DZR-EP
DZR2-EP
DIGITAL IMPEDANCE PROTECTION

The digital impedance protection of type **DZR-EP, DZR2-EP** is part of device family named `EuroProt` . This short description contains special data of this type. General and common features of `EuroProt` family can be found in the `EuroProt` system information sheet. Accordingly it is proposed to study both this short description and system information sheet too, in order to understand the device entirely.

Application field

The ***DZR-EP*** type digital three phase under-impedance protection can be used as short-circuit protection in not grounded (isolated or compensated) networks, i.e. in the Hungarian system in medium voltage level, and in grounded networks, if the minimal short-circuit current and the maximal load current are at the same level, and therefore the selective protection needs impedance measurement instead of overcurrent protection. The protection is provided with offset circle characteristics, which are suitable to solve special protection tasks as well.

The frequent applications of ***DZR-EP*** under-impedance protection are: the reserve protection for generators in case of short-circuits inside the zone of the differential protection., main protection of medium voltage bus-bars of 120 kV/medium voltage transformers, reserve protection for short-circuits inside the zone of transformer differential protection and for short-circuits at the first section of the feeders.

The application of this protection is not advised, if directionality is required, i.e. difference must me made between short-circuits in front of and behind the protection. For these location PROTECTA Co. Ltd. developed the ***DKTVA-EP*** type distance protection for medium voltage networks.

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Main features

The ***DZR-EP*** type digital three phase under-impedance protection belongs to the `EuroProt` family of microprocessor based protections developed by PROTECTA Co. Ltd.

Under-impedance function:
- two stages of three phase under-impedance functions (Z<<, Z<) with individual time delay,
- the offset of the circle characteristics (compaunding) can be set for both stages independently,
- 3 point measuring principle, not sensitive for current transformer saturation,
- shortest operating time: 25 ±5 ms.

Overcurrent function:
- two stages of three phase overcurrent functions (I>>, I>) with individual time delay,
- for the overcurrent stages can individually be selected:
  – trip circuit supervision in each phases,
  – always enabled,
  – enabled only if the MCB-s in the voltage measuring trip, and the impedance stages are disabled.

Software characteristics:
- built-in self-supervision functions,
- event log storing 50 events, and digital event sequence recorder with 1 ms time resolution , recording maximum 300 events,
- analog event log with current and voltage data,
- intelligent digital function matrix,
- two additional timers (T1 and T2) for free application in connection with the matrix,
- the rows of the matrix (relay-functions) can be set for latching.

Hardware characteristics:
- numerical design, with own A/D converter, digital signal processor (DSP) and separate main processor,
- 8 opto-coupler input,
- 16 output relays,
- the type of contacts (NO, NC) can be selected individually when ordering,

Communication:
- 2x16 character LCD display for setting, message display and display of recorded events,
- on line screen on external PC for easier commissioning,
- external communication connection can be set for RS 232 or fibre optic cable,
- optional interface modules for SCADA connection,
- the parameters can be saved and downloaded,
- real-time clock with battery-fed RAM, (can be synchronised from external PC via fibre optic cable, from the SCADA system or via opto-coupler input),

Working principles

The ***DZR-EP*** protection is a microprocessor controlled system, so its functions and their variations are based on software.

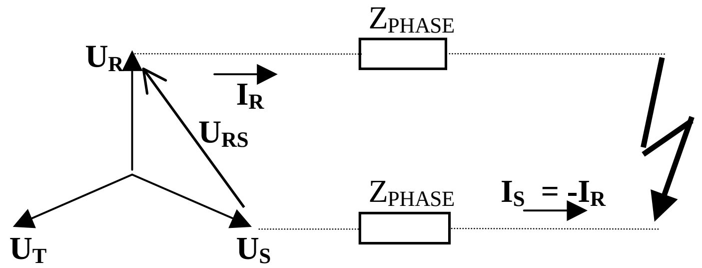
The device contains several 87C196 type 16 bit micro-controller and a DSP performing digital signal processing. The program is stored in EPROM, the message text for the display is stored in EPROM as well. The parameter setting is loaded in EEPROM. Events are recorded in battery supplied RAM.The man-machine interface consists of a keyboard with six push-buttons, above it the two row, 2 x 16 character LCD display, seven LEDs and two SW pushbuttons.
With auxiliary PC and with the handling program a device can easier be operated

The analog current and voltage inputs are connected via inductive internal measuring transformers and low-pass filters to the multiplexer then to the A/D converter, where all current and voltage signals are sampled in every 0,5 ms. The sampled values of the 16 bit A/D converter are passed via high speed CAN bus to the digital signal processors (DSP), which perform arithmetic operation with high speed. The outputs of the DSP are the processed and evaluated measurements, as "started" signals of the relay functions, which are sent to the CPU. The timers and logic functions are performed here.

