneous values of measured quantities as well as significant reactions of the distance protector such as starting, TRIP command, etc.

Disturbance data logging is done as follows:

- for systems faults by starting of the protector,
- for non-started protectors via a function key on the front panel
- for non-started protectors via a binary input signal that can be config-

ured. (not configured in the delivery state)

The maximum logging time for a fault or an externally generated logging is 3.6 s. Four faults of maximum length can be stored.

In case of a system fault a continuous logging from starting "coming" to "going" including a 50 ms set-up time (pre-travel) and a 150 ms overshoot time is performed.

The disturbance data logging invoked by the input signal is a record that includes the period of the input signal.

Key-initiated disturbance data logging is always a continuous record of maximum length.

The stored disturbance data can only be visualised on a PC screen using PC operating and SDA programs.

The disturbance data memory is also designed as a shift memory overwriting the data of the oldest main event.

The installed back-up battery preserves the content of the disturbance data memory if the supply voltage fails.

5.5 Fault localisation

Faults are localised after every "final TRIP" of the distance protector by processing the resulted values from the fault loop selected for distance measuring. Fault localisation determines:

1. the primary fault reactance X_p in Ω ,
2. the distance of fault location l_F in km,
3. the fault distance in percent $l_p = l_F \cdot 100 / l_{100}$.

The result output of the fault localisation includes:

- Entry of the result values into the event memory.
- Additional LCD text display after a "final TRIP" by indicating the primary fault reactance X_p .
- Summary of the real-time information with X_p for the control system.

In types DDS(E) 2 it is tried to find the fault place by the protection also in the case of a starting without tripping.

5.6 Time synchronisation

Beside the default time synchronisation by I&C it is possible to set the time 12:00:00 by an optocoupler input signal.

6 Test functions

6.1 Automatic self-tests

The software of the distance protectors includes a comprehensive package of automatic self-tests. They comprise:



- Self-test on start-up.
A distinction is made between a large and a small start-up test.
 - The large start-up test (cold start) is triggered
 - * on first start-up,
 - * after low voltage of the internal back-up battery,
 - * on restart after a malfunction,
 - * after software reset caused by an operator action.
 - In all other cases, the small start-up test is carried out to make sure that the distance protector is ready to run again within a short time, for example, on reset after a short supply voltage collapse in the event of a large-scale breakdown.

- Cyclic self-test
- The scope of the cyclic self-test corresponds approximately to that of the large start-up test. The cycle time depends on the relevant activity of the distance protector and may last several minutes.
- The measured value check enables the identification of faults in the current or voltage circuit. If a fault is detected in the voltage circuit, the functions "impedance starting", "direction decision", "distance measuring" and "fault localisation" will be blocked immediately, and the "emergency definite-time overcurrent protection" is activated.

Depending on the non-standard operation identified by the self-monitoring function, either the protector will be stopped and a "malfunction" indicated, or the protector continues to operate while issuing an "alarm".

6.2 Callable tests

To test the break and make circuits of the circuit breaker, an auto-reclosing test operation may be performed. This function is activated by pressing the "Tests" key on the DDx 2 or by applying a special input signal. If an auto-reclosure is impossible, this function may work as trip test.

Information concerning the device and the processing of measured quantities can be obtained by use of a disturbance data logging while a function key is operated at the protector.

6.3 Use of test plug devices

To check the installed distance relays regularly, many power supply companies use test plug devices or test selector switches which cause a safe switch

over from the measured quantities of the system to the test devices. The "TRIP" command to the circuit breaker is also included in the switch over. When the "test mode" is established, the test plug device or the test selector switch must provide a binary signal for one optocoupler input of the distance relay.

6.4 Numerical test equipment

Using the PC operating program, the set distance characteristics can be displayed in the RIO format (relay interface by QMICRON), so that they can be taken over into an appropriate test device.

7 Interfaces

Out of the 74 supply terminals available up to 70 terminals are assigned with

- current and voltage circuit,
- inputs of up to 9 optocouplers,
- contact outputs of the 4 trip relays available in total,
- contact outputs of up to 8 signal relays,
- input of the supply voltage.

