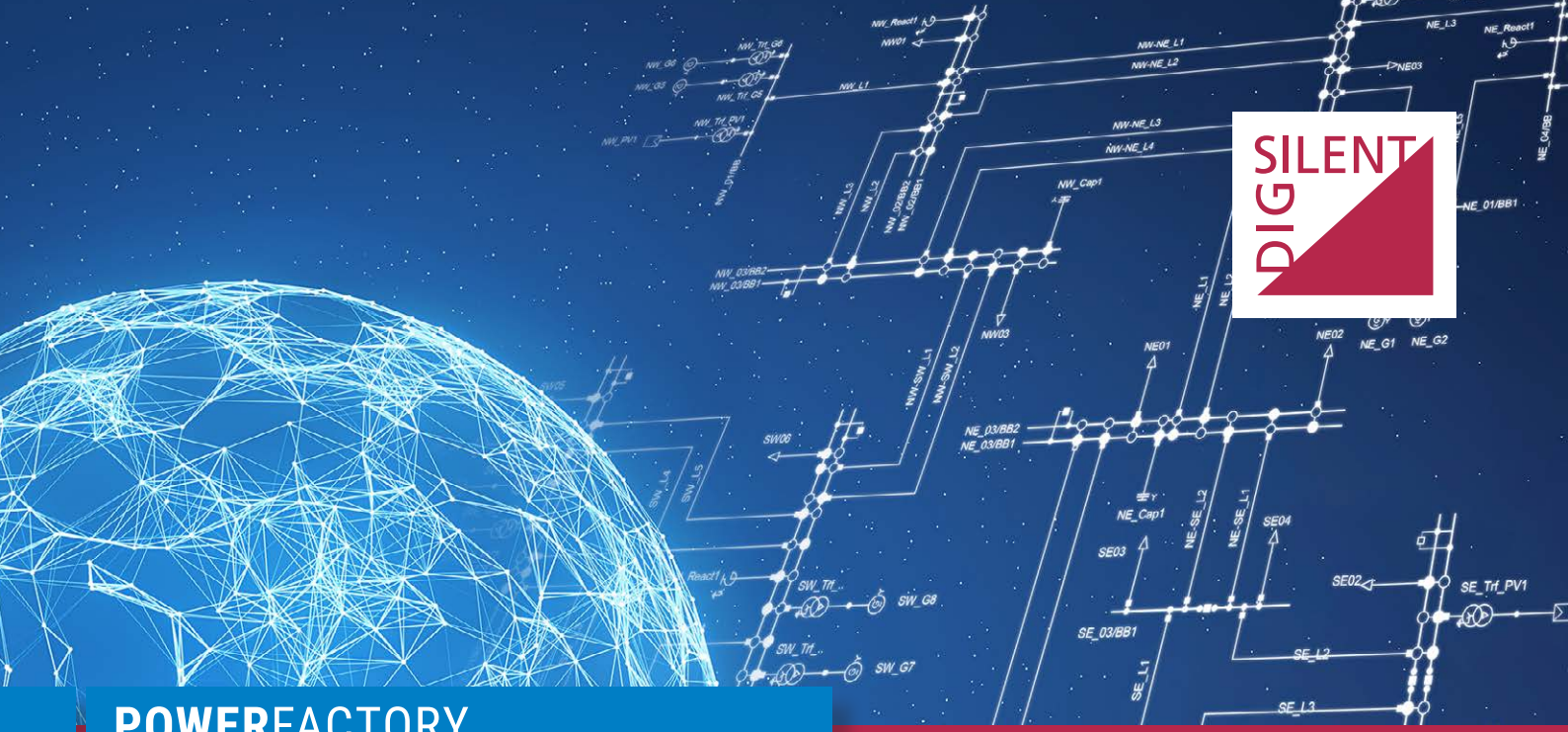

POWERFACTORY

PowerFactory 2021

Technical Reference

Siemens starting unit

RelFdetsie, TypFdetsie

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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Contents

1 General Description

The Siemens starting block implements the fault detection logic available in the Siemens 7SA5x and 7SA6xx relay family; the block has currently been used to implement the Siemens 7SA510, Siemens 7SA511, Siemens 7SA513, Siemens 7SA522 and the Siemens 7SA600 relay model. Four different types of fault detection are available: the "Overcurrent I>>", the "Underimpedance U/I", the "Impedance Z" and the "Underimpedance U/I/phi" detection logic. Accordingly with the relay manuals the following detection logic are active:

- Siemens 7SA510
  1. "Overcurrent I>>".
  2. "Underimpedance U/I".
  3. "Impedance Z".
- Siemens 7SA511
  1. "Overcurrent I>>".
  2. "Underimpedance U/I".
  3. "Impedance Z".
- Siemens 7SA513
  1. "Overcurrent I>>".
  2. "Underimpedance U/I".
  3. "Impedance Z".
- Siemens 7SA522
  1. "Overcurrent I>>".
- Siemens 7SA600
  1. "Overcurrent I>>".
  2. "Underimpedance U/I".
  3. "Impedance Z".
  4. "Underimpedance U/I/phi".

2 Features & User interface

2.1 Siemens Starting Logic (RelFdetsie)

The user can change the block settings using the "Siemens Starting" dialogue ("RelFdetsie" class). The dialogue consists of five tab pages: *Basic Data*, *Underimpedance/Overcurrent*, *Earth Fault Detection*, *Impedance*, and *Common*.

2.1.1 Basic data

The "Basic Data" tab page contains the block name and up to four check buttons which allow to select the active starting logic between the logic available for the given model.

2.1.2 Underimpedance/Overcurrent

When the overcurrent starting is available and the *Overcurrent I>>* checkbox is set the phase currents are compared with the *Iph>>* ("Iphgg" parameter) phase current threshold. The *Siemens 7SA6* starting checks also that the phase current is greater than Iphmin. The *Siemens 7SA522* is using the same z loop validation procedure used by the "impedance Z" logic: with this procedure a fault loop to be declared valid must have an impedance which does not exceed the smallest loop impedance by more than 50%.

When the underimpedance starting is available and the *Underimpedance U/I* checkbox is set the phase currents must exceed a threshold value which is function of the loop voltage. The voltage dependent current threshold characteristic is defined by two current values (*Iph>* and *Iph>>*) and by two voltage values. Independent voltage values can be defined for the ph-ground (*Uphe(I>)* and *Uphe(>>>)*) and for the phase-phase (*Uphph(I>)* and *Uphph(>>>)*) loops.

2.1.3 Earh Fault Detection

The ground detection logic use up two zero sequence current thresholds, a zero sequence voltage threshold and a negative sequence characteristic, which is parabolic for the 7SA522 relay model, to detect the ground fault condition. Different zero sequence voltage threshold can be specified for an earthed network and for a not earthed network. The lower zero sequence current threshold is using a stabilization slope to avoid spurious trips. Such ground detection logic is active whatever starting logic("Overcurrent I>", "Impedance Z" etc) is activated.

Siemens 7SA510 :

The Siemens 7SA510 starting block allows to define:

- One zero sequence current threshold with stabilization slope.
- One zero sequence voltage threshold (different values can be inserted for an earthed network and for a not earthed network).

The ground fault is detected when the zero sequence current is above the threshold OR when the zero sequence voltage is above the threshold.

