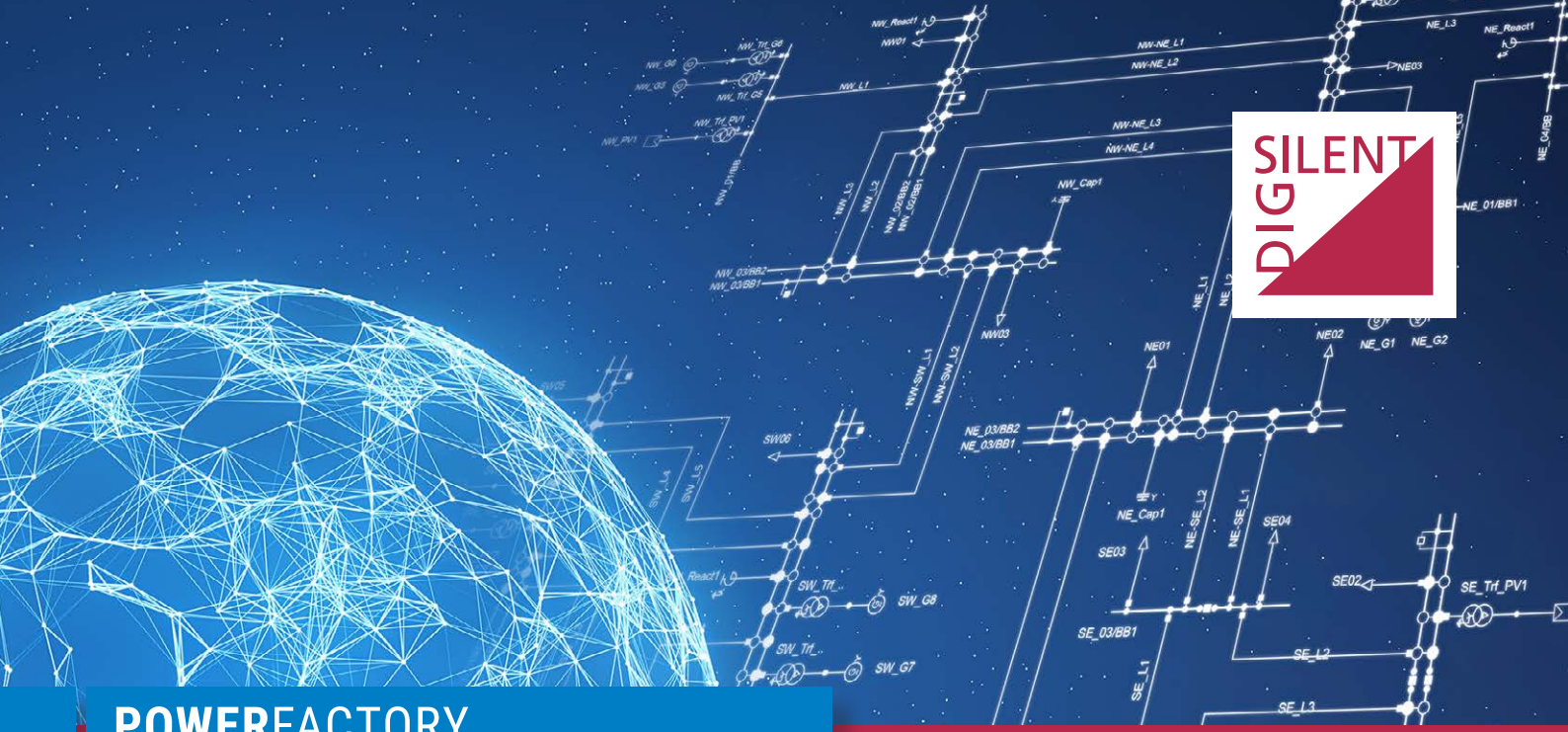

POWERFACTORY

PowerFactory 2021

Technical Reference

Distance Directional

RelDisdir, TypDisdir

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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Contents

1 General Description

The *Distance directional* block (*RelDisDir*/*TypDidDir* class) implements the directional detection logic present in the distance relays. The directional characteristic is determined by the operating quantities, usually the current vectors, and by the polarization quantities, usually the voltage vectors.
Due to the different detection logic present in the distance relays available on the market the block has been developed to include many different logic types. The manufacturer specific usage of the angle parameters is also supported for ABB and Siemens. The impedance values are calculated using the following formulas

$$R = Re(\frac{\bar{V}}{\bar{I}})$$

$$X = Im(\frac{\bar{V}}{\bar{I}})$$

The following directional types can be set:

"Single direction" characteristic :

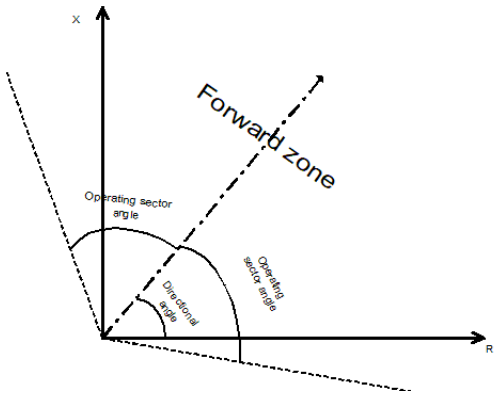


Figure 1.1: The *"Single direction" characteristic*

"Double direction" characteristic, "ABB (multi)" unit :

