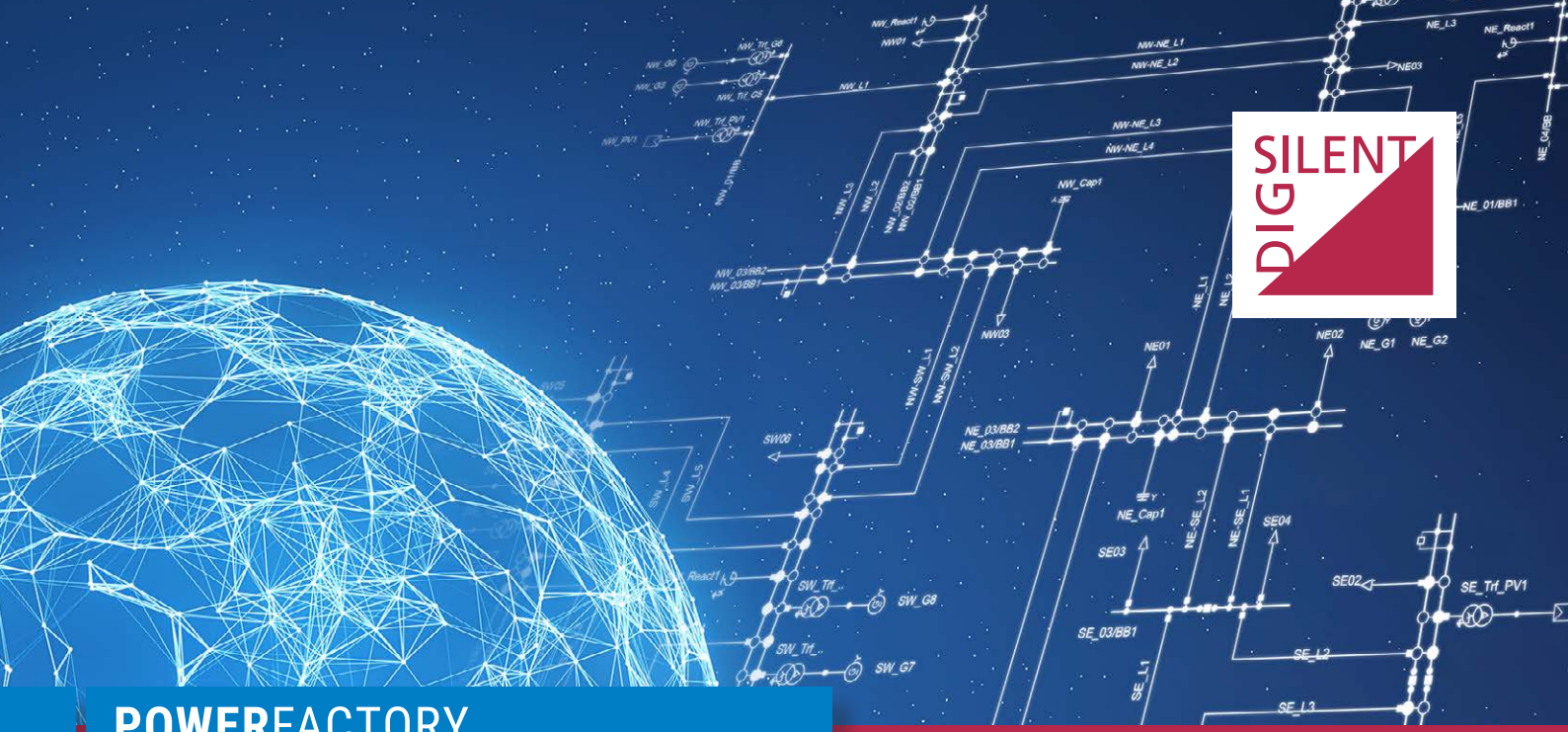

POWERFACTORY

# PowerFactory 2021

## Technical Reference

### Alstom EPAC starting unit

RelFdetalst, TypFdetalst

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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# Contents

# 1 General Description

The Alstom EPAC Starting block implements the fault detection logic available in the following relay models

- Alstom EPAC 3000
- Alstom EPAC 3100
- Alstom EPAC 3500

The following logic of fault detection are available and can be set as always enabled, user configurable or disabled:

- *Overcurrent I>*
- *Impedance Z*

A specific earth fault detection logic is always active.

## 1.1 Available settings

**Alstom EPAC** :

The *Alstom EPAC* starting block defines:

- An overcurrent starting with double current threshold.
- An underimpedance starting logic
- An earth detection logic with zero sequence current threshold and zero sequence voltage threshold .
- Loop preferences for 2 phase-ground fault.

**Alstom PXLN** :

The *Alstom PXLN* starting block defines:

- an overcurrent starting logic with double current threshold
- An earth detection logic with zero sequence current threshold and zero sequence voltage threshold .
- Loop preferences for 2 phase-ground fault.

The *Alstom PXLN* overcurrent starting logic is identical to the Alstom EPAC overcurrent starting logic. For this reason the “Alstom EPAC Starting” element can be used simply disabling the *Impedance Z* logic.

# 2 Features & User interface

## 2.1 Alstom EPAC Starting Logic (RelFdetalst)

The user can change the block settings using the “Alstom EPAC Starting” dialogue (“RelFdetalst” class). The dialogue consists of six tab pages: *Basic Data*, *Ground Detection*, *Overcurrent*, *Underimpedance*, *Phase Preference Logic*, and *Description*.

### 2.1.1 Basic data

The “Basic Data” tab page contains the block name, a link to the relevant starting type object, two check buttons which allow to select the active starting logic between the logic available for the given model, one combo box which allows to define the power system grounding (*Solidly earthed*, *Compensated* or *Isolated*) and three edit boxes which define the line length and positive sequence impedance values. Multiple starting logic can be active at the same time. In Figure 2.1 the whole starting logic is showed.

