

## Features

- Intended for single or two-phase railway systems (16 2/3, 50 or 60 Hz)
- Full scheme distance protection, where each distance protection zone appears as a separate distance relay
- Up to three protection zones with separate measurement for different fault loops
- The zones can, independently, be directional (forward or reverse) or nondirectional
- Independent setting of resistive reach for phase-to-phase and for phase-to-earth measurement
- Zero sequence earth-return compensator factor to get correct reach in reactive direction independent of fault type in solidly grounded systems
- Quadrilateral characteristic with extra directional lines (reduce load encroachment problems)
- Easy setting procedures with direct introduction of line parameters

## Application

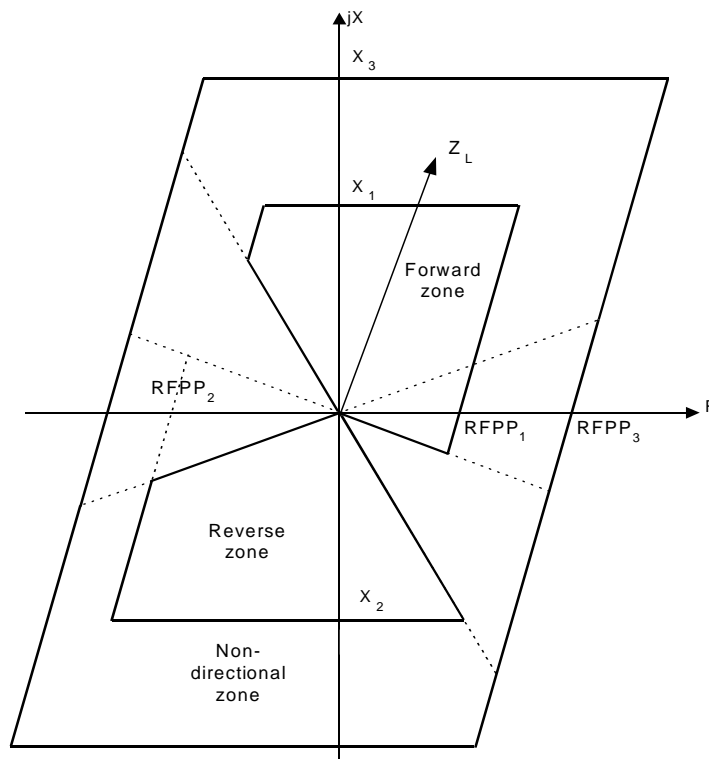
The three zone distance protection, Z(1,2,3)RW is intended for systems.

The protection gives fast and reliable fault clearance of low to moderate impedance earth faults in single phase and two phase solidly earthed systems and phase-to-phase faults in two phase systems.

The zero sequence compensator factor is used to get correct reach in reactive direction independent of fault type and hence gives selectivity for both phase-to-phase and earth faults

in two phase solidly earthed systems. Different setting values for resistive reach are possible for phase-to-phase faults and earth faults.

The three impedance zones can, independent of each other, be directed forwards, reverse or be undirectional. The reach in the reactive and resistive directions can be set independent of each other and independent of the settings for the other zones. The earth-return compensator factor is common for all zones. The reach in reactive and resistive directions is the same, independent of whether the zone is directed forwards or reverse, see Figure 1.



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Figure 1: Impedance zones directed forward and backward

Available communication logic for distance protection increases the possibility of quick and selective clearance of faults on the entire line and also gives the possibility of increased

supplementary resistance coverage at the fault location, which is especially important on short lines.

## Design

The measuring elements collect information about the current and voltage from the A/D converter. The measuring algorithm for one fault loop and three measuring zones is performed in a signal processor. Further signal processors of the same type are added for further measuring loops.

The fundamental frequency - RMS values for the current and voltage are calculated every ms. Comparison of squared amplitudes for current and voltages result in impedance circles according to the formula:

$$\frac{U^2}{Z_{set}} < Z_{set} \cdot I^2$$

(Equation 1)

The inner impedance circle, entered in the characteristics, gives a fast function for close-in faults.

A complex power comparison according to the formula:

$$S = U \cdot I^* < (R_{set} + j \cdot X_{set}) \cdot I^2 \quad (\text{Equation 2})$$

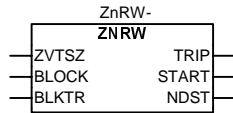
gives the straight-lined function characteristic in the reactive and resistive directions according to figure “Impedance zones directed forward and backward”. When the calculated

impedance lies inside the zone for a certain time, the impedance measuring element gives the trip signal.

The slope of the directional line is calculated in the same way, except it uses the voltage stored in the memory to ensure correct decision of direction even with very low fault voltage.

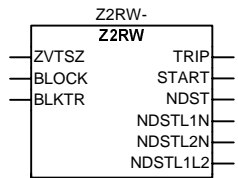
The three impedance zones have the same logical structure. The function block for each zone contains binary inputs and outputs, which can be configured for different external functions, logic circuits, timers or binary inputs and outputs.

## Function block



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Figure 2: Function block for zones 1 and 3 (single and two phase) and zone 2 (single phase)



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Figure 3: Function block for zone 2 (two phase)

## Input and output signals

**Table 1: Input signals for the Z(n)RW function block**

Signal	Description
ZVTSZ	Blocks the operation of distance protection zone n - connected to fuse failure signal FFRW-VTSZ
BLOCK	Blocks the operation of distance protection zone n
BLKTR	Blocks tripping outputs of distance protection zone n

Path in local HMI: ServiceReport/Functions/Impedance (RW)/Zonen (RW)/FuncOutputs

**Table 2: Output signals for the Z1RW and Z3RW function block (single and two phase) and Z2RW (single phase)**

Signal	Description
TRIP	Trip by impedance step n (controlled by the function of the timer $t_n$ )
START	Start of (directional) distance protection zone n
NDST	Non-directional start of distance protection zone n

Path in local HMI: ServiceReport/Functions/Impedance (RW)/Zonen (RW)/FuncOutputs

**Table 3: Output signals for the Z2RW function block (two phase)**

Signal	Description
TRIP	Trip by impedance step n (controlled by the function of the timer $t_2$ )
START	Start of (directional) distance protection zone 2
NDST	Non-directional start of distance protection zone 2
NDSTL1N	Non-directional phase-to-earth-fault start of distance protection zone 2, phase L1
NDSTL2N	Non-directional phase-to-earth-fault start of distance protection zone 2, phase L2
NDSTL1L2	Non-directional phase-to-phase-fault start of distance protection zone 2

## Technical data

**Table 4: Z(n)RW - Impedance function**

Function		Value
Operate time	Typical	1.5 cycle + 10 ms directional
		0.5 cycle + 10 ms non-directional
		50/60 Hz: 24-39 ms
		16 2/3 Hz: 61-77 ms
Reset ratio		<105 %
Static accuracy at 0° and 85°	Voltage range (0.1-1.1) x $U_r$	+/- 5 %
	Current range (0.5-30) x $I_r$	
Static angular accuracy at 0° and 85°	Voltage range (0.1-1.1) x $U_r$	+/- 5 degrees
	Current range (0.5-30) x $I_r$	
Max dynamic overreach at 85° measured with CVT's $0.5 < SIR < 30$		+/- 10 %

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