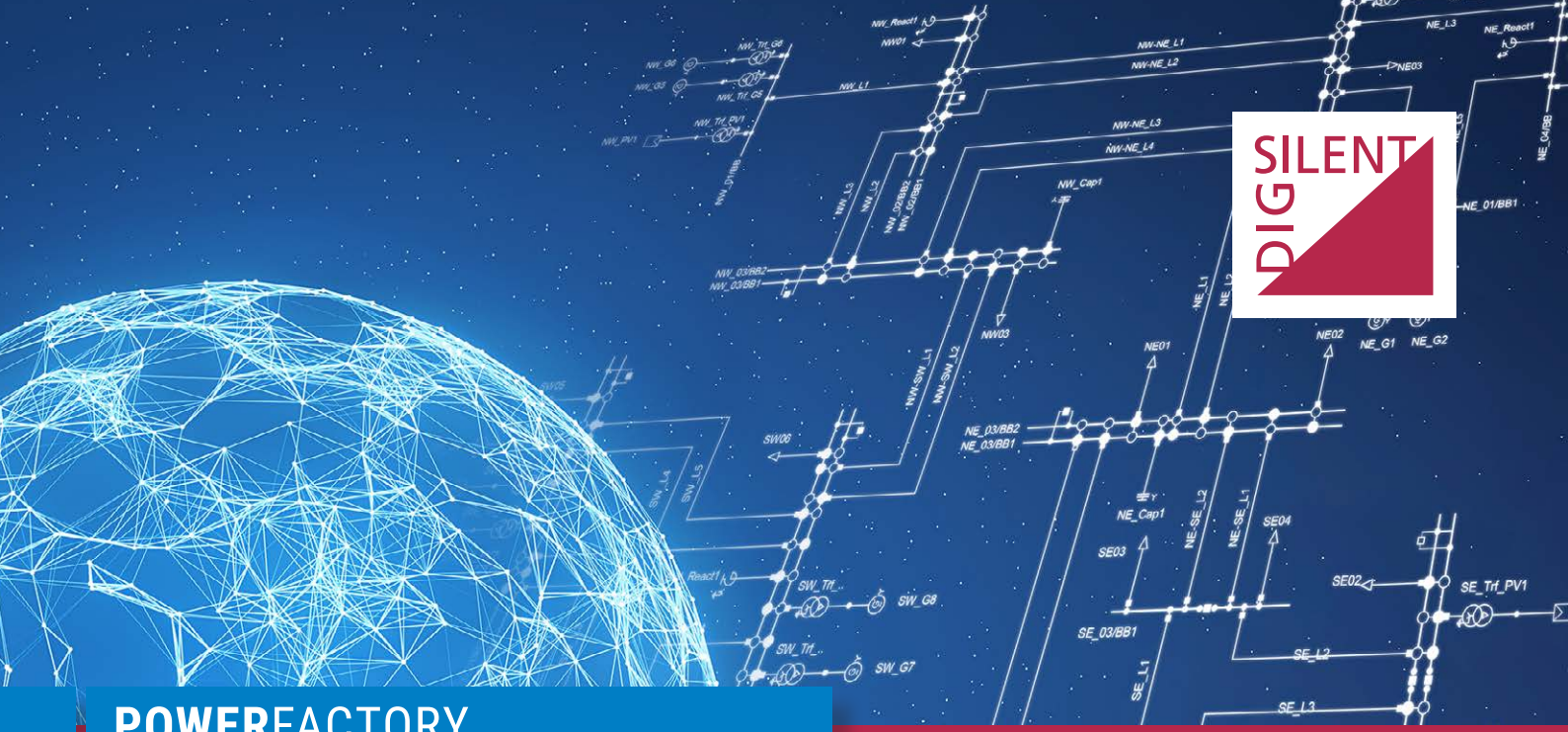


POWERFACTORY

PowerFactory 2021

Technical Reference

ABB starting unit

RelFdetabb, TypFdetabb

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

Publisher:
DIgSILENT GmbH
Heinrich-Hertz-Straße 9
72810 Gomaringen / Germany
Tel.: +49 (0) 7072-9168-0
Fax: +49 (0) 7072-9168-88
info@digsilent.de

Please visit our homepage at:
https://www.digsilent.de

December 1, 2020
PowerFactory 2021
Revision 1

Contents

1 General Description **1**

2 Features & User interface **1**

2.1 ABB Starting Logic (RelFdetabb) 1

2.1.1 Basic data 1

2.1.2 Phase/ground fault conditions 1

ABB REL 100 2

ABB REL 316 2

ABB REL 511 3

ABB REL 521/531 3

ABB REL 670 4

2.1.3 The “Overcurrent” logic 4

2.1.4 The “Impedance Z” logic 5

ABB REL 316 5

ABB REL 511 6

ABB REL 521/531 7

ABB REL670 9

2.1.5 Phase selection logic 10

2.1.6 Description 11

2.2 ABB Starting Type(TypFdetABB) 11

2.2.1 Basic data 11

2.2.2 Phase/Ground Detection 11

2.2.3 Overcurrent 11

2.2.4 Underimpedance 11

2.2.5 Phase Preference 12

2.2.6 Common 12

3 Integration in the relay scheme **12**

4 Logic **13**

4.1 ABB REL 100 13

ABB REL 316 14
ABB REL 511 15
ABB REL 521/531 16
ABB REL 670 17

A Parameter Definitions **18**

A.1 ABB starting block Type (TypFdetabb) 18
A.2 ABB starting Element (RelFdetabb) 19

B Signal Definitions **20**

List of Figures **21**

List of Tables **22**

1 General Description

The ABB starting block implements the fault detection logic available in the ABB REL100, REL 316, REL 5xx relay family and REL670 relay. The REL 5xx relay family consists of the ABB REL 511, REL521 and REL531 relay model logic. Inside the relay manuals such logic is defined as “General Fault Criteria” (GFC) in the ABB REL 511 and “Phase Selection Logic” (PSH) in the ABB REL 100, REL 521, REL 531 and REL 670 relay model logic. Two different types of fault detection are available: “Overcurrent” and “Impedance Z” (underimpedance) detection logic. Both are available in the ABB REL 511 and the REL316 , only the “Impedance Z” (underimpedance) logic is available in the ABB REL 521, REL 531 and in the REL670 relay model logic. The ABB REL 100 is driven only by the overcurrent phase selection logic.

2 Features & User interface

2.1 ABB Starting Logic (RelFdetabb)

The user can change the block settings using the “ABB Starting” dialogue (“RelFdetabb” class). The dialogue consists of 6 tab pages: *Basic data*, *Phase/ground fault conditions*, *Overcurrent*, *Impedance Z*, *Phase Preference Logic*,and *Description*.

2.1.1 Basic data

The “Basic Data” tab page contains the block name and two check boxes which allow to enable/disable separately the *overcurrent* and *underimpedance* logic. If both are disabled the block starting logic is disabled.

2.1.2 Phase/ground fault conditions

The first step in the fault detection logic is to figure out the kind of fault; accordingly with the type of fault the *GFC-STPE* (fault involving ground) and the *GFC-STPP* (phase-phase fault) internal signals will be set. No data are present in such page when the ABB REL 100 starting type is selected. When the ABB REL 511, REL 521/531, and REL 670 starting type is selected two settings, “INReleasePE” and “INBlockPP”, are displayed. Additionally the ABB REL 511 and the ABB REL 670 starting type implements a backup trip with separated phase and ground delay times: the “yout” block output signal is activated after the time set in the “tPP” parameter for the phase fault detection and the time set in the “tPE” parameter for the earth fault detection is expired.

Please note that, for the ABB REL 511, REL 521/531, and REL 670 starting type, the “IminOp” variable is part of “Impedance Z” starting logic and can be set in the “Underimpedance” tab page of the ABB starting block dialogue.

In the following paragraphs the detection logics implemented in the block for available starting types are shown:

ABB REL 100 :

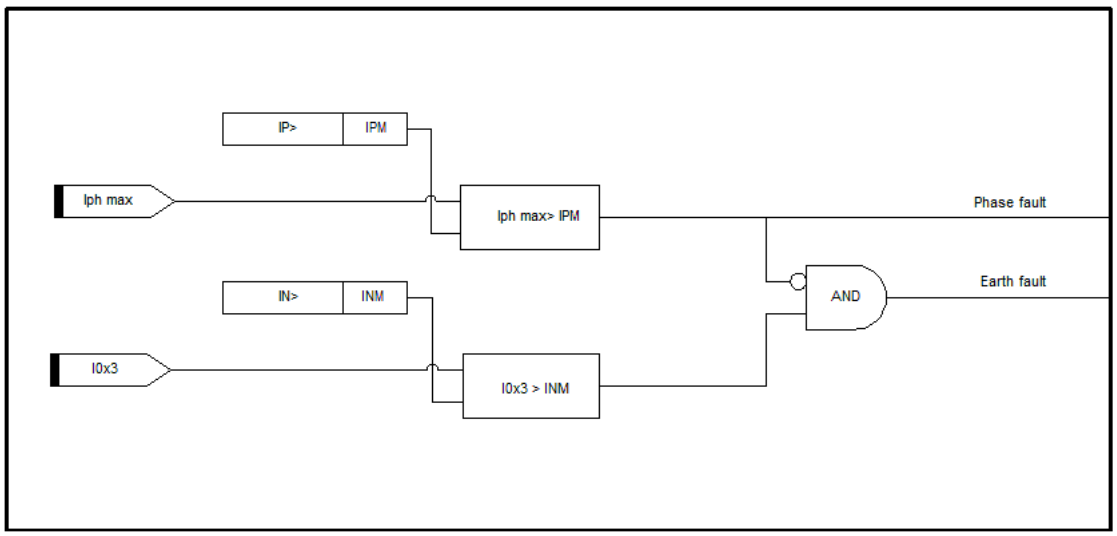


Figure 2.1: *DIgSILENT* The *ABB REL 100 Earth/phase fault detection logic*

ABB REL 316 :