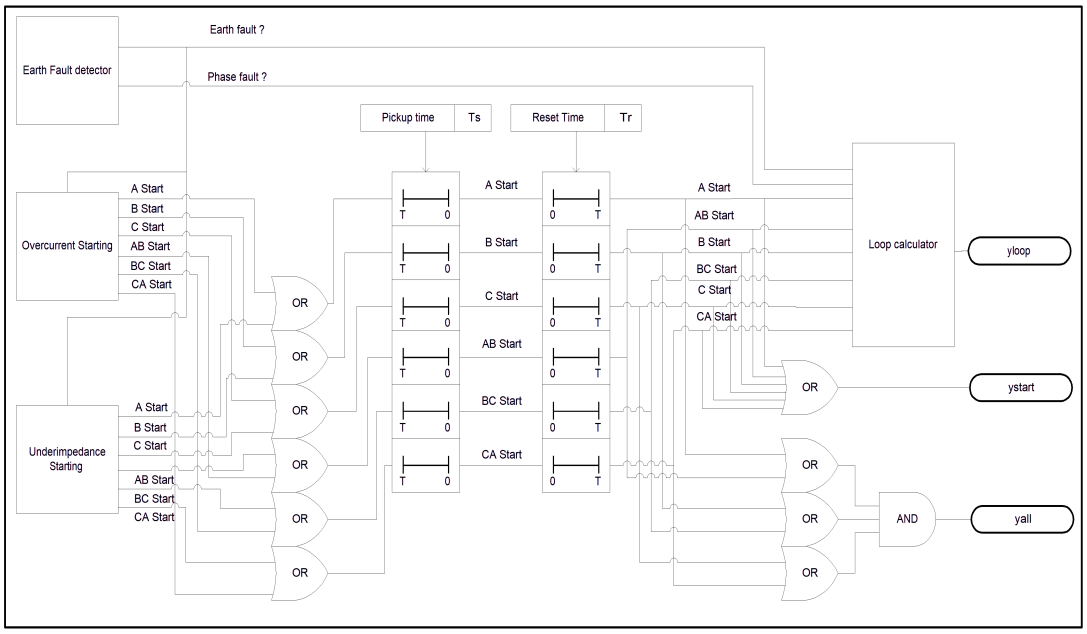
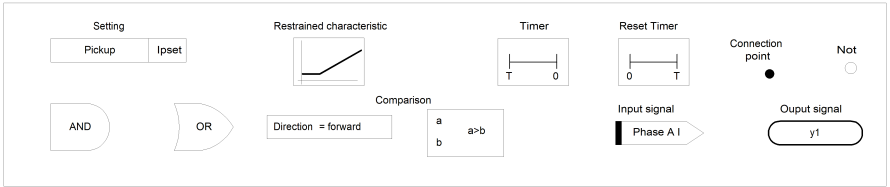



Figure 2.1: *DIgSILENT* Alstom EPAC *starting logic*



### 2.1.2 Overcurrent

When the overcurrent starting is available and the *Overcurrent I>* checkbox is set the phase currents are compared with the *S1* (“S1” parameter) and the *S2(*“S2” parameter) phase current threshold. The phase currents are evaluated and the following quantities are calculated

- *Greatest phase current*.
- *Smallest phase current*.
- *Middle phase current* (the phase current which is not the Greater nor the Smallest phase current).

The following rules are applied to detect the fault type and the loop which must be declared as started:

- if the *Greatest phase current* is greater than “S2” and the *Smallest phase current* is greater than “S1” then a *Three Phase* fault is declared.
- if the *Greatest phase current* is greater than “S2” and the *Middle phase current* is greater than “S1” and an earth fault has been detected by the *Ground Detection* logic then a *Phase-Phase-Ground* fault is declared.
- if the *Greatest phase current* is greater than “S2” and the *Middle phase current* is greater than “S1” and no earth fault has been detected by the *Ground Detection* logic then a *Phase-Phase* fault is declared.
- if the *Greatest phase current* is greater than “S2” and the *Middle phase current* is smaller than “S1” then a *Single Phase Ground* fault is declared.

For any kind of detected fault (except for the *Three Phase* fault ), the phase which is the Greatest phase current and the phase which is the *Middle phase current* are used to calculate the started loops.

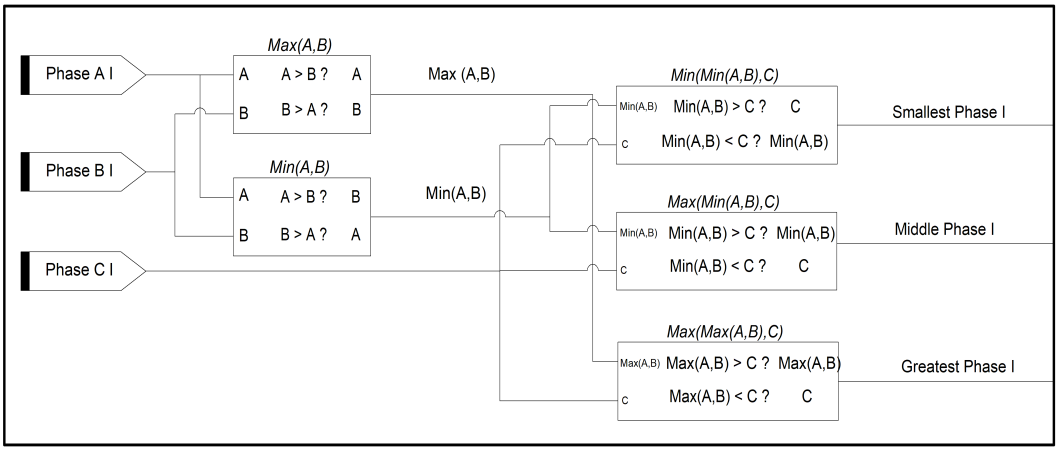
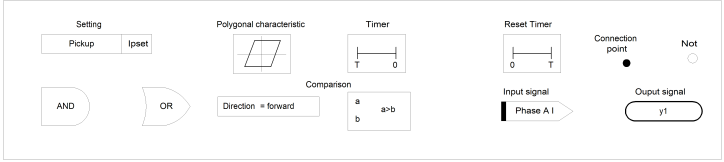



