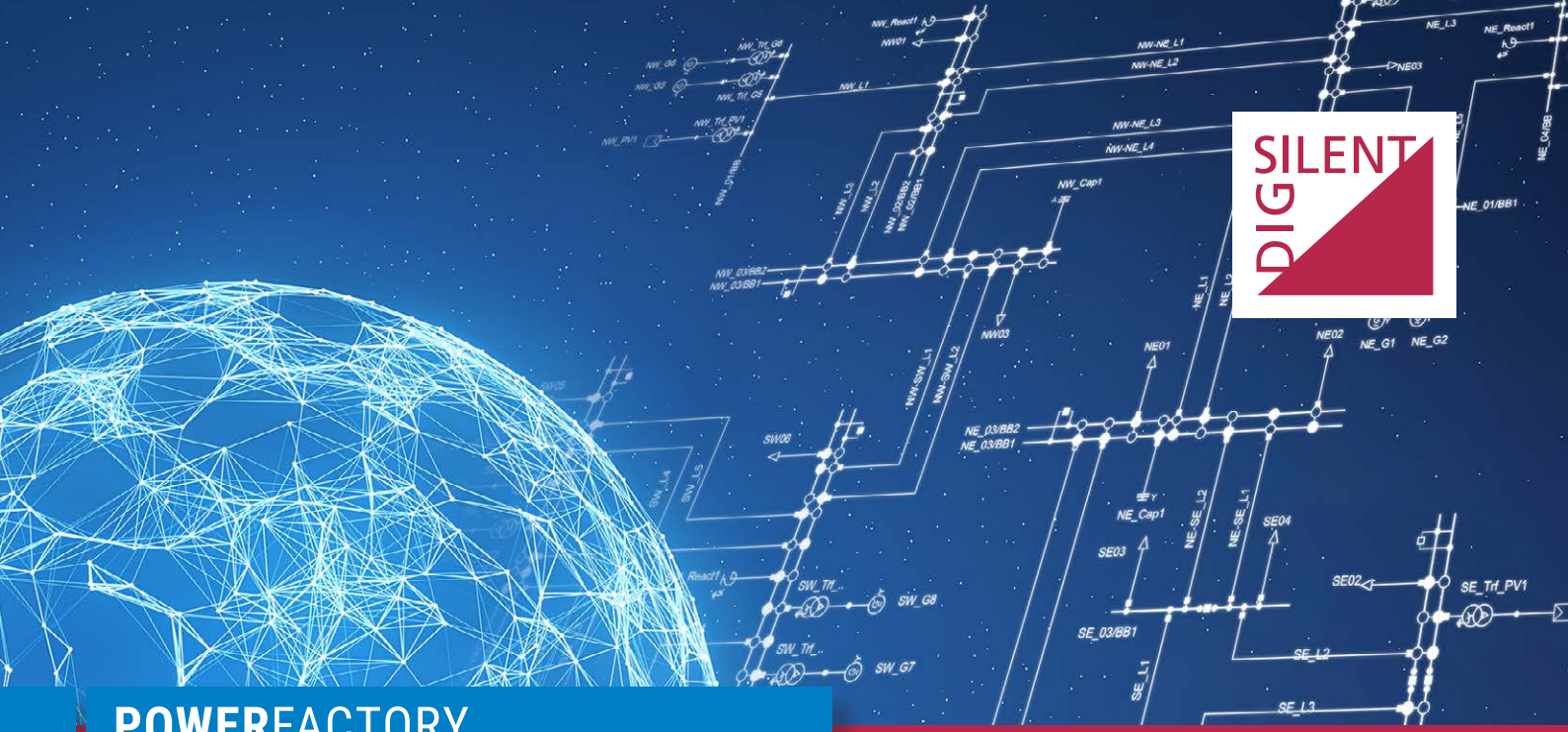

POWERFACTORY

PowerFactory 2021

Technical Reference

Distance Load Encroachment

RelDisloadenc, TypDisloadenc

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POWER SYSTEM SOLUTIONS

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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

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Contents

1 General Description

The *Distance Load Encroachment* implements in the RX diagram a zone which can be entered by the system impedance working point under normal operation conditions without tripping a distance relay. It's typically useful in case of distance relays protecting long heavily loaded lines and can be set in many commercially available relays.

The *PowerFactory Distance Load Encroachment* ("RelDisloadenc" class) implements different shapes and different signal configurations for the single phase, three phases, and six phases *Distance Load Encroachment* type. Its output signal is usually used in the distance relay models to block the distance relay trip zones.

The *Distance Load Encroachment* block is operational during short circuit, load flow and RMS/EMT simulations.

2 Features & User interface

2.1 Distance Load Encroachment (RelDisloadenc)

The user can change the block settings using the "Distance load Encroachment" dialogue ("RelDisloadenc" class). The dialogue consists of two tab pages: *Basic Data*, and *Description*. The main settings are located in the *Basic Data* tab page.

2.1.1 Basic data

The "Distance Load Encroachment"*Basic data* tab page provides a *presentation* area where the red text shows some info regarding:

- The input quantities (*Unit* text box which can be *Earth*, *Phase-Phase*, *Multifunctional*, *Positive Sequence*.
- The load encroachment *characteristic* (it can be one of the following: *Schweitzer*, *Siemens*, *ABB*, *GE*, *Toshiba 1*, and *Toshiba 2*)

The "Basic Data" dialogue contains the following controls:

- An editbox which allows to insert a name to identify the *Load Encroachment* element.
- A pointer to a "Load Encroachment type" object which defines the Load Encroachment type and setting ranges.
- A check box to disable the Load Encroachment element.
- A set of graphical controls which allow to define the load encroachment shape.

The selected *Distance Load Encroachment* type ("ichatp" parameter in the "Distance load Encroachment - Type" dialogue see 2.2.1) defines which settings are available. The settings representing impedances can be entered in terms of primary or secondary impedance.
The graphical controls are combo boxes for ranges of discrete values (as defined in the "Distance Load Encroachment Type" dialogue, see 2.2) otherwise edit boxes.
The block can be disabled using the "Out of service" ("outserv" parameter) check box.