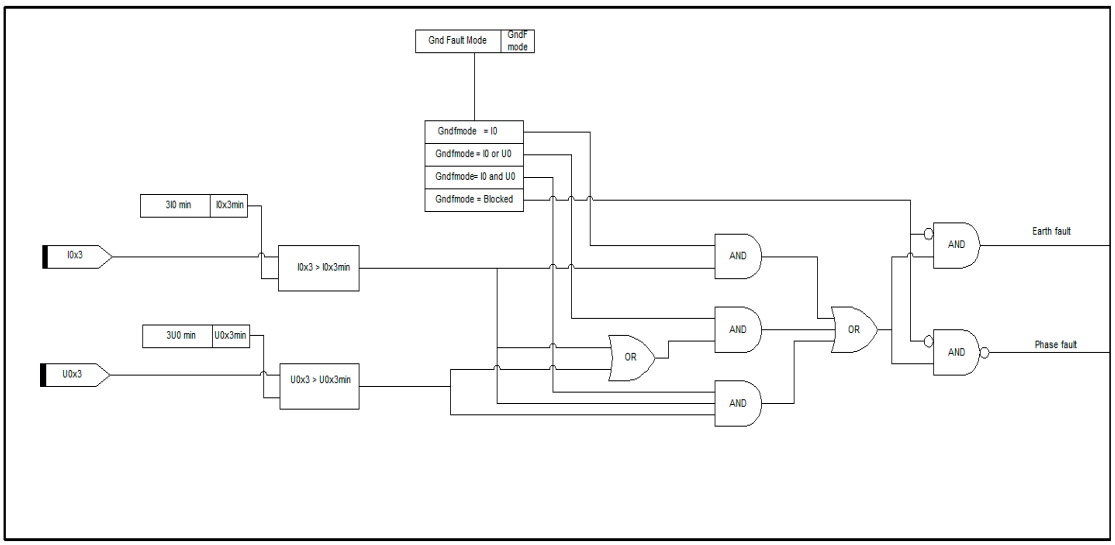


Figure 2.2: *DIgSILENT* The *ABB REL 316 Earth/phase fault detection logic*

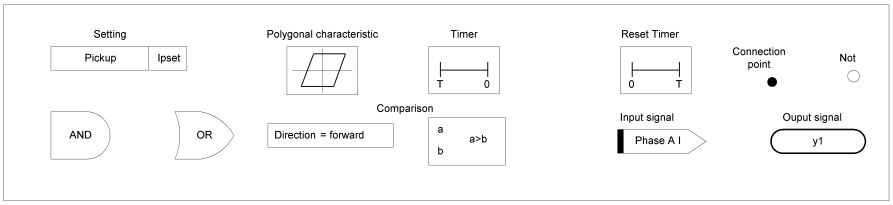


ABB REL 511 :

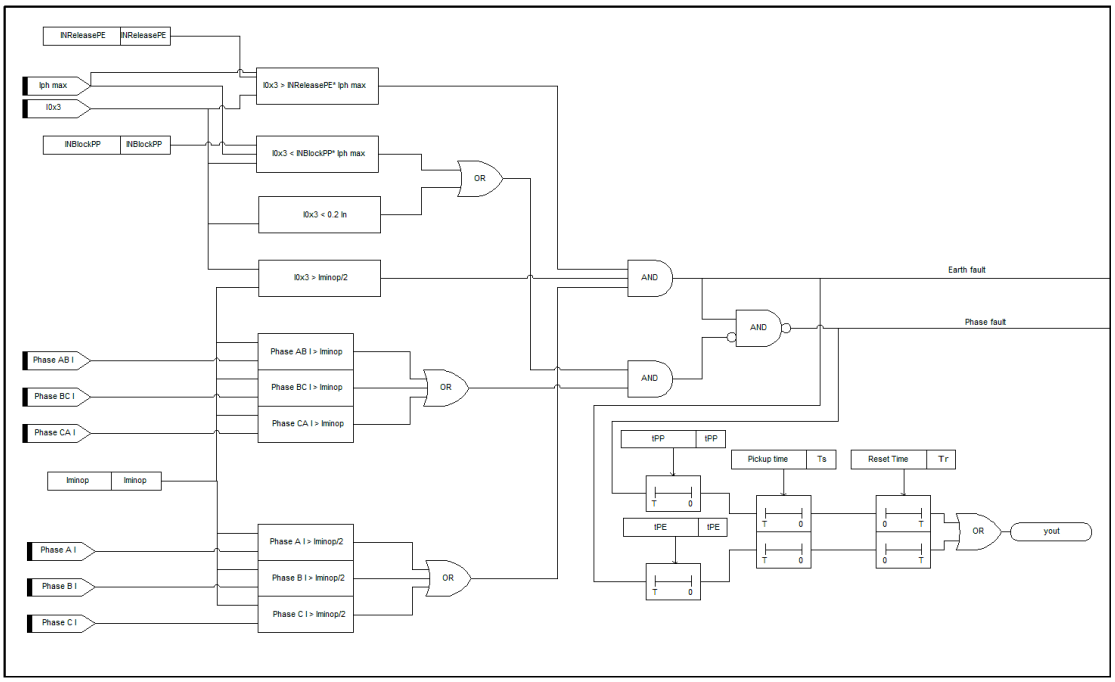


Figure 2.3: *DIgSILENT* The *ABB REL 511 Earth/phase fault detection logic*

ABB REL 521/531 :

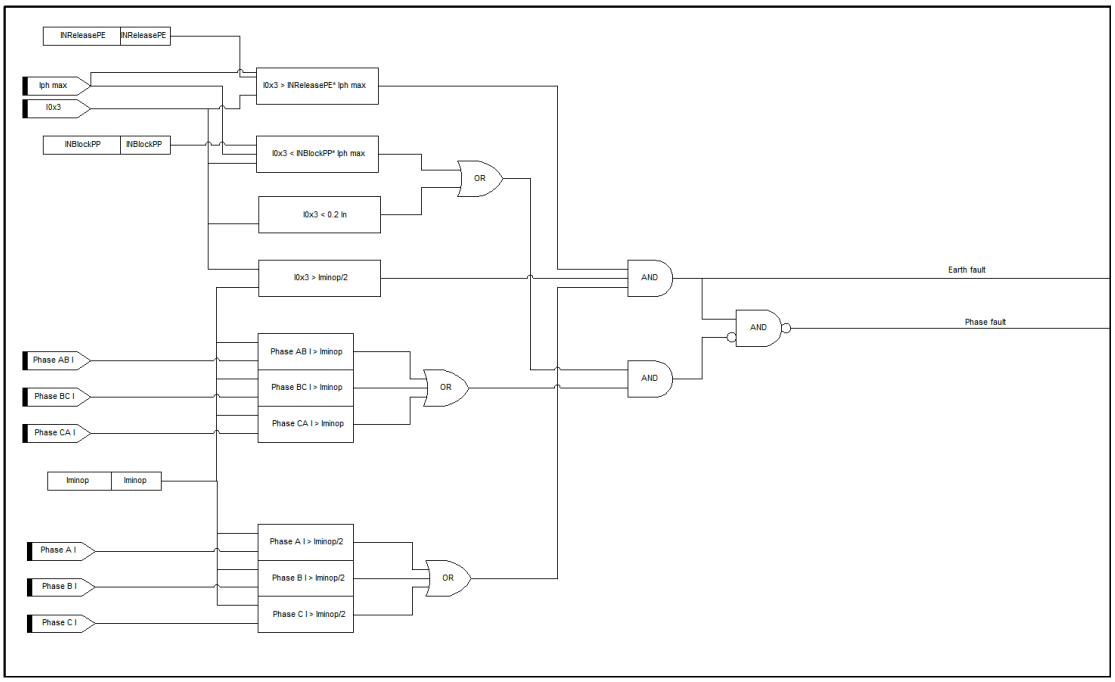


Figure 2.4: *DIgSILENT* The *ABB REL 521/531 Earth/phase fault detection logic*

ABB REL 670 :

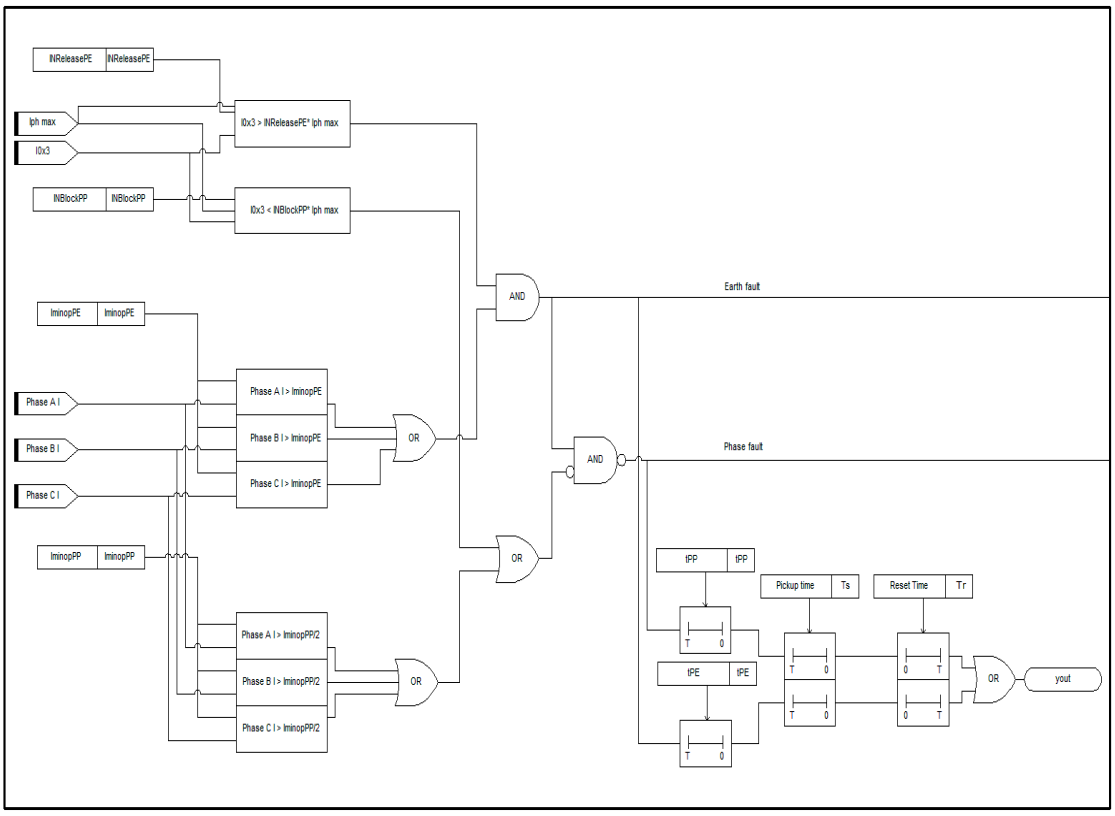
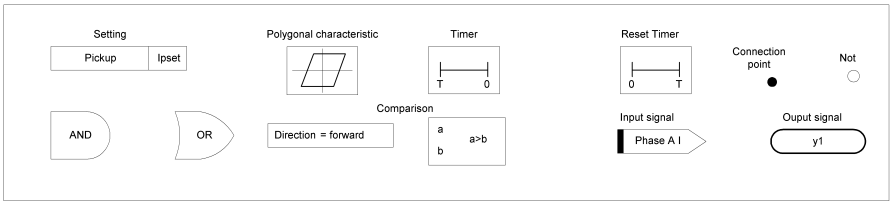


Figure 2.5: *DIgSILENT* The *ABB REL 670 Earth/phase fault detection logic*



2.1.3 The “Overcurrent” logic

The “Overcurrent” tab page contains the settings which allow to configure the overcurrent fault detection logic. The current-based measuring elements evaluate three phase currents and the residual current, comparing them with the set values. “IPM” is the threshold current for the phase measuring elements, and “INM” for the residual current measuring element. The operating conditions are as follows:

- I_A $>$ IPM, I_B $>$ IPM, I_C $>$ IPM for the phase A, B, C current measuring elements
- I0x3 $>$ INM for the residual current measuring element

The “Overcurrent” logic is the unique starting logic present in the ABB REL 100 starting type. It is not available for the the ABB REL 521/531, and REL 670 starting type.