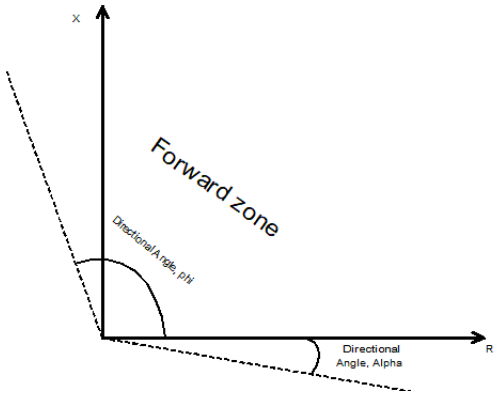


Figure 1.2: The *"Double direction" characteristic, "ABB (multi)" unit*

"Double direction" characteristic, "Siemens (multi)" unit :

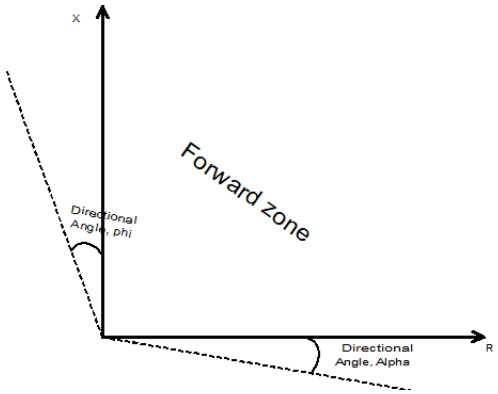


Figure 1.3: The *"Double direction" characteristic, "Siemens (multi)" unit*

The block provides:

- a directional tripping signal; it can be disabled or set to trip in the forward or in the reverse condition; when enabled it can be used to define the direction characteristic of a group of distance protection zones.
- A forward and a reverse signal for each phase or, when the "Siemens (multi)" or the "ABB (multi)" unit is selected, for the phase-phase loops and the phase-ground loops. Using these signals the directional characteristic can be set in a independent way in each distance protection zone.

The *Distance directional* block can be configured to perform the directional check on a single phase or on a three phase system or considering both the phase and the ground loops (6 phases).

2 Features & User interface

2.1 Distance Directional (RelDisdir)

The user can change the block settings using the “Distance Directional” dialogue (“RelDisdir” class). The dialogue consists of 2 tab pages: *Basic data*, and *Description*. The main settings are located in the *Basic data* tab page.

2.1.1 Basic data

The block can be disabled using the “Out of service” check box. The direction for which to activate the ”yout” output signal can be set using the “Tripping direction” combo box. The forward and the reverse angular detection zone can be set using the “Directional Angle”, and the “Operating Setting Angle” control (or the “Directional Angle, phi”, and the “Directional Angle, alpha” control when the ”Unit” is *Multifunctional*). The controls are combo boxes for ranges of discrete values or otherwise edit boxes.

At the bottom of the page the ”Start Time” editbox is shown if the ability to hold the detected direction in case of a three phase fault has been enabled in the ”Distance Directional Type”dialogue (TypDisdir class). The ”3Ph Fault Direction Holding check box is shown only if the ability to hold the detected direction in case of a three phase fault has been set as *User configurable* in the ”Distance Directional Type”dialogue (TypDisdir class).

2.1.2 Description

The *Description* tab page can be used to insert some information to identify the Distance Directional protective element (both with a generic string and with an unique textual string similar to the *Foreign Key* approach used in the relational databases) and to identify the source of the data used to create it.

2.2 Distance Directional Type(TypDisdir)

The *Distance Directional* block main characteristics must be configured in the “Distance Directional Type” dialogue (*TypDisdir* class).

2.2.1 Basic data

The *Basic data* tab page contains the ranges of the controls and some comboboxes used to configure the *Distance Directional* block.

The number of phases is set using the ”No.Phases” combo box (”iphases” variable). The number of phases can be 1 , 3 or 6. The last value is used when both the phase-phase and the phase-ground loops must be evaluated and is used to model the more recent ABB and Siemens distance relays. The number of phases affects the configuration of the input and output signals.

The directional type is set using the ”Type” combo box (”ichatype” variable). The directional type can be ”Single direction” or ”Double direction”. The selected type affect the parameters displayed in the ”Range Definitions” frame: when the ”Single direction” type is set the ”Direction

angle, phi" ("phi" variable) setting and the "Angle Operating Sector" ("phisec" variable) setting are displayed.
When the "Double direction" type is set the "Direction angle, phi" ("phi" variable) setting and the "Directional Angle, alpha" ("alpha" variable) setting are displayed.

The directional *unit* is set using the "Unit" combo box ("aunit" variable). The directional *unit* can be

- Earth
- Phase
- 3 Phase
- Multifunctional
- Multifunctional(digital)
- ABB(Multi)
- Siemens(Multi)

The directional *unit* setting is linked to the value of the "No.Phases" combo box: when the directional *unit* is set equal *Earth* or *Phase* the number of phases is set automatically equal to 1. When it's set equal to *3 Phase* the number of phases is set automatically equal to 3. Any other *Multifunctional* unit sets automatically the number of phases equal to 6.