2.1.2 Description

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

2.2 Distance Load Encroachment Type(TypDisloadenc)

The *Distance Load Encroachment* block main characteristics must be configured in the "Distance Load Encroachment Type" dialogue (*TypDisloadenc* class). The dialogue contains an unique page.

The followings settings can be set:

- A name which identifies the *Load Encroachment* type ("loc_name" parameter).
- The number of phases ("iphases" parameter).
- The Load Encroachment type ("ichatp"parameter).
- The *Unit* type (it can be *Earth*, *Phase-Phase*, *Multifunctional*, *Positive Sequence*) ("aunit" setting).
- A pointer to a *Reference Block* ("prefblock" parameter) which can be used to parametrize the impedance settings.
- The range and the step of the variables used to represent the load encroachment shape (*Reach* ("rReach" parameter), *Angle* ("rAngle" parameter), *RLdFw* ("RLdFw" parameter), *RLdRv* ("RLdRv" parameter) etc).

Reference block :

The *Distance Load Encroachment* element has been conceived to work also together with another relay distance load encroachment element: the distance settings can be set to depend upon the settings of a master distance block specified in the *Reference block* ("prefblock"setting) control. When the master distance block has been set, the *kR*("kR" parameter), the *dR* ("dR" parameter), the *kRFw* ("kRFw" parameter), and the *kRRv* ("kRFw" parameter) are displayed . The block uses the master block *Relay Angle* setting values which depend up on the master load encroachment type; the impedances are calculated b For instance the resistance reach is equal

for the *GE* type: $\text{“}Reach'' = \text{“}Reach''_{master} * \text{“}kR'' + \text{“}dR''$

for the *ABB* type:

$$\begin{array}{c} \text{“}RLdFw'' = \text{“}RLdFw''_{master} * \text{“}kRFw'' + \text{“}dR'' \\ \text{“}RLdRv'' = \text{“}RLdRv''_{master} * \text{“}kRRv'' + \text{“}dR'' \end{array}$$

Advanced Settings The settings which define the *Measurement Time* ("Ts" parameter), the *Reset Time* ("Tr" parameter) and the *Reset Ratio* ("Kr" parameter) can be found at the bottom of the dialogue. The *Reset Ratio* setting is a multiplier which is used to define an impedance reset zone smaller than the load encroachment trip zone. It is defined to avoid any toggle effect for impedance values close to the trip zone boundary.

2.2.1 Load Encroachment types

The block can be configured using the “Type” (“ichatp” parameter)setting as:

- Schweitzer
- Siemens
- ABB
- GE
- Toshiba 1
- Toshiba 2

The following paragraphs shows the shape associated to each *Type*. The relationships between the block settings and the graphical representation of the shape are displayed in the pictures.

Schweitzer :

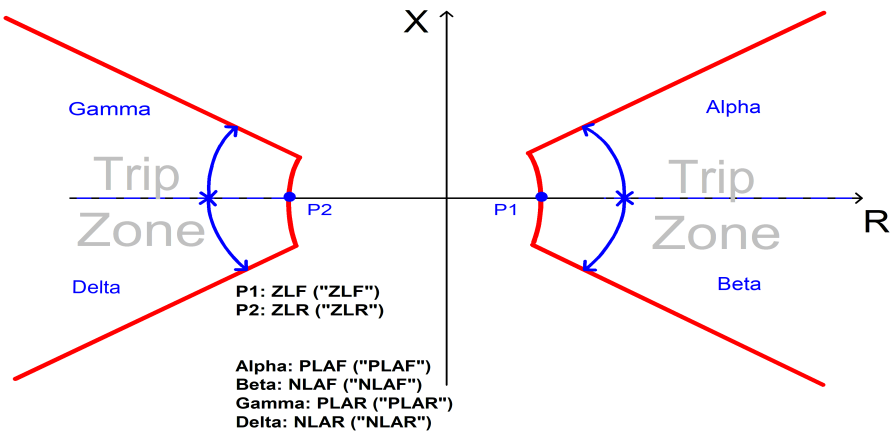


Figure 2.1: The *DIgSILENT* “Schweitzer” load encroachment characteristic

Siemens :

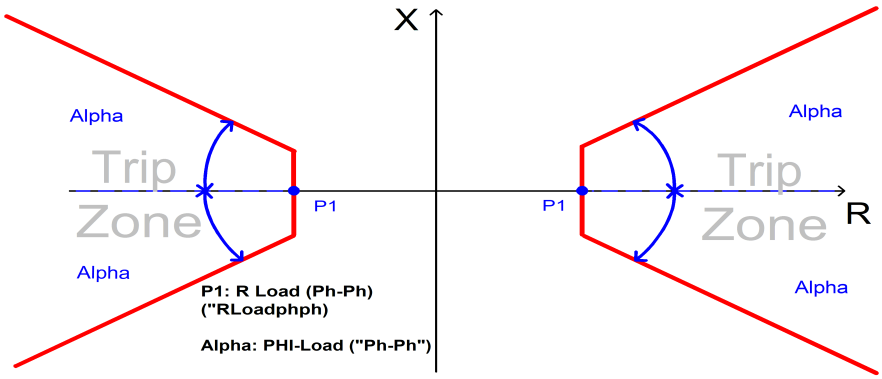


Figure 2.2: The *DIgSILENT* "Siemens" Phase load encroachment characteristic

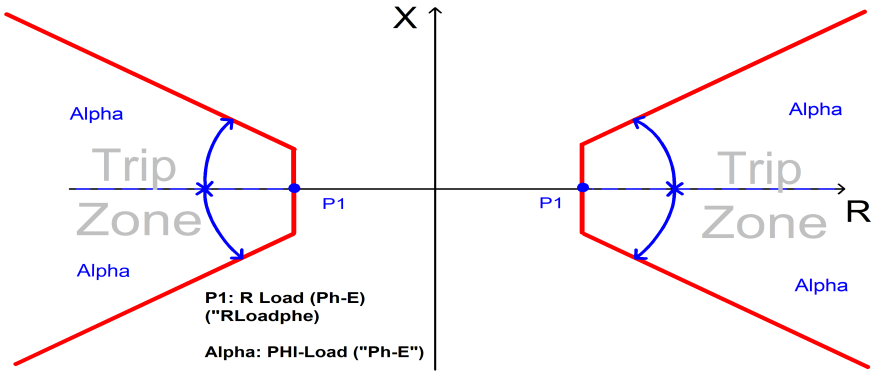


Figure 2.3: The *DIgSILENT* "Siemens" Earth load encroachment characteristic

ABB :