The front 9-pole Sub-D connector constitutes the interface S0 for the operator PC.

The IEC 60870-5-103 interface S1 for connection to the substation control system is available as an option. The optical fibre variant is a point-to-point connection while the RS485 is a twisted-pair half-duplex connection (several devices may be connected).

8 Operation

8.1 Front panel

The following operations can be executed on the front panel:

- Reading and resetting of LED's and display provided automatically by the relay including the following:
 - operating value display during normal operation,
 - LCD report after a "final TRIP" command of the protector,
 - LCD report after switching off the protector and because of an internal malfunction.
 - In case of an alarm, the operating values and the alarms are displayed.
- Setting of the protector
Pressing the password-protected "Setting" key displays an easily comprehensible plain-text menu comprising the following main items:

- *Equipment adaptation* - data concerning the installation and the system,
- *Protective functions* - switching the protective and additional functions on or off,
- *Input configuration* - free assignment and logic combination of optocoupler input signals to device software functions,
- *Output configuration of relays and LED's* - free assignment of the possible output commands to trip relays, pilot relays and LED's, this can generate group signals,
- *Characteristic sets* - setting values for the selected protective functions are separately adjustable for three characteristic sets,
- *Device address*,
- *Operator control* - settings such as date, time, password, protector on/off, operating mode of device, e.g., parameter of the serial interfaces S0 or S1

Note

With the protector's standard delivery settings, in most cases only the characteristic sets have to be adjusted before the device is used in compensated or insulated systems. However, this delivery setting does not reduce in any way the variety of the setting and configuration options.

- Display of stored information
After pressing the "Readout" key the stored information may be indicated on the display:
 - logged events (with running time),
 - all settings,
 - information on the protector type, hard and software version.As the key is not password-protected and the information selection is shown in a plain-text menu, it is easy to get a local readout.
- Calling of tests
Pressing the "Tests" key accesses a menu used for the circuit breaker and the manufacturer's service. The menu is password-protected.

8.2 Control by PC

Although no PC software is necessary for setting and readout of the protection device a PC operator routine COMM-3 and graphic software SDA 2 is available. It is used for preparing and performing the setting of the digital protection relay at the engineer's place of work. In addition to setting the protec-



tors, the routine may also be used for reading out and displaying events and with the additionally graphics software SDA 2 disturbance data can be displayed. Archiving of settings and events is easy to do.

Graphic display and evaluation of disturbance data are by the graphics software featuring the COMTRADE file format (IEEE standard C37.1991). Using this file format data exchange may be performed between compatible devices such as state of the art test devices.

8.3 Control by I&C

The IEC 60870-5-103 interface of digital protectors to the I&C (substation control) equipment is optionally available. Regardless of the manufacturer, this interface supports the connection of protectors to correspondingly compatible I&C equipment.

The scope of signals and commands agreed upon by the compatibility class 2 is available.



9 Specifications

The protection relay satisfies the requirements of the product standards EN 60255-6 (IEC 255-6); DIN 57435, part 303; IEC 255-16.

Mechanical construction

- sheet-steel housing for
 - panel surface mounting
 - or panel flush mounting
- dimensions see Fig. 4 and Fig. 5
- weight approx. 6 kg / 6.6 kg
- degree of protection: housing IP 51
terminals IP 20
- terminals
 - transformers solid wire 0.5 ... 16 mm²
 - stranded wire 0.5 ... 10 mm²
 - others: solid wire 0.2 ... 4 mm²
 - stranded wire 0.2 ... 2.5 mm²

Permissible ambient conditions

- operating temperature -10°C...+55°C
- storage temperature -25°C...+55°C
- transport temperature -25°C...+70°C
- humidity rating, yearly mean value 75%
for 30 days <95% and 40°C
moisture condensation not permitted

