POWERFACTORY

PowerFactory 2021

Technical Reference

Starting/Fault Detector

RelFdetect, TypFdetect

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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Contents

1 General Description

The Starting/Fault Detector block implements the more common fault detection logic present in the distance relays; the block supports the following logic:

- Overcurrent (phase and ground).
- Underimpedance as voltage restrained overcurrent.
- Underimpedance with impedance calculation.

2 Features & User interface

2.1 Starting/Fault Detector dialogue (RelFdetect)

The user can change the block settings using the *Starting/Fault Detector* dialogue ("RelFdetect" class). The dialogue consists of two tab pages: *Basic data*,and *Description*.

2.1.1 Basic data

The "Basic Data" tab page contains the block name and, in the *Type of Starting* frame, one or two radio buttons which allow to enable/disable the *overcurrent* and *Underimpedance* logic. Which starting logic are available can be set using the check box located in the *Available Startings* frame in the starting block type dialogue ("TypFdetect" class). If both starting logic are available only one can be active. If only one logic is available this logic is active be default and cannot be disabled. The *Earth Fault Detection* frame contains, if available, the earth fault detection threshold. The *Overcurrent and Underimpedance* frame contains the current threshold value(s) and, if available, the voltage values which, together with the current values, define the voltage dependent overcurrent characteristic (*Underimpedance*).

2.1.2 Description

The *Description* tab page can be used to insert some information to identify the *Starting/Fault Detector* 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 Starting/Fault Detector Type(TypFdetect)

The *Starting/Fault Detector* block main characteristics must be configured in the "Starting/Fault Detector Type" dialogue (*TypFdetect* class). The dialogue contains two tab pages: *Basic data*, and *Common*.

2.2.1 Basic data

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

- Overcurrent I$>>$
- Underimpedance $U < /I >$

In the *Overcurrent and Underimpedance* frame the *Type* combo box allows to define which kind of underimpedance logic is used. The Overcurrent starting logic is not affected by the selected *Type*. The following starting types are available:

- U-I Type 1
- U-I Type 2
- U-I Type 3
- U-I Type 4
- I-Z
- U-Z

The first four types implements an Underimpedance as voltage restrained overcurrent logic. The *I-Z* type performs an Underimpedance logic with impedance calculation, the *U-Z* type supports the fault detection logic available in some Toshiba distance protections.

The *External Settings* checkbox allows to enable a special overcurrent starting logic which compares the phase and the earth current with the values provided by the following two additional input signals:

- wIset (phase threshold)
- wI0set (ground threshold)

When the *External Settings* is set the Overcurrent logic must be used.

2.2.2 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.

2.3 Overcurrent

The overcurrent-based starting logic measures three phase currents and the residual current, comparing them with the threshold values.

If I_A,I_B and I_C are the phase currents and I0x3 the earth current the operating conditions are the following:

I_A > *Current I >>* or
I_B > *Current I>>* or
I_C > *Current I>>* or
I0x3 > *Current, 3Io*

where
Current I>> is the “ip2” dialogue parameter
“Current, 3Io” is the “ie” dialogue parameter.

2.4 Underimpedance

Six different logic types are available and can be set using the *Type* combo box in the *Overcurrent and Underimpedance* frame in the starting type block dialogue (“TypFdetect” class).

2.4.1 U-I Type 1

The current starting threshold is the *Current I >>*(“Ip2” parameter) value when the voltage is greater than the *Voltage U(I>)* (“U”parameter) value. Otherwise the *Current I>*(“Ip1” parameter) value is used as current threshold.

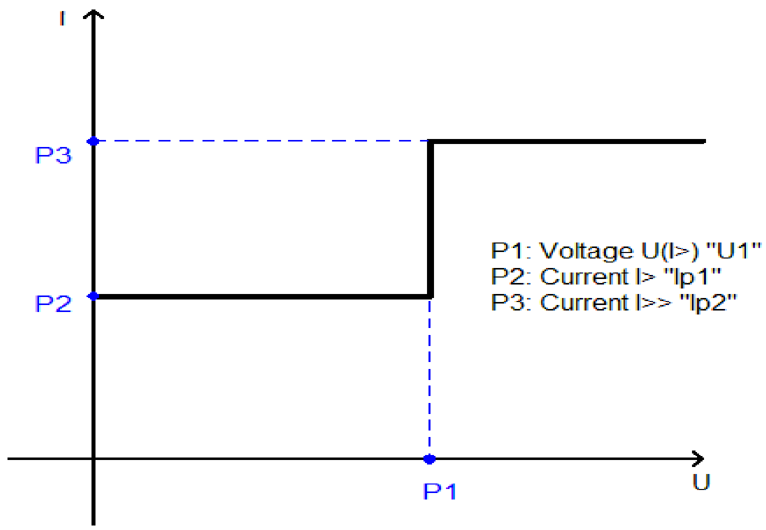


Figure 2.1: The *U-I Type 1 threshold calculation logic*

2.4.2 U-I Type 2

The current starting threshold is the *Current I>>* (“Ip2” parameter) value when the *I>>Fast tripping* check box is set (“iaccel” parameter in the TypFdetect dialogue) and the voltage is greater than the *Voltage U(I>>)* (“up2” parameter) value. The current threshold is the *Current I>* (“Ip1” parameter) value when the voltage is smaller than the *Voltage U(I>)* (“u” parameter) value. When the voltage is smaller than the *Voltage U(I>>)* (“upe” parameter) value and greater than the *Voltage U(I>)* (“u” variable) value the starting threshold is:

$$I_{threshold} = "CurrentI>" + \frac{"CurrentI>>" - "CurrentI>"}{VoltageU(I>>) - VoltageU(I>)} * (U - "VoltageU(I>)")$$

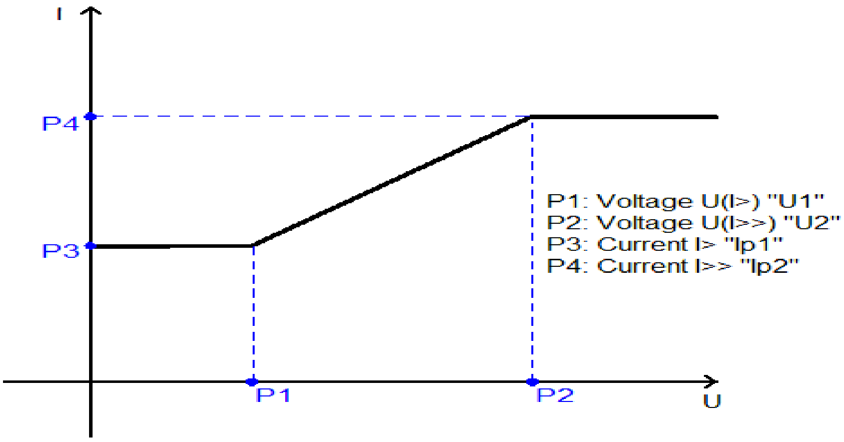


Figure 2.2: The *U-I Type 2 threshold calculation logic*

2.4.3 U-I Type 3

The starting threshold is the *Current I>>* (“Ip2” parameter) value when the *I>>Fast tripping* check box is set (“iaccel” variable in the TypCFdetect dialogue) and the voltage is greater than the rated voltage (“Un”). The current threshold is *Current I>*(“Ip1” parameter) value when the voltage is smaller than the *Voltage U(I>)* (“u” parameter) value. When the voltage is smaller than the rated voltage (“Un”) and greater than the *Voltage U(I>)* (“u” parameter) value the starting threshold is:

$$I_{threshold} = "CurrentI>" + \frac{"CurrentI>>" - "CurrentI>"}{U_n - VoltageU(I>)} * (U - "VoltageU(I>)")$$

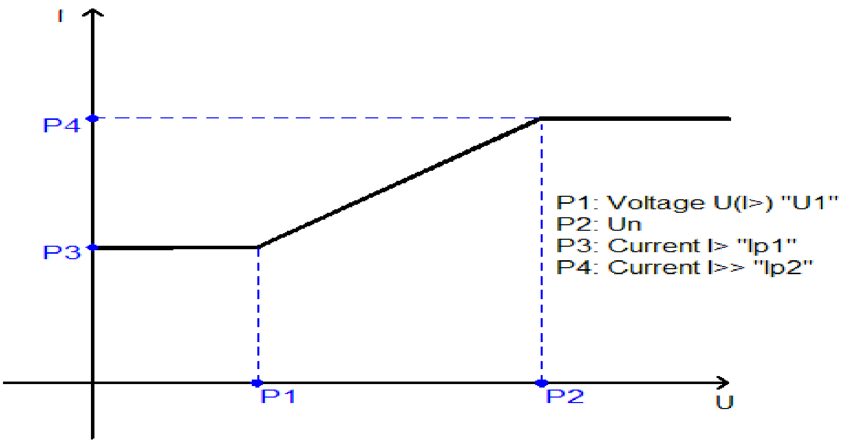


Figure 2.3: The *U-I Type 3 threshold calculation logic*

2.4.4 U-I Type 4

The current starting threshold is the *Current I>>* ("Ip2" parameter) value when the *I>>Fast tripping* is set ("iaccel" parameter in the TypFdetect dialogue) and the voltage is greater than the rated voltage ("Un"). Its the *Current I>*("Ip1" parameter) value when the voltage is smaller than $U1 = \frac{Un}{\textit{Current } I>>} * I$ value. When the voltage is smaller than the rated voltage ("Un") value and greater than $U1 = \frac{Un}{\textit{Current } I>>} * I$ value the starting threshold is:

$$I_{threshold} = "CurrentI>" + \frac{"CurrentI>>" - CurrentI>"}{U_n - U_1} * (U - U_1)$$