2.1.4 The “Impedance Z” logic

The “Impedance Z” tab page contains the settings which allow to configure the impedance fault detection logic. The fault condition is detected when the calculated impedance point is within the set boundaries of the starting impedance characteristic. Different “Impedance” characteristics are available for the ABB REL 316, the ABB REL 511, the ABB REL 521 and 531 starting type and for the ABB REL 670 starting type.

In the following paragraphs the impedance zones implemented for the available starting types are shown:

ABB REL 316 :

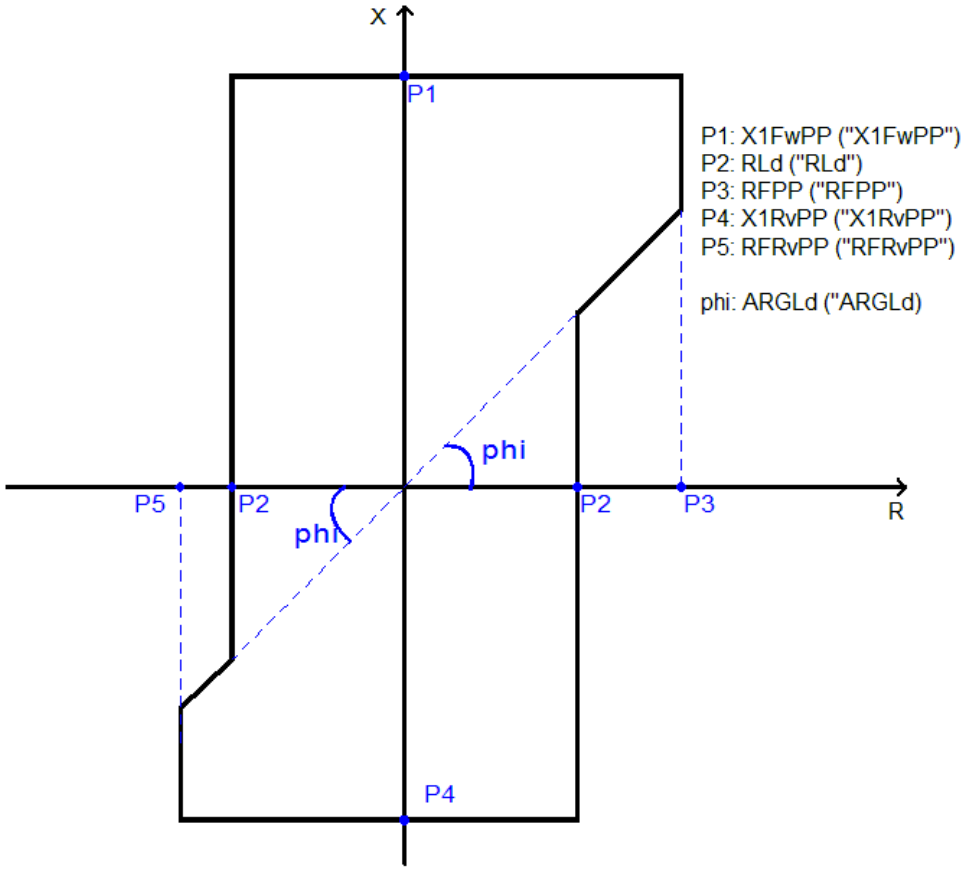


Figure 2.6: *DIgSILENT* The *ABB REL 316 phase-phase loops impedance zone*

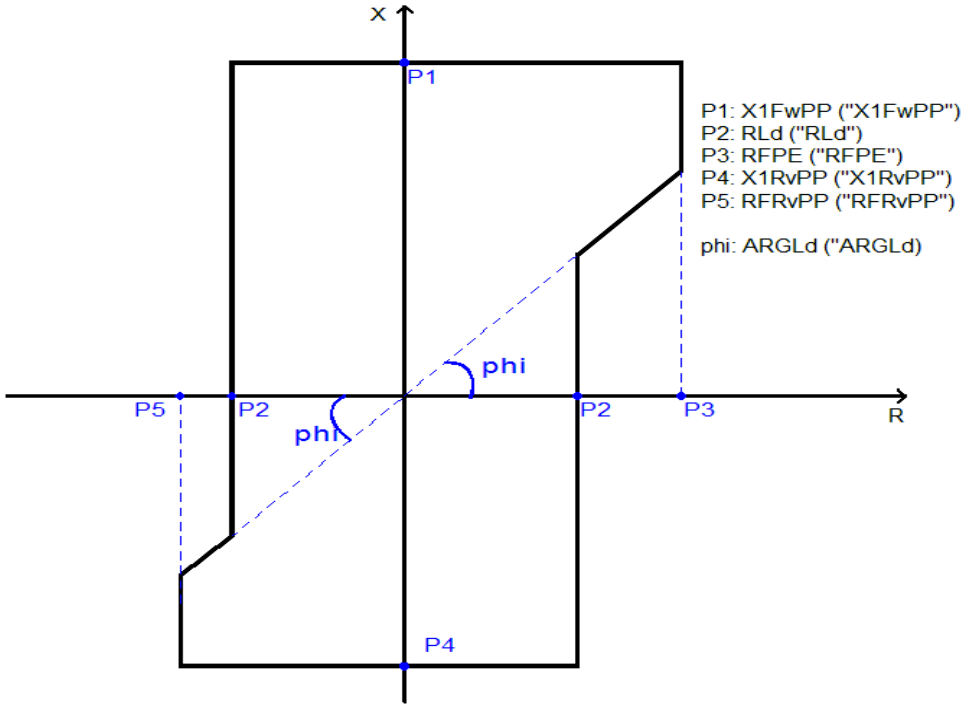


Figure 2.7: *DIgSILENT* The *ABB REL 316 phase-ground loops impedance zone*

ABB REL 511 :

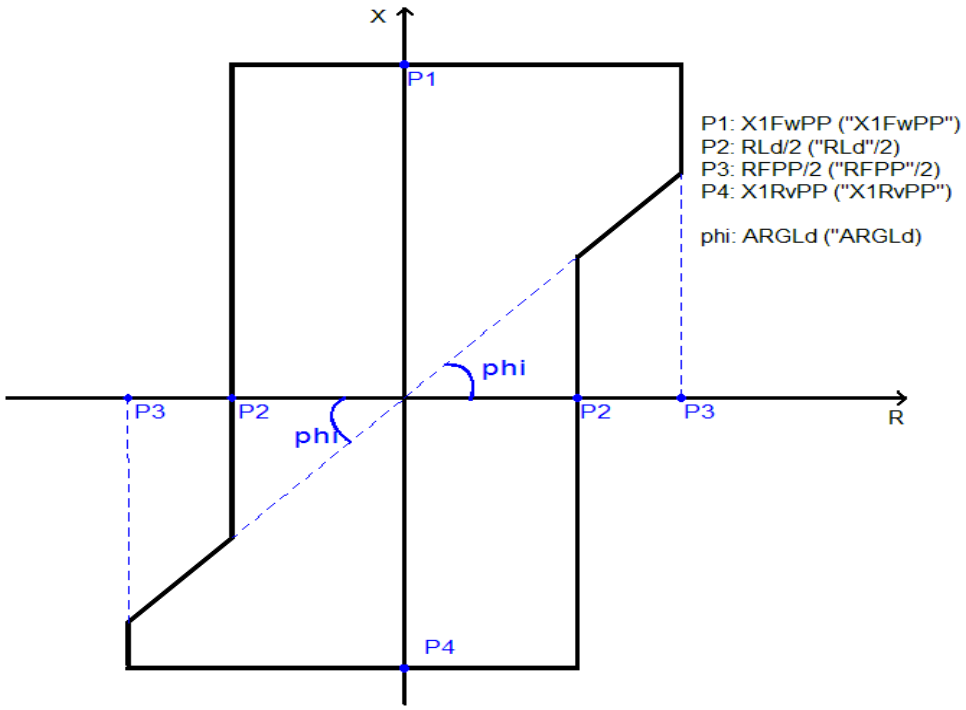


Figure 2.8: *DIgSILENT* The *ABB REL 511 phase-phase loops impedance zone*

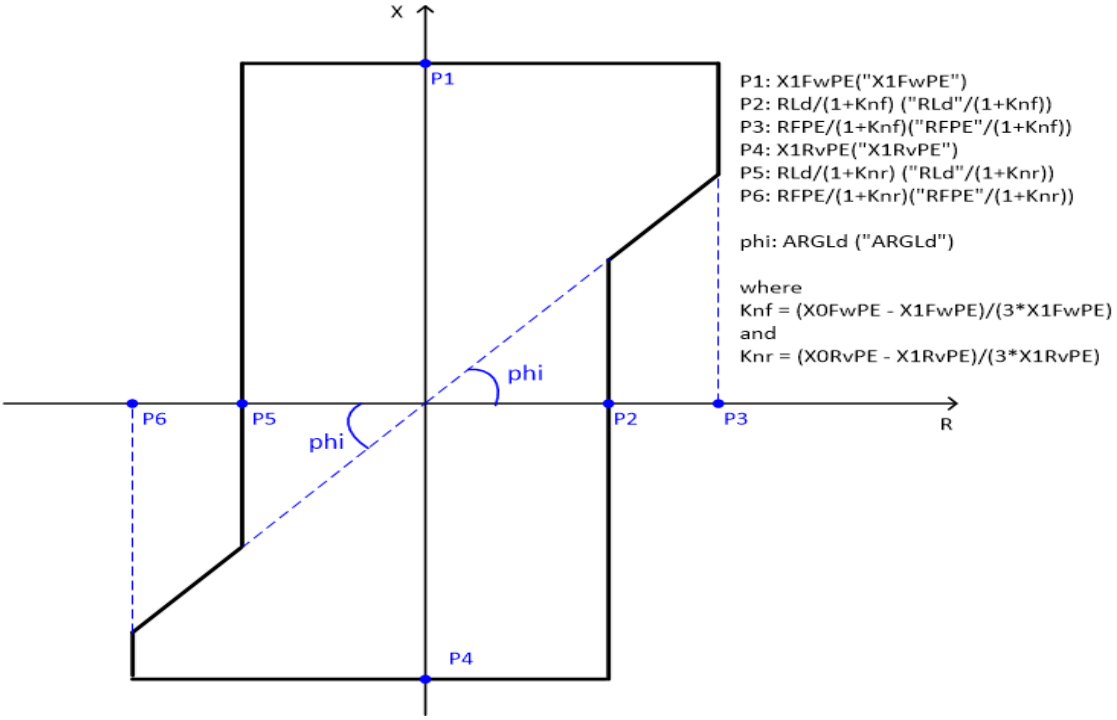


Figure 2.9: *DIgSILENT* The *ABB REL 511 phase-ground loops impedance zone*

ABB REL 521/531 :