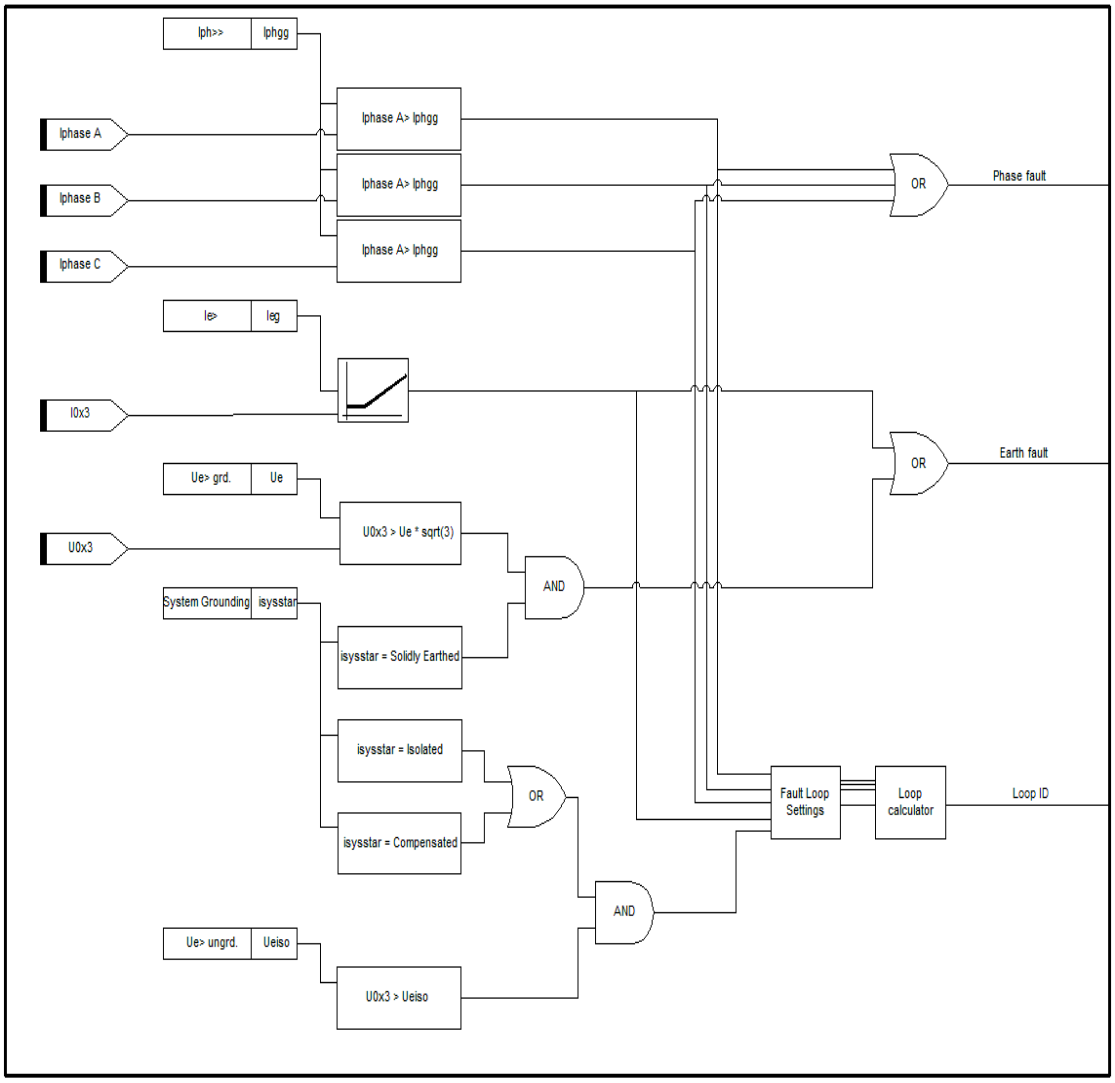
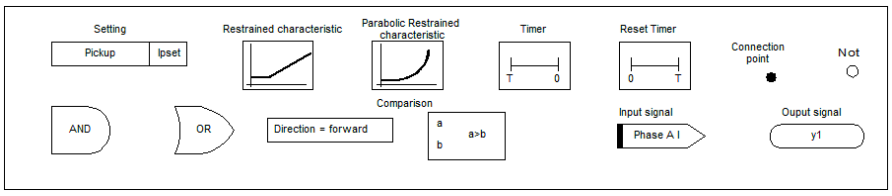


Figure 2.1: *DIgSILENT* The *Siemens 7SA510 Earth/phase fault detection logic*



Siemens 7SA511 :

The Siemens 7SA511 starting block allows to define:

- One zero sequence current threshold with stabilization slope.
- One zero sequence voltage threshold (different values can be inserted for an earthed network and for a not earthed network).

The ground fault is detected when the zero sequence current is above the threshold OR when the zero sequence voltage is above the threshold.

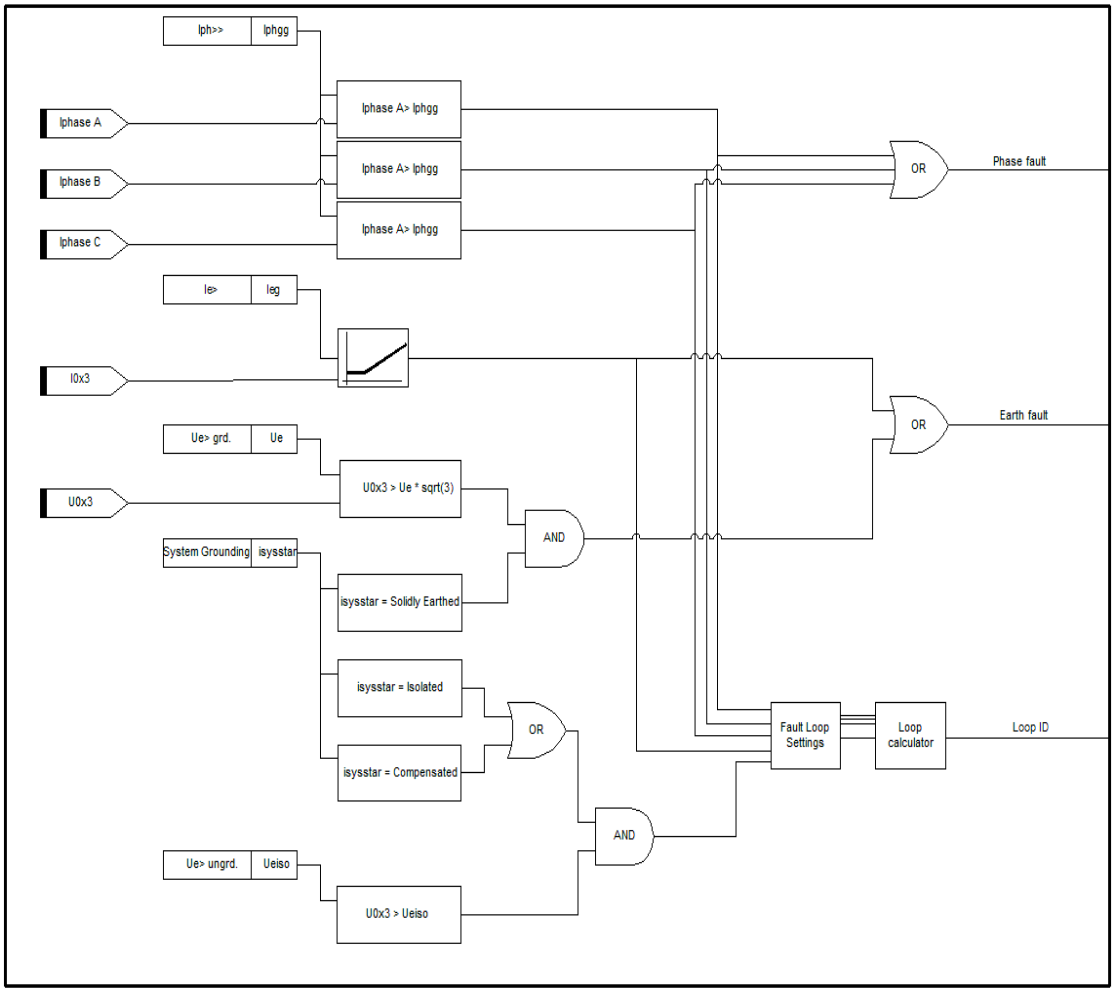
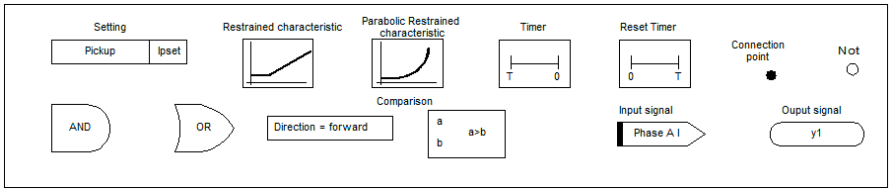


Figure 2.2: *DIgSILENT* The *Siemens 7SA511 Earth/phase fault detection logic*



Siemens 7SA513 :

The Siemens 7SA513 starting block allows to define:

- One zero sequence current threshold with stabilization slope and one without stabilization slope.
- One zero sequence voltage threshold (different values can be inserted for an earthed network and for a not earthed network).
- A negative sequence threshold (the threshold is set equal to 0.1 pu): to declare a ground fault also the zero sequence current must be above the first zero sequence current threshold (the stabilization slope is not used in this case).

