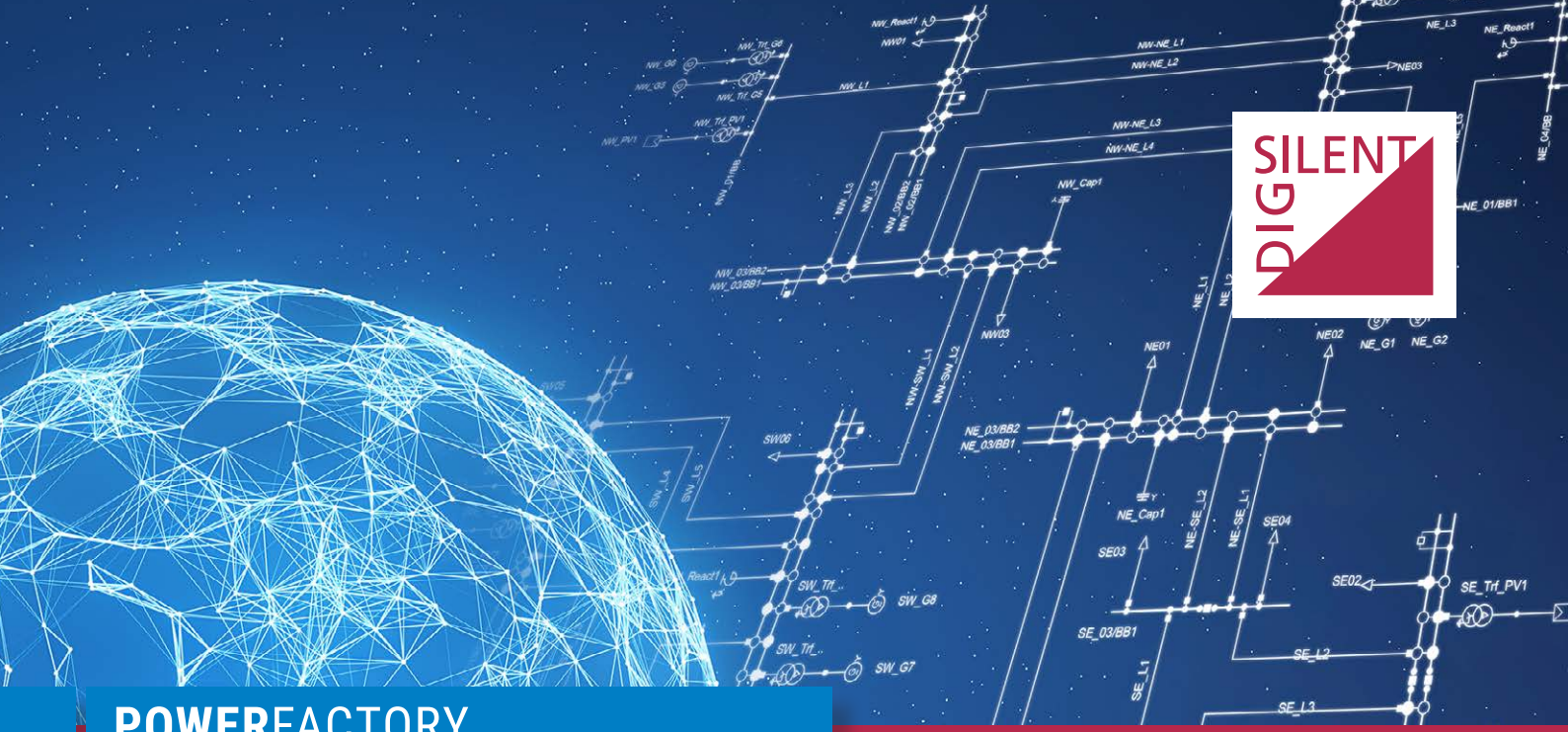

POWERFACTORY

PowerFactory 2021

Technical Reference

ABB REL 301

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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Contents

1 Model information

Manufacturer ABB

Model REL 301

Variants The ABB REL 301 PowerFactory relay models can be used to simulate the REL 300 and the MDAR protective relays. The reference firmware versions are 2.20, 2.21, 2.21, 2.23. However please consider that the model has been implemented with a reduced set of the features available in the relays.

2 General description

The ABB REL 301 line distance protection device is a numerical transmission line protection system with three or four zones of distance protection, optional pilot zone logic, metering, a fault locator and self diagnostics. All measurements and logic use microprocessor technology. It's is recommended for protection of transmission lines where to 1 1/2-2 cycle relaying time is acceptable.

The ABB REL 301 PowerFactory relay models consist of a monolithic model scheme.

The following model versions are available:

- REL 301 1 Amp
- REL 301 5 Amp

The relay models have been implemented trying to simulate the most commonly used protective functions.

The relay models contain the measurement and acquisition units, the polarizing elements, the directional elements for the distance elements, the mho distance elements, a set of timers, the overcurrent elements, the undervoltage element, the output logic.