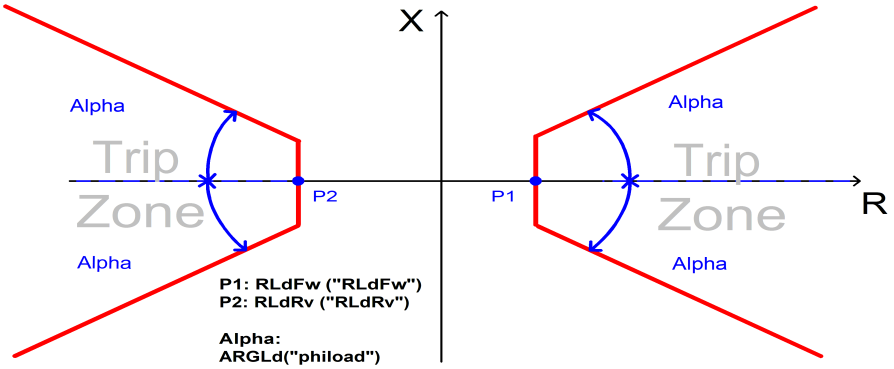


Figure 2.4: The *DIgSILENT* "ABB" load encroachment characteristic

GE :

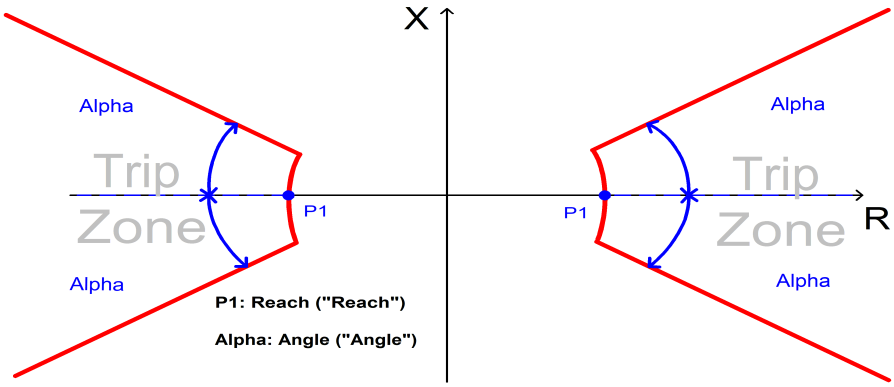


Figure 2.5: The *DIgSILENT* "GE" load encroachment characteristic

Toshiba 1 :

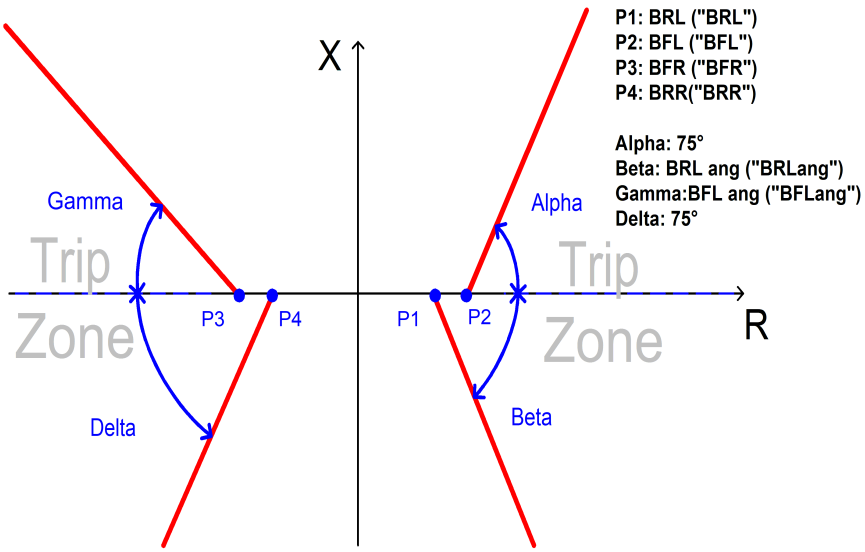


Figure 2.6: The *DIgSILENT* "Toshiba 1" load encroachment characteristic

Toshiba 2 :