Mechanical strength

- resistance to earthquakes (IEC 255-21-3)
 - nominal frequency range 1...35 Hz
 - cut-off frequency 8...9 Hz
 - horizontal 3.5 mm; 10 m/s²
 - vertical 1.5 mm; 5 m/s²
- vibration strain (IEC 255-21-1, IEC 68-2-6)
 - Fc: 10...150 Hz; 0.075 mm; 1g
- repeated impact strain (IEC 255-21-2, 68-2-27+29)
 - Ea: 11 ms; 15 g; Eb: 16 ms; 10 g

Auxiliary power supply

- U_H depending on design 24-65.5 V DC
or 60-137 V DC, 60-100 V AC
or 110-320 V DC, 100-240 V AC
- operating range 0.8-1.1·U_H
for 24-65.5 V - version: 0.84-1.1·U_H
- power consumption <20 W
- stored energy time in case of auxiliary power failure, based on nominal voltage
≥ 50 ms
- backup battery for event-data
3 V CR ½ AA lithium

Measuring input circuits

- nominal frequency 50 Hz
- current paths (different terminals)
 - rated current (I_n) 1 A / 5 A
 - load capability
 - permanent 4·I_n
 - 1 sec 100·I_n
 - limiting dynamic value (10 ms) 250·I_n
 - power consumption at I_n < 0.25 VA
 - DDSE 2: power consumption I_N at I_n < 0.4 VA
- voltage paths
 - rated voltage (V_n) 100 V, option: 110 V
 - load capability 1.5·V_n
 - power consumption at V_n < 0.3 VA

Binary signal inputs (optocoupler)²

- nominal input voltage (V_i) 24...220 V DC
- power consumption <4·10⁻⁴·(V_i)² W
- logic low level <10 V

Output relays

- trip relays (marked: S1... S4)
- switching voltage 300 V DC, 250 V AC
- limiting making capacity 2000 W (VA)
- limiting breaking capacity 50...250 W (voltage- and load dependent)
 - 0.25 A at 220 V DC, L/R = 0 ms
 - 0.15 A at 220 V DC, L/R = 40 ms
- both contacts in series:
 - 0.25 A at 220 V DC, L/R = 40 ms
- limiting continuous current 8 A
- limiting short-time current for 0.5 s 30 A
- pilot relays (marked M1... M8)
 - switching voltage 300 V DC, 250 V AC
 - switching current 8 A
 - switching capacity <2000 VA, 50...220 W (voltage- and load dependent)
 - limiting continuous current 6 A

Serial interfaces

- PC interface (RS 232)
 - front panel 9-pin Sub-D connector
 - electrical isolation 1.5 kV
- IEC 60870-5-103 interface optional
 - optical fibre connector F-SMA
 - optical wavelength 850 nm
 - distance < 1 km
 - permissible path attenuation < 8 dB
 - glass fibre 62.5/125 µm
 - idle position light on
 - or RS 485 half-duplex
 - unit load 1
 - electrical isolation 1.6 kV, 1 s
 - connection terminal

Displays

- LED's green: 1; red: 1; yellow: 10
- LC display four-line display of 20 alphanumeric characters each illuminated

Setting values and ranges (selection)

- number of switchable characteristic sets 3
- current starting
 - overcurrent stage I> 0.4...8·I_n
 - earth-fault current stage I_E> 0.1...2·I_n
 - resetting ratio
 - I> 0.95
 - I_E> 0.20...0.95
 - time t_{IE}> for I_E> 0...9.99 s
- underimpedance starting (see Fig. 1)
 - reactance X_f, X_r 10...400 Ω
 - impedance Z for circle 10...200 Ω
 - angle φ₁, φ₂, φ₃, φ₄ 20...80 °
- short-circuit direction decision
 - internal angle 10...80 °
 - voltage memory use 0.5...6 V
- zero power direction detection
 - selection of measured quantities U_{NE}, I_E