The model implementation has been based on the information available in the relay manual [1] [2].

3 Supported features

3.1 Measurement and acquisition

The voltage and the current are measured by one three phase current transformer (”Ct” block), one single phase current transformer (”Ctpol” block) and one three phase voltage transformer (”Vt” block).

Four measurement units (”Measurement”, ”Delta Measure”, ”Measurement Seq” and ”Neutral Measure” block) are fed by these CTs and this VT.

3.1.1 Available Units

- One three phase current transformers measuring the phase current (”Ct” block).
- One single phase current transformers measuring the neutral sequence current(”Ctpol” block).
- One three phase voltage transformer measuring the phase voltages(”Vt” block).
- One three phase measurement element calculating both the current and voltage values (”Measurement” block).
- One three phase measurement element calculating the phase to phase currents and the phase to phase voltages (”Delta Measure” block).
- One three phase measurement element calculating the current and the voltage sequence vectors (”Measurement Seq” block).
- One single phase measurement block calculating the neutral current used by the polarizing element (”Neutral Measure” block)

3.1.2 Functionality

The input current and voltage values are sampled at 8 samples/cycle. The values are processed by a DFT filter, operating over a cycle, which then calculates the voltage and current values used by the protective elements.

The ”Delta Measure” block calculates the current and voltage ph-ph values used by the phase-phase loop distance elements.

3.1.3 Data input

The nominal current and the nominal voltage values MUST be entered in all the measurement blocks.

3.2 Main Relay protective elements

The polarizing element, the directional elements, the mho distance elements are working together to simulate the ABB REL 301 distance functionalities. The ancillary overcurrent element and a voltage protective element are also modeled.

3.2.1 Available Units

- Three mho distance elements for the phase loops (”Z1P”, ”Z2P” and ”Z3P” block)
- Three timers associated to the phase mho elements (”ZT1P”, ”ZT2P” and ”ZT3P” block)
- Three mho distance elements for the ground loops (”Z1G” , ”ZT1G”, ”Z2G”, ”ZT2G” ”, ”Z3G”, ”ZT3G block)
- Three timers associated to the ground mho elements (”ZT1G”, ”ZT2G” and ”ZT3G” block)
- One phase mho for the pilot (i.e. trip transfer) logic (”PLTP” block)
- One ground mho for the pilot (i.e. trip transfer) logic (”PLTG” block)
- One polarizing block (”Polarizing” block)
- One phase directional element (”Dir Ph” block)
- Three ground directional elements (”Dir Grnd Io-Vo”,”Dir Grnd Io-Ip” and ”Dir Grnd Neg Seq.” block).
- One 3 phase directional time defined overcurrent element (”ITP” block).
- Two 3 phase time defined overcurrent elements (”IM” and ”IL” block).
- One ground directional inverse time overcurrent element (”GB” block).
- One ground directional time defined overcurrent element (”ITG” block).
- Two ground time defined overcurrent elements (” I0M” and ”I0L” block).
- One 3 phase undervoltage element (”LV”).

3.2.2 Functionality

Directional elements The directional elements use the angles between the current and the voltage to figure out the fault direction. The phase directional element implements an angle comparison logic between the phase current and voltages. The ground directional logic is implemented by three directional elements which uses the angle comparison between the following quantities:

- Zero sequence voltage and current (”Dir Grnd Io-Vo” block).
- Negative sequence voltage and current (”Dir Grnd Neg Seq.” block).
- Residual current and zero sequence current measured by the neutral core CT (”Dir Grnd Io-Ip” block).

The zero sequence voltage and current logic is used if not enough zero sequence current measured by the neutral core CT is available. The resulting directional decision is combined by an *or* boolean logic (”Logic dir grnd” block) with the directional decision coming from the negative sequence voltage and current logic.

Polarizing element The polarizing element is calculating the voltage vectors used by the mho elements.

Mho elements Separated mho elements are monitoring the phase-ground and the phase-phase loops. The starting of the phase mho elements is controlled by the ”IM” overcurrent element trip, the starting of the ground mho elements is controlled by the ”I0M” overcurrent element trip.

Timers The timers are connected to the mho output signals. Separated timers are available for the phase and the ground loops.

Overcurrent The inverse time element (”GB” block) is supporting the following inverse time and definite time trip characteristics with optional delayed reset:

- Definite time (const)
- MC0-2 (Short-Time)
- MC0-5 (Long-Time)
- MC0-6 (Definite
- MC0-7 (Moderately inverse)
- MC0-8 (Inverse)
- MC0-9 (Very inverse)
- MC0-11 (Extremely inverse)

The inverse time element trip characteristic equations comply with the Westinghouse curve data.

The *IM* element and the *I0M* element supervision respectively the phase and the ground mho elements.