3 Integration in the relay scheme

The *Distance Directional*"RelDisdir" type class name is *TypDisdir*. The *Distance directional* dialogue class name is *RelDisdir* . There are four main versions of the block:

- Single Phase
- Three Phases
- Six Phases
- Six Phases for ABB or Siemens

The typical connection of *Distance Directional*"RelDisdir" block is showed in Figure 3.1.

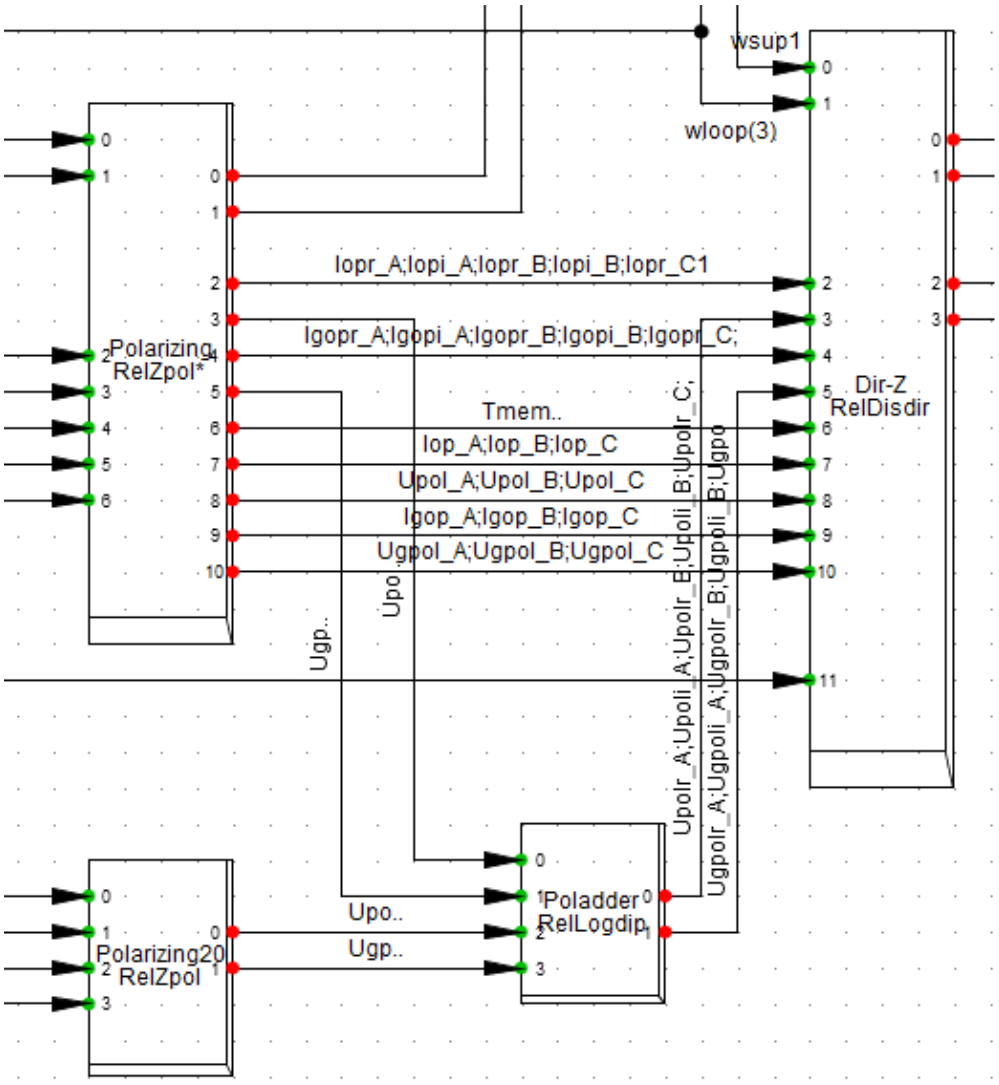


Figure 3.1: The *Distance Directional connection for an ABB distance relay*

3.1 Distance directional configurations

The distance directional element has some typical configurations. The more common are:

Number of phase: 1 Type: ”Single Direction” or ”Double Direction” Unit: ”Earth” or ”Phase” It checks the directional characteristic of only one phase, it provides forward and reverse signals (2 signals). Usually the ”Type” is ”Single direction”. It’s the simplest element used for older static distance relays.

Number of phase: 3 Type: ”Single Direction” or ”Double Direction” Unit: ”3 Phase” It checks the directional characteristic of three phase, it provides forward and reverse signals for each phase (6 signals). Usually the ”Type” is ”Single direction”. It’s the element used for the static distance relays.