Figure 2.2: Alstom EPAC *Greatest, Smallest and Middle Phase Current selection logic*



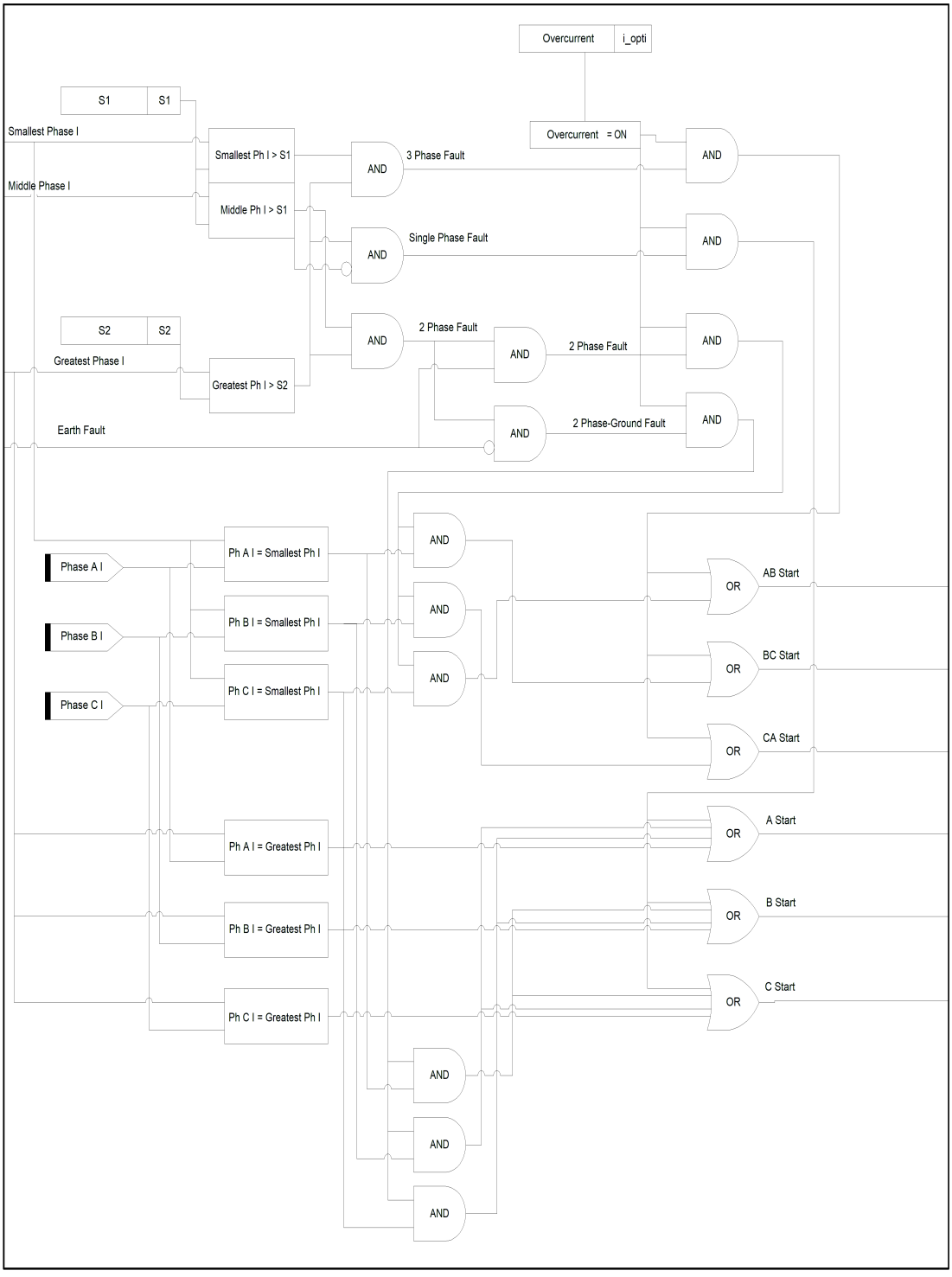
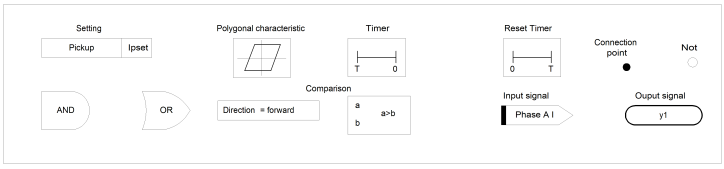



Figure 2.3: *DIgSILENT* Alstom EPAC Overcurrent starting logic



### 2.1.3 Underimpedance

When the underimpedance starting is available and the *Impedance Z* checkbox has been set, if the *Overcurrent* starting logic didn't detect any fault, the phase impedances and the phase-phase impedances are evaluated using the distance starting zone shapes shown in Figure 2.5, Figure 2.6, and Figure 2.7.
Different distance starting zone shapes are active for the phase faults (see Figure 2.5), for the earth faults for the first distance protection zone(see Figure 2.6) and for the earth faults for the other distance protection zones (see Figure 2.7).
The distance starting zone shapes are defined using the "Z reach" ("Zmax" parameter) setting and the "+R reach" ("Rmax" parameter) setting of the polygonal element pointed in the *Underimpedance* tab page of the "Alstom EPAC Starting Type" by "Z01 Reference block" ("pz01referenceblock") and "Z02 Reference block" ("pz02referenceblock").