- internal angle 10...80 °
- earth-fault direction detection
 - operate value P> (Q>) 0.002...0.5 V_n·I_n
- distance stage (see Fig. 2)
 - angle α 45...90 °
 - time stages t₁₁, t₁₂, t₂, t₃, t₄, t₅, t₆ 0...12 s
for each stage Z₁₁, Z₁₂, Z₂, Z₃, Z₄
 - reactance X 0.05...150 Ω
 - resistance R_{LL}, R_{LE} 0.05...150 Ω
 - Z₁₁ / Z₁₂ stages additional
 - overreaching factor f₁₁, f₁₂ 0.01...9.99
- AR
 - number of reclosures 1...5
 - short open time 0.05...9.99 s
 - long open time 1...300 s
 - action time window 0.05...9.99 s
 - reclaim and blocking time 1...300 s
- definite-time overcurrent emergency protection
 - overcurrent stage I>_{OTP} 0.4...8·I_n
 - earth-fault current stage I_E>_{OTP} 0.1...2·I_n
 - resetting ratio
 - I>_{OTP} 0.95
 - I_E>_{OTP} 0.20...0.95
 - time stage t_I>_{OTP}, t_{I_E}>_{OTP} 0...9.99 s

Routine testing

- dielectric test 2.5 kV, 50 Hz, 1 s
exceptions: power supply 2.83 kV DC
RS485 1.6 kV, 1 s
- Each protection relay will be subjected to a 72-hour alternate temperature test while in function.

Type testing

- impulse voltage test 5 kV; 1.2/50 µs; 500 Ω
- dielectric test 2.5 kV, 50 Hz, 60 s
exceptions: power supply 2.83 kV DC
RS485 1.5 kV, 60 s
- PC interface depending on design 0 kV or 1.5 kV
- EMC noise immunity EN 50082-2, severity class 3
 - electromagnetic RF field
 - magnetic field of power engineering frequency
 - discharge of static electricity (ESD)
 - fast transients (bursts)
 - transients (surges)
 - RF interference test (IEC 255-22-1)
 - transformer cross voltage 2.5 kV
- EMC emitted interference EN 50081-2

² On special-wish, differently from the default long-range input voltage optocoupler inputs can be dimensioned for a Low/High switching voltage of about 60 V.



Order data DDS 2 and DDS 2

	PI.-No.: 1743	5	↑	↑	↑
rated voltage: 6 th digit	Vn = 100 V	0	↑	↑	↑
	Vn = 110 V	1	↑	↑	↑
auxiliary voltage: 7 th digit ³	110 / 240 V DC/AC	0	↑	↑	↑
	60 - 137 V DC	1	↑	↑	↑
	24 - 65 V DC	2	↑	↑	↑
type of housing: 8 th digit	panel surface-mounted		↑	↑	↑
	CT terminals down	0	↑	↑	↑
	CT terminals right	2	↑	↑	↑
	CT terminals left	4	↑	↑	↑
	panel flush-mounted		↑	↑	↑
	CT terminals down	1	↑	↑	↑
	CT terminals right	3	↑	↑	↑
	CT terminals left	5	↑	↑	↑
IEC interface / language: 9 th digit	Fibre optical / German	0	↑	↑	↑
	Fibre optical / English	1	↑	↑	↑
	RS485 / German	5	↑	↑	↑
	RS485 / English	6	↑	↑	↑
design: 10 th digit	DDS 2, min. equipment	0	↑	↑	↑
	DD 2, with Z<, IEC 60870-5-103	1	↑	↑	↑
	DDS 2, w/o IEC 60870-5-103	3	↑	↑	↑
	DDS 2, with IEC 60870-5-103	4	↑	↑	↑
	DDS 2, with IEC 60870-5-103	6	↑	↑	↑

design includes:	0	1	3	4	6
binary inputs	6	9	9	6	9
trip relays	4	4	4	4	4
pilot relays (1 changeover)	2	2	2	2	2
pilot relays (1 make contact)	3	5	5	3	5
pilot relays (1 break contact)	1	1	1	1	1
PC interface electric. isolated	X	X	X	X	X
IEC 60870-5-103 interface	-	X	-	X	X
auto recloser	-	X	X	-	X
impedance starting Z<	-	X	-	-	-
earth-fault direction decision	-	-	-	-	-