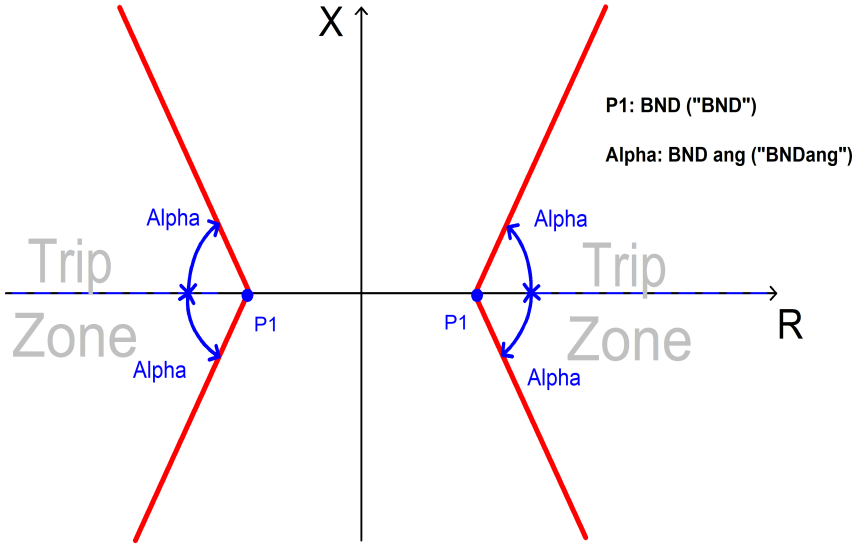


Figure 2.7: The *DIgSILENT* "Toshiba 2" load encroachment characteristic

3 Integration in the relay scheme

An instance of *Distance Load Encroachment* element (*RelDisloadenc* class) must be put in the relay scheme. As already shown, there are three main versions of the block: a single phase, a three phases version and a six phases version. The selection of the type is done by the “No. of Phases” (“iphases” parameter) in the *Distance Load Encroachment Type* (“TypDisloadenc” class). The number and the name of the input signals depends only upon which of these versions is used. The typical connection of a 3 phase *Distance Load Encroachment* (“RelDisloadenc”class) block is showed in Figure 3.1.

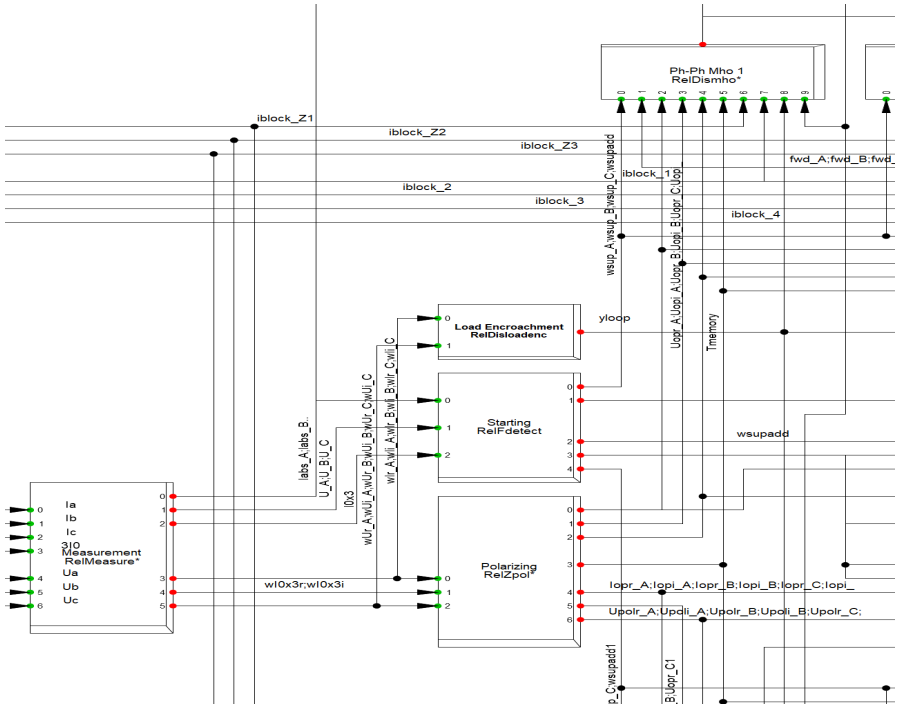


Figure 3.1: The *DIgSILENT PowerFactory* typical connection scheme of a 3 phase *Distance Load Encroachment* (“RelDisloadenc” class) block.

The “yloop” output signal of the “Load Encroachment” block is connected to the “wldblock”input signal of the “Ph-Ph Mho 1” block which represents the first trip zone of a distance relay. The “Load Encroachment” block calculates the phase impedances using the phase currents (“wIr_A”, “wIi_A”,“wIr_B”, “wIi_B”, “wIr_C”, “wIi_C”) and the voltages (“wUr_A”, “wUi_A”,“wUr_B”, “wUi_B”, “wUr_C”, “wUi_C”)provided by the “Measurement” block. The “Load Encroachment” block inhibits selectively the operation of the phases of the mho element identified by the value of its “yloop” output signal. The loop IDs are listed in table 3.1.

Table 3.1: loop id

Loop ID	Loop	Loop ID	Loop	Loop ID	Loop
0	None	10	AB & BC	20	B & C & BC
1	A	11	BC & CA	21	C & A & CA
2	B	12	CA & AB	22	A & B & C
3	C	13	A & AB	23	AB & BC & CA
4	AB	14	B & BC	24	AB & BC & CA &
5	BC	15	C & CA		A & B & C
6	CA	16	B & AB		
7	A & B	17	C & BC		
8	B & C	18	A & CA		
9	C & A	19	A & B & AB		