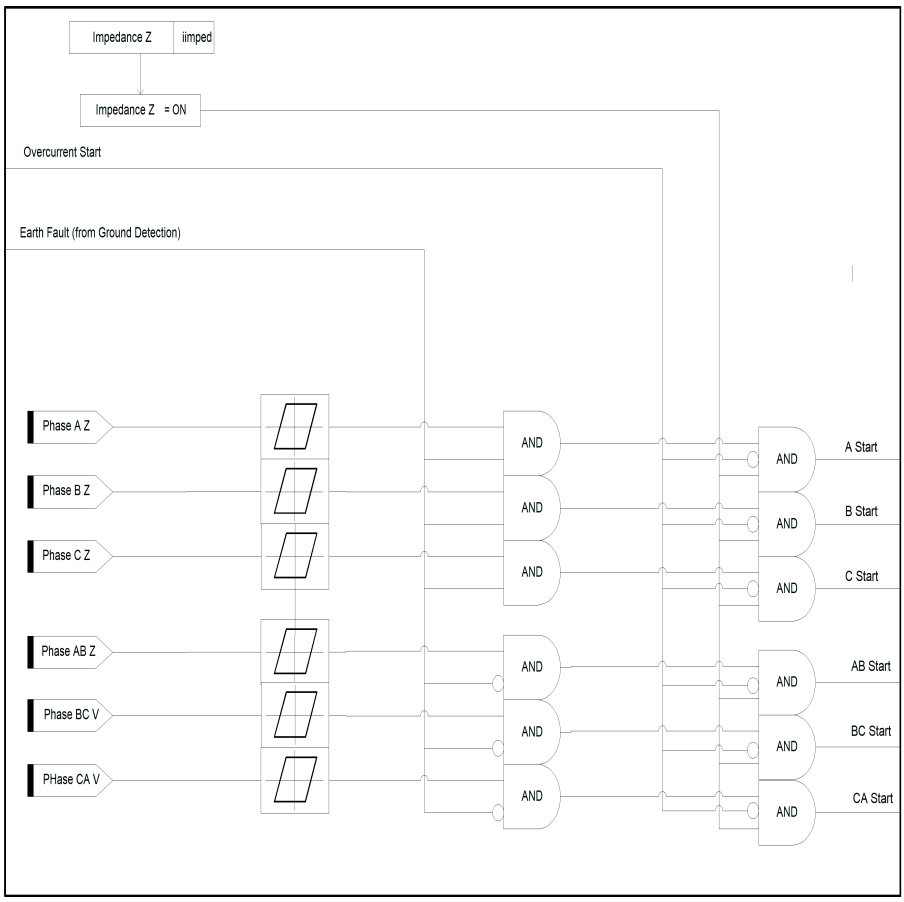
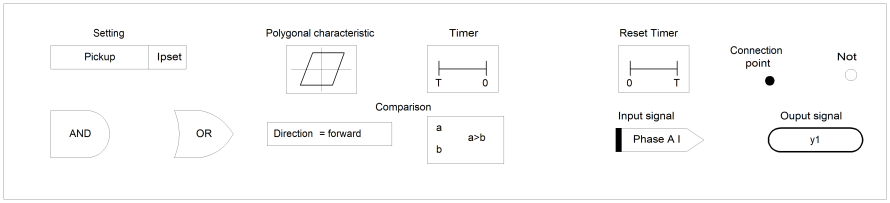



