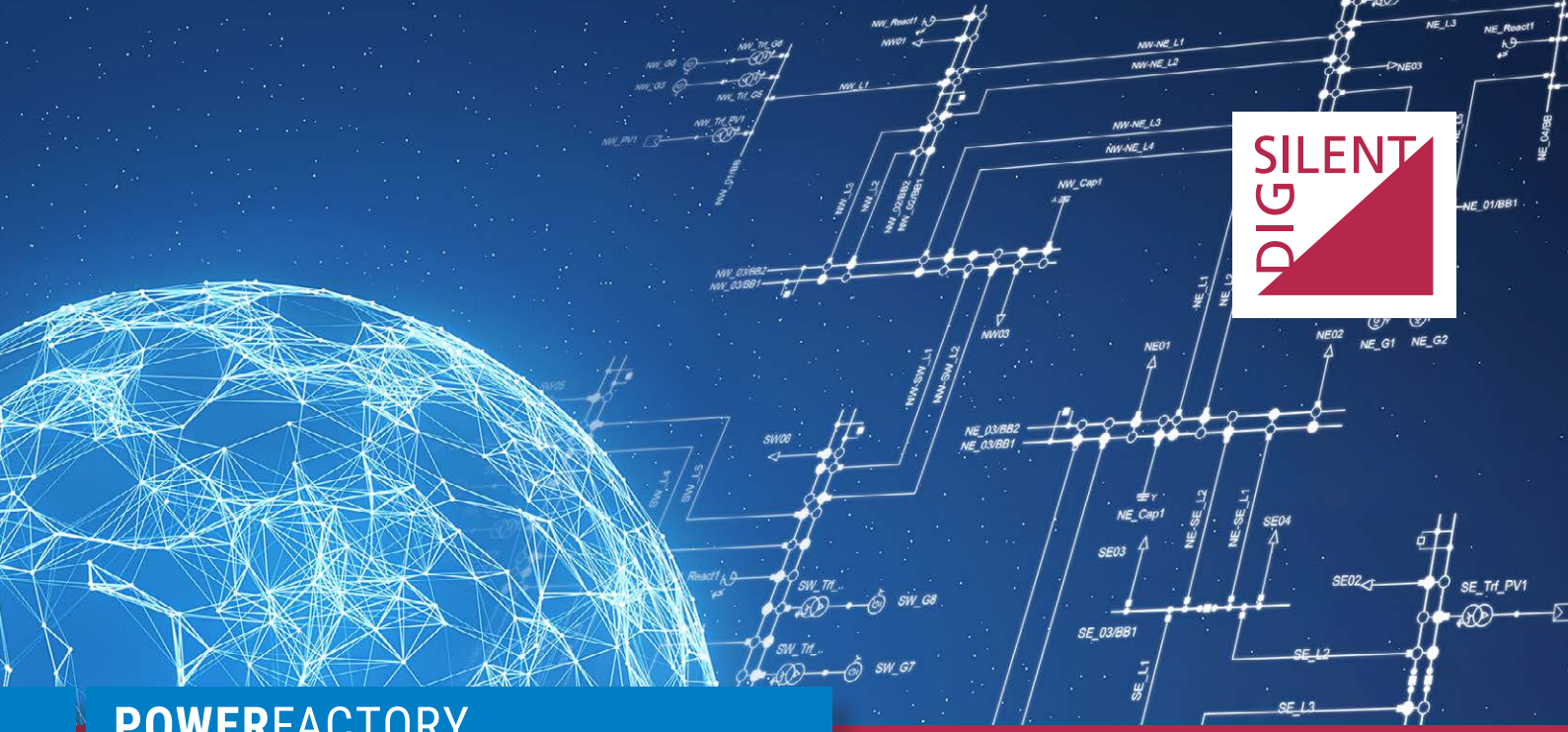

POWERFACTORY

PowerFactory 2021

Technical Reference

Differential Protection

RelBiasidiff, TypBiasidiff

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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PowerFactory 2021
Revision 1