The user can decide to detect the ground fault when both the zero sequence current and the zero sequence voltage are above the threshold or when one of them is above the threshold.

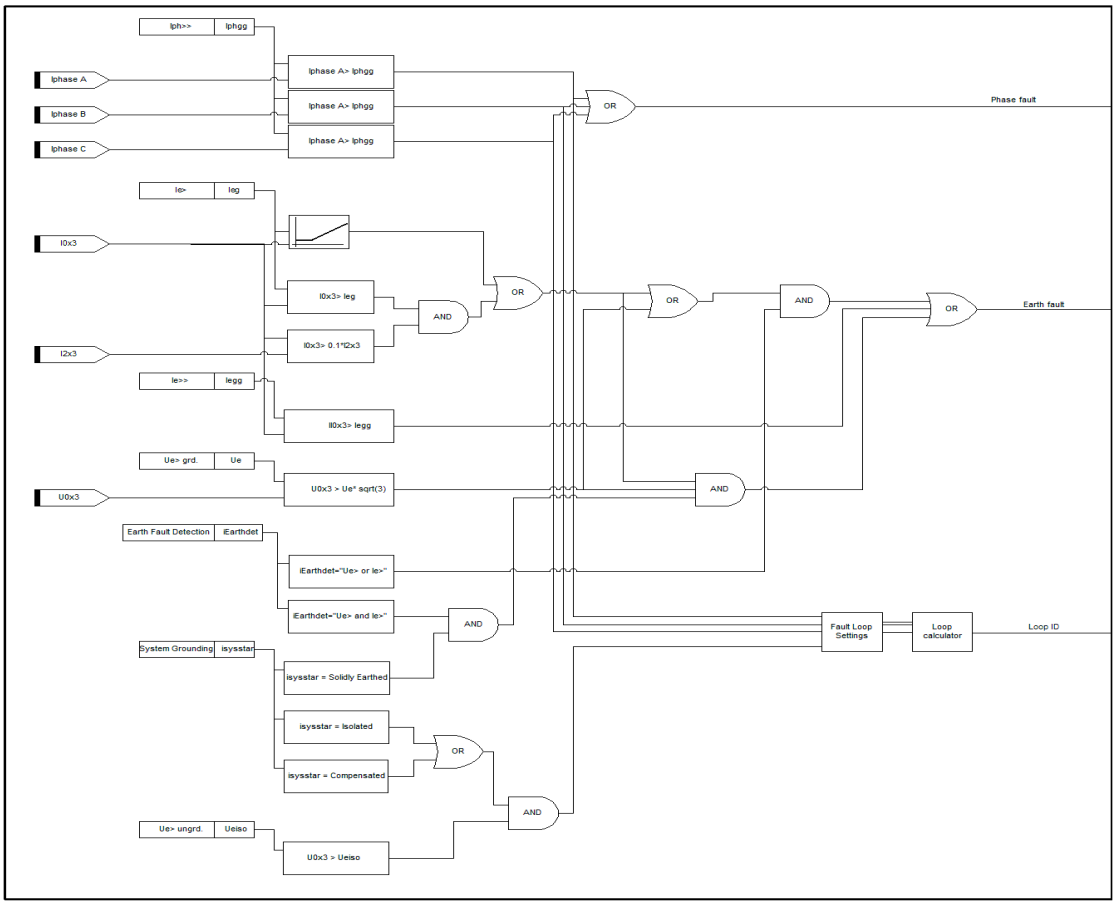
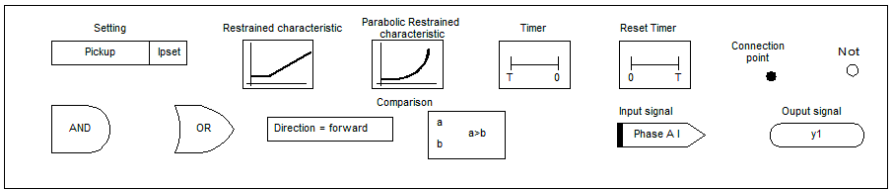


Figure 2.3: *DIgSILENT* The *Siemens 7SA513 Earth/phase fault detection logic*



Siemens 7SA522 :

The Siemens 7SA522 starting block allows to define:

- One zero sequence current threshold with stabilization slope.
- One zero sequence voltage threshold (different values can be inserted for an earthed network and for a not earthed network).
- A negative sequence parabolic characteristic (the starting threshold is equal to 0.13 pu). Please note that both the zero sequence current and the negative sequence current must be greater than a threshold(NegSeqThr variable).

The user can decide to detect the ground fault when both the zero sequence current and the zero sequence voltage are above the threshold or when one of them is above the threshold.

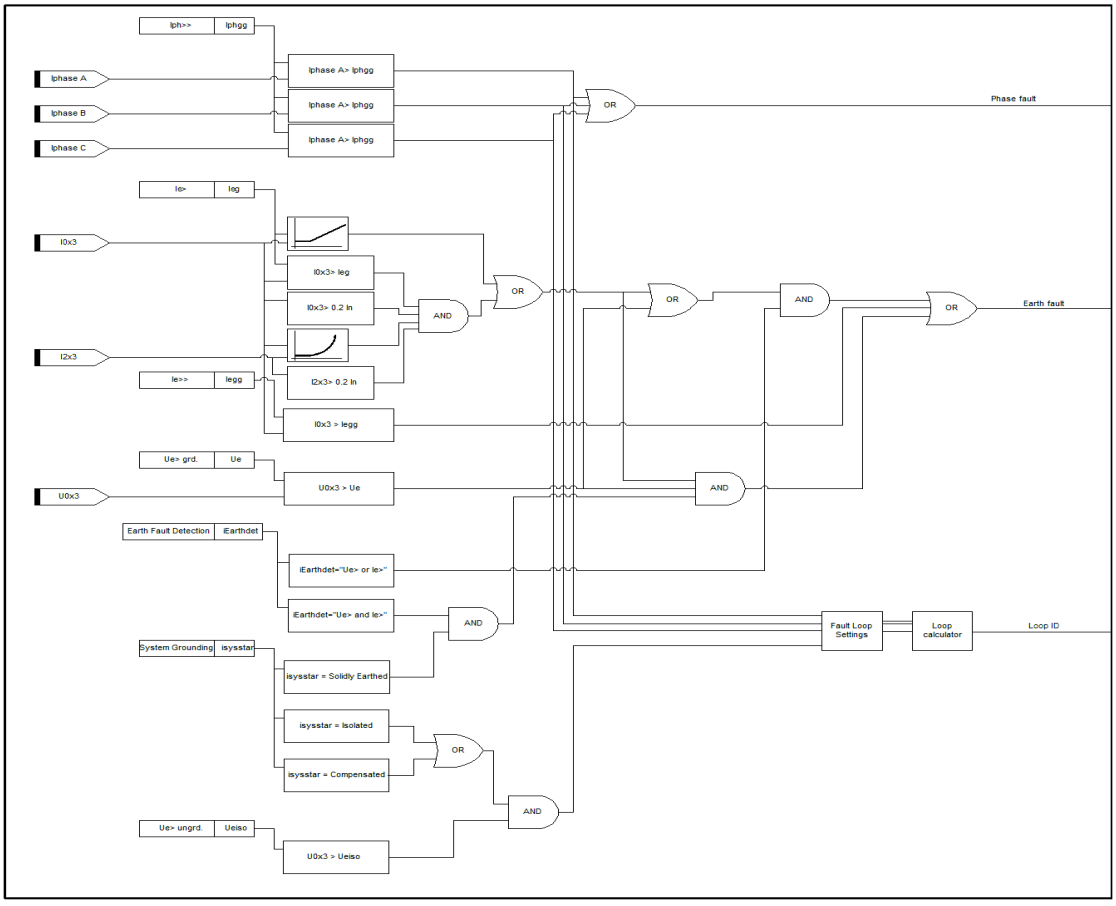
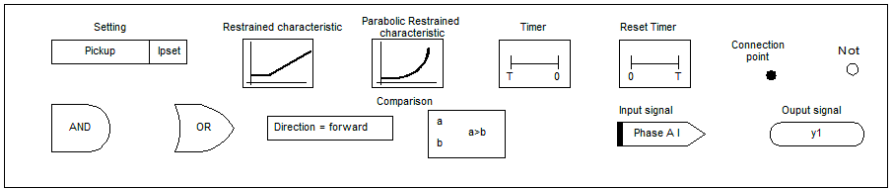