Figure 2.4: *DIgSILENT* Alstom EPAC *Underimpedance starting logic*



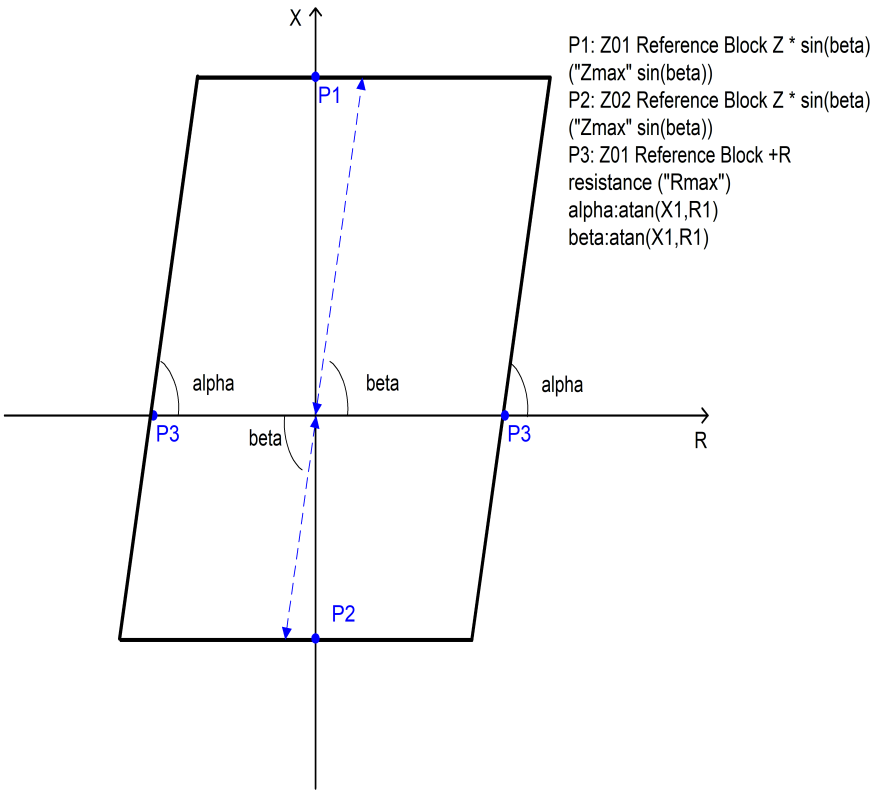



Figure 2.5: *DIgSILENT* The *Underimpedance phase starting detection zone*

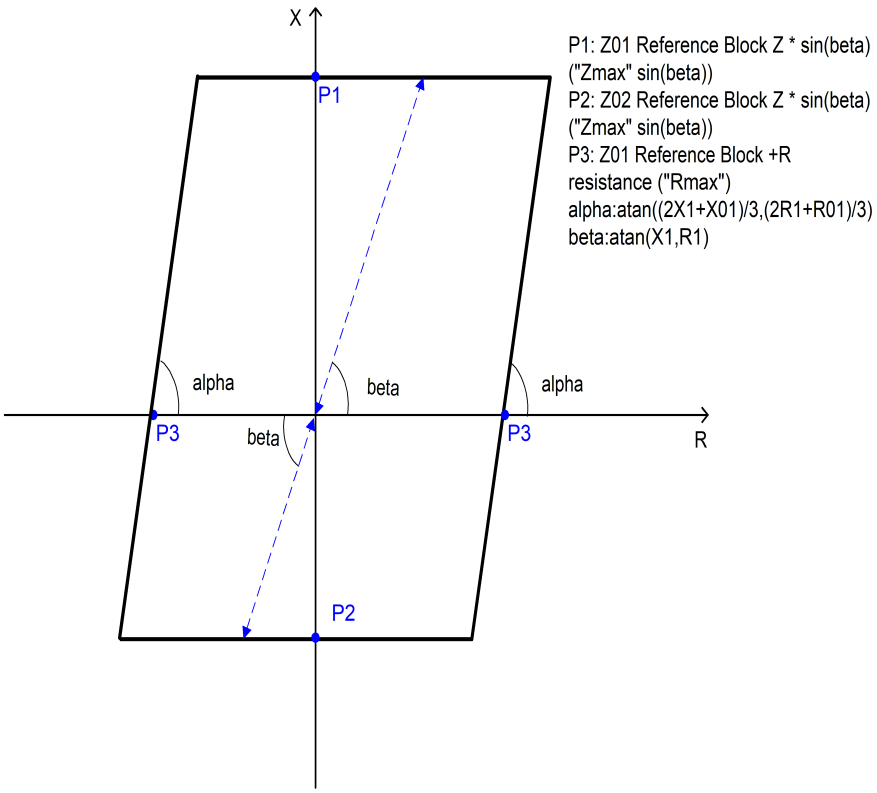



Figure 2.6: *DIgSILENT* The *Underimpedance ground starting detection zone 1*

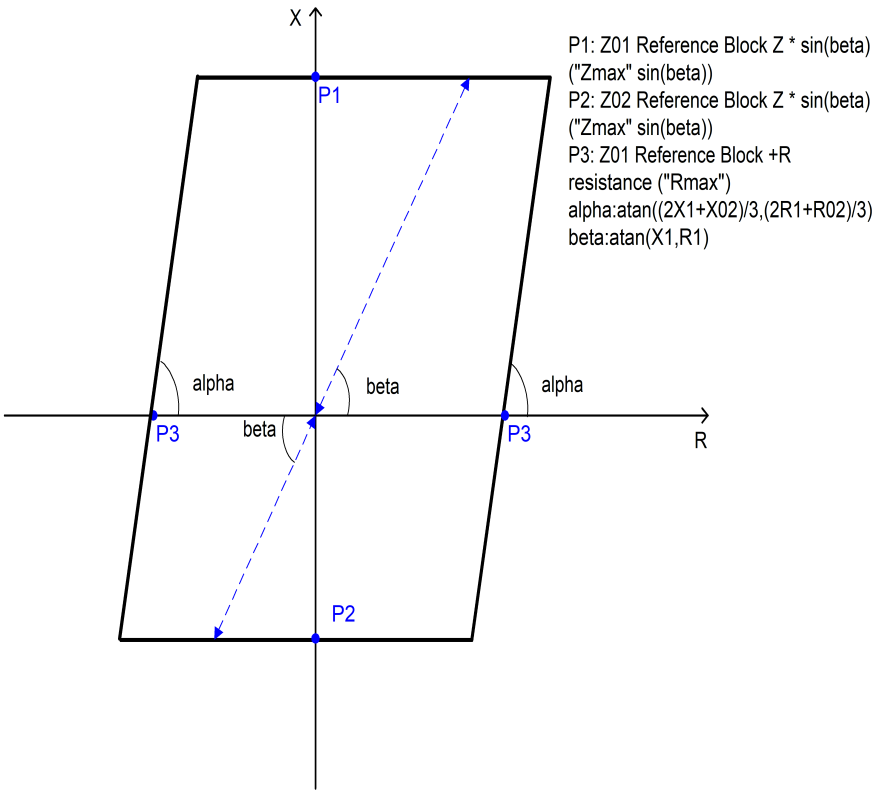



Figure 2.7: *DIgSILENT* The *Underimpedance ground starting detection zone* $> 1$

The unique difference between the

### 2.1.4 Ground Detection

The ground detection logic use one zero sequence current threshold and one zero sequence voltage threshold to detect the ground fault condition.
A ground fault is declared if the zero sequence current is greater than “Residual current threshold” (“sIr” parameter) edit box value or the zero sequence voltage is greater than “Residual voltage threshold” (“sUr parameter”) edit box value.
Just below the two mentioned edit boxes the “Tripping on maximum residual voltage” (“iutripen”) check box allows to enable/disable the operation of the “yout” ouput signal when the the zero sequence voltage is greater than “Residual voltage threshold” (“sUr”) for a time greater than “Tripping time delay” (“Temp”).