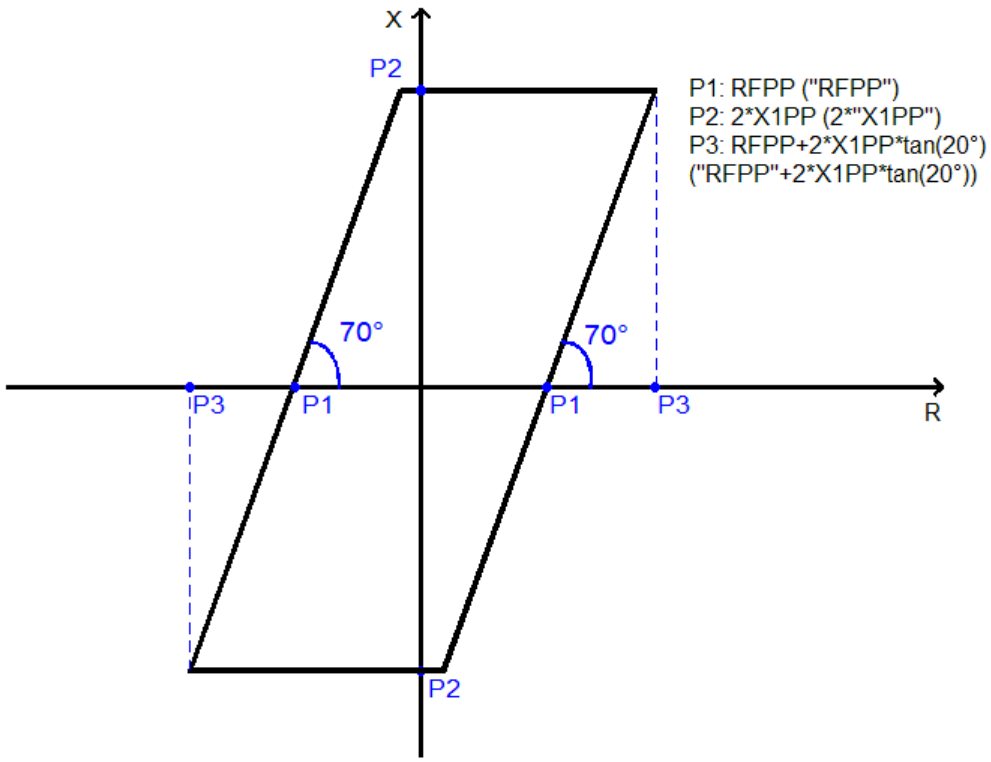


Figure 2.10: *DIgSILENT* The *ABB REL 521/531 phase-phase loops impedance zone*

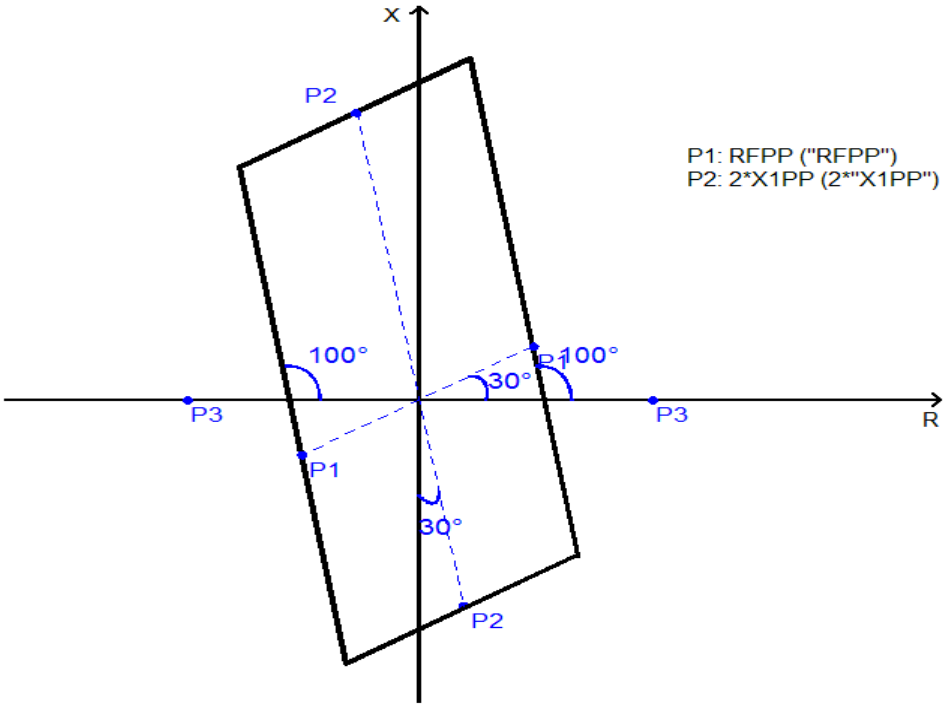


Figure 2.11: *DIgSILENT* The *ABB REL 521/531 phase-phase loops for 3phase faults impedance zone*

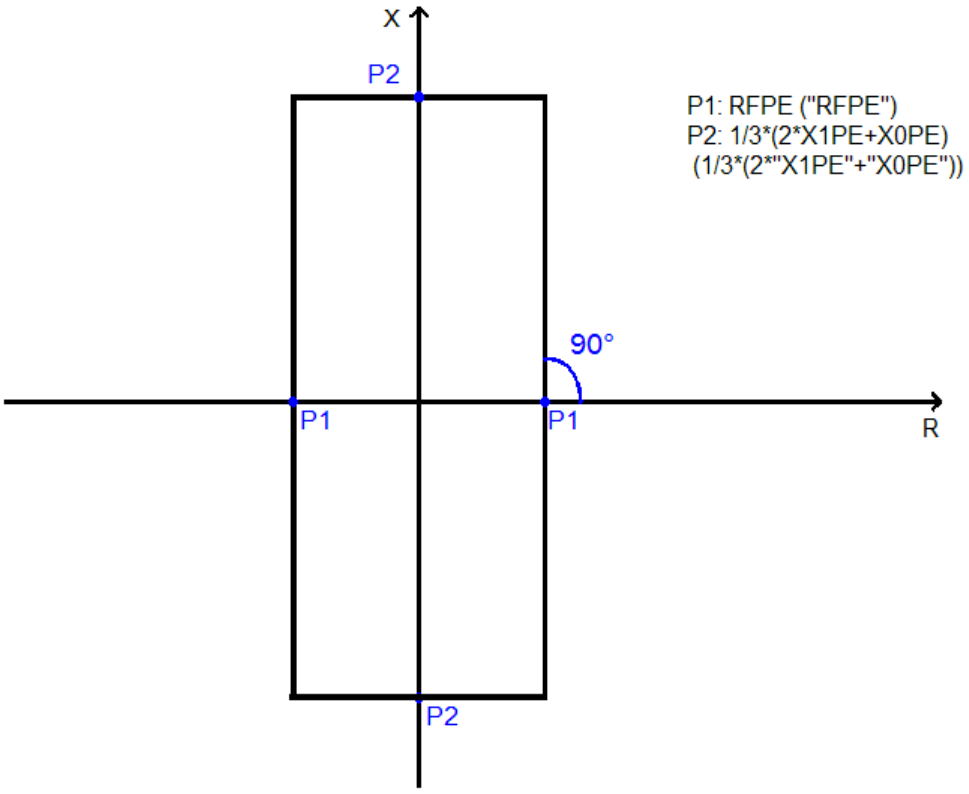


Figure 2.12: *DIgSILENT* The *ABB REL 521/531 phase-ground loops impedance zone*

ABB REL670 :