4 Logic

4.1 Single phase

4.1.1 Analog

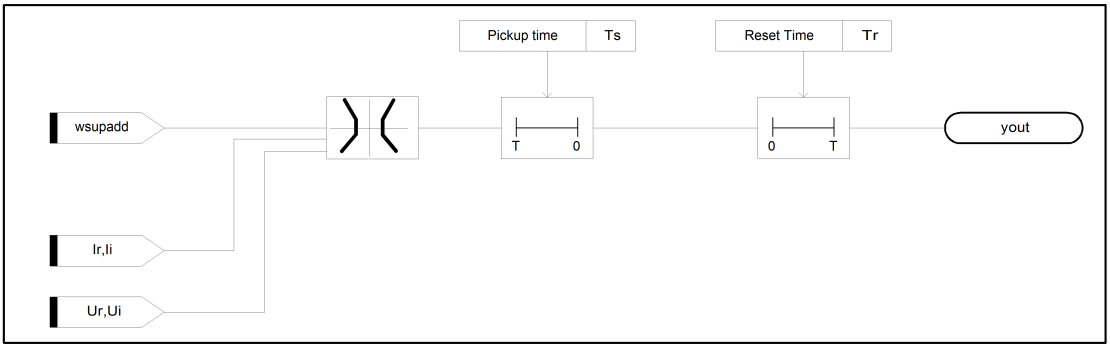


Figure 4.1: The *DIgSILENT Single phase Load Encroachment* logic

4.1.2 Digital

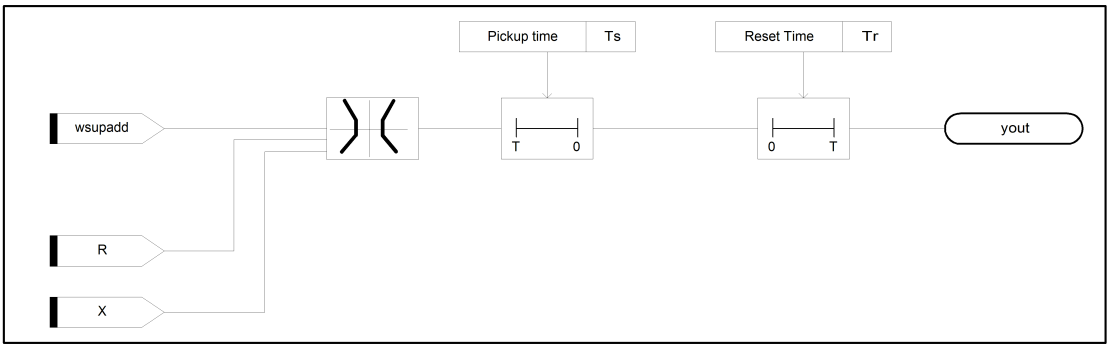
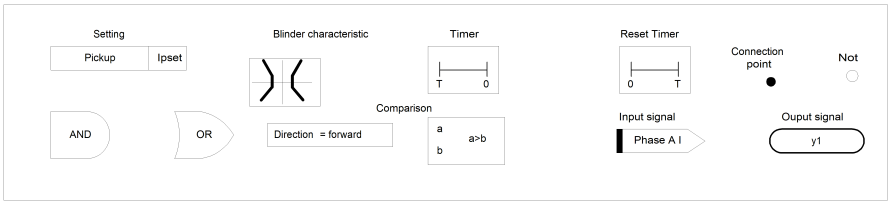


Figure 4.2: The *DIgSILENT Single phase Digital Load Encroachment* logic



4.2 3 phase

4.2.1 Analog

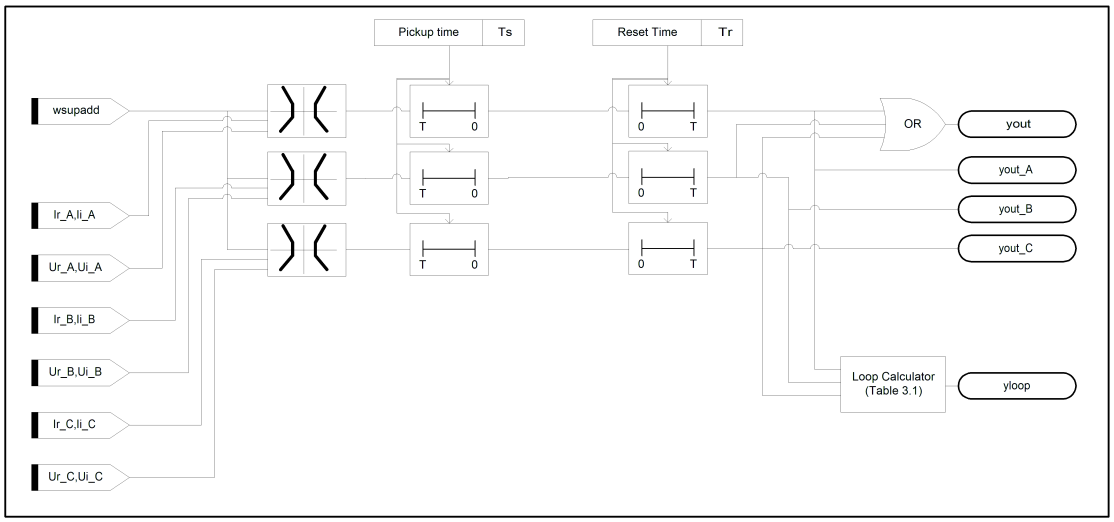


Figure 4.3: The *DIgSILENT 3 phases Analog Load Encroachment* logic

4.2.2 Digital

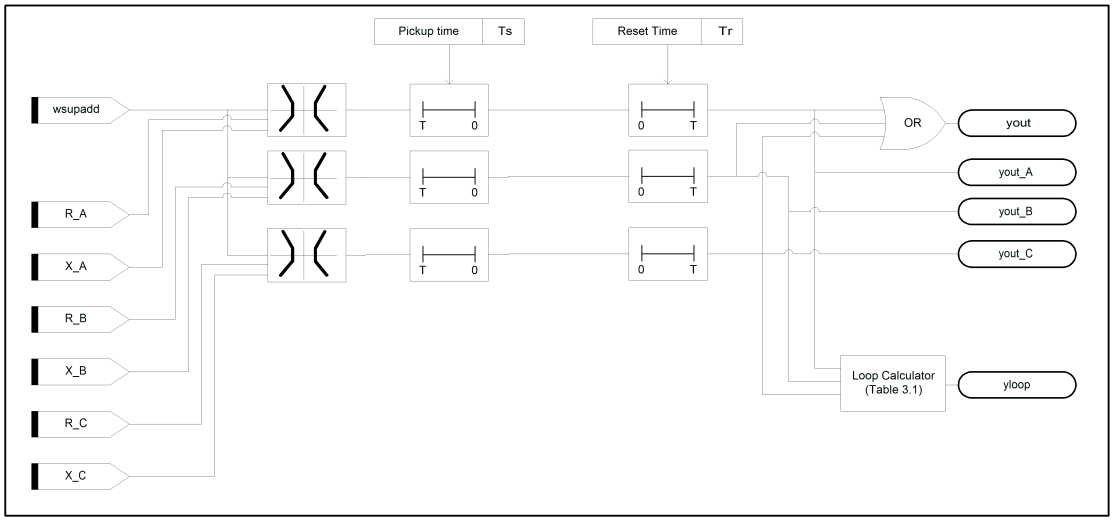
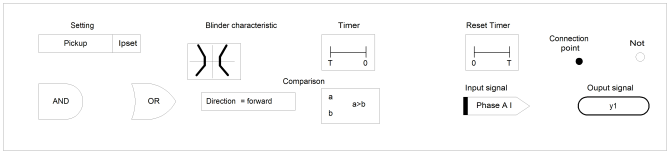