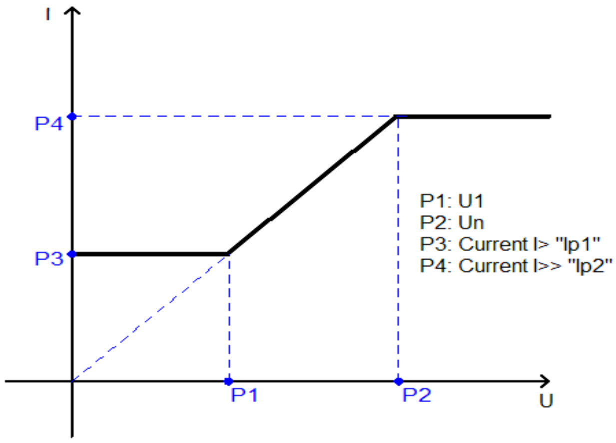


Figure 2.4: The *U-I Type 4 threshold calculation logic*

2.4.5 I-Z

The starting conditions are

- $I >$ *Current I>* ("Ip1" variable)
- $"InpedanceZ" * \vec{I} < \vec{U}$

where
Impedance Z< is the "Z" parameter
and
I and *U* are the input current and voltage represented as complex values.

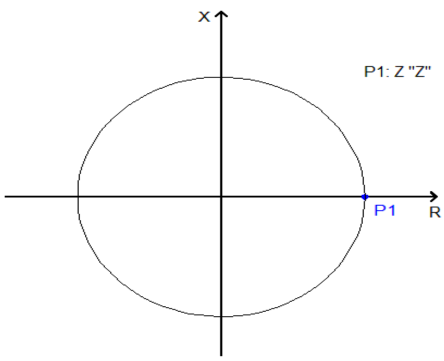


Figure 2.5: The *ZI starting characteristic*

2.4.6 U-Z

The *U-Z* starting logic is specific for the Toshiba distance protections. The characteristic is obtained by a combination of the following equations:

$|V| <= V_s$ equation (1)
$|V - IZ_s| <= V_s$ equation (2)
$-V_s <= V sin\Theta <= V_s$ equation (3)
$0 <= V cos\Theta <= |IZ_s|$ equation (4)

where
V = fault voltage
I = fault current
Θ = line angle input parameter
Z_s = impedance input parameter
V_s = undervoltage input parameter

If equation (1) or equation (2), or both equations (3) and (4) are established, the starting condition is declared.

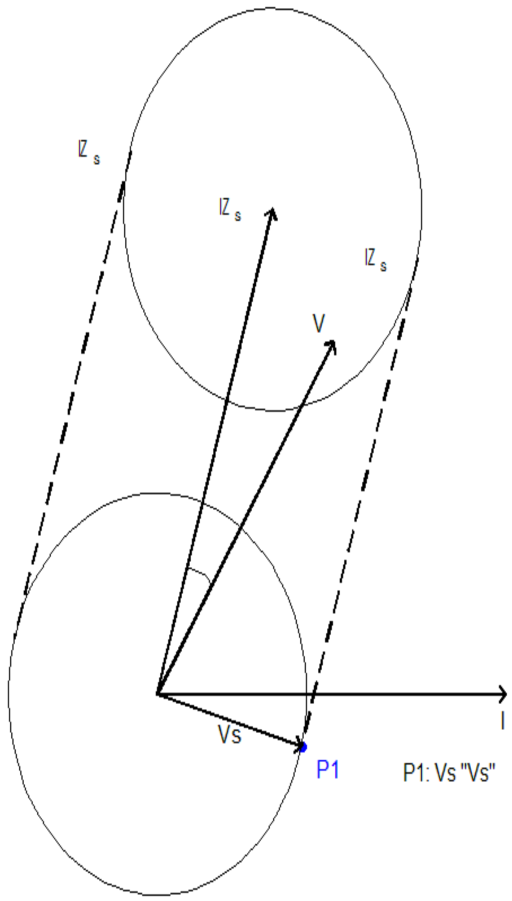


Figure 2.6: The *ZU starting characteristic*

3 Integration in the relay scheme

The *Starting/Fault Detector* type class name is *TypFdetect*. The *Starting/Fault Detector* dialogue class name is *RelFdetect*. In the relay scheme the *Starting/Fault Detector* 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.