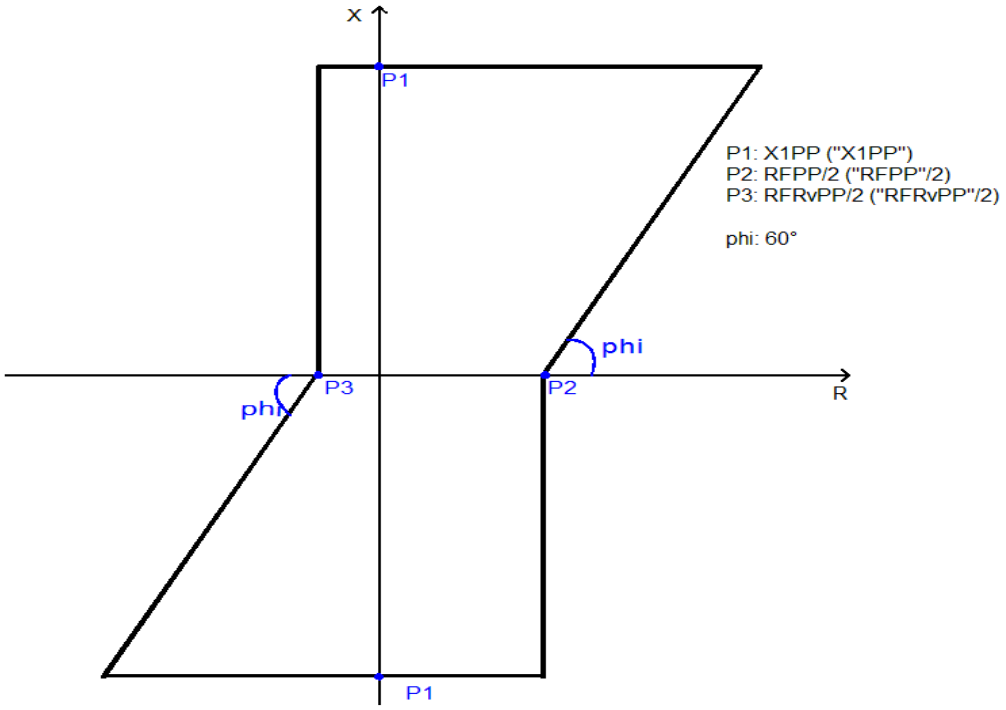


Figure 2.13: *DIgSILENT* The *ABB REL 670 phase-phase loops impedance zone*

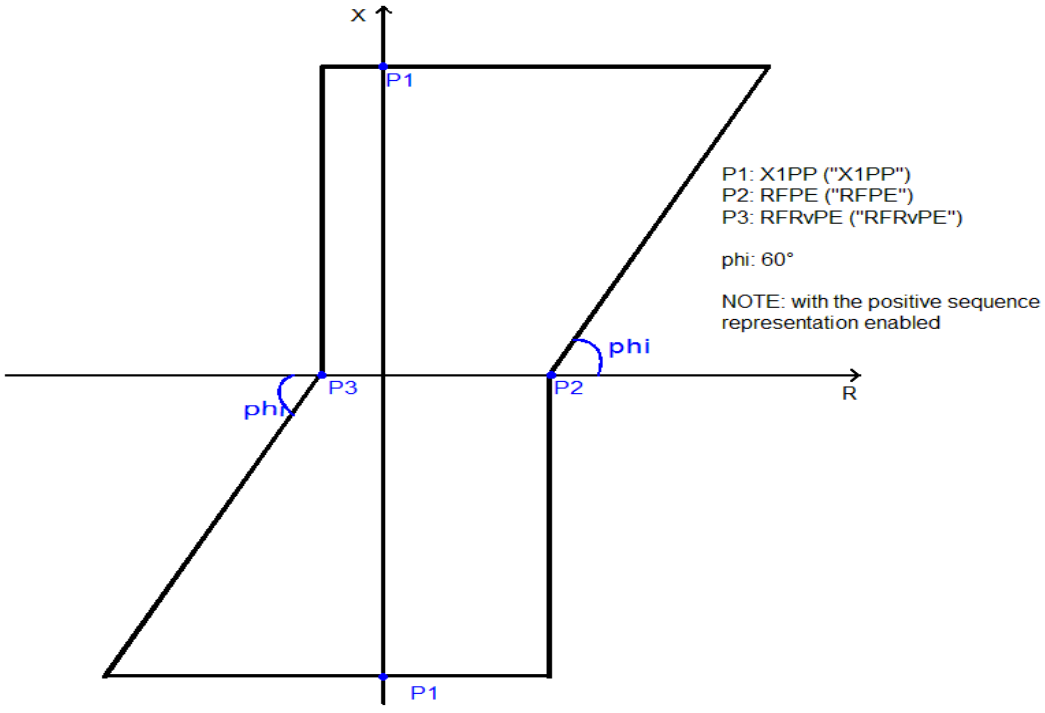


Figure 2.14: *DIgSILENT* The *ABB REL 670 phase-ground loops impedance zone*

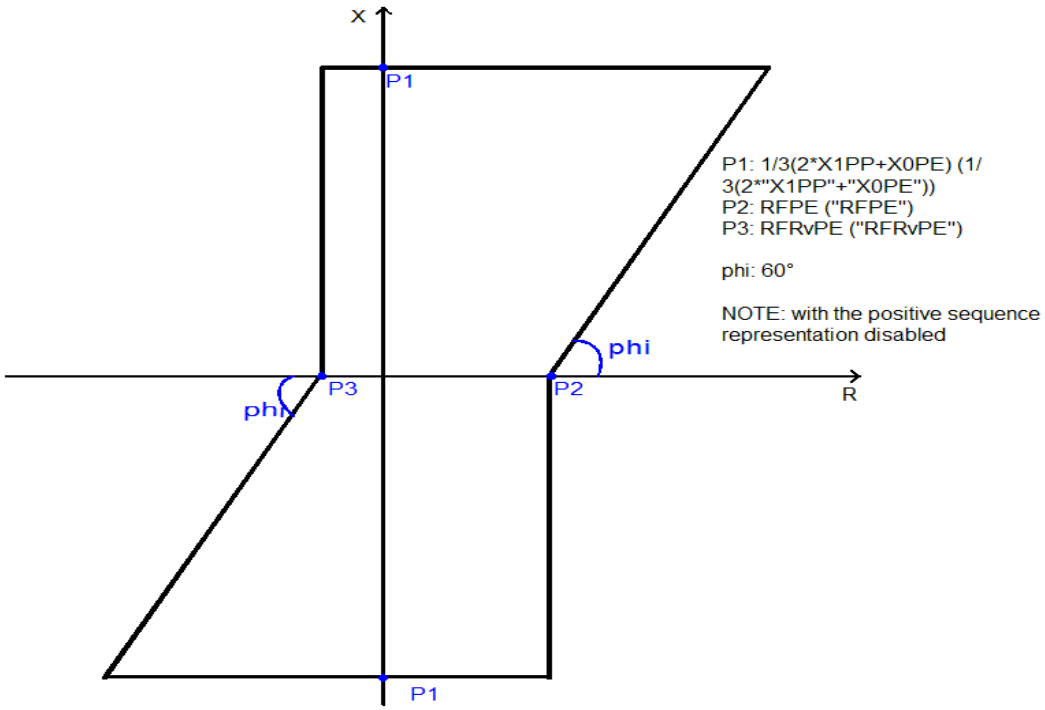


Figure 2.15: *DIgSILENT* The *ABB REL 670 phase-ground loops impedance zone (Force positive sequence raresentation disabled)*

2.1.5 Phase selection logic

The “Phase selection logic” tab page contains the settings which allow to decide which phase(s) to trip in case of cross-country faults in isolated or high impedance-grounded networks. It works as a possible addition to the standard ABB starting logic.

It consists of two different parts:

- A first part which inhibits the element start for single-pole earth faults.
- A second part which initiates the start for the cross-country faults, and allow to select a fault-loop to use in the trip evaluation logic.

The behaviour of the Phase selection logic can be configured setting the “Phase Pref” combo box (“Phase Pref” variable).

- When *“NoFilter”* is selected, the logic doesn’t inhibit the trip for any single-phase-to-earth faults.
- When *“NoPref”* is set, the logic inhibits relay trip for *single phase to earth* faults but allows the trip without any phase preference when a *“cross-country”* fault has been detected.

The phase preference tripping at “cross-country” faults allow to define the sequence of phases which must be opened when a phase-phase ground fault has been detected.
For instance it allows to define that phase *L1* must be evaluated before *L2* and *L2* before *L3* using the notation *“123”*. The preference can be defined as *cyclic* or “Phase Pref” adding in the notation a *“c”* or a *“a”*. A *“Bl”* present in the notation indicates that the fault in the last listed phase will not be tripped in any cases.

2.1.6 Description

The *Description* tab page can be used to insert some information to identify the ABB Starting 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 ABB Starting Type(TypFdetABB)

The *ABB Starting* block main characteristics must be configured in the “ABB Starting Type” dialogue (*TypABBFdet* class). The dialogue contains six tab pages: *Basic data*, *Phase/Ground Detection*, *Overcurrent*, *Underimpedance*, *Phase Preference*,and *Common*.

2.2.1 Basic data

The *Basic data* tab page contains the combox which allow to select the active ABB starting type. The following types are available:

- REL 100
- REL 316
- REL 511
- REL 521
- REL 531
- REl 670

Please notice that the REL 521 and the REL 531 implement the same starting logic.

2.2.2 Phase/Ground Detection

It contains the range definition for the element parameters available in the “Phase/ground fault conditions” tab page.

2.2.3 Overcurrent

The *Overcurrent* tab page defines the ranges of the element parameters available in the “Overcurrent” tab page.

2.2.4 Underimpedance

The *Underimpedance* tab page contains the range definition for the element parameters available in the “Impedance Z” tab page.

2.2.5 Phase Preference

It contains the range definition for the element parameters available in the “Phase Preference Logic” tab page.

2.2.6 Common

The *Common* tab page defines the pickup delay (*Pickup Time*“Ts” parameter), the *Reset Time* (“Tr” parameter) and two separated *Reset Ratios* for the *Overcurrent* and *Impedance Z* starting logic (“KrI” and “KrRX” parameter) of the ABB starting element. Please notice that the *overcurrent Reset Ratio* “KrI” must be smaller than 1 and the *Impedance Z Reset Ratio* “KrRX” must be greater than 1.

3 Integration in the relay scheme

The *ABB starting* type class name is *TypFdetabb*. The *ABB starting* dialogue class name is *RelFdetabb*. In the relay scheme the ABB starting element gets the voltage and the current signals from the measurement element. The signal with the ID(s) of the started loop(s) is used by the polygonal or the mho trip zones.

A complete connection scheme is showed here below.

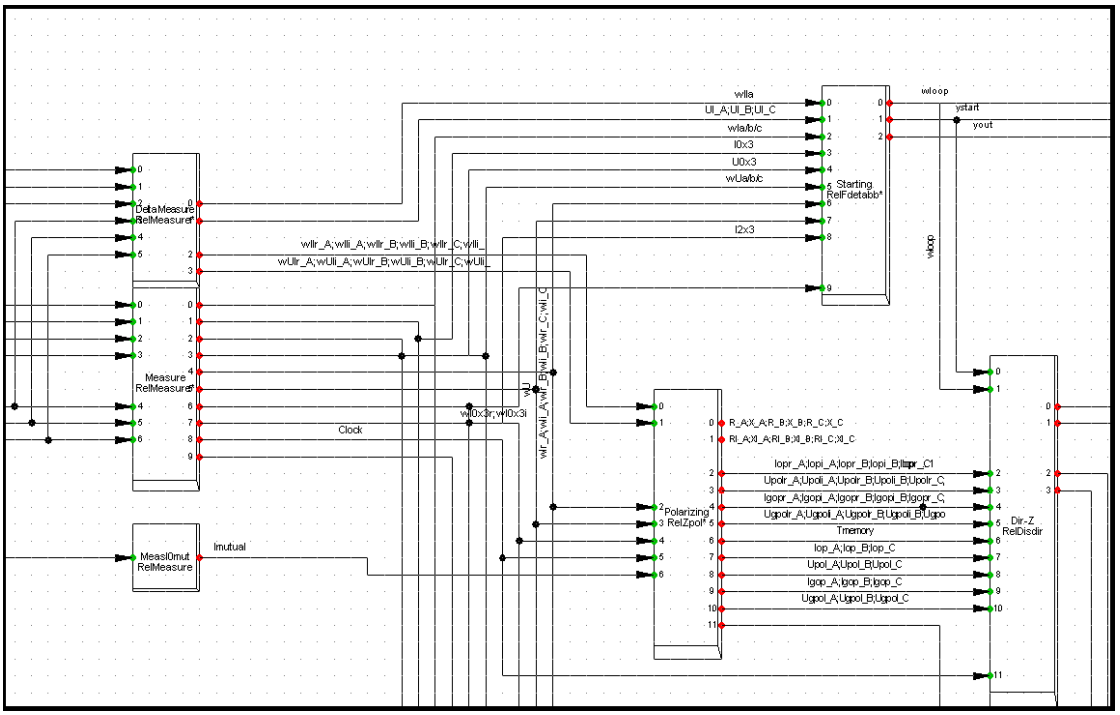


Figure 3.1: *DIgSILENT* Connection scheme of an *ABB starting* “RelFdetabb” block.