Figure 4.4: The *DIgSILENT 3 phases Digital Load Encroachment* logic



4.3 6 phases

4.3.1 Analog

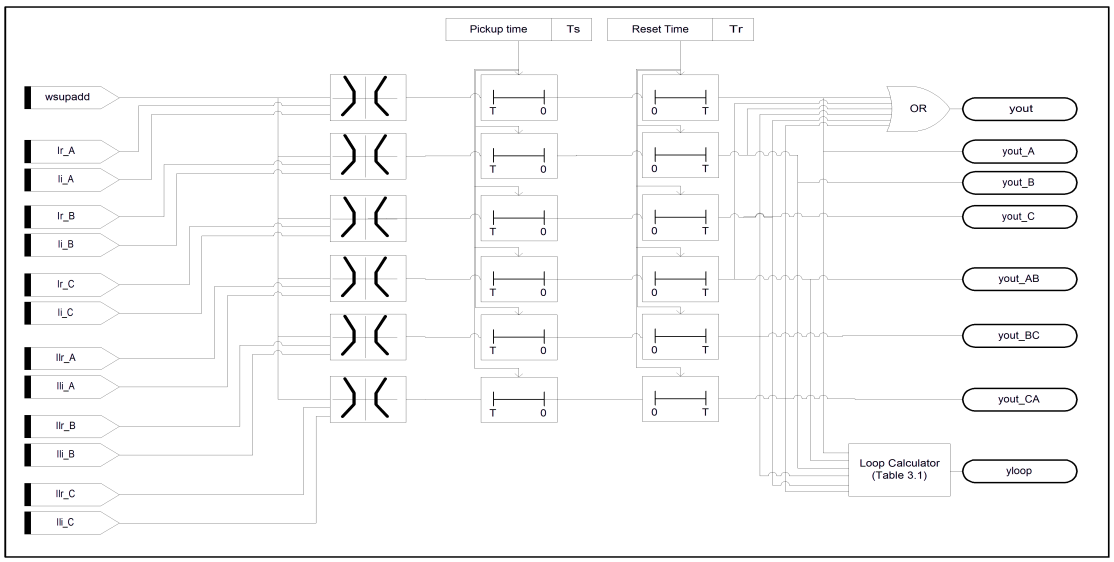


Figure 4.5: The *DIgSILENT 6 phases Analog Load Encroachment* logic

4.3.2 Digital

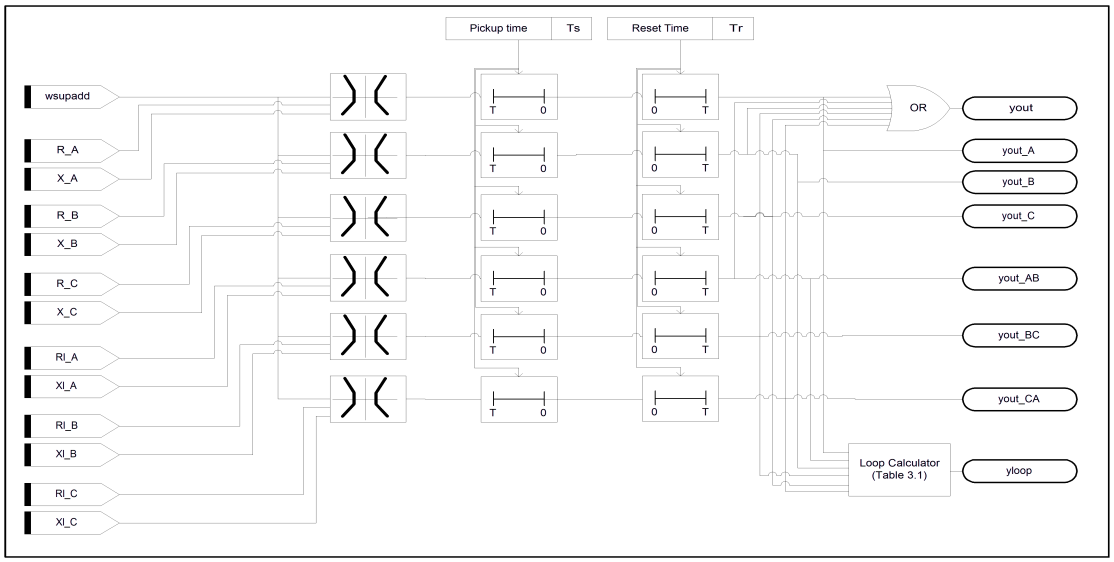
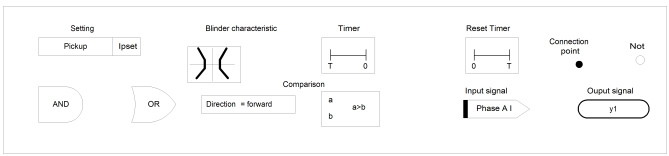


Figure 4.6: The *DIgSILENT 6 phases Digital Load Encroachment* logic



A Parameter Definitions

A.1 Distance Load Encroachment Type (TypDisloadenc)

Table A.1: Input parameters of Distance Load Encroachment type (*TypDisloadenc*)