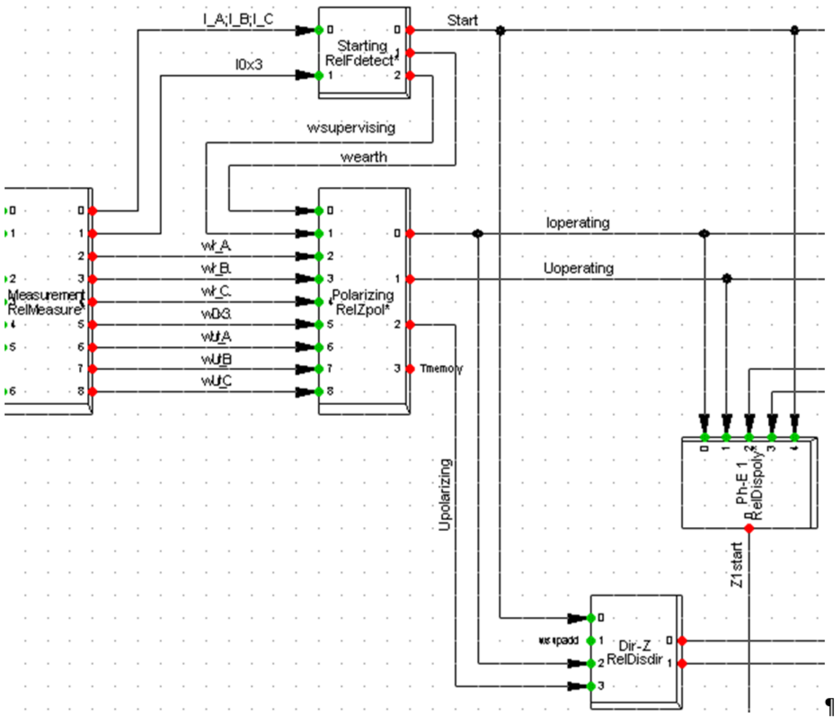


Figure 3.1: *DIgSILENT* Connection scheme of a 3 phase *Differential Protection* “RelBiasidiff” block.

In this scheme the *Starting/Fault Detector Starting* block gets the phase and the zero sequence currents from the measurement block. The *Start* starting signal is used to activate the *Dir-z* directional block and the trip blocks (in the picture the *Ph-E1* block). Additional info regarding the fault type are provided to the Polarizing block using the *wsupervising* and the *wearth* signals.

4 Logic

4.1 Overcurrent

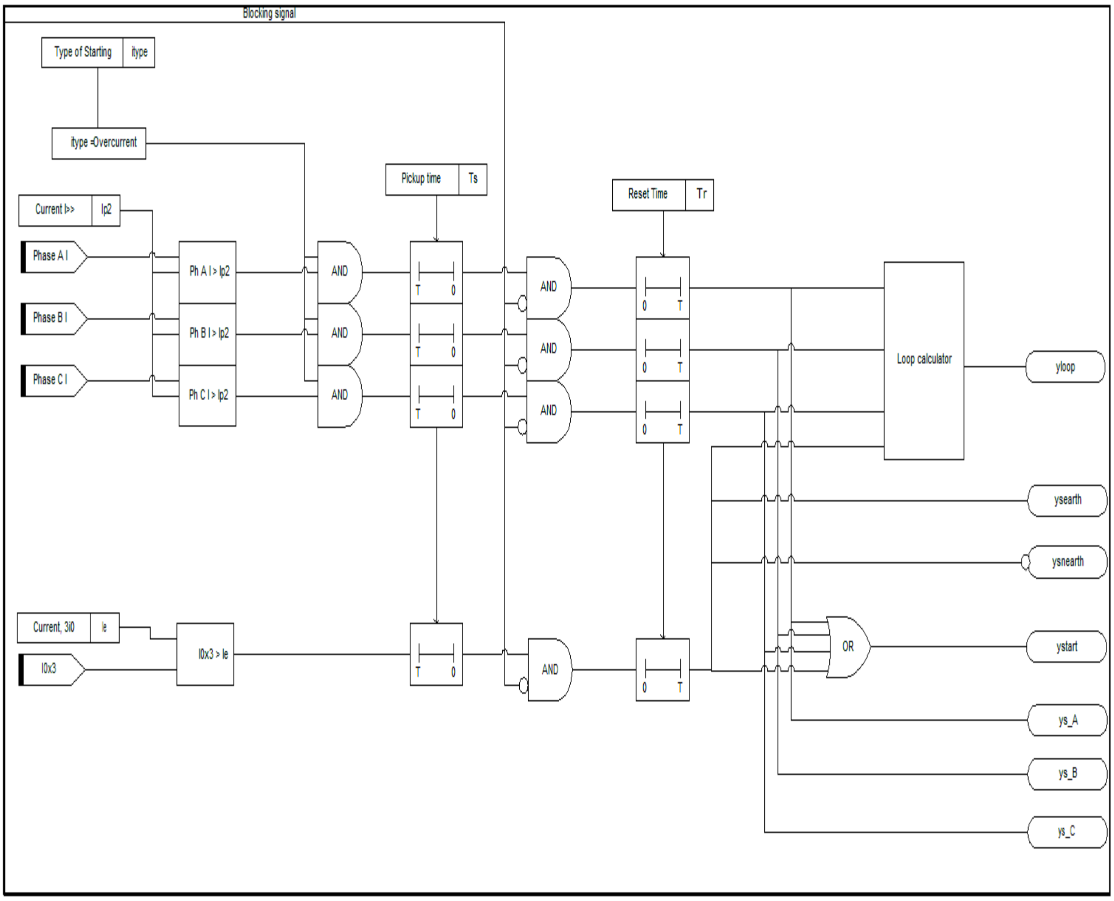
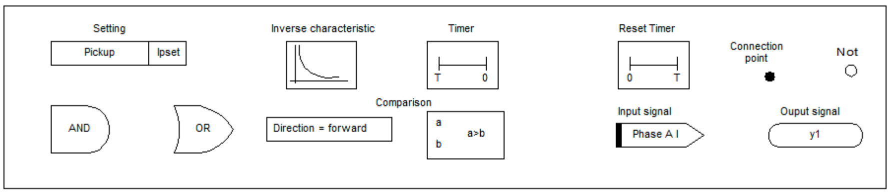