Figure 2.4: *DIgSILENT* The *Siemens 7SA522 Earth/phase fault detection logic*



Siemens 7SA6 :

The Siemens 7SA600 starting block allows to define:

- One zero sequence current threshold with user configurable stabilization slope.
- One zero sequence voltage threshold (different values can be inserted for an earthed network and for a not earthed network).
- A negative sequence parabolic characteristic (the starting threshold is 0.13 pu). Please note that both the zero sequence current and the negative sequence current must be greater than a threshold(NegSeqThr variable)

The user can decide to detect the ground fault when both the zero sequence current and the zero sequence voltage are above the threshold or when one of them is above the threshold.

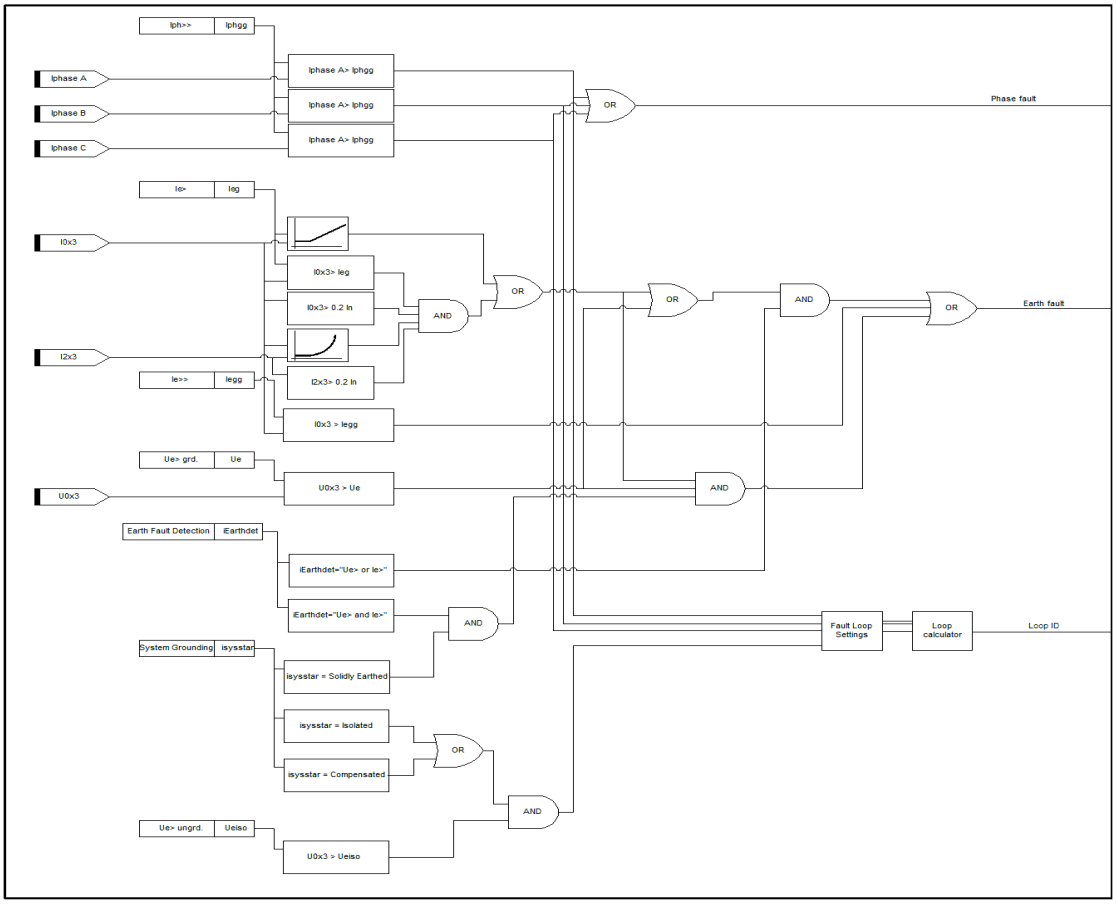
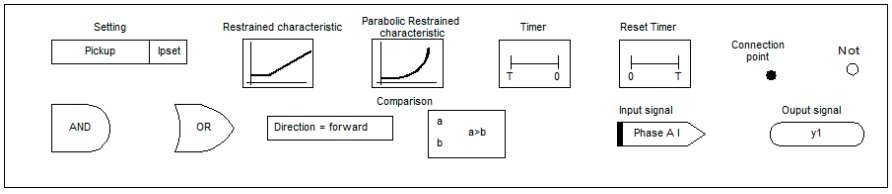


Figure 2.5: *DIgSILENT* The *Siemens 7SA6 Earth/phase fault detection logic*



2.1.4 Impedance

The “Impedance” tab page contains the settings which allow to configure the impedance fault detection zone available in the Siemens 7SA510, 7SA511, and 7SA513 relay models. When the other starting types are selected only a phase overcurrent threshold (“Iph>>” edit box, “Iphgg” parameter) is shown and internally the starting logic removes from the faulted loop list the loops having a current greater than the overcurrent threshold but an impedance which is greater than 150% the smallest loop impedance.