Number of phase: 6 Type: Single Direction” or ”Double Direction” Unit: ”Multifunctional” It checks the phase-phase and the phase-Ground loops, it provides forward and reverse signals for each phase (6 signals)

Number of phase: 6 Type: ”Single Direction” or ”Double Direction” Unit: ”Multifunctional(digital)” It checks the phase-phase and the phase-Ground loops, it provides forward and reverse signals for the phase loop group and for the ground loop group (4 signals)

Number of phase: 6 Type: ”Double Direction” Unit: ”ABB(multi)” It checks the phase-phase and the phase-Ground loops, it provides forward and reverse signals for the phase loop group and for the ground loop group (4 signals). It’s used to implement the directional element of the ABB REL distance relay family.

Number of phase: 6 Type: ”Single Direction” or ”Double Direction” Unit: ”Siemens(multi)” It checks the phase-phase and the phase-Ground loops, it provides forward and reverse signals for the phase loop group and for the ground loop group (4 signals). It’s used to implement the directional element of the Siemens 7SAxxx distance relay family (the Siemens 7Sa522 directional element type is ”Double Direction”, all other relays are using the ”Single Direction” type).

4 Logic

4.1 Single phase

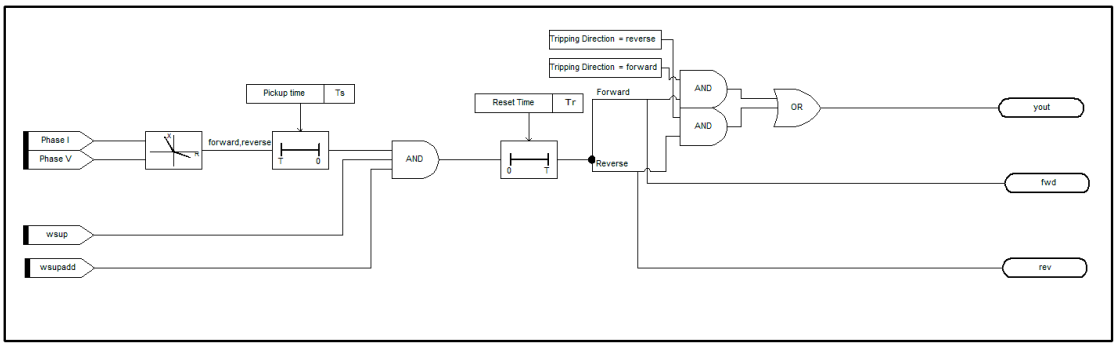
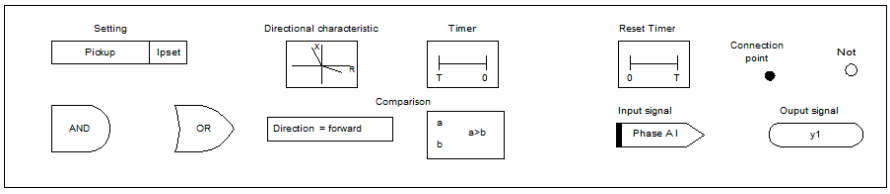


Figure 4.1: The *Distance Directional single phase (CalDisdir1p)logic*



4.2 Three phases

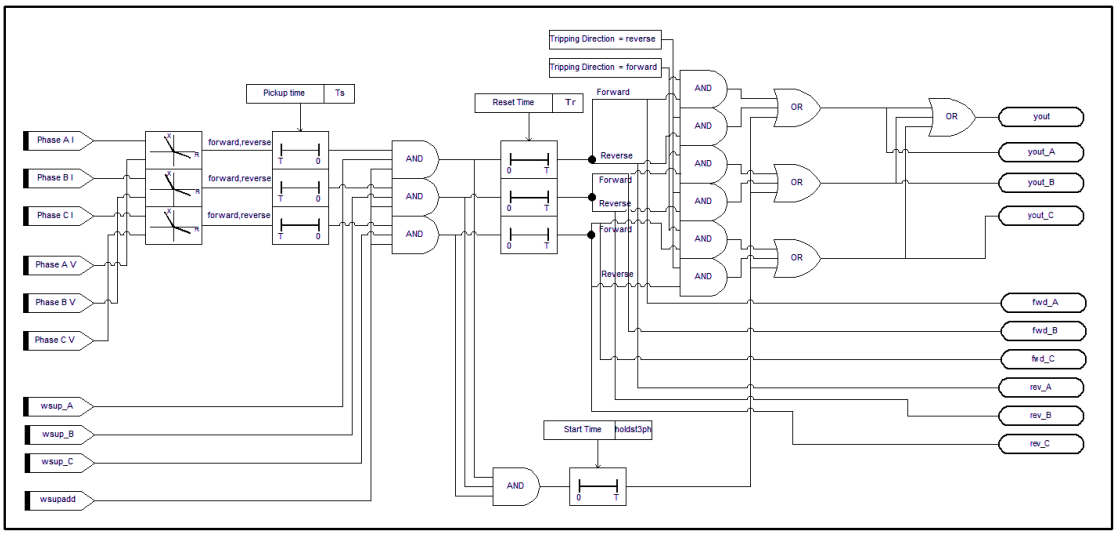
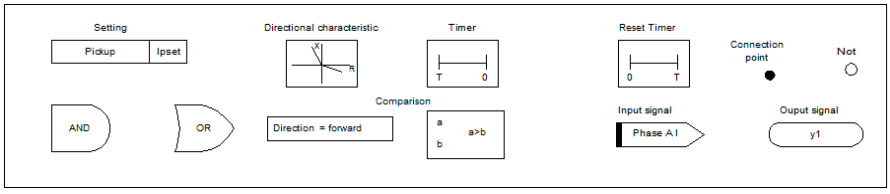