Figure 4.1: The *Starting/Fault Detector block Overcurrent starting logic*



4.2 Underimpedance U-I

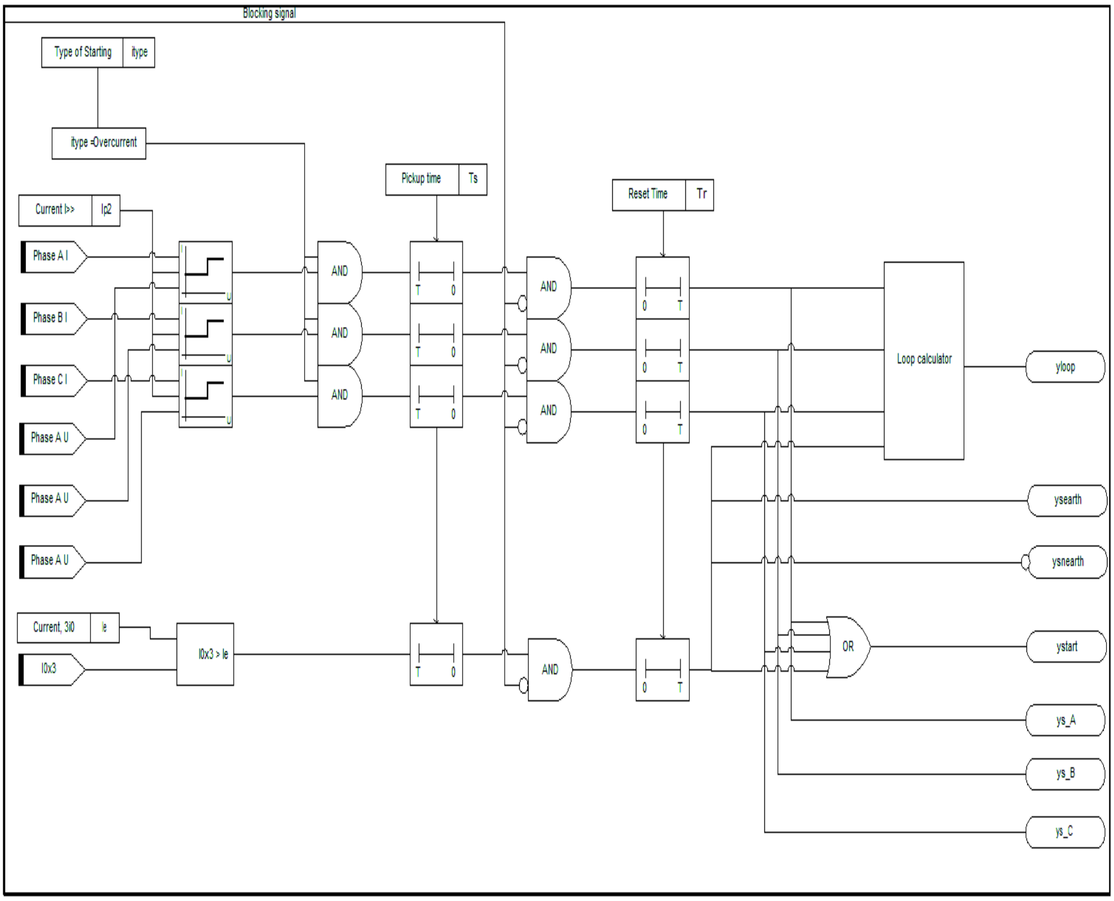
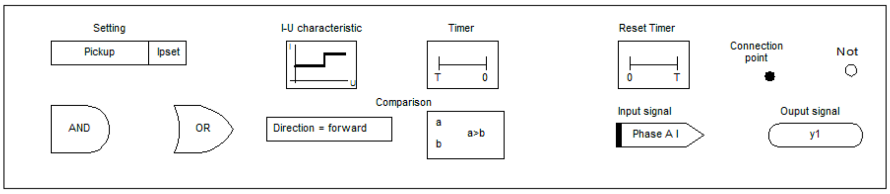