4 Logic

4.1 ABB REL 100

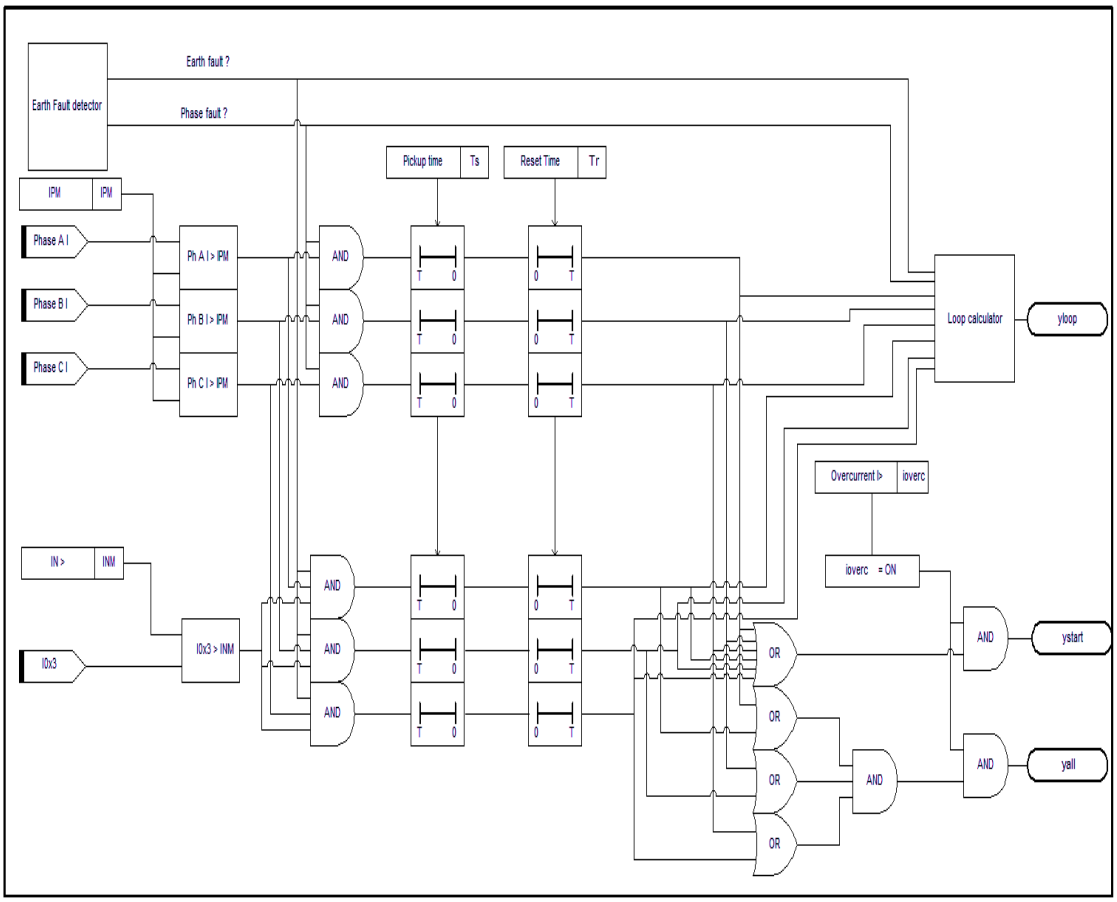


Figure 4.1: The *ABB REL 100 starting logic*

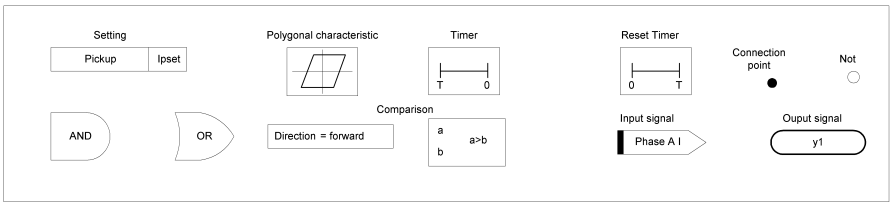


ABB REL 316 :

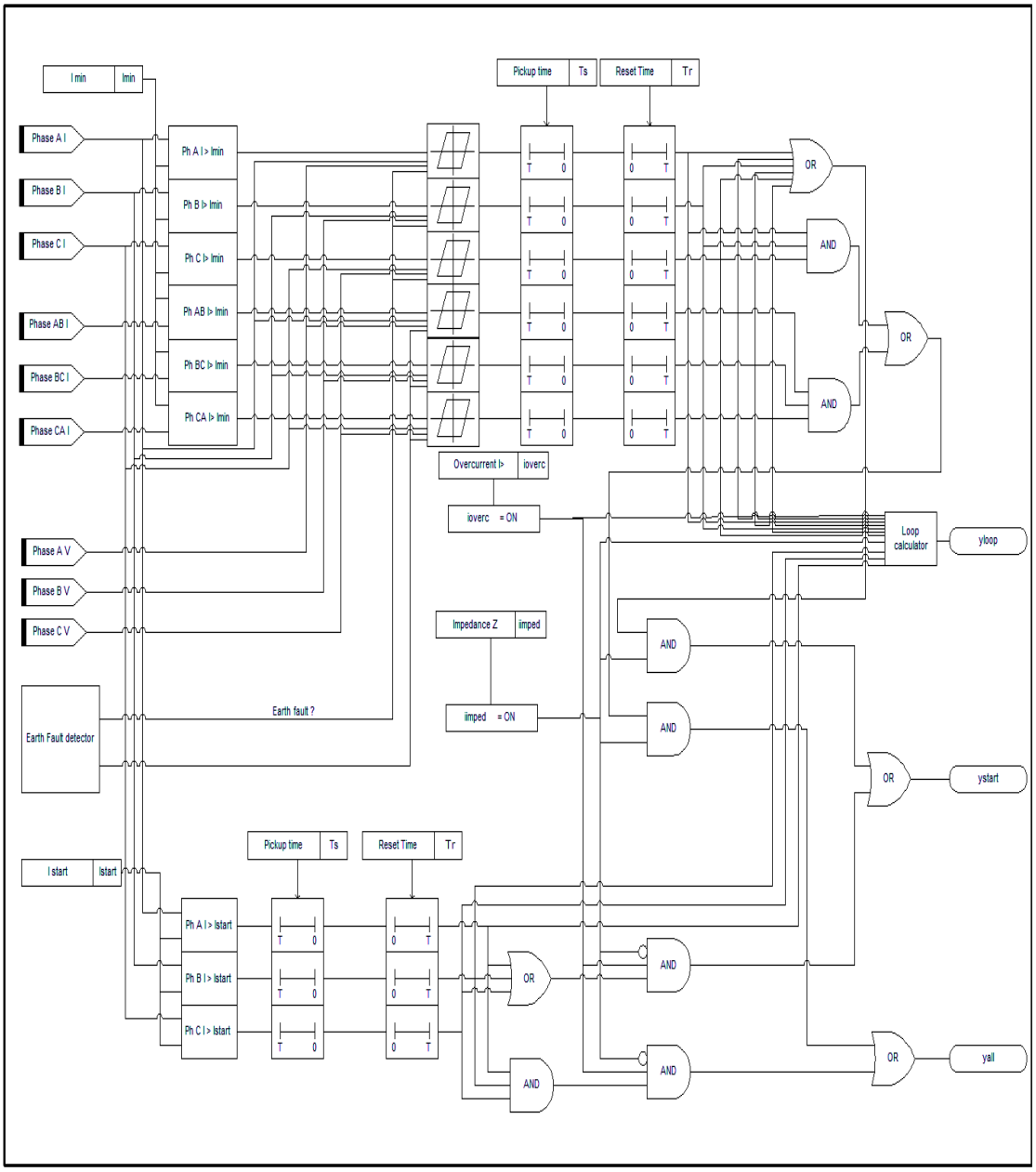


Figure 4.2: *DIgSILENT* The *ABB REL 316 starting logic*

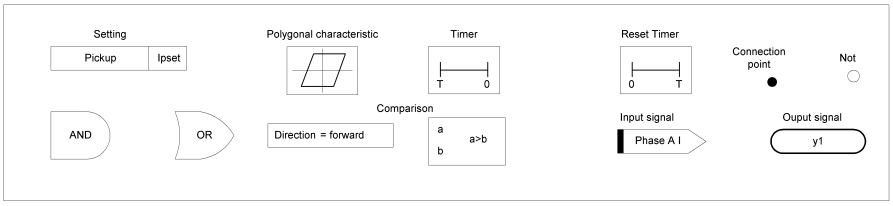


ABB REL 511 :

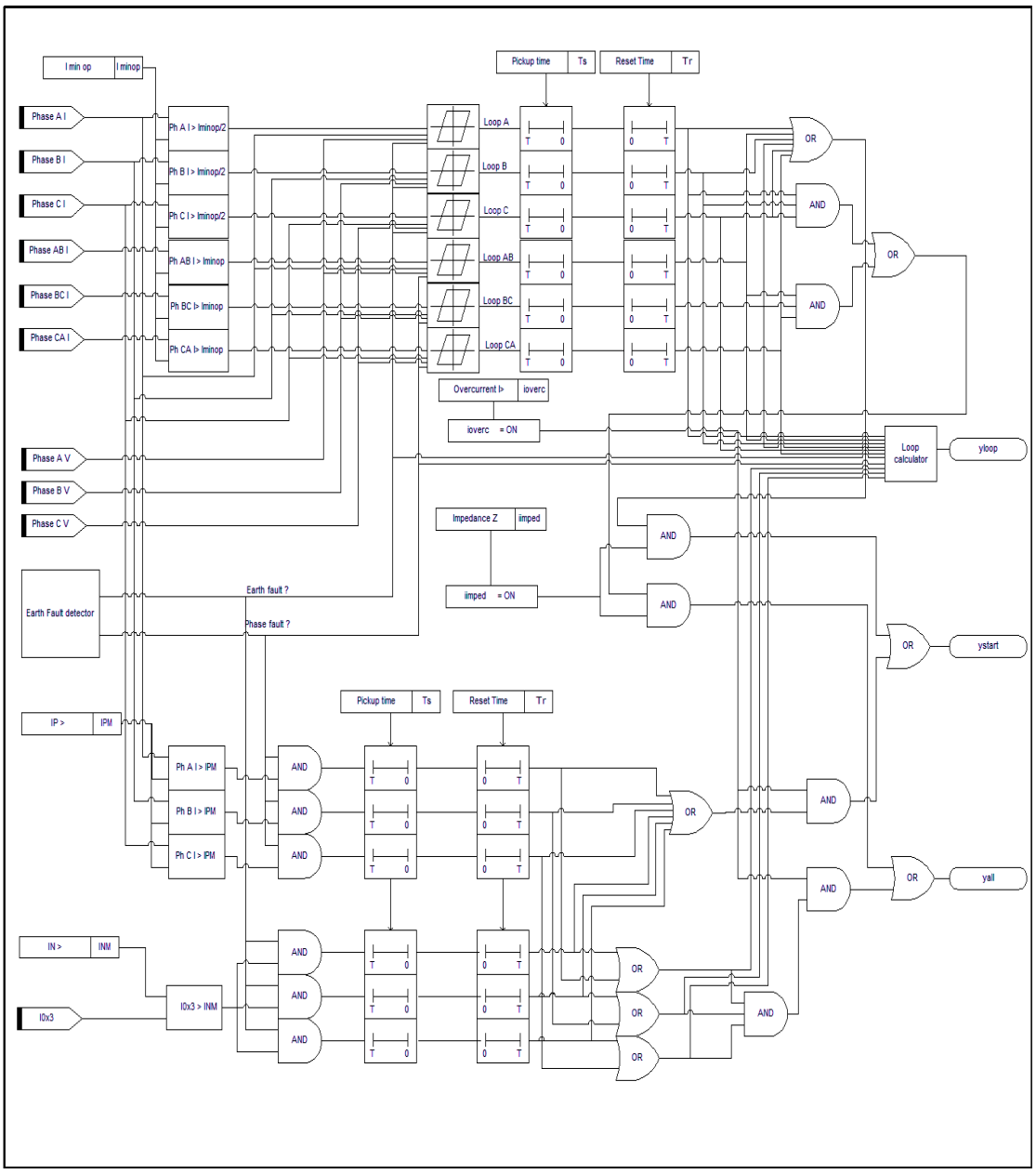


Figure 4.3: *DIgSILENT* The *ABB REL 511 starting logic*

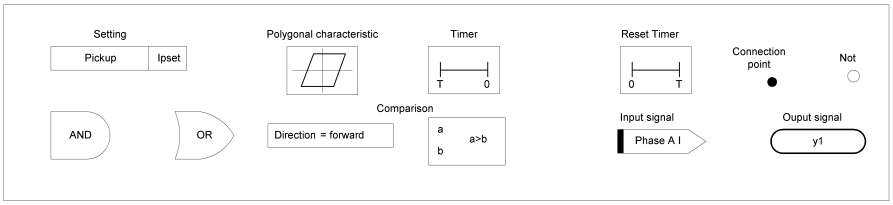


ABB REL 521/531 :