Figure 4.2: The *Distance Directional three phasse (CalDisdir3p)logic*



4.3 Six phases

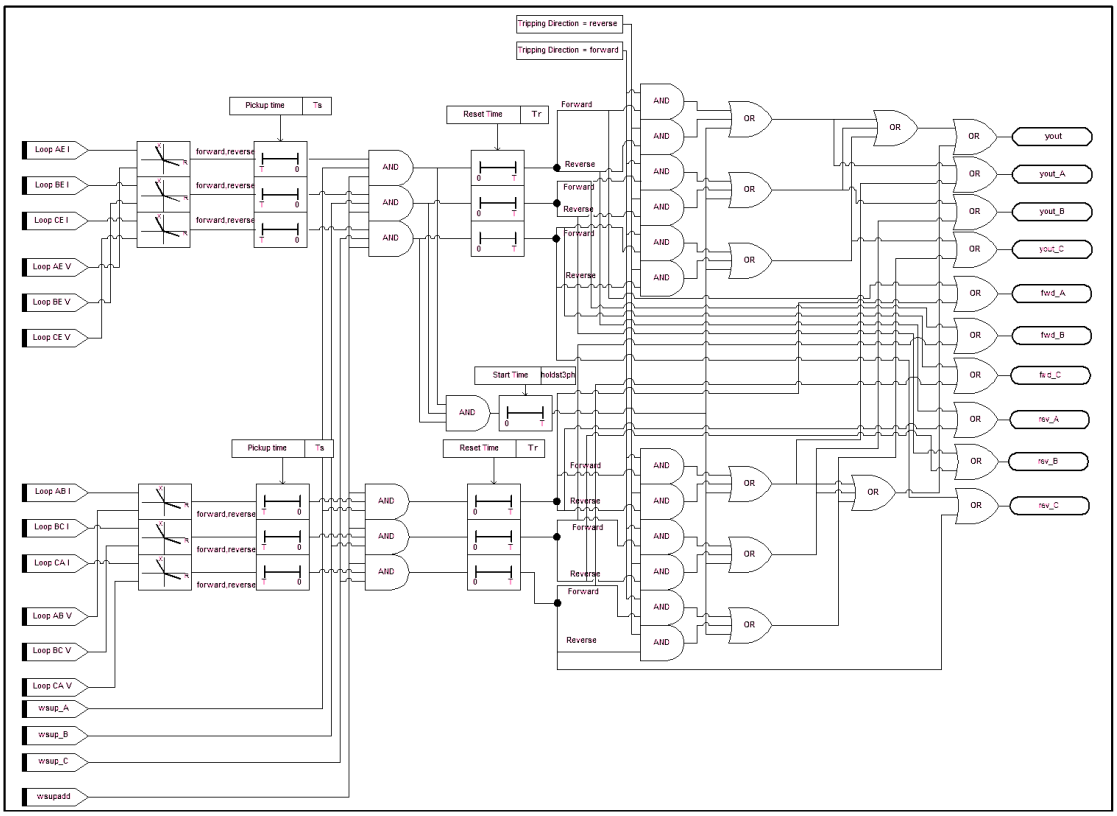
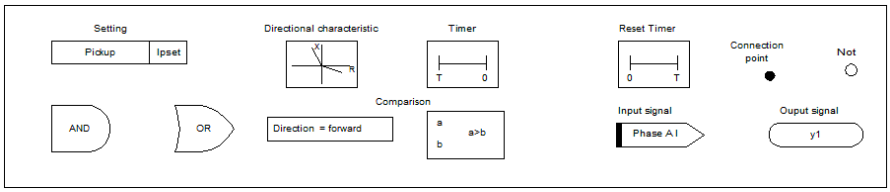