Order data DDSE 2

	PI.-No.: 1743	6	↑	↑	↑
rated voltage: 6 th digit	Vn = 100 V	0	↑	↑	↑
	Vn = 110 V	1	↑	↑	↑
auxiliary voltage: 7 th digit ³	110 / 240 V DC/AC	0	↑	↑	↑
	60 - 137 V DC	1	↑	↑	↑
	24 - 65 V DC	2	↑	↑	↑
type of housing: 8 th digit	panel surface-mounted		↑	↑	↑
	CT terminals down	0	↑	↑	↑
	CT terminals right	2	↑	↑	↑
	CT terminals left	4	↑	↑	↑
	panel flush-mounted		↑	↑	↑
	CT terminals down	1	↑	↑	↑
	CT terminals right	3	↑	↑	↑
	CT terminals left	5	↑	↑	↑
IEC interface / language: 9 th digit	Fibre optical / German	0	↑	↑	↑
	Fibre optical / English	1	↑	↑	↑
	RS485 / German	5	↑	↑	↑
	RS485 / English	6	↑	↑	↑
design: 10 th digit	min. equipment	0	↑	↑	↑
	max. equipment	1	↑	↑	↑
	min. equipm. w/o IEC 60870-5-103	3	↑	↑	↑
	min. equipm. with IEC 60870-5-103	4	↑	↑	↑

DDSE 2 design includes:	0	1	3	4
binary inputs	6	9	9	6
trip relays	4	4	4	4
pilot relays (1 changeover)	2	2	2	2
pilot relays (1 make contact)	3	5	5	3
pilot relays (1 break contact)	1	1	1	1
PC interface electric. isolated	X	X	X	X
IEC 60870-5-103 interface	-	X	-	X
auto recloser	-	X	X	-
impedance starting Z<	-	-	-	-
earth-fault direction decision	X	X	X	X

Optocoupler inputs:

On special wish, differently from the default long-range input voltage optocoupler inputs can be delivered with a Low/High switching voltage of about 60 V.

This wish is separated with order to declare.

Heed please that when using two-wire signal loop two optocoupler-inputs are connected in series. Therefore, only the half of the auxiliary voltage is available at an input.

Accessories

PC-protector interconnecting cable
PI. No.: 1743 900 010

COMM-3 PC operator software

• **Management program**
 PI.-No.: 1744 990 00-
 Variant: 10th digit ↑
 Full-version 0
 Upgrade from COMM-2 to 3 1
 Update of COMM-3 2
 Demo version 9
 On supplied CDROM the user manual exists as a PDF-file.

• **Device programs**

PI.-No.: 1744 991 ↑↑↑
 Type of device: 8th and 9th digit ↑↑↑
 all devices [structure versions] 00
 DM 2 [1004] 10
 DSRZ(W) 2 [2001] 20
 DSZ(W) 2 [3007] 30
 DSZW 4 [3105] 31
 DSZ 4 [3205] 32
 DQ2S 2, DQ3S 2 [4008] 40
 DD 2 [5033] 50
 P9x-DD.. 6 [5601] 56
 DDS(E) 2 [6002] 60
 DSRZE 2 [7000] 70
 P9x-DS.. 6 [7604] 76
 Variant: 10th digit ↑↑↑
 current structure version 0
 old structure version 1

When reordering a device program the structure version number of the device is necessary additionally (see label on device). Example for DSZ 2, old structure version 3001:

PI.-No. 1744 991 **301- 3001**

SDA 2 graphics software

PI.-No.: 1744 992 000
On supplied CDROM the user manual exists as a PDF-file.