Parameter	Description	Unit
loc_name	The name assigned by the user to the Load Encroachment type object	Text
iphases	Number of phases (it can be 1, 3, 6)	Integer
ichatp	Load encroachment type (it can be *Schweitzer*, *Siemens*, *ABB*, *GE*, *Toshiba 1*, *Toshiba 2*)	Integer
aunit	Type of load encroachment unit (Earth, Phase-Phase, Multi-functional, Positive Sequence)	Text
prefblock	Reference block (used for a parametrized representation of the load encroachment shape)	Pointer
rdR	Load encroachment range of the resistance additive factor with the Reference block	Text
rkR	Load encroachment range of the resistance multiplicative factor with the Reference block	Text
rkRFw	Load encroachment range of the forward resistance multiplicative factor with the Reference block	Text
rkRRv	Load encroachment range of the reverse resistance multiplicative factor with the Reference block	Text
rRloadphph	Phase-Phase load encroachment resistance lower limit range (Siemens)	Text
rRloadphe	Phase-Earth load encroachment resistance lower limit range (Siemens)	Text
rphiloadphph	Phase-Phase load encroachment sector angle range (Siemens)	Text
rphiloadphe	Phase-Earth load encroachment sector angle range (Siemens)	Text
rZLF	Load encroachment forward direction impedance lower limit range (Schweitzer)	Text
rZLR	Load encroachment reverse direction impedance lower limit range (Schweitzer)	Text
rPLAF	Load encroachment sector forward direction positive angle range (Schweitzer)	Text
rNLAF	Load encroachment sector forward direction negative angle range (Schweitzer)	Text
rPLAR	Load encroachment sector reverse direction positive angle range (Schweitzer)	Text
rNLAR	Load encroachment sector reverse direction negative angle range (Schweitzer)	Text
rReach	Load encroachment resistance lower limit range (GE)	Text
rAngle	Load encroachment sector angle range (GE)	Text
rRloadfw	Load encroachment forward direction resistance lower limit range (ABB)	Text
rRloadrev	Load encroachment reverse direction resistance lower limit range (ABB)	Text
rphiload	Load encroachment sector angle range (ABB)	Text
rBFR	Load encroachment resistance lower limit range in the I quadrant (Toshiba 1)	Text
rBFL	Load encroachment resistance lower limit range in the II quadrant (Toshiba 1)	Text
rBRR	Load encroachment resistance lower limit range in the III quadrant (Toshiba 1)	Text
rBRL	Load encroachment resistance lower limit range in the IV quadrant (Toshiba 1)	Text
rBFLang	Load encroachment II quadrant sector angle range	Text
rBRLang	Load encroachment IV quadrant sector angle range	Text
rBND	Load encroachment resistance lower limit range (Toshiba 2)	Text
rBNDang	Load encroachment angle range (Toshiba 2)	Text
Ts	Measurement time	Seconds
Tr	Reset time	Seconds
Kr	Reset ratio	Real number

A.2 Distance Load Encroachment Element (RelDisloadenc)

Table A.2: Input parameters of Distance Load Encroachment element (*RelDisloadenc*))

Parameter	Description	Unit
loc_name	The name assigned by the user to the Load Encroachment object	Text
typ_id	Pointer to the relevant TypDisloadenc object	Pointer
dR	Load encroachment resistance additive factor with the Reference block	Real number
kR	Load encroachment resistance multiplicative factor with the Reference block	Real number
kRFw	Load encroachment forward resistance multiplicative factor with the Reference block	Real number
kRRv	Load encroachment reverse resistance multiplicative factor with the Reference block	Real number
Rloadphph	Phase-Phase load encroachment resistance lower limit (Siemens)	Sec.Ohm
Rloadphe	Phase-Earth load encroachment resistance lower limit (Siemens)	Sec.Ohm
philoadphph	Phase-Phase load encroachment sector angle (Siemens)	Deg
philoadphe	Phase-Earth load encroachment sector angle (Siemens)	Deg
ZLF	Load encroachment forward direction impedance lower limit (Schweitzer)	Sec.Ohm
ZLR	Load encroachment reverse direction impedance lower limit (Schweitzer)	Sec.Ohm
PLAF	Load encroachment sector forward direction positive angle (Schweitzer)	Deg
NLAF	Load encroachment sector forward direction negative angle (Schweitzer)	Deg
PLAR	Load encroachment sector reverse direction positive angle (Schweitzer)	Deg
NLAR	Load encroachment sector reverse direction negative angle (Schweitzer)	Deg
Reach	Load encroachment resistance lower limit (GE)	Sec.Ohm
Angle	Load encroachment sector angle (GE)	Deg
Rloadfw	Load encroachment forward direction resistance lower limit (ABB)	Sec.Ohm
Rloadrev	Load encroachment reverse direction resistance lower limit (ABB)	Sec.Ohm
phiload	Load encroachment sector angle range (ABB)	Deg
BFR	Load encroachment resistance lower limit in the I quadrant (Toshiba 1)	Sec.Ohm
BFL	Load encroachment resistance lower limit in the II quadrant (Toshiba 1)	Sec.Ohm
BRR	Load encroachment resistance lower limit in the III quadrant (Toshiba 1)	Sec.Ohm
BRL	Load encroachment resistance lower limit in the IV quadrant (Toshiba 1)	Sec.Ohm
BFLang	Load encroachment II quadrant sector angle	Deg
BRLang	Load encroachment IV quadrant sector angle	Deg
BND	Load encroachment resistance lower limit range (Toshiba 2)	Sec.Ohm
BNDang	Load encroachment angle range (Toshiba 2)	Deg

B Signal Definitions

B.1 Single phase

Table B.1: Input/output signals of the single phase Load Encroachment element (*CalDisload-enc1p*)

Name	Description	Unit	Type	Model
Ir	Operating Current real part	Sec Amps	IN	Any
Ii	Operating Current imaginary part	Sec Amps	IN	Any
Ur	Polarizing Voltage real part	Sec Volt	IN	Any
Ui	Polarizing Voltage imaginary part	Sec Volt	IN	Any
R	Resistance	Sec Ohm	IN	Any
X	Inductance	Sec Ohm	IN	Any
wsupadd	Supervisioning signal	Seconds(or 1/0 RMS/EMT simulation)	IN	Any
yout	Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any