Figure 4.3: The *Distance Directional six phases (CalDisdir6p)logic*



4.4 ABB(multi) and Siemens(multi)

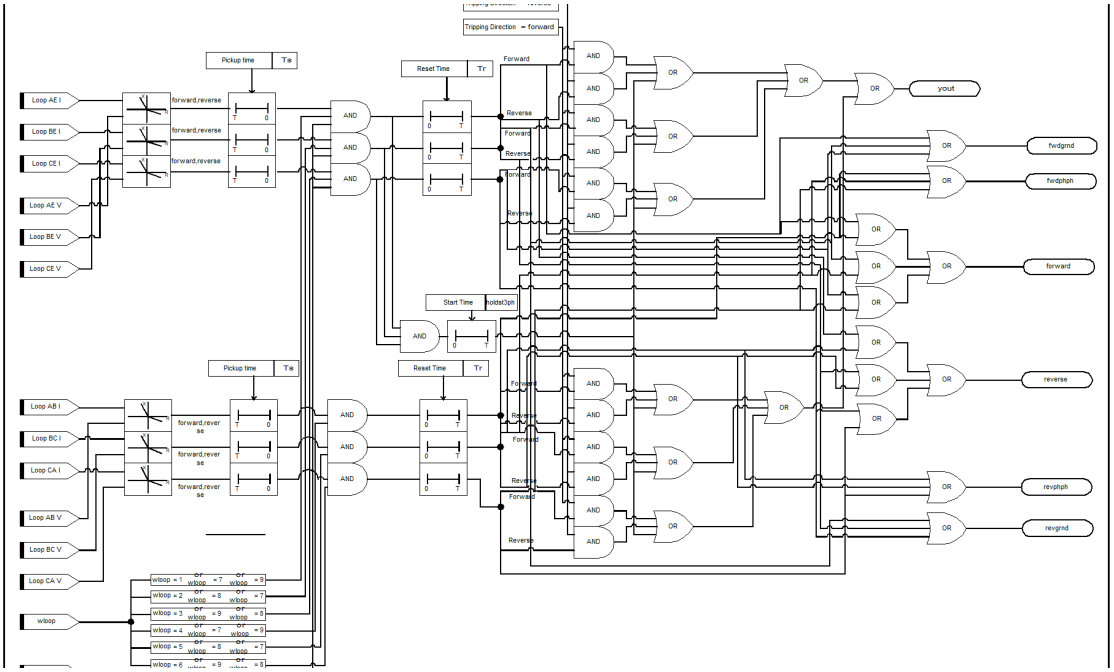
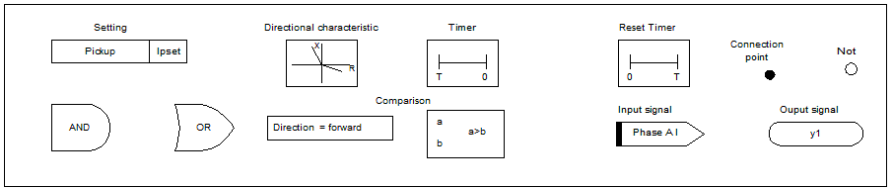


Figure 4.4: The *Distance Directional ABB(multi) and Siemens(multi) (CalDisdirsie and CalDisdirabb)logic*



5 Input Parameters definition

5.1 Distance Directional Type (TypDisDir)

Table 5.1: Input parameters of the Distance Directional type (*TypDisdir*))

Parameter	Description	Unit
loc_name	The directional type block name	Text
loc_name	The distance directional type block name	Text
iphases	The number of phases (1 or 3 or 6)	Integer
ichatp	The directional type. It can be ”single direction” or ”double direction’	Integer
aunit	By which type of distance element the directional comparison is used. It can be ”Earth”, ”Phase”, ”3 Phase”, ”Multifunctional”, ”Multifunctional(digital)”, ”ABB(Multi)”, ”Siemens(Multi)”	Text
rphi	Range of the ”Phi directional angle”	Text
ralpha	Range of the ”Alpha directional angle”	Text
roffset	Range of the ”Offset angle”	Text
rphisec	Range of the ”Operating Sector angle”	Text
ihold3ph	3Ph Fault Direction holding mode (”Disabled”, ”Enabled”, ”User Configurable”)	Integer
rholdst3ph	Range of the 3Ph Fault Direction holding time	Text
iholdstunit	3Ph Fault Direction holding time unit	Text
Ts	Pickup Time	Seconds
Tr	Reset time	Seconds
Kr	Reset ratio	Seconds

5.2 Distance Directional element (RelDisDir)

Table 5.2: Input parameters of the Distance Directional element (*RelDisdir*))

Parameter	Description	Unit
loc_name	The distance directional block name	Text
typ_id	Reference to the distance directional type block	Pointer
outserv	Flag to enable/disable the block	Y/N
phi	Phi directional angle	Real
alpha	Alpha directional angle	Real
offset	Offset angle	Real
phisec	Operating Sector angle	Real
ihold3ph	Flag to enable/disable the 3Ph Fault Direction holding	Integer
holdst3ph	3Ph Fault Direction holding time	Real (Seconds)
choldst3ph	3Ph Fault Direction holding time	Real (Cycles)

6 Input/Output signals definition

6.1 Single phase signals definition

Table 6.1: Input/output signals of the single phase Distance Directional element (*CalDisdir1p*)

Name	Description	Unit	Type	Model
Iopr	Operating Current real part	Amperes	IN	Any
Iopi	Operating Current imaginary part	Amperes	IN	Any
Upolr	Polarizing voltage real part	Volts	IN	Any
Upoli	Polarizing voltage imaginary part	Volts	IN	Any
wsup	Supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wsupadd	Additional supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wtimer	Timer input signal	Seconds (or 1/0 during the simulation)	IN	Any
yout	Distance directional element trip signal Seconds (or 1/0 during the simulation)	Seconds (or 1/0 during the simulation)	OUT	Any
fwd	Signal on when the element detects a forward condition Seconds (or 1/0 during the simulation)	Seconds (or 1/0 during the simulation)	OUT	Any
rev	Signal on when the element detects a reverse condition Seconds (or 1/0 during the simulation)	Seconds (or 1/0 during the simulation)	OUT	Any

6.2 Three phases signals definition

Table 6.2: Input/output signals of the three phase Distance Directional element (*CalDisdir3p*)