User manual COMM-3, SDA2 printed

PI.-No.: 1744 993 0- ↑↑
 Language: 9th digit ↑↑
 German 0
 English 1
 Manual: 10th digit ↑
 COMM-3 0
 SDA 2 1

³ for complete voltage range see Specifications

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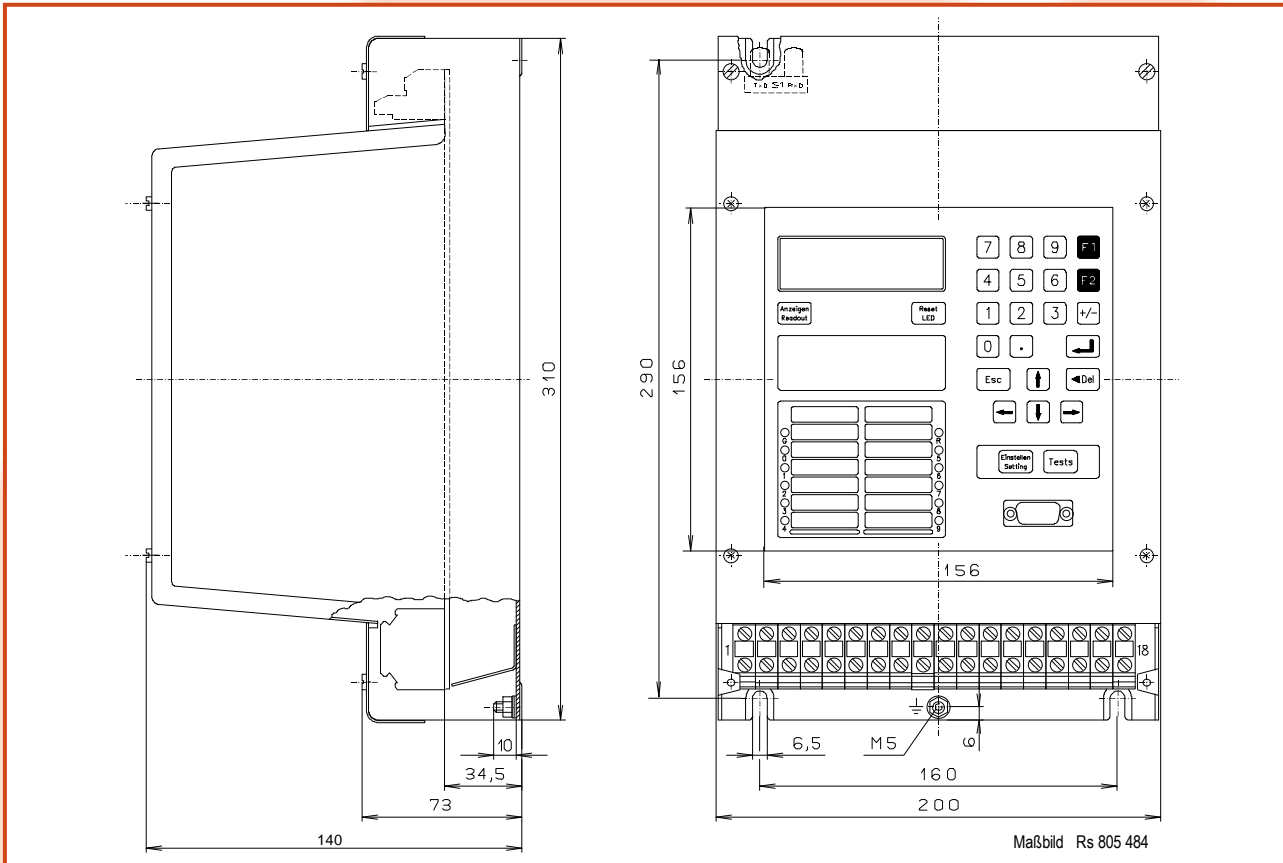


Fig. 4: Housing of D...2 series for panel surface-mounting, lower terminal cover not shown in top view. With the horizontal models the keypad is turned + or -90°.