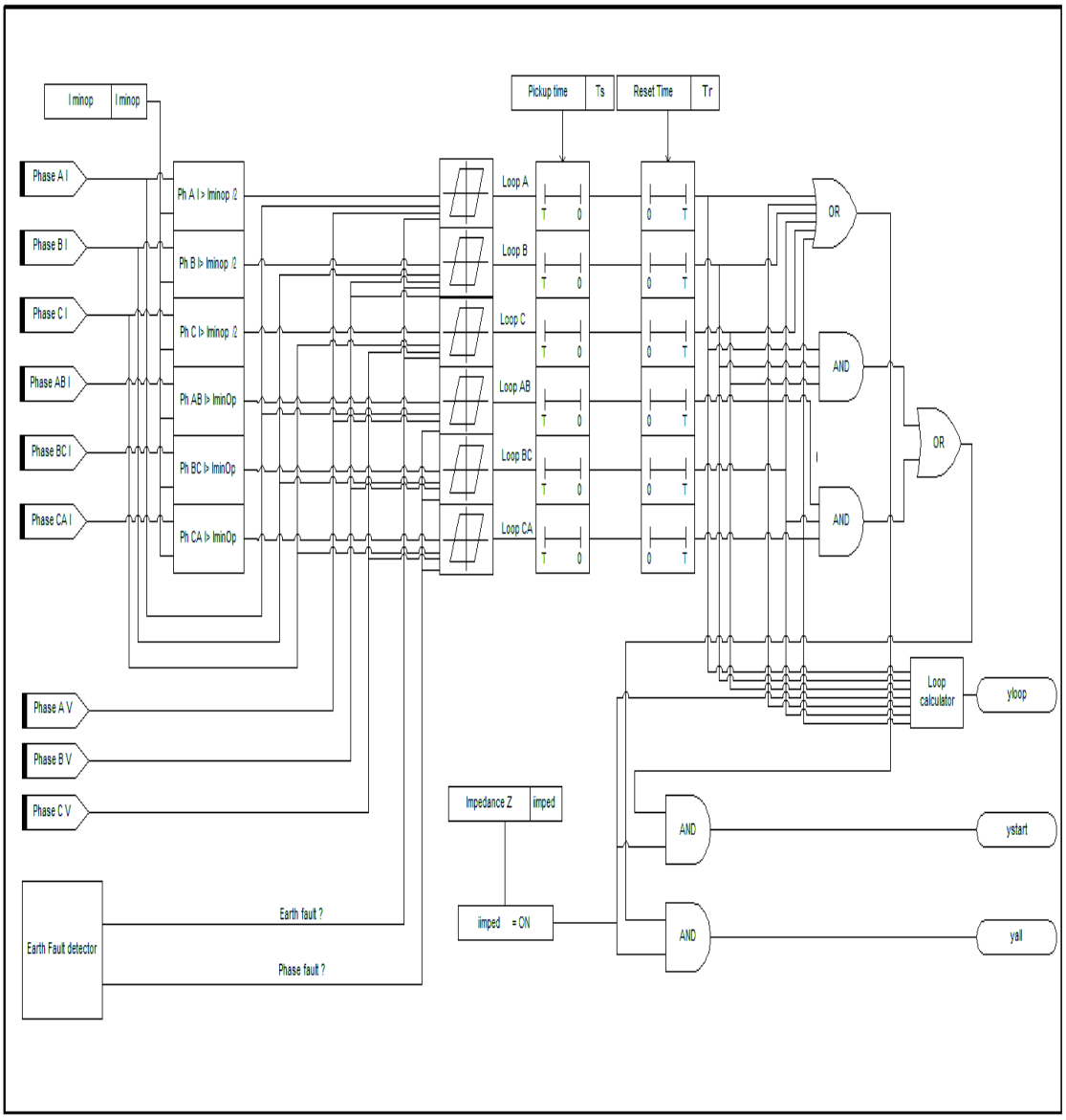


Figure 4.4: *DIgSILENT* The *ABB REL 521/531 starting logic*

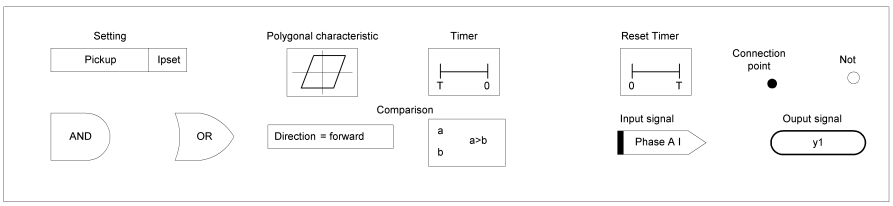


ABB REL 670 :

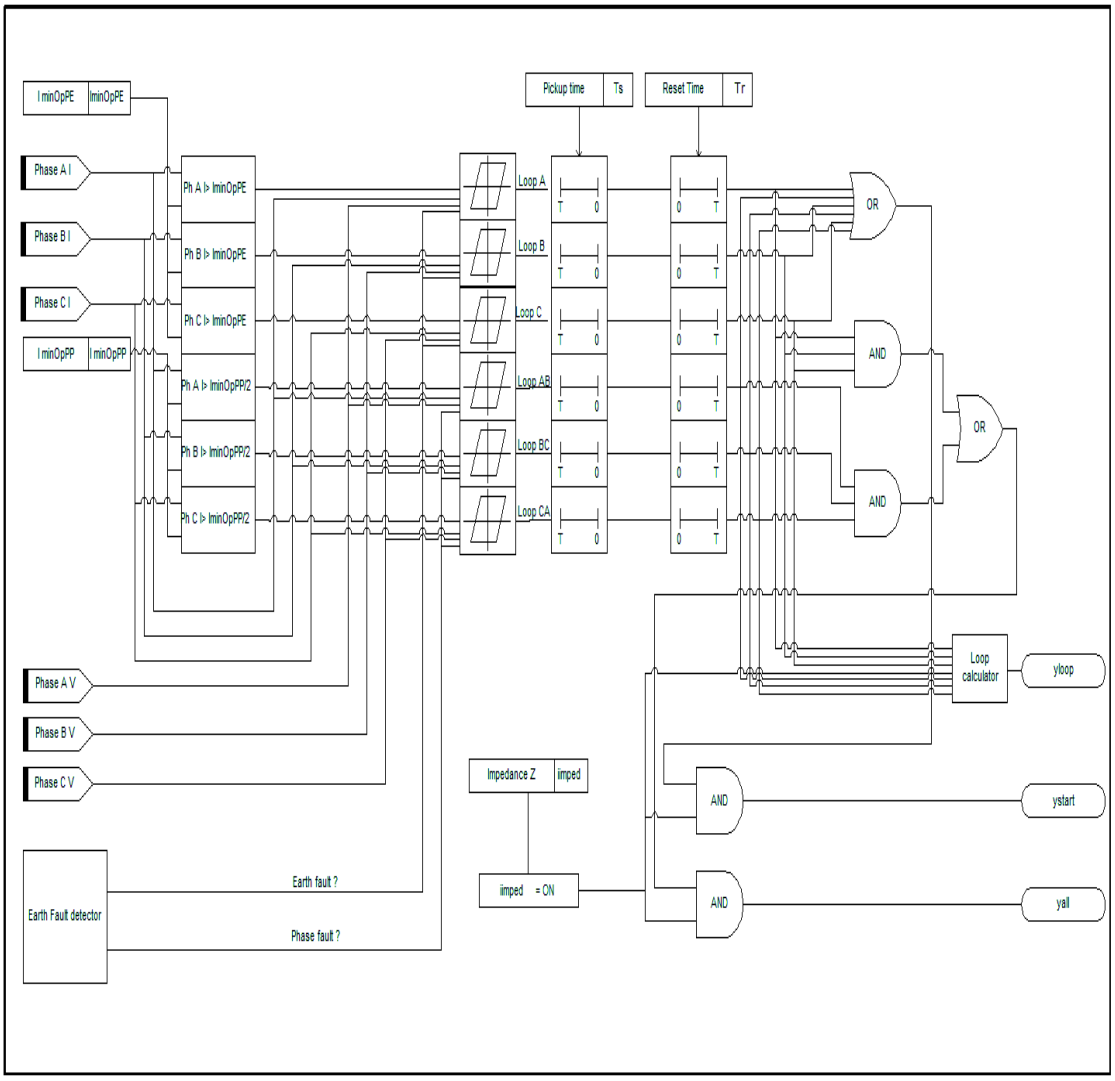
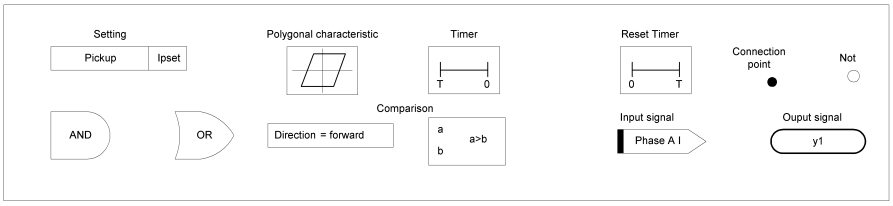


Figure 4.5: *DIgSILENT* The *ABB REL 670 starting logic*



A Parameter Definitions

A.1 ABB starting block Type (TypFdetabb)

Table A.1: Input parameters of ABB Starting type (*TypFdetabb*)