B.2 3 phase

Table B.2: Input/output signals of 3 phase Load Encroachment element (*CalDisloadenc*)

Name	Description	Unit	Type	Model
Ir_A	Operating current phase A-Phase B real part	Sec Amps	IN	Any
Ii_A	Operating current phase A-Phase B imaginary part	Sec Amps	IN	Any
Ir_B	Operating current phase B-Phase C real part	Sec Amps	IN	Any
Ii_B	Operating current phase B-Phase C imaginary part	Sec Amps	IN	Any
Ir_C	Operating current phase C-Phase A real part	Sec Amps	IN	Any
Ii_C	Operating current phase C-Phase A imaginary part	Sec Amps	IN	Any
Ur_A	Polarizing voltage phase A-Phase B real part	Sec V	IN	Any
Ui_A	Polarizing voltage phase A-Phase B imaginary part	Sec V	IN	Any
Ur_B	Polarizing voltage phase B-Phase C real part	Sec V	IN	Any
Ui_B	Polarizing voltage phase B-Phase C imaginary part	Sec V	IN	Any
Ur_C	Polarizing voltage phase C-Phase A real part	Sec V	IN	Any
Ui_C	Polarizing voltage phase C-Phase A imaginary part	Sec V	IN	Any
Rl_A	Resistance phase A-Phase B	Sec Ohm	IN	Any
Xl_A	Inductance phase A-Phase B	Sec Ohm	IN	Any
Rl_B	Resistance phase B-Phase C	Sec Ohm	IN	Any
Xl_B	Inductance phase B-Phase C	Sec Ohm	IN	Any
Rl_C	Resistance phase C-Phase A	Sec Ohm	IN	Any
Xl_C	Inductance phase C-Phase A	Sec Ohm	IN	Any
wsupadd	Supervisioning signal	Seconds(or 1/0 RMS/EMT simulation)	IN	Any
yout	Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any
yout_A	Phase A Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any
yout_B	Phase B Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any
yout_C	Phase C Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any
yloop	ID of the loop impedances in the trip zone	Integer	OUT	Any

B.3 6 phase

Table B.3: Input/output signals of 6 phase Load Encroachment element (*CalDisloadenc6p*)

Name	Description	Unit	Type	Model
Ir_A	Operating current phase A-Phase B real part	Sec Amps	IN	Any
Ii_A	Operating current phase A-Phase B imaginary part	Sec Amps	IN	Any
Ir_B	Operating current phase B-Phase C real part	Sec Amps	IN	Any
Ii_B	Operating current phase B-Phase C imaginary part	Sec Amps	IN	Any
Ir_C	Operating current phase C-Phase A real part	Sec Amps	IN	Any
Ii_C	Operating current phase C-Phase A imaginary part	Sec Amps	IN	Any
Igr_A	Operating current phase A real part	Sec Amps	IN	Any
Igi_A	Operating current phase A imaginary part	Sec Amps	IN	Any
Igr_B	Operating current phase B real part	Sec Amps	IN	Any
Igi_B	Operating current phase B imaginary part	Sec Amps	IN	Any
Igr_C	Operating current phase C real part	Sec Amps	IN	Any
Igi_C	Operating current phase C imaginary part	Sec Amps	IN	Any
Ur_A	Polarizing voltage phase A-Phase B real part	Sec V	IN	Any
Ui_A	Polarizing voltage phase A-Phase B imaginary part	Sec V	IN	Any
Ur_B	Polarizing voltage phase B-Phase C real part	Sec V	IN	Any
Ui_B	Polarizing voltage phase B-Phase C imaginary part	Sec V	IN	Any
Ur_C	Polarizing voltage phase C-Phase A real part	Sec V	IN	Any
Ui_C	Polarizing voltage phase C-Phase A imaginary part	Sec V	IN	Any
Ugr_A	Polarizing voltage phase A real part	Sec V	IN	Any
Ugi_A	Polarizing voltage phase A imaginary part	Sec V	IN	Any
Ugr_B	Polarizing voltage phase B real part	Sec V	IN	Any
Ugi_B	Polarizing voltage phase B imaginary part	Sec V	IN	Any
Ugr_C	Polarizing voltage phase C real part	Sec V	IN	Any
Ugi_C	Polarizing voltage phase C imaginary part	Sec V	IN	Any
R_A	Resistance phase A	Sec Ohm	IN	Any
X_A	Inductance phase A	Sec Ohm	IN	Any
R_B	Resistance phase B	Sec Ohm	IN	Any
X_B	Inductance phase B	Sec Ohm	IN	Any
R_C	Resistance phase C	Sec Ohm	IN	Any
X_C	Inductance phase C	Sec Ohm	IN	Any
Rl_A	Resistance phase A-Phase B	Sec Ohm	IN	Any
Xl_A	Inductance phase A-Phase B	Sec Ohm	IN	Any
Rl_B	Resistance phase B-Phase C	Sec Ohm	IN	Any
Xl_B	Inductance phase B-Phase C	Sec Ohm	IN	Any
Rl_C	Resistance phase C-Phase A	Sec Ohm	IN	Any
Xl_C	Inductance phase C-Phase A	Sec Ohm	IN	Any
wsupadd	Supervisioning signal	Seconds(or 1/0 RMS/EMT simulation)	IN	Any
yout	Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any
yout_A	Phase A Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any
yout_B	Phase B Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any
yout_C	Phase C Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any
yout_AB	Phase A-Phase B Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any
yout_BC	Phase B-Phase C Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any
yout_CA	Phase C-Phase A Tripping signal/time	Seconds(or 1/0 RMS/EMT simulation)	OUT	Any
yloop	ID of the loop impedances in the trip zone	Integer	OUT	Any

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