Contents

1 General Description

The differential block implements a phase comparison or a magnitude percentage restrained differential protection scheme including a waveform blocking criterion based on the 2_{nd} the 4_{th} and the 5_{th} harmonic and an unrestrained differential trip algorithm for heavy internal faults. The magnitude percentage restrained differential protection feature simulates a double slope characteristic with a shape similar to the characteristic represented in Figure 1.1:

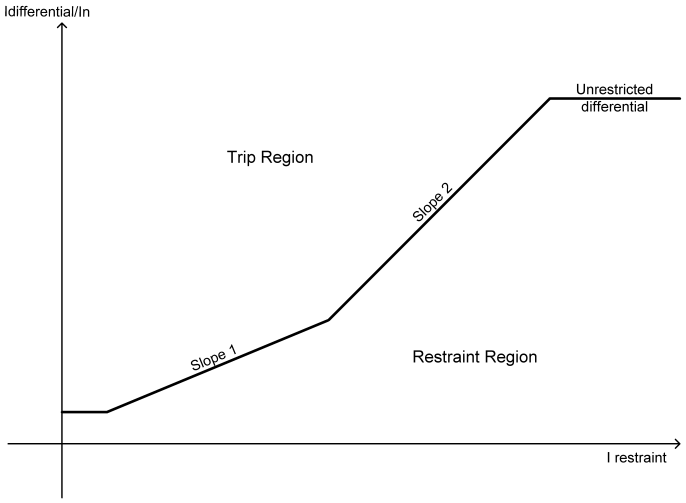


Figure 1.1: *DIgSILENT* The *Differential Protection* "RelBiasidiff"differential characteristic.

The phase comparison differential protection feature simulates an angular trip/restraint zone with a shape similar to the characteristic represented in Figure 1.2:

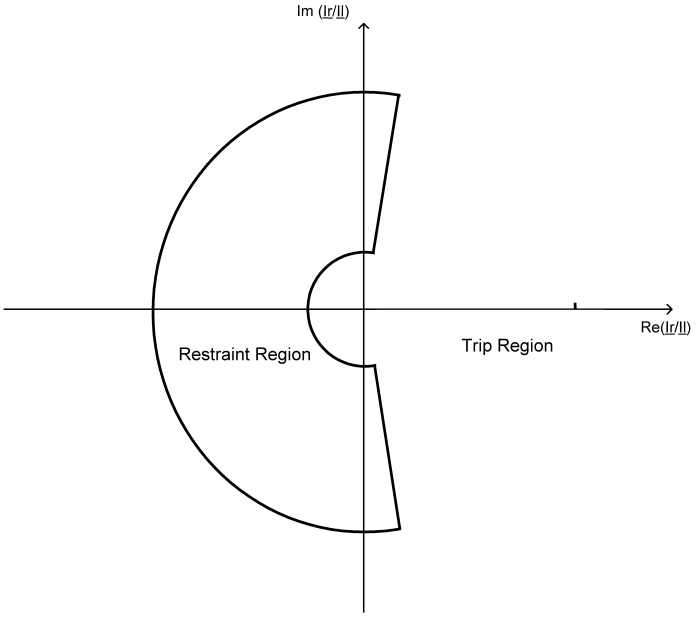


Figure 1.2: *DIgSILENT* The *Differential Protection* "RelBiasIdiff"phase difference diagram.

The *Differential Protection* "RelBiasidiff"block is operational during short circuit, load flow and RMS/EMT simulations. The harmonic blocking requires an EMT simulation.

2 Features & User interface

2.1 Differential Protection (RelBiasidiff)

The user can change the block settings using the “Differential Protection”dialogue (“RelBiasidiff”class). The dialogue consists of 4 tab pages: *Basic data*, *Tap*, *Harmonic Blocking*, and *Description*. The main settings are located in the *Basic data* tab page.

2.1.1 Basic data

The “Differential Protection” dialogue provides a *presentation* area where the red text shows some info regarding:

- The international (IEC and ANSI) symbols used to represent the block protective function.
- How many currents are measured by the block.