The earth detection logic is showed in Figure 2.8

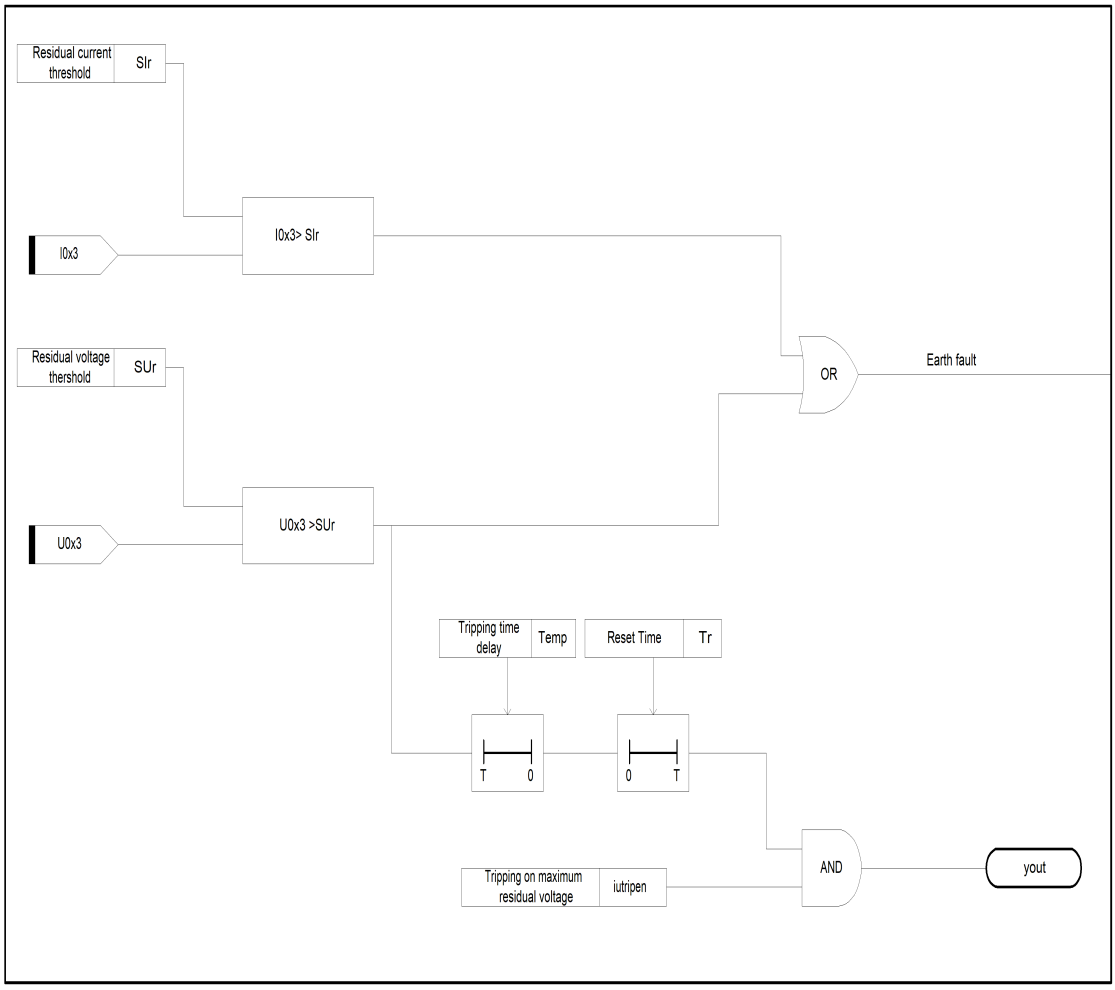
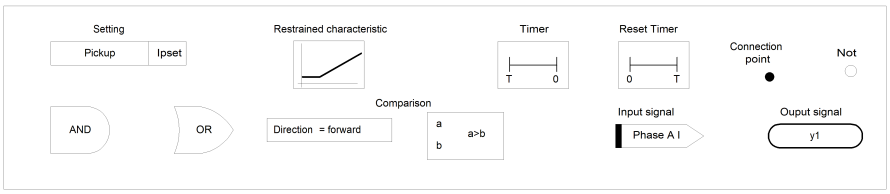



Figure 2.8: *DIgSILENT* Alstom EPAC *Earth detection starting logic*



### 2.1.5 Phase preference Logic

The *Fault Loop* logic defines additional loop selection preferences in case of Phase-Phase-Ground.
The “Enable” (“ienabled” parameter) check box allows to enable or disable the *Phase preference Logic*.

**Phase preferences for Ph-Ph-E Faults** (“PhasePref” parameter) It’s the logic applied when a Phase-Phase-Ground fault has been detected. One between the following options can be selected:

- *A(C) acyclic*
- *C(A) acyclic*
- *A(B) acyclic*
- *B(A) acyclic*
- *B(C) acyclic*
- *C(B) acyclic*
- *A(C) cyclic*
- *C(A) cyclic*

Table 2.1: Started loop applying the Phase Preferences logic to a Ph-Ph-Grnd fault

| FaultType | A(C) acyclic | C(A) acyclic | A(B) acyclic | B(A) acyclic | B(C) acyclic | C(B) acyclic | A(C) cyclic | C(A) cyclic |
|---|---|---|---|---|---|---|---|---|
| **A-B-Grnd** | A | A | A | B | B | B | B | A |
| **A-C-Grnd** | A | C | A | A | C | C | A | C |
| **B-C-Grnd** | C | C | B | B | B | C | C | B |

### 2.1.6 Description

The *Description* tab page can be used to insert some information to identify the Alstom EPAC 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 Alstom EPAC Starting Type(TypFdetalst)

The *Alstom EPAC Starting* block main characteristics must be configured in the “Alstom EPAC Starting Type” dialogue (*TypFdetalst* class). The dialogue contains five tab pages: *Basic Data*, *Ground Detection*, *Overcurrent*, *Underimpedance*, and *Common*.