In the following paragraphs the impedance zones implemented for the 7SA510, 7SA511, and 7SA513 starting type is shown:

Siemens 7SA510, 7SA511, and 7SA513 phase-phase impedance :

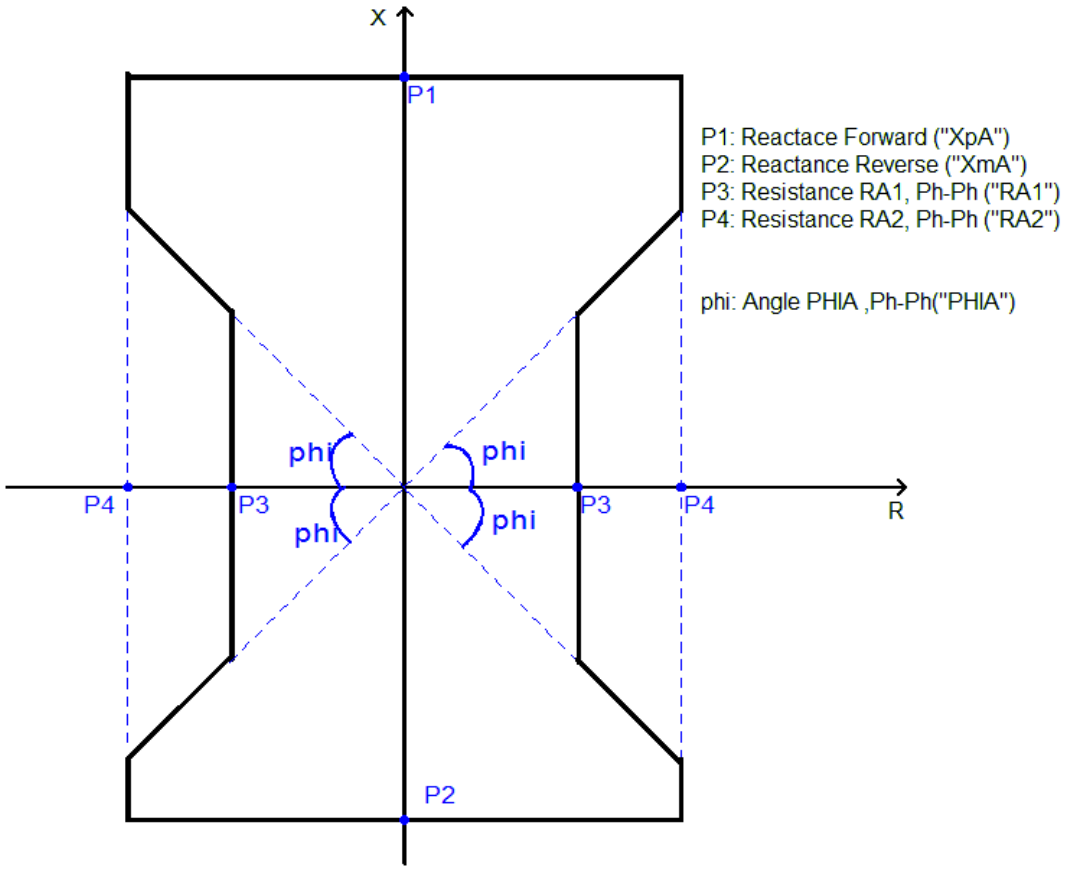


Figure 2.6: *DIgSILENT* The *Siemens 7SA510, 7SA511, and 7SA513 phase-phase loops impedance zone*

Siemens 7SA510, 7SA511, and 7SA513 phase-ground impedance :

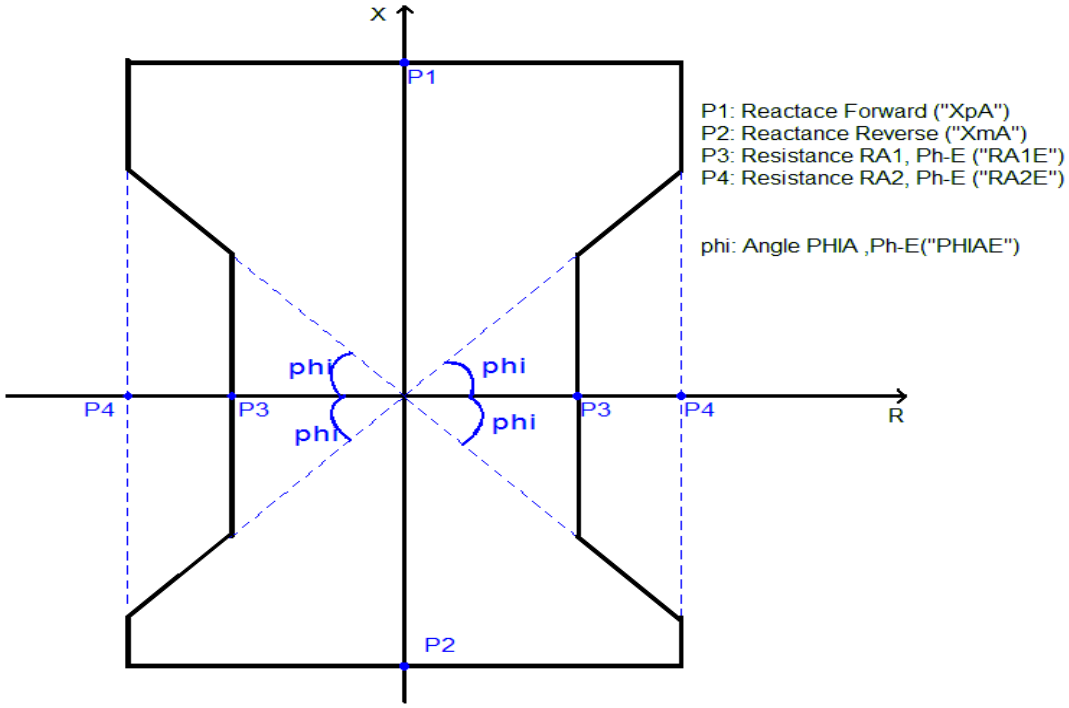


Figure 2.7: *DIgSILENT* The *Siemens 7SA510, 7SA511, and 7SA513 phase-ground loops impedance zone*

2.1.5 Fault Loop Settings

The *Fault Loop* logic is a possible addition to the standard Siemens starting logic. It consists of two different parts: one part contains the rules to apply to the isolated and high-impedance earthed networks and one part the rules to apply to the earthed networks. In the part for isolated and high-impedance earthed networks the phase preference for Ph-Ph-Earth faults can be defined. In the part for earthed networks the user can define: - the phase preference for Ph-Ph-Earth faults. - the 3phase fault detection rule. - the single phase fault detection rule.

The Siemens 7SA510 allows to define:

- In isolated and high-impedance earthed networks: the phase preference for Ph-Ph-Earth. faults.
- In earthed networks the 3phase fault detection rule and the single phase fault detection rule. The Siemens 7SA511 allows defining:
- In isolated and high-impedance earthed networks the phase preference for Ph-Ph-Earth faults.
- In earthed networks the phase preference for Ph-Ph-Earth faults ,the 3phase fault detection rule and the single phase fault detection rule.

The Siemens 7SA513 allows to define:

- In isolated and high-impedance earthed networks: the phase preference for Ph-Ph-Earth. faults.

- In earthed networks the 3phase fault detection rule and the single phase fault detection rule.
-

The Siemens 7SA522 allows to define:

- In insulated and high-impedance earthed networks: the phase preference for Ph-Ph-Earth faults.
- In earthed networks, the phase preference for Ph-Ph-Earth faults.

The Siemens 7SA600 allows to define:

- In isolated and high-impedance earthed networks, the phase preference for Ph-Ph-Earth faults.
- In earthed networks, the phase preference for Ph-Ph-Earth faults and the single phase fault detection rule.

2.1.6 Description

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

The *Siemens Starting* block main characteristics must be configured in the “Siemens Starting Type” dialogue (*TypFdetsie* class). The dialogue contains five tab pages: *Basic Data*,*Underimpedance/Overcurrent Earth Fault Detection*, *Impedance*, and *Common*.

2.2.1 Basic Data

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

- 62
- 510
- 511
- 513
- 522
- 600

Please notice that the 7SA511 and the 7SA510 implement the same starting logic.

Four check boxes (*Overcurrent I>>*, *Underimpedance U_j/I>*, *Impedance Z*, and *Underimpedance U_j/I>/phi*) allow to define which starting types are shown in the “Siemens Starting” dialogue (“RelFdetsie” class).

2.2.2 Underimpedance/Overcurrent

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

2.2.3 Earth Fault Detection

The *Earth Fault Detection* tab page contains the range definition for the element parameters available in the “Earth Fault Detection” tab page.