The block can be disabled using the “Out of service”check box. The current threshold and the time delay can be set using the “Differential Current”, the “Release Threshold”and the “Time Setting” control. The controls are combo boxes for ranges of discrete values or otherwise edit boxes. The blue text provides additional info regarding the current threshold in terms of primary current.

2.1.2 Tap

The *Tap* tab page has been added to support the Schweitzer protective relay models. The page defines the value of the *Tap* settings and of the *Max Rated Power* setting.
The differential thresholds set in the *Basic Data* tab page can expressed in terms of multiple of the value defined as *Tap 1*. The other *Tap* settings are available for documentation purpose only.
The *Max Rated Power* value is used as transformer rated power to calculate the transformer rated current; *Tap 1* is set equal to the calculated transformer rated current when the *Assume Tap* button is pressed.

2.1.3 Harmonic Blocking

This tab page defines the harmonic thresholds for the harmonic blocking features configuration.

The relevant *Harmonic Blocking* tab page of the *Differential Protection (TypBiasidiff)* dialogue (see 2.2.3 must be used to define which features are available. Depending up on the configuration it could be possible to define the following features

- which harmonics are considered to block the trip
- enable/disable the phase interblocking
- select the *mode* used to trigger the interblocking (*phase harmonic average*, *single phase harmonic*, *2 phases harmonic*)

2.1.4 Description

The *Description* tab page can be used to insert some information to identify the Differential Protection 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 Differential Protection Type(TypBiasidiff)

The *Differential Protection* block main characteristics must be configured in the “Differential Protection Type”dialogue (*TypBiasidiff* class). The dialogue contains four tab pages: *Basic data*, *Tap*, *Harmonic Blocking*, and *Advanced Settings*.

2.2.1 Basic data

The *Basic data* tab page contains most of the controls used to configure the *Differential Protection* block.

The block can be configured using the “Type”combo box variable as:

- 3 phase magnitude differential element(“3ph”)
- Single phase magnitude differential element (“1ph”)
- 3 phase phase comparison differential element(“3ph Phase Comparison”)
- Single phase phase comparison differential element(“1ph Phase Comparison”)
- Restricted Earth Fault (“Restricted Earth Fault”)

The *Differential Protection* (“RelBiasidiff”)element has been conceived to work together with the other relay elements: some settings can be set to depend upon the settings of other differential blocks:

- The element can be set to get a threshold value reference from another block: the *Release threshold* (“Idiff”parameter) value becomes a multiplier of the *Differential Threshold* (“Itap”parameter) set in the other block.
- The element can be set to get the time from another block: the *Time Setting* (“Tset”parameter) value becomes a multiplier of the same parameter set in the other block.

2.2.2 Tap

The *Tap* tab page has been added to support the Schweitzer protective relay models. The page defines the ranges of the *Tap* settings and of the *Max Rated Power* setting.
Multiple *Tap* value ranges are available to support differential relay with multiple current inputs.

2.2.3 Harmonic blocking

The harmonic block feature is active if the relevant harmonic current inputs(Harm2CT1_A, Harm4CT1_A, Harm5CT1_A, Harm2CT2_A etc) are connected. The *Harmonic blocking* can be set to consider the *2nd Harmonic*, the *4th Harmonic* and the *5th Harmonic*. Independent thresholds can be set for each harmonic component.
For each phase if at least one of the harmonic input currents is above the relevant harmonic threshold the phase differential restrained threshold trip is inhibited. In other words, to inhibit the trip of the restrained threshold of the differential block, for each phase at least one harmonic of one CT must be above the harmonic threshold (i.e. 4th harmonic in the CT #2). The unrestrained threshold ("Idiffunrest"parameter) is not affected by the harmonic blocking.