Name	Description	Unit	Type	Model
Iopr_A	Phase A operating Current real part	Amperes	IN	Any
Iopr_B	Phase B operating Current real part	Amperes	IN	Any
Iopr_C	Phase C operating Current real part	Amperes	IN	Any
Iopi_A	Phase A operating Current imaginary part	Amperes	IN	Any
Iopi_B	Phase B operating Current imaginary part	Amperes	IN	Any
Iopi_C	Phase C operating Current imaginary part	Amperes	IN	Any
Upolr_A	Phase A polarizing voltage real part	Volts	IN	Any
Upolr_B	Phase B polarizing voltage real part	Volts	IN	Any
Upolr_C	Phase C polarizing voltage real part	Volts	IN	Any
Upoli_A	Phase A polarizing voltage imaginary part	Volts	IN	Any
Upoli_B	Phase B polarizing voltage imaginary part	Volts	IN	Any
Upoli_C	Phase C polarizing voltage imaginary part	Volts	IN	Any
wsup_A	Phase A supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wsup_B	Phase B supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wsup_C	Phase C supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wsupadd	Additional supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wtimer	Timer input signal	Seconds (or 1/0 during the simulation)	IN	Any
yout	Distance directional element trip signal	Seconds (or 1/0 during the simulation)	OUT	Any
yout_A	Phase A distance directional element trip signal	Seconds (or 1/0 during the simulation)	OUT	Any
yout_B	Phase B distance directional element trip signal	Seconds (or 1/0 during the simulation)	OUT	Any
yout_C	Phase C distance directional element trip signal	Seconds (or 1/0 during the simulation)	OUT	Any
fwd_A	Signal on when the element detects a Phase A forward condition	Seconds (or 1/0 during the simulation)	OUT	Any
fwd_B	Signal on when the element detects a Phase B forward condition	Seconds (or 1/0 during the simulation)	OUT	Any
fwd_C	Signal on when the element detects a Phase C forward condition	Seconds (or 1/0 during the simulation)	OUT	Any
rev_A	Signal on when the element detects a Phase A reverse condition	Seconds (or 1/0 during the simulation)	OUT	Any
rev_B	Signal on when the element detects a Phase B reverse condition	Seconds (or 1/0 during the simulation)	OUT	Any
rev_C	Signal on when the element detects a Phase C reverse condition	Seconds (or 1/0 during the simulation)	OUT	Any

6.3 Six phases signals definition

Table 6.3: Input/output signals of the six phase Distance Directional element (*CalDisdir6p*)

Name	Description	Unit	Type	Model
Ioprr_A	Loop AB operating current real part	Amperes	IN	Any
Ioprr_B	Loop BC operating current real part	Amperes	IN	Any
Ioprr_C	Loop CA operating current real part	Amperes	IN	Any
Iopii_A	Loop AB operating current imaginary part	Amperes	IN	Any
Iopii_B	Loop BC operating current imaginary part	Amperes	IN	Any
Iopii_C	Loop CA operating current imaginary part	Amperes	IN	Any
Igoprr_A	Loop AE operating current real part	Amperes	IN	Any
Igoprr_B	Loop BE operating current real part	Amperes	IN	Any
Igoprr_C	Loop CE operating current real part	Amperes	IN	Any
Igopii_A	Loop AE operating current imaginary part	Amperes	IN	Any
Igopii_B	Loop BE operating current imaginary part	Amperes	IN	Any
Igopii_C	Loop CE operating current imaginary part	Amperes	IN	Any
Upolr_A	Loop AB polarizing voltage real part	Volts	IN	Any
Upolr_B	Loop BC polarizing voltage real part	Volts	IN	Any
Upolr_C	Loop CA polarizing voltage real part	Volts	IN	Any
Upoli_A	Loop AB polarizing voltage imaginary part	Volts	IN	Any
Upoli_B	Loop BC polarizing voltage imaginary part	Volts	IN	Any
Upoli_C	Loop CA polarizing voltage imaginary part	Volts	IN	Any
Ugpolr_A	Loop AE polarizing voltage real part	Volts	IN	Any
Ugpolr_B	Loop BE polarizing voltage real part	Volts	IN	Any
Ugpolr_C	Loop CE polarizing voltage real part	Volts	IN	Any
Ugpoli_A	Loop AE polarizing voltage imaginary part	Volts	IN	Any
Ugpoli_B	Loop BE polarizing voltage imaginary part	Volts	IN	Any
Ugpoli_C	Loop CE polarizing voltage imaginary part	Volts	IN	Any
wsup_A	Loop AB/AE supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wsup_B	Loop BC/BE supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wsup_C	Loop CA/CE supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wsupadd	Additional supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wearth	Earth fault detected supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wtimer	Timer input signal	Seconds (or 1/0 during the simulation)	IN	Any
yout	Distance directional element trip signal	Seconds (or 1/0 during the simulation)	OUT	Any
yout_A	Loop A distance directional element trip signal	Seconds (or 1/0 during the simulation))	OUT	Any
yout_B	Loop B distance directional element trip signal	Seconds (or 1/0 during the simulation))	OUT	Any
yout_C	Loop C distance directional element trip signal	Seconds (or 1/0 during the simulation))	OUT	Any
fwd_A	Signal on when the element detects a loop A forward condition	Seconds (or 1/0 during the simulation))	OUT	Any
fwd_B	Signal on when the element detects a loop B forward condition	Seconds (or 1/0 during the simulation))	OUT	Any
fwd_C	Signal on when the element detects a loop C forward condition	Seconds (or 1/0 during the simulation))	OUT	Any
rev_A	Signal on when the element detects a loop A reverse condition	Seconds (or 1/0 during the simulation))	OUT	Any
rev_B	Signal on when the element detects a loop B reverse condition	Seconds (or 1/0 during the simulation))	OUT	Any
rev_C	Signal on when the element detects a loop C reverse condition	Seconds (or 1/0 during the simulation))	OUT	Any