The central processor communicates via parallel bus with the opto-coupler inputs and with the relay drivers.
The under-impedance protection function is in all three phases a two stage impedance relay, and there is additionally a two stage overcurrent relay as well. Each stages have individual timers Each stage contains 3-3 parallel impedance functions. Their operations is enabled by overcurrent relays with 0,2xI_n fix setting. The staring caused by the highest phase current enables the operation of both impedance stage in all three phases. The measurements is disabled by the trip of midget CB in the voltage transformer secondary circuit with selectable NO or NC contacts.

The two overcurrent functions contain RMS measurements. The delay of both stages can be set independently. It can be selected by parameter setting if it is always enabled or enabled only in case of tripping the midget CB, causing the disabling of the impedance functions.

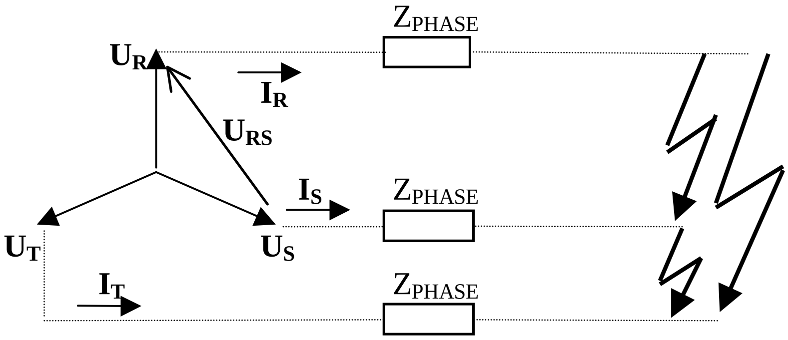
In case of DZR designed for not solidly grounded networks the impedance measurements are performed according to the formula for the three phases $\frac{U_{RS}}{2I_R}$, $\frac{U_{ST}}{2I_S}$ and $\frac{U_{TR}}{2I_T}$. The impedance setting is the positive sequence impedance of the line. In case of two-phase short-circuits the explanation is drawn on Fig. 1.



$$Z_{MEAS} = \frac{U_{RS}}{2.I_R} = Z_{PHASE}$$

Fig. 1
2Ph measurement

In case of 3 phase short-circuits the impedance relays measure $\frac{\sqrt{3}}{2}$ -times less values, they "overreach". The operating distance of the function in case of 3 phase short-circuit is $\frac{2}{\sqrt{3}}$ = 1,15 times greater, than that of 2 phase short-circuits. For the explanation see Fig. 2.



$$\frac{I_{3F}}{I_{2F}} = \frac{2}{\sqrt{3}}$$

Fig. 2
3Ph measurement

In the DZR2 version for solidly grounded networks in case of earth faults the phase voltage is divided by the phase current compounded with the zero sequence current, and they calculate the positive sequence impedance, proportional to the distance..

The setting of the impedance function is made according to the characteristics shown in Fig. 3.