The harmonic blocking operates independently for each phase. It means that the harmonic content of each phase current is evaluated independently and the trip of that phase is inhibited if the harmonic content of the phase current is above the relevant threshold. A phase interblocking logic is available and can be configured using the *Interlock Configuration* settings. Separated *Interlock Configuration* settings are available for the *2nd Harmonic* ("ih2intblockconf"parameter), the *4th Harmonic* ("ih4intblockconf"parameter), and the *5th Harmonic* ("ih5intblockconf"parameter). The phase interblocking logic can be configured to consider the average harmonic content calculated on the three phases or the single phase harmonic content using the *Interlock Mode* settings ("ih2blockcalcmethod", "ih4blockcalcmethod", and "ih5blockcalcmethod"parameter). When the single phase harmonic content is evaluated, the interblocking logic can be set to operate when a single phase harmonic content is above the threshold or when at least 2 phase harmonic contents are above the threshold.

The harmonic current signals are usually coming from normal RelMeasure blocks. The type of such RelMeasure blocks (TypMeasure) must be set to calculate the RMS using a filter. The number of the harmonic can be set using the *Harmonic* edit box ("dftharmonic"parameter) when the *DFT 1 cycle*, the *DFT 1/2 cycle* and the *Cosine* filter is set filter, using the *First harmonic* and *Last Harmonic* edit boxes ("fftfirstharm"and "fftlastharm"parameter) for the *FFT* filter is set. Please note that in this last case, to obtain correct results, *fftfirstharm* and *fftlastharm* must be set equal to the same value.

The harmonic block can be disabled using

- the *Disable harmonic blocking* check box ("harmblockdisable"parameter) in the *Harmonic block* tab page of the differential element (RelBiasidiff) dialogue
- the "iblockharmrestr"block input signal.

2.2.4 Advanced Settings

The *Advanced Settings* tab page defines the pickup delay (*Pickup Time*"Ts"parameter and *Trip Loop Time* "Tlt"parameter) and the *Reset Time* ("Tr"parameter) and the *Reset Ratio* ("Kr"paramter) of the differential element. If the *Timer includes pick-up time* ("iincTs "parameter) check box is set the pickup delay is not considered in the calculation of the total trip time.
Calculating a short circuit, a load flow or a RMS simulation the pickup delay is equal to the *Pickup Time* plus the *Trip Loop Time*.
Calculating an EMT simulation it is equal to the *Pickup Time*.

2.3 Differential features

2.3.1 The percentage restrained threshold

The differential threshold is function of the *Restraint current* value. The logic used to calculate the restrained threshold must be selected using the *Restraint type* combo box in the TypBiasidiff dialogue. The available logics are:

- *Average*: the *Restraint Current* is calculated using the average of the CT current RMS values for each phase.
- *Scalar product*: the following formula is used $\sqrt{|\underline{ICT1_A} * \underline{ICT2_A}|}$
- *Maximum*: the *Restraint Current* is calculated using the maximum current value between the CT current RMS values for each phase.
- *Scalar Sum*: the *Restraint Current* is calculated as the summation for each phase of RMS values of the CT currents.

The percentage restrained differential threshold is calculated using the restraint current value, calculated as described here above, and the percentage slope values. The slope shape, usually named *Differential Characteristic* must be set using the *Characteristic* combo box in the TypBiasidiff dialogue. The available *Differential Characteristics* are:

- *Standard*
- *Independent 2nd slope*
- *All Slopes Independent*
- *Transition zone*
- *Toshiba*