Parameter	Description	Unit
loc_name	Name assigned by the user to the block type	Text
Prodname	The ABB starting block type (“REL 100”, “REL 316”, “REL 511”, “REL 521”, “REL 531” or “REL 670”)	Text
rINReleasePE	Range of INReleasePE (setting for fault type detection)	Text
rINBlockPP	Range of INBlockPP (setting for fault type detection)	Text
rtPP	Range of tPP (fault detection backup phase trip delay)	Text
rtPE	Range of tPE (fault detection backup ground trip delay)	Text
rIPM	Range of IPM (phase overcurrent starting threshold)	Text
rINM	Range of INM (ground overcurrent starting threshold)	Text
rARGLd	Range of ARGLd (underimpedance starting load angle)	Text
rIMinOp	Range of IminOp (underimpedance starting minimum operation current)	Text
rIMinOpPP	Range of IminOpPP (underimpedance phase-phase loops starting minimum operation current)	Text
rIMinOpPE	Range of IminOpPE (underimpedance phase-ground loops starting minimum operation current)	Text
rRLd	Range of RLd (underimpedance starting load resistance)	Text
rX1RvPP	Range of X1RvPP (reverse phase underimpedance starting inductance)	Text
rX1FwPP	Range of X1FwPP (forward phase underimpedance starting inductance)	Text
rX1PP	Range of X1PP (phase underimpedance starting inductance) REL 521/531/670	Text
rRFPP	Range of RFPP (phase underimpedance starting resistance)	Text
rX1RvPE	Range of X1RvPP (reverse ground underimpedance starting positive sequence inductance)	Text
rX1FwPE	Range of X1FwPP (forward ground underimpedance starting positive sequence inductance)	Text
rX1PE	Range of X1PE (ground underimpedance starting positive sequence inductance) REL 521/531/670	Text
rX0RvPE	Range of X0RvPP (reverse ground underimpedance starting zero sequence inductance)	Text
rX0FwPE	Range of X0FwPE (forward ground underimpedance starting zero sequence inductance)	Text
rX0PE	Range of X0PE (ground underimpedance starting zero sequence inductance) REL 521/531/670	Text
rRFPE	Range of RFPE (ground underimpedance starting resistance)	Text
rRFRvPP	Range of RFRvPP (phase underimpedance reverse starting resistance)	Text
rRFRvPE	Range of RFRvPE (ground underimpedance reverse starting resistance)	Text
rINmM	Range of InmM (Operate value of residual current for cross-country faults)	Text
rU0x3M	Range of U0x3M (Operate value of residual voltage for cross-country faults)	Text
rUPNm	Range of UPNm (Operate value of under voltage non directional phase selection phase to- earth measurement)	Text
rUPPm	Range of UPPm (Operate value of under voltage non directional phase selection phase to- phase measurement)	Text
Ts	Pick up time, its the time spent measuring the currents in the load flow and short circuit calculation and in the RMS simulation	Seconds
Tr	Reset time, its the delay with which the block reset the trip outputs after that the start	Seconds
KrRX	Underimpedance reset ratio	Real number
KrI	Current reset ratio	Real number

A.2 ABB starting Element (RelFdetabb)

Table A.2: Input parameters of ABB Starting element (*RelFdetabb*))

Parameter	Description	Unit
loc_name	Name assigned by the user to the block	Text
INReleasePE	INReleasePE (setting for fault type detection)	%I_{rated} ground
INBlockPP	INBlockPP (setting for fault type detection)	%I_{rated} phase
tPP	tPP (fault detection backup phase trip delay)	Seconds
tPE	tPE (fault detection backup ground trip delay)	Seconds
IPM	IPM (phase overcurrent starting threshold)	%I_{rated} phase
INM	INM (ground overcurrent starting threshold)	%I_{rated} ground
ARGLd	ARGLd (underimpedance starting load angle)	Degrees
IminOp	IminOp (underimpedance starting minimum operation current)	%I_{rated} phase
IminOpPP	IminOpPP (underimpedance starting phase-phase loops minimum operation current)	%I_{rated} phase
IminOpPE	IminOpPE (underimpedance starting phase-ground loops minimum operation current)	%I_{rated} phase
RLd	RLd (underimpedance starting load resistance)	Secondary Ohm
X1RvPP	X1RvPP (reverse phase underimpedance starting inductance)	Secondary Ohm
X1FwPP	X1FwPP (forward phase underimpedance starting inductance)	Secondary Ohm
X1PP	X1PP (phase underimpedance starting inductance) REL 521/531/670	Secondary Ohm
RFPP	RFPP (phase underimpedance starting resistance)	Secondary Ohm
X1RvPE	X1RvPP (reverse ground underimpedance starting positive sequence inductance)	Secondary Ohm
X1FwPE	X1FwPP (forward ground underimpedance starting positive sequence inductance)	Secondary Ohm
X1PE	X1PE (ground underimpedance starting positive sequence inductance) REL 521/531/670	Secondary Ohm
X0RvPE	X0RvPP (reverse ground underimpedance starting zero sequence inductance)	Secondary Ohm
X0FwPE	X0FwPE (forward ground underimpedance starting zero sequence inductance)	Secondary Ohm
X0PE	X0PE (ground underimpedance starting zero sequence inductance) REL 521/531/670	Secondary Ohm
RFPE	RFPE (ground underimpedance starting resistance)	Secondary Ohm
RFRvPP	RFRvPP (phase underimpedance reverse starting resistance)	Secondary Ohm
RFRvPE	RFRvPE (ground underimpedance reverse starting resistance)	Secondary Ohm
PhasePref	Phase preference. It can be NoFilter, NoPref, 132c, 312c, 132a, 123a, 321a, 312a, 213a, 231a, 132aBI, 123aBI, 321aBI, 312aBI, 213aBI, 231aBI	
InmM	InmM (Operate value of residual current for cross-country faults)	%I_{rated} ground
U0x3M	U0x3M (Operate value of residual voltage for cross-country faults)	%U_{rated}
UPNm	UPNm (Operate value of under voltage non directional phase selection phase to- earth measurement)	%U_{rated}
UPPm	UPPm (Operate value of under voltage non directional phase selection phase to- phase measurement)	%U_{rated}
PhSelMode	E/F detector selection mode (REL 316 only)	Integer
GndFmode	Ground fault mode (REL 316 only)	Integer
Imin	Enabling current (REL 316 only)	%I_{rated} phase
Istart	Pick up level of the overcurrent starter	%I_{rated} phase
I0x3min	Earth current pickup level for the E/F detector	I_{rated} ground
U0x3min	Earth voltage pickup level for the E/F detector	%U_{rated}

B Signal Definitions

Table B.1: Input/output signals of the ABB starting element (*CalFdetabb*)

Name	Description	Unit	Type	Model
I_A	Phase A current	Secondary Amperes	IN	Any
I_B	Phase B current	Secondary Amperes	IN	Any
I_C	Phase C current	Secondary Amperes	IN	Any
II_A	Phase A Phase B current	Secondary Amperes	IN	Any
II_B	Phase B Phase C current	Secondary Amperes	IN	Any
II_C	Phase C Phase A current	Secondary Amperes	IN	Any
I0x3	Zero sequence current	Secondary Amperes	IN	Any
U0x3	Zero sequence voltage	Secondary Volts	IN	Any
R_A	Phase A loop resistance	Secondary Ohms	IN	Any
X_A	Phase A loop inductance	Secondary Ohms	IN	Any
R_B	Phase B loop resistance	Secondary Ohms	IN	Any
X_B	Phase B loop inductance	Secondary Ohms	IN	Any
R_C	Phase C loop resistance	Secondary Ohms	IN	Any
X_C	Phase C loop inductance	Secondary Ohms	IN	Any
RI_A	Phase A - Phase B loop resistance	Secondary Ohms	IN	Any
XI_A	Phase A Phase B loop inductance	Secondary Ohms	IN	Any
RI_B	Phase B - Phase C loop resistance	Secondary Ohms	IN	Any
XI_B	Phase B Phase C loop inductance	Secondary Ohms	IN	Any
RI_C	Phase C - Phase A loop resistance	Secondary Ohms	IN	Any
XI_C	Phase C Phase A loop inductance	Secondary Ohms	IN	Any
U_A	Phase A voltage	Secondary Volts	IN	Any
U_B	Phase B voltage	Secondary Volts	IN	Any
U_C	Phase C voltage	Secondary Volts	IN	Any
UI_A	Phase A Phase B voltage	Secondary Volts	IN	Any
UI_B	Phase B Phase C voltage	Secondary Volts	IN	Any
UI_C	Phase C Phase A voltage	Secondary Volts	IN	Any
yloop	ID of the loop from which the fault must be removed		OUT	Any
ystart	Starting signal/ starting time Y/N or seconds		OUT	Any
yout	Backup trip signal/ backup trip time Y/N or seconds	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any

List of Figures

2.1 *DIgSILENT* The *ABB REL 100 Earth/phase fault detection logic* 2

2.2 *DIgSILENT* The *ABB REL 316 Earth/phase fault detection logic* 2

2.3 *DIgSILENT* The *ABB REL 511 Earth/phase fault detection logic* 3

2.4 *DIgSILENT* The *ABB REL 521/531 Earth/phase fault detection logic* 3

2.5 *DIgSILENT* The *ABB REL 670 Earth/phase fault detection logic* 4

2.6 *DIgSILENT* The *ABB REL 316 phase-phase loops impedance zone* 5

2.7 *DIgSILENT* The *ABB REL 316 phase-ground loops impedance zone* 6

2.8 *DIgSILENT* The *ABB REL 511 phase-phase loops impedance zone* 6

2.9 *DIgSILENT* The *ABB REL 511 phase-ground loops impedance zone* 7

2.10 *DIgSILENT* The *ABB REL 521/531 phase-phase loops impedance zone* 7

2.11 *DIgSILENT* The *ABB REL 521/531 phase-phase loops for 3phase faults impedance zone* 8

2.12 *DIgSILENT* The *ABB REL 521/531 phase-ground loops impedance zone* 8

2.13 *DIgSILENT* The *ABB REL 670 phase-phase loops impedance zone* 9

2.14 *DIgSILENT* The *ABB REL 670 phase-ground loops impedance zone* 9

2.15 *DIgSILENT* The *ABB REL 670 phase-ground loops impedance zone (Force positive sequence raresentation disabled)* 10

3.1 *DIgSILENT* Connection scheme of an *ABB starting* “RelFdetabb” block. 12

4.1 The *ABB REL 100 starting logic* 13

4.2 *DIgSILENT* The *ABB REL 316 starting logic* 14

4.3 *DIgSILENT* The *ABB REL 511 starting logic* 15

4.4 *DIgSILENT* The *ABB REL 521/531 starting logic* 16

4.5 *DIgSILENT* The *ABB REL 670 starting logic* 17

List of Tables

A.1 Input parameters of ABB Starting type (*TypFdetabb*) 18

A.2 Input parameters of ABB Starting element (*RelFdetabb*)) 19

B.1 Input/output signals of the ABB starting element (*CalFdetabb*) 20