Figure 4.2: The *Starting/Fault Detector block Underimpedance U-I starting logic*



4.3 Underimpedance I-Z

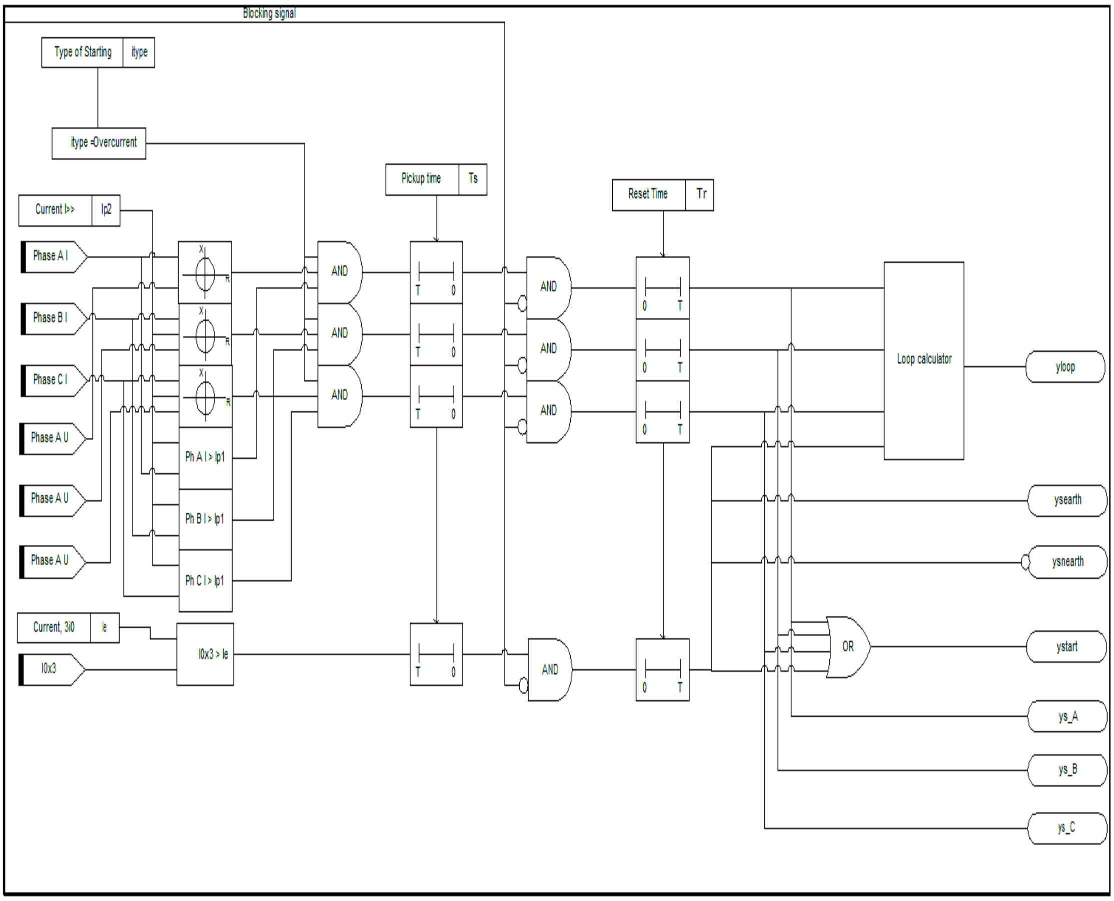
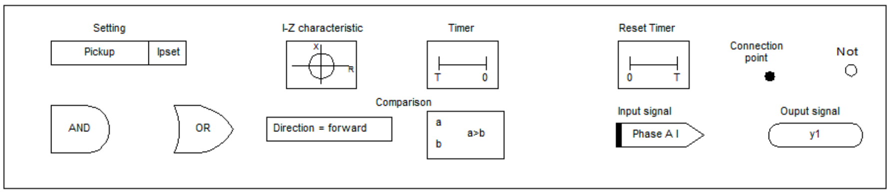


Figure 4.3: The *Starting/Fault Detector block Underimpedance I-Z starting logic*



A Parameter Definitions

A.1 Starting/Fault Detector Type (TypFdetect)

Table A.1: Input parameters of Fdetect type (*TypFdetect*)

Parameter	Description	Unit
loc_name	Name assigned by the user to the block type	Text
ioverc	Flag to enable/disabled the overcurrent starting logic	Integer
iundimp	Flag to enable/disabled the underimpedance starting logic	Integer
atype	Starting type(it can be *Earth*, *Phase-Phase* or *Multifunctional* if it operates as a phase-phase and an earth element at the same time)	Text
iextern	Flag to enable/disable the block external starting	Integer
rIe	Range of the ground current threshold “Ie”	Text
rIp1	Range of the phase current first threshold “Ip1” (voltage controlled threshold)	Text
rIp2	Range of the phase current second threshold “Ip2”	Text
iunit	Phase current unit (it can be *pu* or *sec.Amp*)	Integer
rU	Range of the phase voltage restrain element first threshold“U”	Text
rUp2	Range of the phase voltage restrain element second threshold “Up2”	Text
uunit	Phase voltage unit (it can be *pu* or *sec.V*)	Integer
iaccel	Flag to enable the phase current second threshold accelerated trip	Integer
rZ	Range of the impedance threshold “Z”(available only when the Underimpedance *I-Z* type is set)	Text
rTheta	Range of the Impedance Angle “Theta”	Text
Tsr	Reset time delay	Real number
Kr	Reset ratio	Real number