2.3.2 Differential Characteristic

Standard

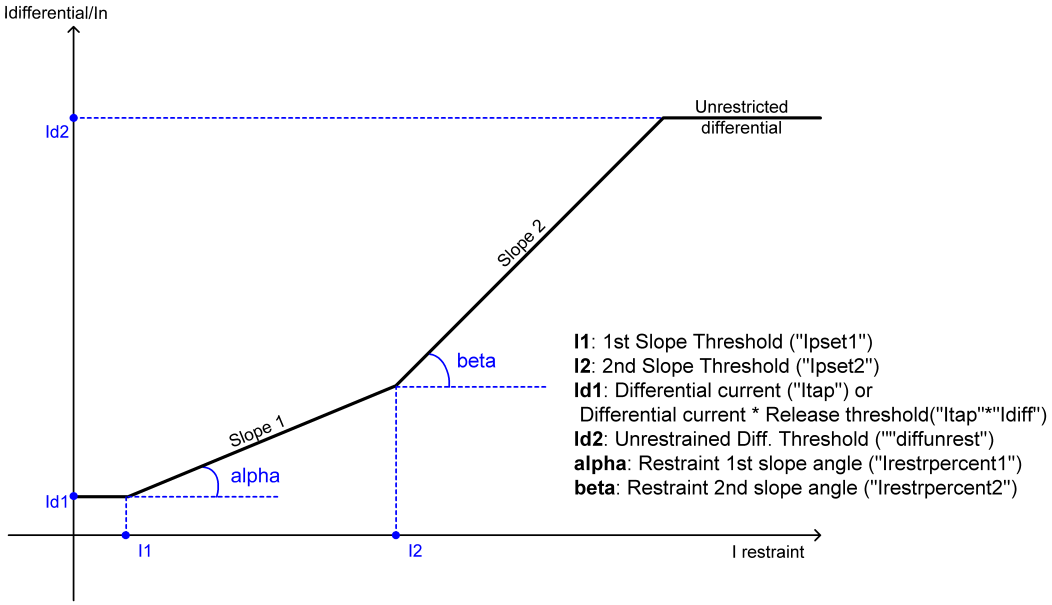


Figure 2.1: *DIgSILENT* The *Differential Protection* "RelBiasidiff"standard characteristic.

Independent 2nd Slope

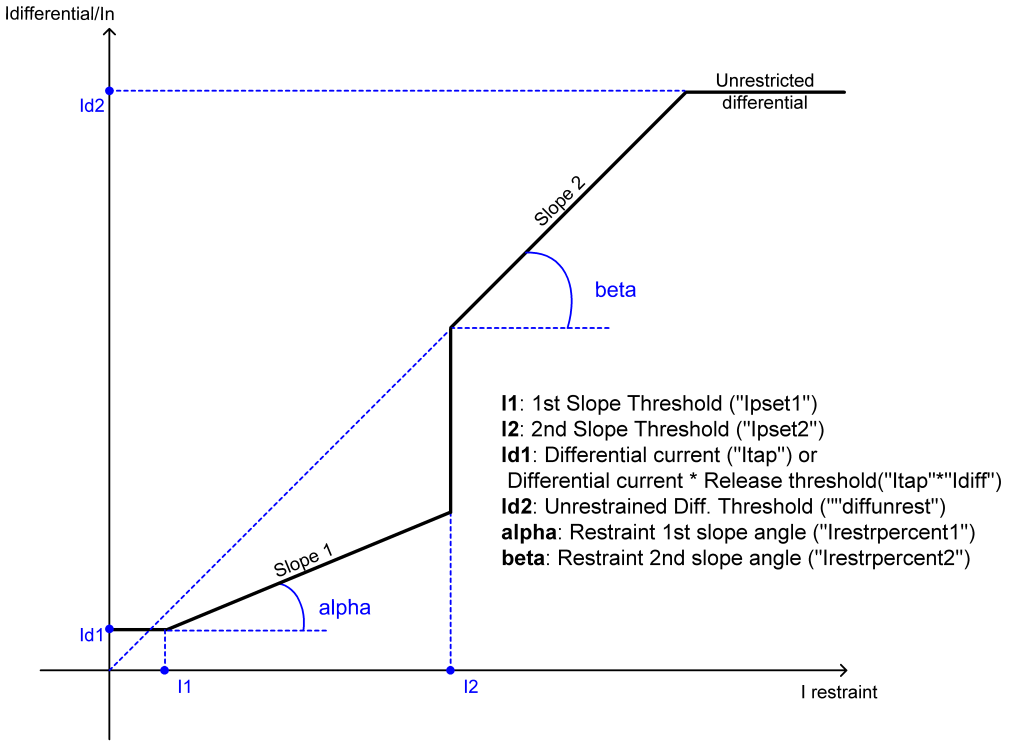


Figure 2.2: *DIgSILENT* The *Differential Protection* "RelBiasidiff"Independent 2nd Slope characteristic.