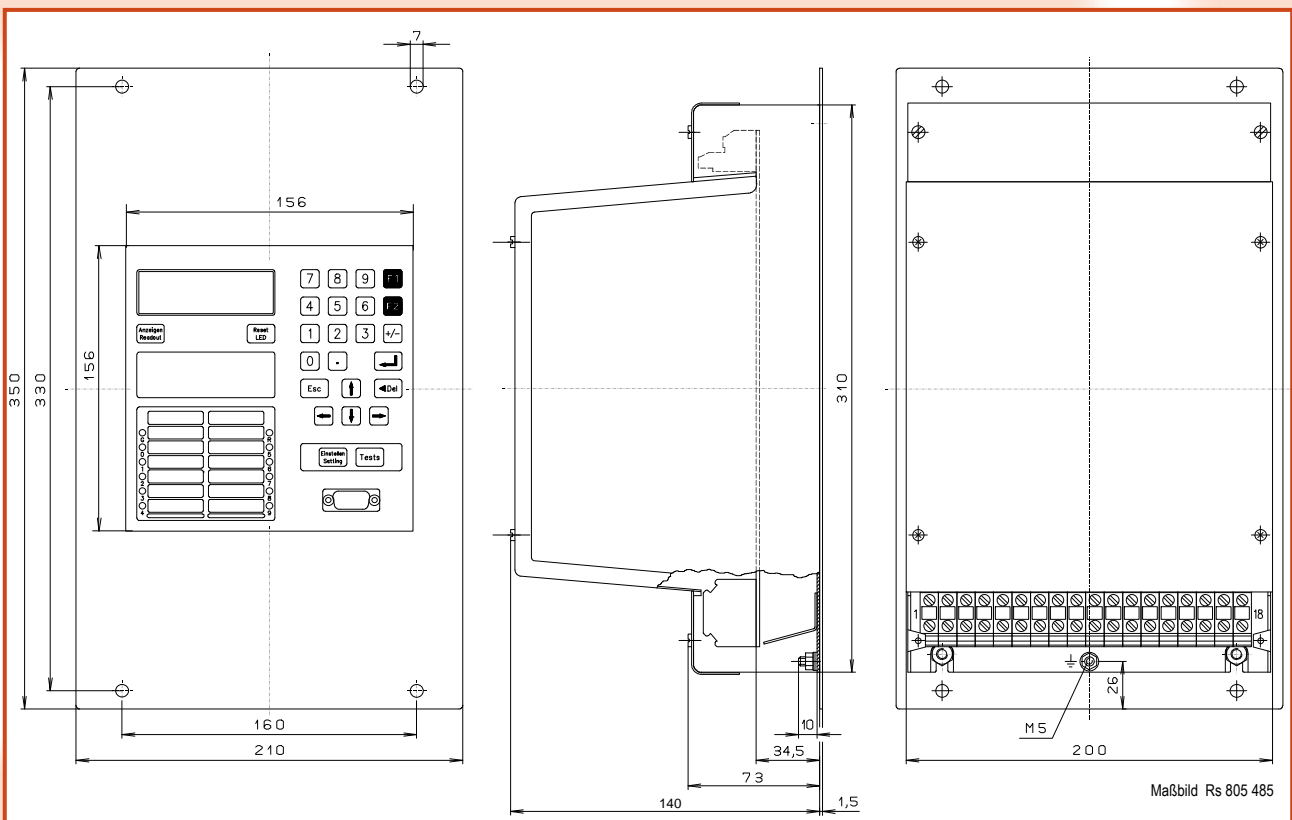
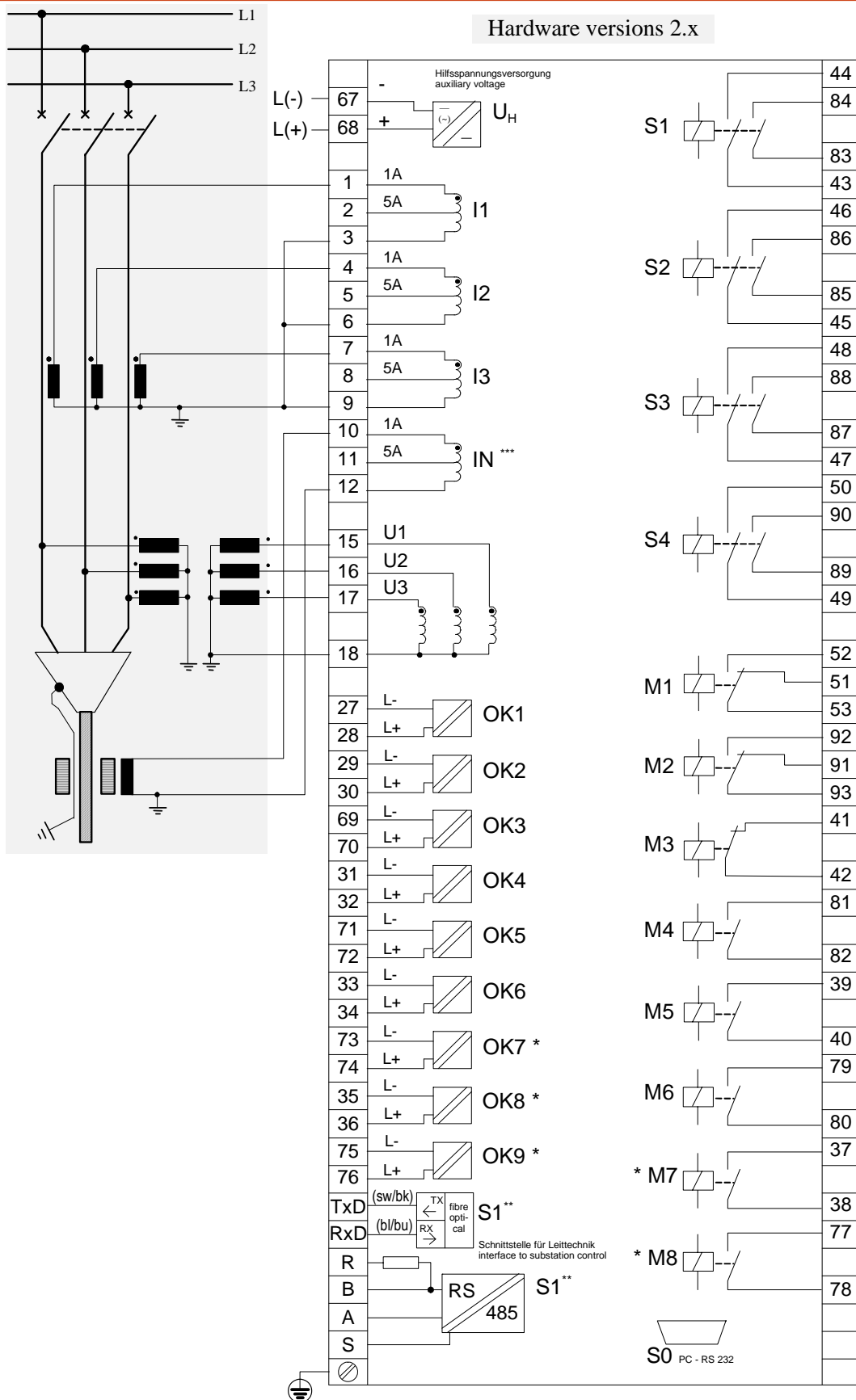


Fig. 5: Housing of D...2 series for panel flush-mounting, lower terminal cover not shown in rear view (right). The panel cut-out should be 202 mm * 312 mm when device will be put through from front side. With the horizontal models the keypad is turned + or -90°.



Hardware versions 2.x



*) not in PI-No. 1743 xxx xx0 and 1743 xxx xx4 **) not in PI-No. 1743 xxx xx0 and 1743 xxx xx3, alternative as fibre optical or RS485 interface ***) only in DDSE 2

Fig. 6: Terminal assignment of DD 2, DDS 2, DDSE 2, connection example for In = 1 A and DDSE 2

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