A.2 Starting/Fault Detector Element (RelFdetect)

Table A.2: Input parameters of Starting/Fault Detector element (*RelFdetect*))

Parameter	Description	Unit
loc_name	Name assigned by the user to the block	Text
typ_id	Pointer to the starting type block	Pointer
itype	Active starting type (it can be Overcurrent or Underimpedance)	Integer
Ip1	The phase current first threshold in secondary amperes	Sec Amperes
ip1	The phase current first threshold in pu	pu
Ip2	The phase current second threshold in secondary amperes	Sec Amperes
ip2	The phase current second threshold in pu	pu
Ie	The ground current threshold in secondary amperes	Sec Amperes
ie	The ground current threshold in pu	pu
U	The phase voltage restrain element first threshold in secondary volts	Sec Volts
u	The phase voltage restrain element first threshold in pu	pu
Up2	The phase voltage restrain element second threshold in secondary volts	Sec Volts
up2	The phase voltage restrain element second threshold in pu	pu
Z	The impedance threshold for the Underimpedance *Z-I* type element	Sec Ohm
Theta	The impedance angle threshold for the Underimpedance *Z-U* type element	Degrees

B Signal Definitions

B.1 *Overcurrent* logic

Table B.1: Input/output signals of the Starting/Fault Detector element (*CalFdetect*)

Name	Description	Unit	Type	Model
I_A	Phase A current RMS value	Secondary amperes	IN	Any
I_B	Phase B current RMS value	Secondary amperes	IN	Any
I_C	Phase C current RMS value	Secondary amperes	IN	Any
I0x3	Zero sequence current RMS value	Secondary amperes	IN	Any
iblock	Blocking signal	Seconds or 1/0 during the simulation	IN	Any
yloop	ID of the loop which has been detected in the starting condition	Integer	OUT	Any
ystart	Starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_A	Loop A starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_B	Loop B starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_C	Loop C starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysearth	Earth fault starting signal	Seconds or 1/0 during the simulation	OUT	Any
ysnearth	Earth fault negated starting signal	Seconds or 1/0 during the simulation	OUT	Any
ysl_A	Loop AB starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysl_B	Loop BC starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysl_C	Loop CA starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysall	All loop starting signal	Seconds or 1/0 during the simulation	OUT	Any

B.2 *Underimpedance Type U-I 1, 2, 3, 4* logic

Table B.2: Input/output signals of the Starting/Fault Detector element (*CalFdetectui*)

Name	Description	Unit	Type	Model
I_A	Phase A current RMS value	Secondary amperes	IN	Any
I_B	Phase B current RMS value	Secondary amperes	IN	Any
I_C	Phase C current RMS value	Secondary amperes	IN	Any
I0x3	Zero sequence current RMS value	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
iblock	Blocking signal	Seconds or 1/0 during the simulation	IN	Any
yloop	ID of the loop which has been detected in the starting condition	Integer	OUT	Any
ystart	Starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_A	Loop A starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_B	Loop B starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_C	Loop C starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysearth	Earth fault starting signal	Seconds or 1/0 during the simulation	OUT	Any
ysnearth	Earth fault negated starting signal	Seconds or 1/0 during the simulation	OUT	Any
ysl_A	Loop AB starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysl_B	Loop BC starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysl_C	Loop CA starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysall	All loop starting signal	Seconds or 1/0 during the simulation	OUT	Any

B.3 *Underimpedance I-Z* logic

Table B.3: Input/output signals of the Starting/Fault Detector element (*CalFdetectzi*)

Name	Description	Unit	Type	Model
I_A	Phase A current RMS value	Secondary amperes	IN	Any
Ir_A	Phase A current real part	Secondary amperes	IN	Any
Ii_A	Phase A current imaginary part	Secondary amperes	IN	Any
I_B	Phase B current RMS value	Secondary amperes	IN	Any
Ir_B	Phase B current real part	Secondary amperes	IN	Any

Table B.3: Input/output signals of the Starting/Fault Detector element (*CalFdetectzi*)