All Slopes Independent

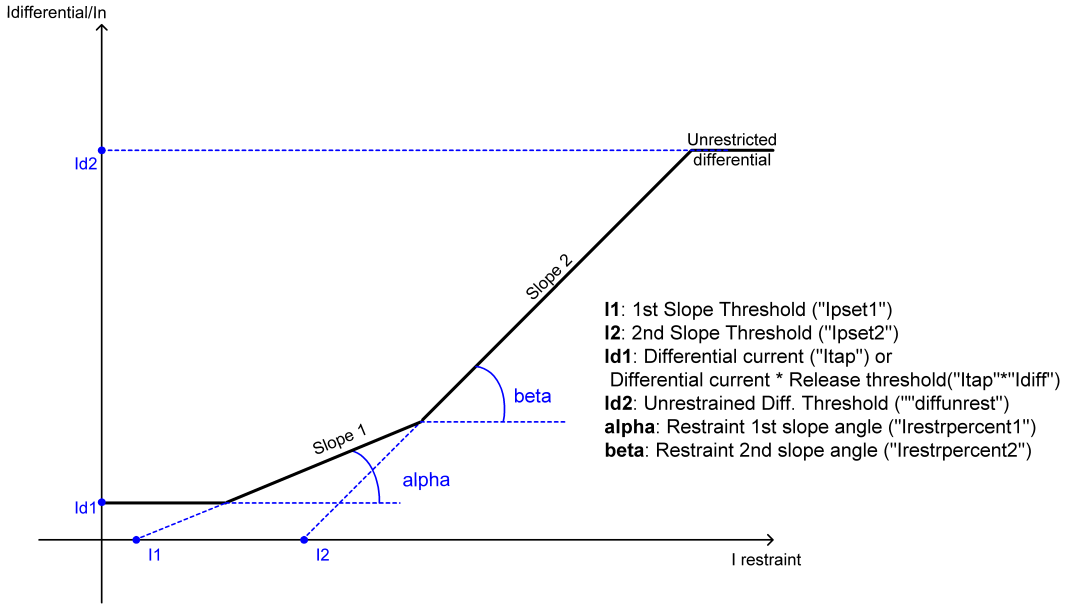


Figure 2.3: *DIgSILENT* The *Differential Protection* "RelBiasidiff"All Slopes Independent characteristic.