### 2.2.1 Basic Data

The *Basic data* tab page contains the “Model” combobox (“prodname” parameter) which allows to select the active “Alstom EPAC Starting” type. The following types are available:

- EPAC 3000
- EPAC 3100
- EPAC 3500

The “Model” combobox is used only for documentation purpose, the implemented starting logic is unique and is not affected by the selected model.

The two combo boxes *Overcurrent I>Configuration* (“ioverccconf” parameter) and *Underimpedance*(“iimpedconf” parameter) allow to define which starting types are shown in the “Alstom EPAC Starting” dialogue (“RelFdetalst” class). Each combobox contains the following options

- *Disabled*
- *Enabled*
- *User Configurable*

When the *Disabled* option is selected the relevant check box is hidden in the “Basic Data” tab page of the “Alstom EPAC Starting” dialogue. When the *Enabled* option is selected the relevant check box is showed as checked and cannot be modified. When the *User Configurable* option is selected the relevant check box is showed and can be checked or unchecked.

### 2.2.2 Ground Detection

The *Ground Detection* tab page contains the range definition for the element parameters available in the “Ground Detection” tab page of the “Alstom EPAC Starting” dialogue.

### 2.2.3 Overcurrent

The *Overcurrent* tab page contains the range definition for the element parameters available in the “Overcurrent” tab page of the “Alstom EPAC Starting” dialogue.

### 2.2.4 Underimpedance

The *Underimpedance* tab page contains the range definition for the element parameters available in the “Underimpedance” tab page of the “Alstom EPAC Starting” dialogue.

### 2.2.5 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* (“KrI” parameter) and the the *Underimpedance* (“KrRX” parameter). Please notice that the *Overcurrent* “KrI” parameter must be smaller than 1 and the *Impedance Z* “KrRX” parameter must be greater than 1.

# 3 Integration in the relay scheme

The *Alstom EPAC Starting* type class name is *TypFdetalst*. The *Alstom EPAC Starting* dialogue class name is *RelFdetalst*. In the relay scheme the Alstom EPAC 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.

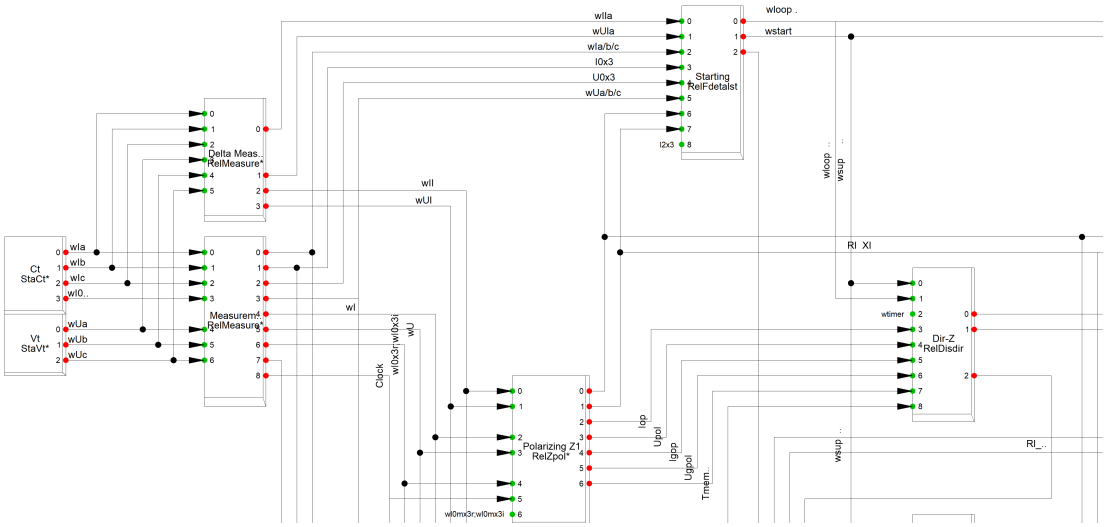



Figure 3.1: *DIgSILENT* Connection scheme of a *Alstom EPAC Starting* “RelFdetalst” block.

# A Parameter Definitions

## A.1 Alstom EPAC Starting block Type (TypFdetalst)

Table A.1: Input parameters of Alstom EPAC Starting type (*TypFdetalst*)