2.2.4 Impedance

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

2.2.5 Common

The *Common* tab page defines the pickup delay (*Pickup Time*“Ts” parameter), the *Reset Time* (“Tr” parameter) and four separated *Reset Ratios* for the *Overcurrent* (“KrI” parameter), the *Impedance* (“KrRX” parameter), the *Voltage* (“KrU” parameter) and the *Earth detection* (“Kre” parameter) starting logic of the Siemens starting element. Please notice that the *Overcurrent* “KrI” parameter and the *Earth detection* “Kre” parameter must be smaller than 1 and the *Impedance Z* “KrRX” parameter and the *Voltage* “KrU” parameter must be greater than 1.

3 Integration in the relay scheme

The *Siemens starting* type class name is *TypFdetsie*. The *Siemens starting* dialogue class name is *RelFdetsie*. In the relay scheme the Siemens 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.

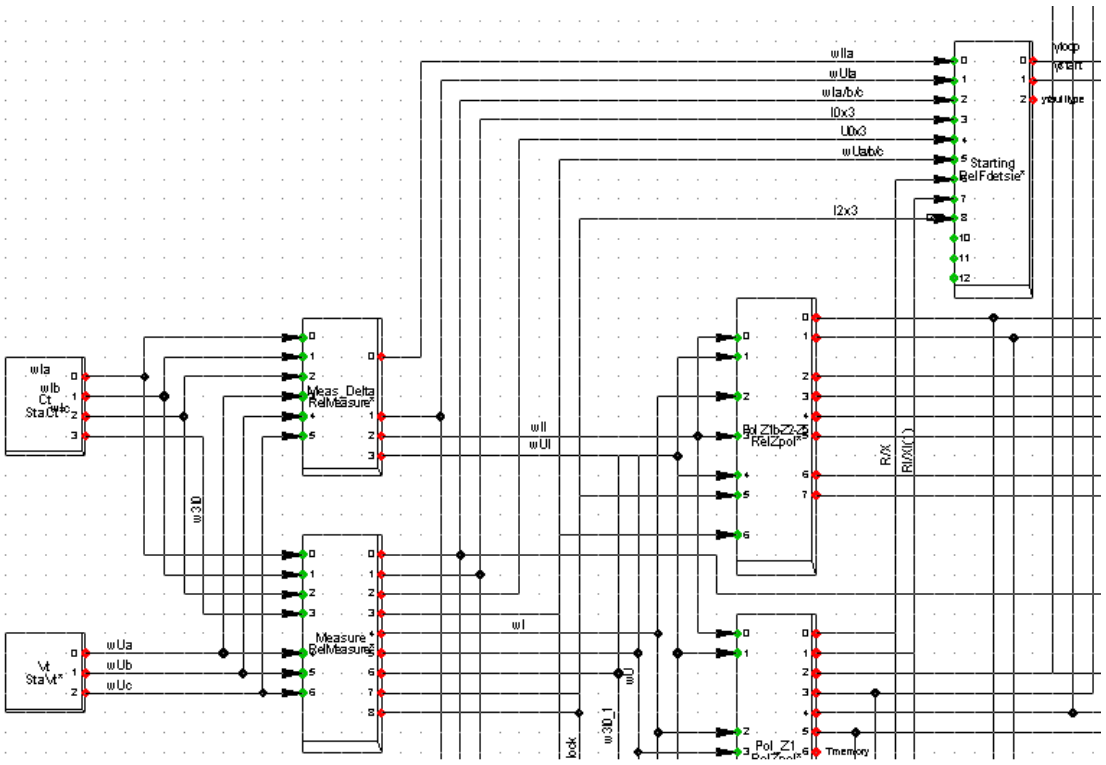


Figure 3.1: *DIgSILENT* Connection scheme of a *Siemens starting* “RelFdetsie” block.

4 Logic

4.1 Siemens 7SA510

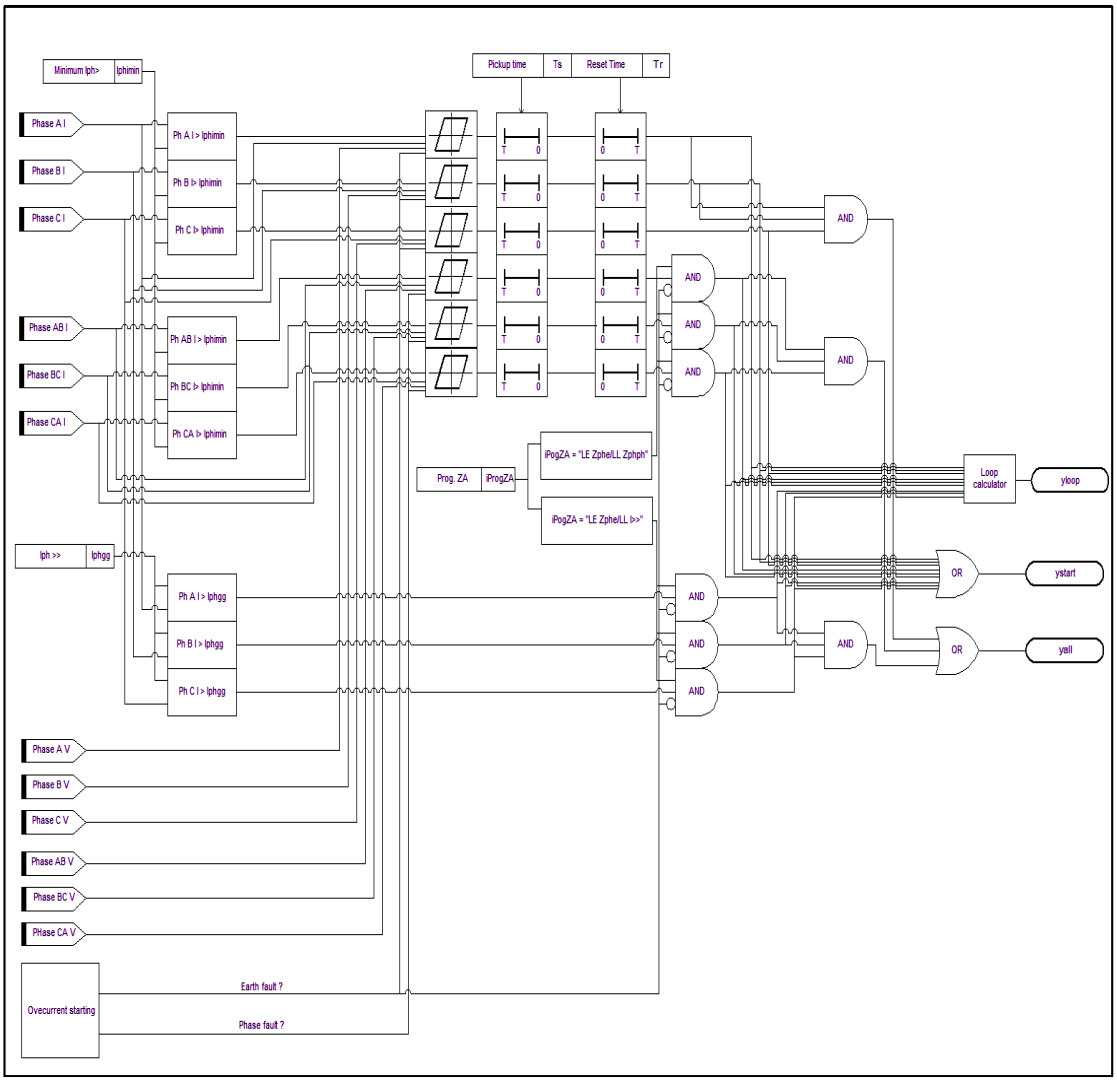
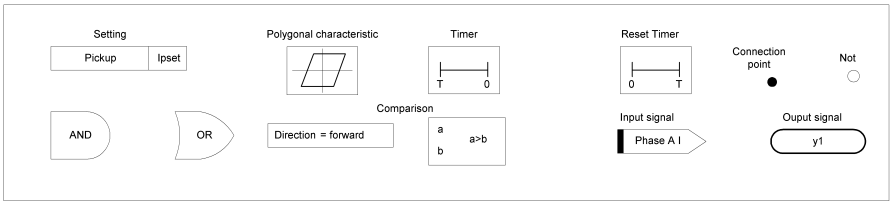