Transition Zone

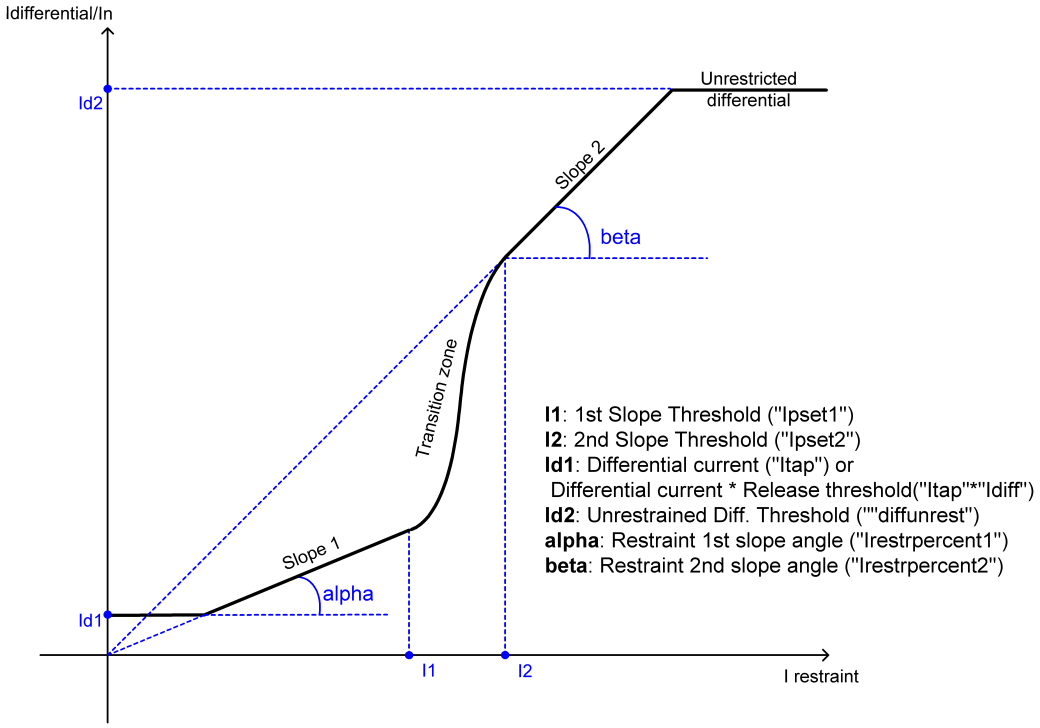


Figure 2.4: *DIgSILENT* The *Differential Protection* "RelBiasidiff"Transition Zone Independent characteristic.

Toshiba

The *Toshiba Differential Characteristics* has different shapes for the 3 phase and the single phase differential.

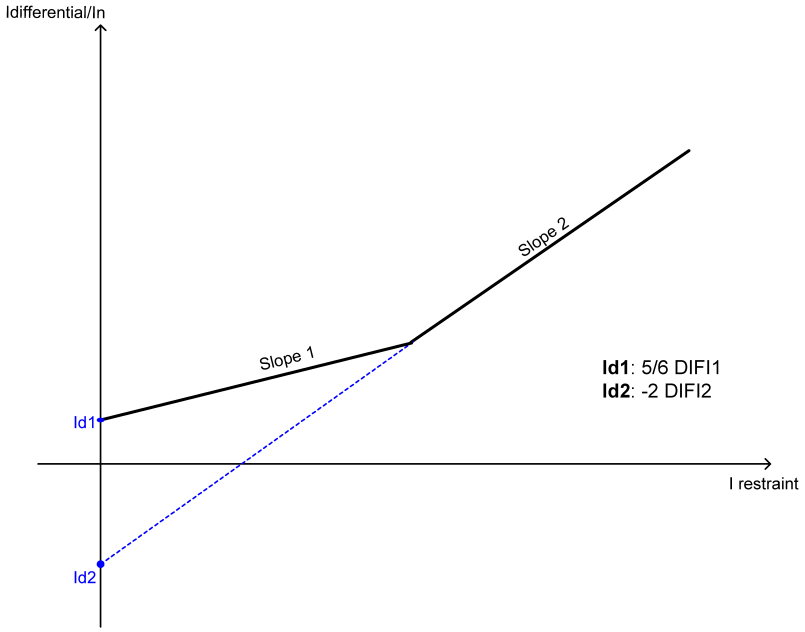


Figure 2.5: *DIgSILENT* The *Differential Protection* “RelBiasidiff”Toshiba 3 phase characteristic.

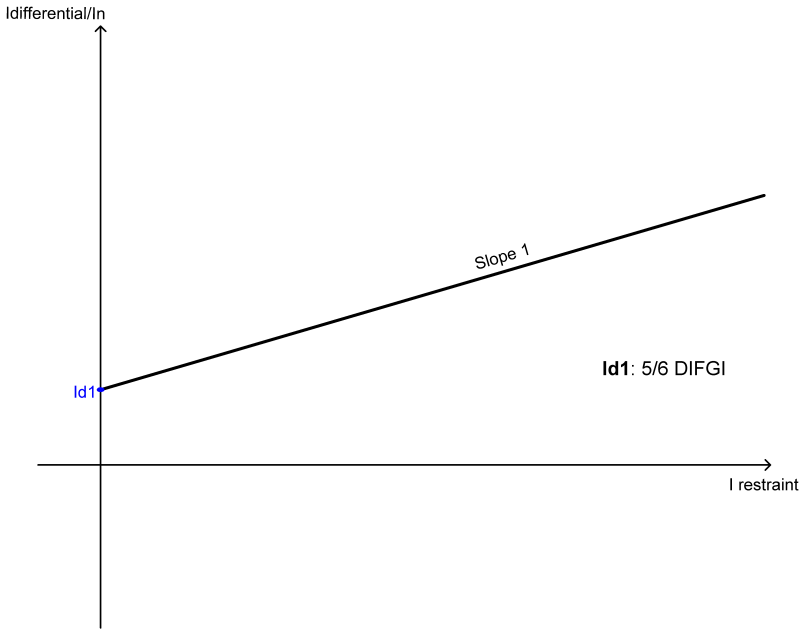


Figure 2.6: *DIgSILENT* The *Differential Protection* “RelBiasidiff” Toshiba single phase (ground) characteristic.