3.2.3 Data input

The relationships between the relay settings and the model parameters can be found in the following tables (the relay model parameter names are listed between brackets):

Phase Directional element :

No user input is required.

Ground Directional elements :

When the ”DIRU” setting is ”ZSEQ” the ”Dir Grnd Io-Vo” and the ”Dir Grnd Io-Ip” block must be manually disabled. When ”DIRU” is ”DUAL” the ”Dir Grnd Neg Seq.” block must be manually disabled.

Polarizing element :

Address	Relay Setting	Model block	Model setting	Note
	ZOL/Z1L	Polarizing	k0 (k0)	

The relay model ”Angle” (phik0) paramter must be calculated manually using the ”PANG” and the ”GANG” relay settings.

Mho impedance elements :

Address	Relay Setting	Model block	Model setting	Note
	Z1P	Z1P	Replica Impedance (Zm)	
	PANG	Z1P	Relay Angle (phi)	
		Z2P	Relay Angle (phi)	
		Z3P	Relay Angle (phi)	
		PLTP	Relay Angle (phi)	
	Z2P	Z2P	Replica Impedance (Zm)	
	Z3P	Z1P	Replica Impedance (Zm)	
	PLTP	PLTP	Replica Impedance (Zm)	
	Z3FR	Z3P	Tripping Direction (idir)	
		Z3G	Tripping Direction (idir)	
	Z1G	Z1G	Replica Impedance (Zm)	
	GANG	Z1G	Relay Angle (phi)	
		Z2G	Relay Angle (phi)	
		Z3G	Relay Angle (phi)	
		PLTG	Relay Angle (phi)	
	Z2G	Z2G	Replica Impedance (Zm)	
	Z3G	Z1G	Replica Impedance (Zm)	
	PLTG	PLTG	Replica Impedance (Zm)	

Timers :

Address	Relay Setting	Model block	Model setting	Note
	T1	ZT1P	Time Setting (Tcdelay)	
		ZT1G	Time Setting (Tcdelay)	
	T2P	ZT2P	Time Setting (Tdelay)	
	T2G	ZT2G	Time Setting (Tdelay)	
	T3P	ZT3P	Time Setting (Tdelay)	
	T3G	ZT3G	Time Setting (Tdelay)	

Overcurrent :

The relationships between the relay settings and the model parameters can be found in the following table:

Address	Relay Setting	Model block	Model setting	Note
	IL	IL	Pickup Current (Ipsetr)	
	IM	IM	Pickup Current (Ipsetr)	
	ITP	ITP	Pickup Current (Ipsetr)	
	IOS	I0L	Pickup Current (Ipsetr)	
	IOM	I0M	Pickup Current (Ipsetr)	

Address	Relay Setting	Model block	Model setting	Note
	ITG	ITG	Pickup Current (Ipsetr)	
	DIRU	Dir Grnd Io-Ip	Out of Service (outserv)	Disable ”Dir Grnd Io-Ip” and ”Dir Grnd Io-Vo” to use the directional neg. seq., disable ”Dir Grnd Neg Seq” to use the overcurrent directional.
		Dir Grnd Io-Vo	Out of Service (outserv)	
		Dir Grnd Neg Seq	Out of Service (outserv)	
	GBCV	GDIR	Characteristic(pcharac)	
	GBPU	GDIR	Current Setting (Ipsetr)	
	GTC	GDIR	Time Dial (Tpset)	
	GDIR	GDIR	Tripping Direction (idir)	

Voltage :

The relationships between the relay settings and the model parameters can be found in the following table:

Address	Relay Setting	Model block	Model setting	Note
	LV	LV	Pickup Voltage (Usertr)	

3.3 Output logic

The output logic is the interface between the relay and the power system.

3.3.1 Available Units and Signals

The trip logic is implemented by the "Output Logic" block.

The relay output signal is ”yout”.

3.3.2 Functionality

The ”Output Logic” block operates the power breaker when a trip command has been issued by any protective element. The block output signal used to operate the breaker is ”yout”.

3.3.3 Data input

Please disable the ”Output Logic” block to disable the relay model ability to open the power circuit.

4 Features not supported

The following features are not supported:

- Zone extension.
- Overcurrent elements directional characteristic for the 2nd zone phase torque control.
- Automatic reclosing and synchronizing feature.
- Breaker failure protection.
- Out of step logic.
- Directional minimum sensitivity in volt-amperes (a minimum sensitivity of 0.1 is present).
- Current change fault detector.
- Voltage change fault detector.
- Loss of potential supervisor.

5 References

[1] ABB Automation, Inc., Coral Springs, FL Allentown, PA USA. *REL 301/302 Version 1.20 Numerical Distance Relay Instruction Leaflet 40-386.1F)*, July 1998.

[2] ABB Automation, Inc., Coral Springs, FL Allentown, PA USA. *REL 301 and REL 302 Numerical Transmission Line Protection System Descriptive Bulletin 41-441M*, September 1996.