Figure 4.1: The *Siemens 7SA510 starting logic*



4.2 Siemens 7SA511

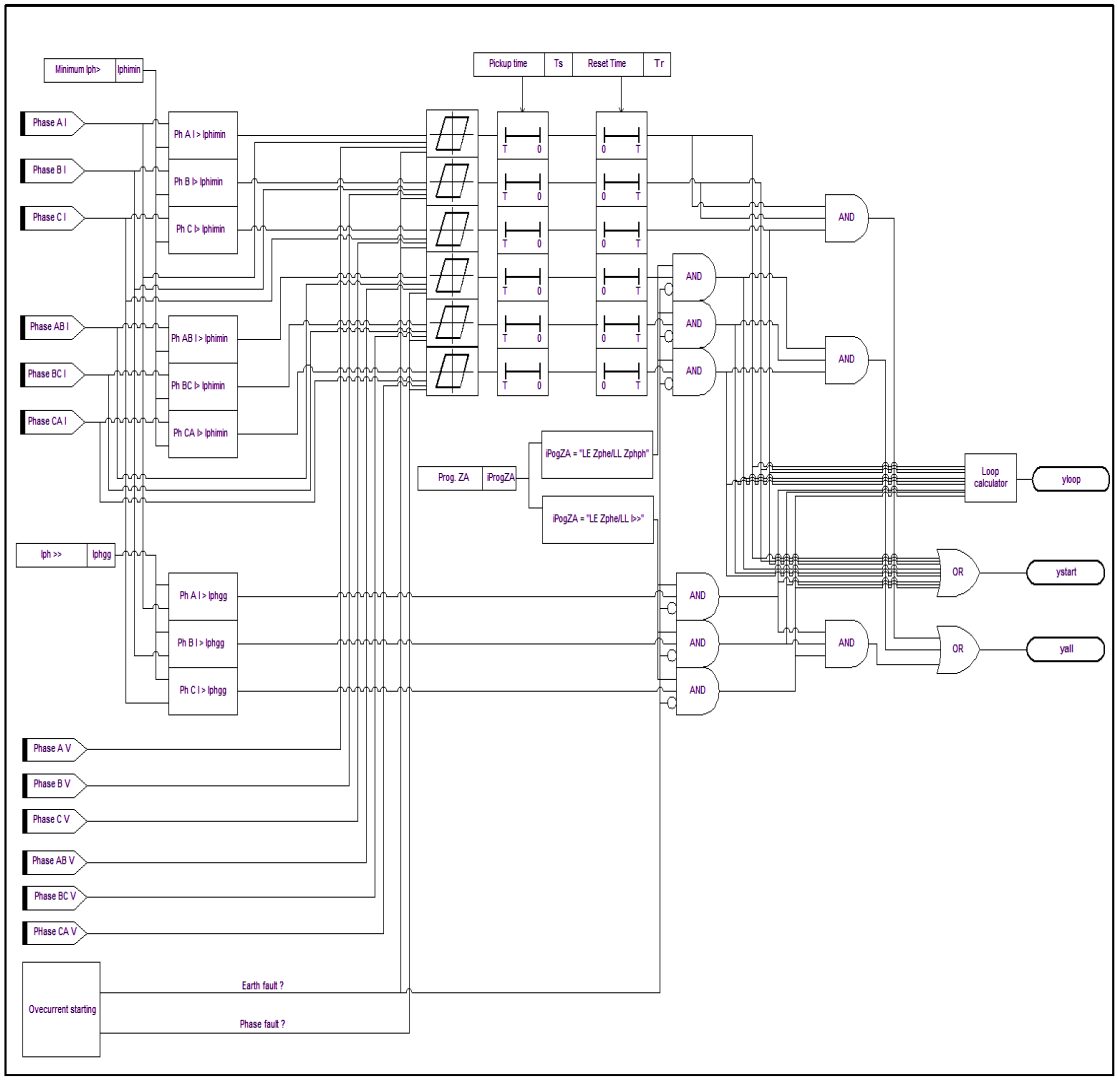
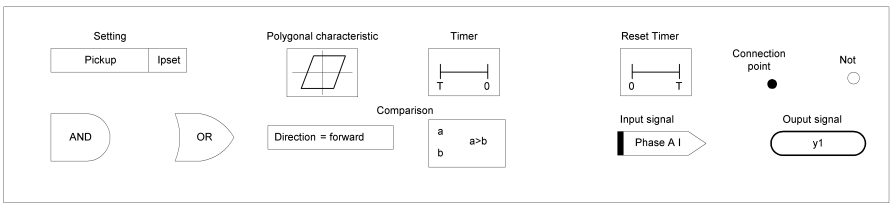


Figure 4.2: The *Siemens 7SA511 starting logic*



4.3 Siemens 7SA513

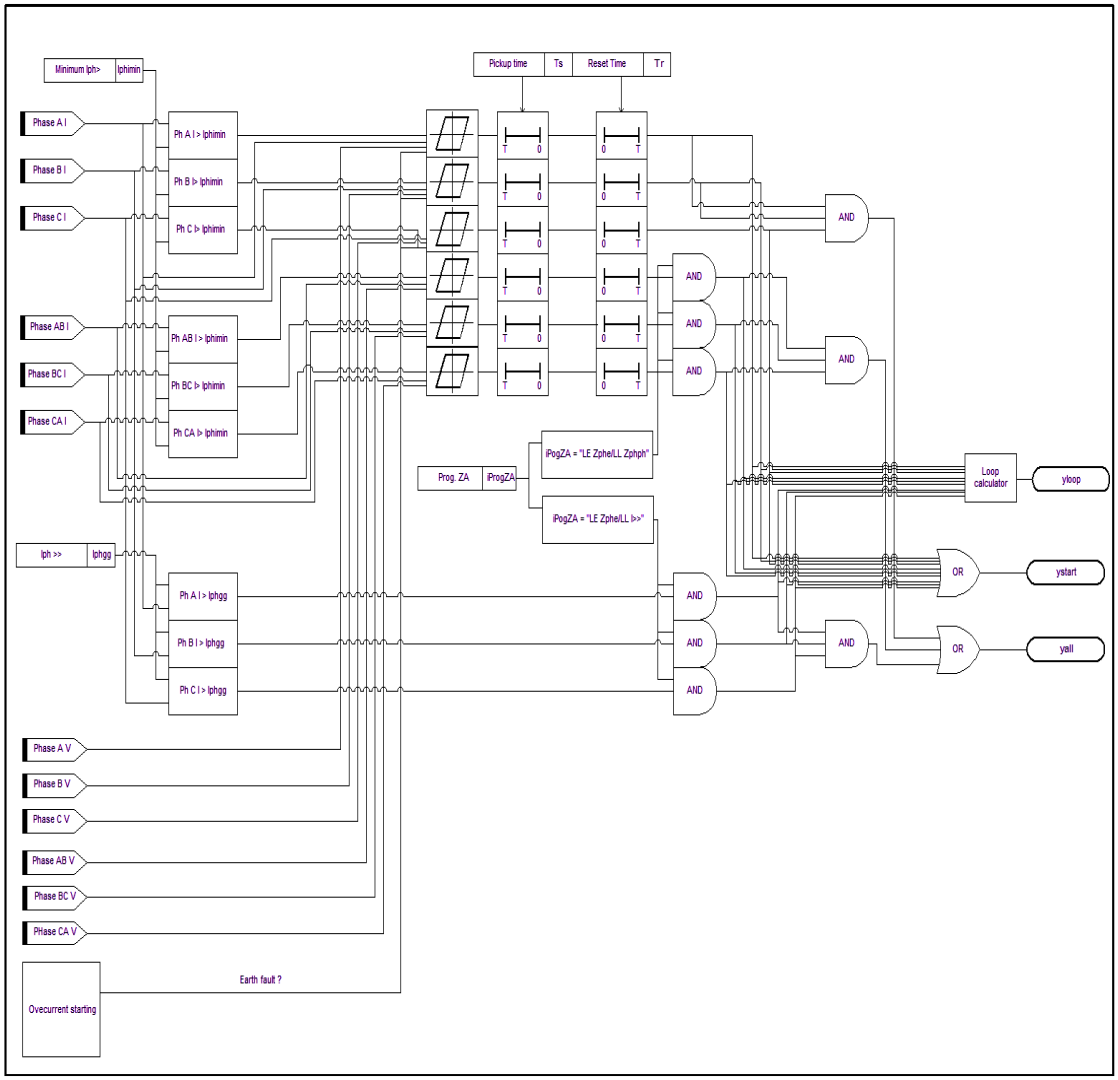
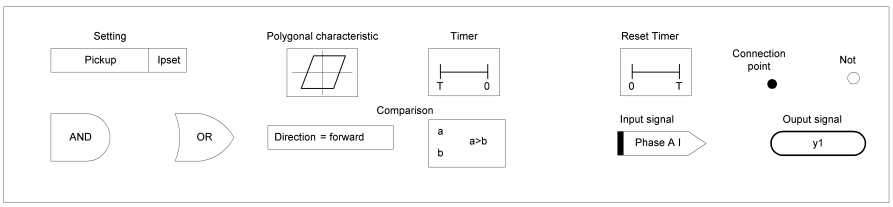