| Parameter | Description | Unit |
|---|---|---|
| loc_name | Name assigned by the user to the block type | Text |
| prodname | The starting block type (supported types: *EPAC 3000*, *EPAC 3100*, *EPAC 3500* ) | Text |
| rlinelen | Range of the *Line Length* variable | Text |
| rR1 | Range of the Line positive sequence reactance | Text |
| rX1 | Range of the Line positive sequence resistance | Text |
| iovercconf | Flag defining if the overcurrent starting is always *Enabled*, *Disabled* or is *User Configurable* | Integer |
| iimpedconf | Flag defining how the impedance starting is always *Enabled*, *Disabled* or is *User Configurable* | Integer |
| rSIr | Range of the *Residual Current Threshold* used for the earth fault detection | Text |
| rSUr | Range of the *Residual Voltage Threshold* used for the earth fault detection | Text |
| rTemp | Range of the *Tripping Time Delay* used for the earth fault detection | Text |
| rS1 | Range of the first phase overcurrent starting threshold | Text |
| rS2 | Range of the second phase overcurrent starting threshold | Text |
| pz01refblock | Pointer to an EPAC type polygonal element which defines the forward direction Z reach and the R reach of the impedance starting | PF object pointer |
| pz02refblock | Pointer to an EPAC type polygonal element which defines the reverse direction Z reach | PF object pointer |
| rX01 | Range of the Reactance which define the angle of the starting earth impedance shape (zone 1) | Text |
| rX02 | Range of the Reactance which define the angle of the starting earth impedance shape (zone $>1$) | Text |
| rR01 | Range of the Resistance which define the angle of the starting earth impedance shape (zone 1) | Text |
| rR02 | Range of the Resistance which define the angle of the starting earth impedance shape (zone $>1$) | 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 condition is not anymore verified | Seconds |
| KrRX | Underimpedance reset ratio | Real number |
| KrI | Current Starting reset ratio | Real number |

## A.2 Alstom EPAC Starting Element (RelFdetalst)

Table A.2: Input parameters of Alstom EPAC Starting element (*RelFdetalst*))

| Parameter | Description | Unit |
|---|---|---|
| loc_name | Name assigned by the user to the block | Text |
| ioverc | Flag to enable the current starting logic | Integer |
| iimped | Flag to enable the underimpedance starting logic | Integer |
| ineutrearth | Earthing system (*Solidly Earthed*, *Compensated*, *Insulated*) (documentation purpose only) | Integer |
| linelen | The *Line Length* variable (documentation purpose only) | Text |
| R1 | The Line positive sequence reactance (used for the forward and reverse reach of the impedance zone starting) | Text |
| X1 | The Line positive sequence resistance | Text |
| SIr | The *Residual Current Threshold* used for the earth fault detection | Text |
| SUr | The *Residual Voltage Threshold* used for the earth fault detection | Text |
| Temp | The *Tripping Time Delay* used for the earth fault detection | Text |
| S1 | The first phase overcurrent starting threshold | Text |
| S2 | The second phase overcurrent starting threshold | Text |
| X01 | The Reactance which define the angle of the starting earth impedance shape (zone 1) | Text |
| X02 | The Reactance which define the angle of the starting earth impedance shape (zone $>1$) | Text |
| R01 | The Resistance which define the angle of the starting earth impedance shape (zone 1) | Text |
| R02 | The Resistance which define the angle of the starting earth impedance shape (zone $>1$) | Text |
| ienabled | Flag to enable/disable the Ph-Ph-grnd fault phase preferences | Integer |
| PhasePref | Phase preferences logic for a Ph-Ph-grnd fault | Text |

# B Signal Definitions

Table B.1: Input/output signals of the Alstom EPAC Starting element (*CalFdetalst*)

| Name | Description | Unit | Type | Model |
|---|---|---|---|---|
| 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 |
| Rl_A | Phase A - Phase B loop resistance | Secondary Ohms | IN | Any |
| Xl_A | Phase A  Phase B loop inductance | Secondary Ohms | IN | Any |
| Rl_B | Phase B - Phase C loop resistance | Secondary Ohms | IN | Any |
| Xl_B | Phase B  Phase C loop inductance | Secondary Ohms | IN | Any |
| Rl_C | Phase C - Phase A loop resistance | Secondary Ohms | IN | Any |
| Xl_C | Phase C  Phase A loop inductance | Secondary Ohms | IN | Any |
| 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 |
| Il_A | Phase A - Phase B current | Secondary Amperes | IN | Any |
| Il_B | Phase B - Phase C current | Secondary Amperes | IN | Any |
| Il_C | Phase C - Phase A current | Secondary Amperes | IN | Any |
| I0x3 | Zero sequence current | Secondary Amperes | IN | Any |
| I2x3 | Negative sequence current | Secondary Amperes | IN | Any |
| wIr_A | Phase A current real part | Secondary Amperes | IN | Any |
| wIi_A | Phase A current imaginary part | Secondary Amperes | IN | Any |
| wIr_B | Phase B current real part | Secondary Amperes | IN | Any |
| wIi_B | Phase B current imaginary part | Secondary Amperes | IN | Any |
| wIr_C | Phase C current real part | Secondary Amperes | IN | Any |
| wIi_C | Phase C current imaginary part | Secondary Amperes | IN | Any |
| wI0x3r | Zero sequence current real part | Secondary Amperes | IN | Any |
| wI0x3i | Zero sequence current imaginary part | Secondary Amperes | 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 |
| U0x3 | Zero sequence voltage | Secondary Volts | IN | Any |
| wUr_A | Phase A voltage real part | Secondary Volts | IN | Any |
| wUi_A | Phase A voltage imaginary part | Secondary Volts | IN | Any |
| wUr_B | Phase B voltage real part | Secondary Volts | IN | Any |
| wUi_B | Phase B voltage imaginary part | Secondary Volts | IN | Any |
| wUr_C | Phase C voltage real part | Secondary Volts | IN | Any |
| wUi_C | Phase C voltage imaginary part | Secondary Volts | IN | Any |
| yloop | ID of the loop from which the fault must be removed | | OUT | Any |
| ystart | Starting signal/ starting time | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| ysall | Starting signal/ starting time for all loops (3ph fault) | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| yout | Trip signal (Zero sequence voltage greater than “sUR” ) for a time greater than “Temp” | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| yloop1E | ID of the loop of the first earth zone from which the fault must be removed | | OUT | Any |
| ystart1E | Starting signal/ starting time of the first earth zone | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |
| ysall1E | Starting signal/ starting time for all loops (3ph fault) of the first earth zone | Seconds (or 1/0 RMS/EMT simulation) | OUT | Any |

# List of Figures

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