6.4 ABB(multi) or Siemens(multi) unit signals definition

Table 6.4: Input/output signals of the ABB(multi) or Siemens(multi) Distance Directional element (*CalDisdirabb and CalDisdirsie*)

Name	Description	Unit	Type	Model
Ioprr_A	Loop AB operating current real part	Amperes	IN	Any
Ioprr_B	Loop BC operating current real part	Amperes	IN	Any
Ioprr_C	Loop CA operating current real part	Amperes	IN	Any
Iopii_A	Loop AB operating current imaginary part	Amperes	IN	Any
Iopii_B	Loop BC operating current imaginary part	Amperes	IN	Any

Table 6.4: Input/output signals of the ABB(multi) or Siemens(multi) Distance Directional element (*CalDisdirabb and CalDisdirsie*)

Name	Description	Unit	Type	Model
Iopi_C	Loop CA operating current imaginary part	Amperes	IN	Any
Igopr_A	Loop AE operating current real part	Amperes	IN	Any
Igopr_B	Loop BE operating current real part	Amperes	IN	Any
Igopr_C	Loop CE operating current real part	Amperes	IN	Any
Igopi_A	Loop AE operating current imaginary part	Amperes	IN	Any
Igopi_B	Loop BE operating current imaginary part	Amperes	IN	Any
Igopi_C	Loop CE operating current imaginary part	Amperes	IN	Any
Upolr_A	Loop AB polarizing voltage real part	Volts	IN	Any
Upolr_B	Loop BC polarizing voltage real part	Volts	IN	Any
Upolr_C	Loop CA polarizing voltage real part	Volts	IN	Any
Upoli_A	Loop AB polarizing voltage imaginary part	Volts	IN	Any
Upoli_B	Loop BC polarizing voltage imaginary part	Volts	IN	Any
Upoli_C	Loop CA polarizing voltage imaginary part	Volts	IN	Any
Ugpolr_A	Loop AE polarizing voltage real part	Volts	IN	Any
Ugpolr_B	Loop BE polarizing voltage real part	Volts	IN	Any
Ugpolr_C	Loop CE polarizing voltage real part	Volts	IN	Any
Ugpoli_A	Loop AE polarizing voltage imaginary part	Volts	IN	Any
Ugpoli_B	Loop BE polarizing voltage imaginary part	Volts	IN	Any
Ugpoli_C	Loop CE polarizing voltage imaginary part	Volts	IN	Any
wsup	Supervision signal	Seconds (or 1/0 during the simulation)	IN	Any
wloop	ID of the faulted loop		IN	Any
wtimer	Timer input signal	Seconds (or 1/0 during the simulation)	IN	Any
yout	Distance directional element trip signal	Seconds (or 1/0 during the simulation)	OUT	Any
forward	Signal on when the element detects a forward condition	Seconds (or 1/0 during the simulation)	OUT	Any
reverse	Signal on when the element detects a reverse condition	Seconds (or 1/0 during the simulation)	OUT	Any
fwdphph	Signal on when the element detects a phase - phase loop forward condition	Seconds (or 1/0 during the simulation)	OUT	Any
revphph	Signal on when the element detects a phase - phase reverse condition	Seconds (or 1/0 during the simulation)	OUT	Any
fwdgrnd	Signal on when the element detects a phase - ground loop forward condition	Seconds (or 1/0 during the simulation)	OUT	Any
revgrnd	Signal on when the element detects a phase - ground reverse condition	Seconds (or 1/0 during the simulation)	OUT	Any
fwd_A	Signal on when the element detects a loop A forward condition	Seconds (or 1/0 during the simulation))	OUT	Any, ABB only
fwd_B	Signal on when the element detects a loop B forward condition	Seconds (or 1/0 during the simulation))	OUT	Any, ABB only
fwd_C	Signal on when the element detects a loop C forward condition	Seconds (or 1/0 during the simulation))	OUT	Any, ABB only
rev_A	Signal on when the element detects a loop A reverse condition	Seconds (or 1/0 during the simulation))	OUT	Any, ABB only
rev_B	Signal on when the element detects a loop B reverse condition	Seconds (or 1/0 during the simulation))	OUT	Any, ABB only
rev_C	Signal on when the element detects a loop C reverse condition	Seconds (or 1/0 during the simulation))	OUT	Any, ABB only

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