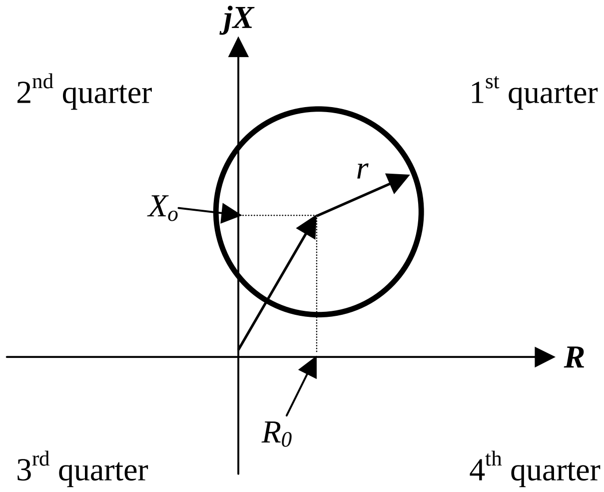


Fig. 3
Characteristics of the impedance function

Technical data

Rated secondary current, I_n	1A or 5 A,
Rated secondary voltage (line), U_n	100 V or 200 V
Rated frequency	50 Hz or 60 Hz
Overload capacity, voltage circuit thermal, continuous	$2xU_{phase}=2xU_n/\sqrt{3}$
current circuit thermal, continuous 1 s	$4xI_n$ $100xI_n$ (ha I_n = 1 A) $50xI_n$ (ha I_n = 5 A)
Dynamic current limit	$100xI_n$
Accuracy, impedance relays (above 50 % I_n)	±5 %
Accuracy, current relays (above 50 % I_n)	±2 %
Accuracy, timers, with 10 ms steps with 1 s steps	±3 ms ±12 ms
Reset ratio, current relays	95 %
Output relay contacts	12 pcs print relay
Type of contacts (NO/NC):	*to be selected at ordering, factory setting 1 NC* *11 NO*
Output contacts, electrical data: rated switching voltage continuous load current making current DC breaking capability at 220 V, at pure conductive load at load of L/R = 40 ms *option* at load of L/R = 40 ms	 250 V 8 A 16 A 0,25 A 0,14 A 4 A
Auxiliary DC voltage (the same supply unit) voltage tolerance	220 V or 110 V 88...310 V
Permissible ambient temperature	0° ...50° C
Insulation test (IEC 255)	2 kV, 50 Hz 5 kV, 1,2/50 µs
Disturbance test (IEC 255)	2,5 kV, 1 MHz

Electrostatic discharge (ESD, IEC 801-2)	8 kV
Burst test (IEC 801-4)	2 kV
Setting ranges	
Impedance function second stage	
centre of the characteristics (real axis), Z< Ro(*10*Cu*Ci)	0...10000 mOhm, step10 mOhm
centre of the characteristics (imaginary axis), Z< Xo(*10*Cu*Ci)	0...10000 mOhm, step10 mOhm
radius of the characteristics Z< r(*10*Cu*Ci)	0...10000 mOhm, step10 mOhm
setting of the quarters Z< RoXo position	1...4, step1
Impedance function first stage	
centre of the characteristics (real axis), Z<< Ro(*10*Cu*Ci)	0...10000 mOhm, step10 mOhm
centre of the characteristics (imaginary axis), Z<< Xo(*10*Cu*Ci)	0...10000 mOhm, step10 mOhm
radius of the characteristics Z<< r(*10*Cu*Ci)	0...10000 mOhm, step10 mOhm
setting of the quarters Z<< RoXo position	1...4, step1
Remarks: The values of the constants in the formulas above: Cu = 1, if Un = 100 V, Cu = 2, if Un = 200V Ci = 1, if In = 1 A, $Ci = \frac{1}{5}$, if In = 5 A so the value of the factor: (10*Cu*Ci) = $\frac{Un}{10.In}$	
Low set overcurrent stage, I> / In[AV]	30...2500 %, step: 10 %
High set overcurrent stage, I>> / In[AV]	30...2500 %, step: 10 %
CT primary rated current, In[AV]	50...2500 A, step: 25 A
Delay of second impedance stage, t Z>	0...10000 ms, step: 10 ms
Delay of first impedance stage, t Z>>	0...10000 ms, step: 10 ms
Delay of low set overcurrent stage, t I>	0...10000 ms, step: 10 ms
Delay of high set overcurrent stage, t I>>	0...10000 ms, step: 10 ms
Delay of additional timer 1, t T1	0...10000 ms, step: 10 ms
Delay of additional timer 2, t T2	0...10000 ms, step: 10 ms
Healthy-to-work failure signal timer t[fail]	2 s fix value
External communication type	RS 232 or fibre optic cable
Serial communication Baud rate	150...19200 Baud (2x steps)
Optical fibre cable operation mode	Radial or loop
Daily automatic self-check time	0...23 hours 59 minutes (step 1 min)
Automatic self-check block	setting 60 min

Design, size

An ***EuroProt*** device is always rack mounted, it has two design forms. One of the form is suitable to be mounted into standard 19" cabinet frame, this form is also suitable to be mounted directly to a relay panel with flash mounted form. The other form is a relay panel mounted device with raised-hinged form. Its size depends on the chosen form.

Outline size of *19"cabinet frame mounted device*:

Width	Height	Depth
483 mm	132,5 mm	201 mm

Outline of the *panel mounted device with raised-hinged form*:

Width	**Height**	**Depth**
490 mm	250 mm	250 mm

Weight: 8 kg.

Options

The device can be extended by optional units:

- digital disturbance recorder (see separate information sheet),
- SCADA connection (see *EuroProt* system information sheet),
- 8 additional opto-coupler inputs to **PROTLOG** operating equations,
- output relays with 4 A breaking capability.

Information required with order

- Protection type [DZR-EP],
- Protection case type [19" cabinet frame mounted device, or panel mounted device with flash mounted form, panel mounted device with raised-hinged form,
- Rated current [1 A, 5 A],
- Rated voltage [100 V, 200 V],
- Output relay contact type [NC or NO, if deviates from the *Technical Data*],
- Options if needed
- Needed trip circuit supervision.

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