Figure 4.3: The *Siemens 7SA513 starting logic*



A Parameter Definitions

A.1 Siemens starting block Type (TypFdetsie)

Table A.1: Input parameters of Siemens Starting type (*TypFdetsie*)

Parameter	Description	Unit
loc_name	Name assigned by the user to the block type	Text
iprodno	The SIEMENS starting block type (supported number: 510, 511, 513, 522, 600)	Text
ioverc	Flag to enable the overcurrent tstarting	Integer
iundimp	Flag to enable the U/I starting	Integer
iimped	Flag to enable the impedance starting	Integer
iundimpphi	Flag to enable the U/I/phi starting	Integer
rIphgg	Range of phase overcurrent starting threshold	Integer
rIphg	Range of the first phase overcurrent threshold of the U/I starting element	Text
rUpheIg	Range of the ground voltage threshold enabling the Iphg current threshold(U/I starting element)	Text
rUpheIgg	Range of the ground voltage threshold enabling the Iphgg current threshold(U/I starting element)	Text
rUphphIg	Range of the phase voltage threshold enabling the Iphg current threshold(U/I starting element)	Text
rUphphIgg	Range of the phase voltage threshold enabling the Iphgg current threshold(U/I starting element)	Text
rIphig	Range of the first overcurrent threshold of the U/I/Phi starting element	Text
rUpheIgphi	Range of the ground voltage threshold enabling the Iphg current threshold(U/I/phi starting element)	Text
rUphphIgphi	Range of the phase voltage threshold enabling the Iphg current threshold(U/I/phi starting element)	Text
rphig	Range of $\phi >>$	Text
rphis	Range of $\phi <$	Text
rIeg	Range of the first ground overcurrent threshold	Text
rIegg	Range of the 2nd ground overcurrent threshold	Text
rUe	Range of the ground voltage threshold (ground fault detection) for grounded systems	Text
rUeiso	Range of the ground voltage threshold (ground fault detection) for ungrounded systems	Text
rEstabfac	Range of the ground current threshold stabilization slope	Text
NegSeqThr	ange of negative sequence threshold	Text
rIphmin	Range of the phase minimum current	Text
rXpA	Range of the impedance starting zone positive reactance	Text
rXmA	Range of the impedance starting zone negative reactance	Text
rRA1	Range of impedance starting zone phase internal resistance	Text
rRA2	Range of impedance starting zone phase external resistance	Text
rRA1E	Range of impedance starting zone ground internal resistance	Text
rRA2E	Range of impedance starting zone ground external resistance	Text
rPHIA	Range of impedance starting zone phase angle	Text
rPHIAE	Range of impedance starting zone ground angle	Text
Ts	Pick up time, it's the time spent measuring the currents in the load flow and short circuit calculation and in the RMS simulation	Seconds
Tr	Reset time, it's 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
KrU	Voltage reset ratio	Real number
kre	Earth current reset ratio	Real number

A.2 Siemens starting Element (RelFdetsie)

Table A.2: Input parameters of Siemens Starting element (*RelFdetsie*))

Parameter	Description	Unit
loc_name	Name assigned by the user to the block	Text
Iphgg	Phase overcurrent starting threshold	%Irated ph
Iphg	First phase overcurrent threshold of the U/I starting element	% Irated ph
UpheIg	Ground voltage threshold enabling the Iphg current threshold(U/I starting element)	% Urated
UpheIgg	Ground voltage threshold enabling the Iphgg current threshold(U/I starting element)	% Urated
UphphIg	Voltage threshold enabling the Iphg current threshold(U/I starting element)	% Urated
UphphIgg	Phase voltage threshold enabling the Iphgg current threshold(U/I starting element)	% Urated
Iphig	First overcurrent threshold of the U/I/Phi starting element	% Irated ph
UpheIgphi	Ground voltage threshold enabling the Iphg current threshold(U/I/phi starting element)	% Urated
UphphIgphi	Phase voltage threshold enabling the Iphg current threshold(U/I/phi starting element)	% Urated
rphig	$\phi >$	Degrees
phis	$\phi <$	Degrees
Ieg	First ground overcurrent threshold	% Irated grnd
Iegg	2nd Ground overcurrent threshold	% Irated grnd
Ue	Ground voltage threshold (ground fault detection) for grounded systems	% U rated
Ueiso	Ground voltage threshold (ground fault detection) for ungrounded systems	% U rated
Estabfac	Ground current threshold stabilization slope	%
Iphmin	Phase minimum current	% Irated
XpA	Impedance starting zone positive reactance	Sec Ohm
XmA	Impedance starting zone negative reactance	Sec Ohm
RA1	Impedance starting zone phase *internal* resistance	Sec Ohm
RA2	Impedance starting zone phase *external* resistance	Sec Ohm
RA1E	Impedance starting zone ground *internal* resistance	Sec Ohm
RA2E	Impedance starting zone ground *external* resistance	Sec Ohm
PHIA	Impedance starting zone phase angle	Degrees
PHIAE	Impedance starting zone ground angle	Degrees
iPhPhE	Ph-Ph-Earth Faults loop selection rule in earthed networks	
i3PhDet	3 phase fault detection rule in earthed networks	
i1PhFLT	Single phase fault selection rule in earthed networks	
iPHPRE	Ph-Ph-Earth Faults loop selection rule in non-earthed networks	
isysstar	System grounding(Solidly earthed = 0, Compensated = 1, Isolated= 2)	
iEarthdet	Ground fault condition in earthed networks(Ue> AND Ie> =0, Ue> OR Ie> = 1)	
effectphi	Direction in which the phi compensation is applied(Forward & reverse = 0, Forward = 1)	
iProgZA	It determines if the impedance must be used for the both the phase and the ground loops or the overcurrent starting is used for the phase loops(LE Zphe/LL Zphph = 0, LE Zphe/LL I>>= 1)	
iProgUI	It determines whether the phase phase loops or the phase earth loops are always valid, or whether this depends on the earth fault detection (LE Uphe/LL Uphph = 0,LE Uphph/LL Uphph = 1,LE Uphe/LL Uphe = 2,LE Uphe/LL I>>= 3)	

B Signal Definitions

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

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	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
ysall	Starting signal/ starting time for all loops (3ph fault) Y/N or seconds	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
yfaulttype	Fault type ID		OUT	Any

List of Figures

List of Tables