Name	Description	Unit	Type	Model
Ii_B	Phase B current imaginary part	Secondary amperes	IN	Any
I_C	Phase C current RMS value	Secondary amperes	IN	Any
Ir_C	Phase C current real part	Secondary amperes	IN	Any
Ii_C	Phase C current imaginary part	Secondary amperes	IN	Any
I0x3	Zero sequence current RMS value	Secondary amperes	IN	Any
I0x3r	Zero sequence current real part	Secondary amperes	IN	Any
I0x3i	Zero sequence current imaginary part	Secondary amperes	IN	Any
Ur_A	Phase A voltage real part Secondary Volts	Secondary Volts	IN	Any
Ui_A	Phase A voltage imaginary part Secondary Volts	Secondary Volts	IN	Any
Ur_B	Phase B voltage real part Secondary Volts	Secondary Volts	IN	Any
Ui_B	Phase B voltage imaginary part Secondary Volts	Secondary Volts	IN	Any
Ur_C	Phase C voltage real part Secondary Volts	Secondary Volts	IN	Any
Ui_C	Phase C voltage imaginary part Secondary Volts	Secondary Volts	IN	Any
iblock	Blocking signal	Seconds or 1/0 during the simulation	IN	Any
yloop	ID of the loop which has been detected in the starting condition	Integer	OUT	Any
ystart	Starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_A	Loop A starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_B	Loop B starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_C	Loop C starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysearth	Earth fault starting signal	Seconds or 1/0 during the simulation	OUT	Any
ysnearth	Earth fault negated starting signal	Seconds or 1/0 during the simulation	OUT	Any
ysl_A	Loop AB starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysl_B	Loop BC starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysl_C	Loop CA starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysall	All loop starting signal	Seconds or 1/0 during the simulation	OUT	Any

B.4 *Underimpedance U-Z* logic

Table B.4: Input/output signals of the Starting/Fault Detector element (*CalFdetectzu*)

Name	Description	Unit	Type	Model
Ir_A	Phase A current real part	Secondary amperes	IN	Any
Ii_A	Phase A current imaginary part	Secondary amperes	IN	Any
Ir_B	Phase B current real part	Secondary amperes	IN	Any
Ii_B	Phase B current imaginary part	Secondary amperes	IN	Any
Ir_C	Phase C current real part	Secondary amperes	IN	Any
Ii_C	Phase C current imaginary part	Secondary amperes	IN	Any
Ur_A	Phase A voltage real part Secondary Volts	Secondary Volts	IN	Any
Ui_A	Phase A voltage imaginary part Secondary Volts	Secondary Volts	IN	Any
Ur_B	Phase B voltage real part Secondary Volts	Secondary Volts	IN	Any
Ui_B	Phase B voltage imaginary part Secondary Volts	Secondary Volts	IN	Any
Ur_C	Phase C voltage real part Secondary Volts	Secondary Volts	IN	Any
Ui_C	Phase C voltage imaginary part Secondary Volts	Secondary Volts	IN	Any
iblock	Blocking signal	Seconds or 1/0 during the simulation	IN	Any
yloop	ID of the loop which has been detected in the starting condition	Integer	OUT	Any
ystart	Starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_A	Loop A starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_B	Loop B starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_C	Loop C starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysearth	Earth fault starting signal	Seconds or 1/0 during the simulation	OUT	Any
ysnearth	Earth fault negated starting signal	Seconds or 1/0 during the simulation	OUT	Any

Table B.4: Input/output signals of the Starting/Fault Detector element (*CalFdetectzu*)

Name	Description	Unit	Type	Model
ysl_A	Loop AB starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysl_B	Loop BC starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysl_C	Loop CA starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysall	All loop starting signal	Seconds or 1/0 during the simulation	OUT	Any

B.5 *External Starting* logic

Table B.5: Input/output signals of the Starting/Fault Detector element (*CalFdetectst*)

Name	Description	Unit	Type	Model
I_A	Phase A current RMS value	Secondary amperes	IN	Any
I_B	Phase B current RMS value	Secondary amperes	IN	Any
I_C	Phase C current RMS value	Secondary amperes	IN	Any
I0x3	Zero sequence current RMS value	Secondary amperes	IN	Any
wIset	Phase current starting threshold	Secondary amperes	IN	Any
wI0set	Ground current starting threshold	Secondary amperes	IN	Any
ystart	Starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_A	Loop A starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_B	Loop B starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
y_C	Loop C starting signal/ starting time	Seconds or 1/0 during the simulation	OUT	Any
ysearth	Earth fault starting signal	Seconds or 1/0 during the simulation	OUT	Any
ysnearth	Earth fault negated starting signal	Seconds or 1/0 during the simulation	OUT	Any
Iabs_A	Phase A current RMS value (equal to the I_A input signal)	Secondary amperes	OUT	Any
Iabs_B	Phase B current RMS value (equal to the I_B input signal)	Secondary amperes	OUT	Any
Iabs_C	Phase C current RMS value (equal to the I_C input signal)	Secondary amperes	OUT	Any
I0x3abs	Zero sequence current RMS value (equal to the I0x3 input signal)	Secondary amperes	OUT	Any

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