2.3.3 Phase comparison with restraint region

The phase comparison devices are usually used as primary protection of a power line. A differential block type which is selectable in 3phase or single phase modes, is available to model such a devices. The *3phase comparison differential* and the *single phase comparison differential* type compare the angle between two currents provided by a local measurement device and a remote measurement device and allow to define a restraint area where the trip is not allowed. The PF relay model must be instanced with two current transformers measuring the current at the two line terminals.

The shape of the restraint region is described by two settings, as shown in picture 2.7 where the alpha plane, which represents the phasor or complex ratio of remote (IR) to local (IL) currents, is displayed.

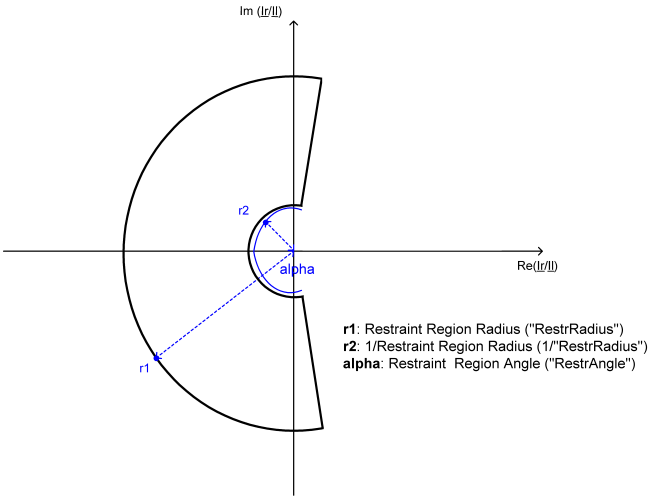


Figure 2.7: *DIgSILENT* The *Differential Protection* “RelBiasIdiff”phase comparison diagram (alpha plane).

Arbitrarily assign current flowing into the protected line to have zero angle, and current flowing out of the protected line to have angle 180 degrees. Five Amps of load current flowing from the local to the remote relay produces an A-phase current of 50 at the local measurement, and 5180 at the remote measurement. The block trips when the alpha plane ratio travels outside the restraint region, and the difference current and/or the local current is above a settable threshold. The block restrains when the alpha plane ratio remains inside the restraint region, or when there is insufficient difference current and/or local current.

The *Restraint region Angle* (“RestrAngle”parameter)determines the angular extent of the restraint region. The *Restraint region Radious* (“RestrRadious”parameter) determines the outer radius of the restraint region. The inner radius is the reciprocal of the *Restraint region Radious* (“RestrRadius”parameter). The *Differential threshold* (“Idiff”parameter) determines the minimum differential current value which allows the block trip and the *Current threshol* (“IM”parameter) determines the minimum *local* current value which allows the block trip.

3 Integration in the relay scheme

The *Differential Protection*“RelBiasidiff ” type class name is *TypBiasidiff* . The *Differential Protection* dialogue class name is *RelBiasidiff*. As already shown, there are two main versions of the block: a single phase and a three phase version. The number and the name of the input signals depends only upon which of these versions is used.

The *Irdiff_A*, *Irdiff_B* and *Irdiff_C* differential block output signals (Irdiff for the single phase differential block) must be connected to a measurement block calculating the RMS values of the differential currents. The output signals of the measurement block must be sent back to the *Idiffabs_A*, *Idiffabs_B* and *Idiffabs_C* differential block input signals (*Idiffabs* for the single phase differential block). The values present inside such input signals are compared with the differential threshold to decide how to set the differential trip signals. The complete “3 phase differential”connection scheme for a 2 Cts system is showed here below.

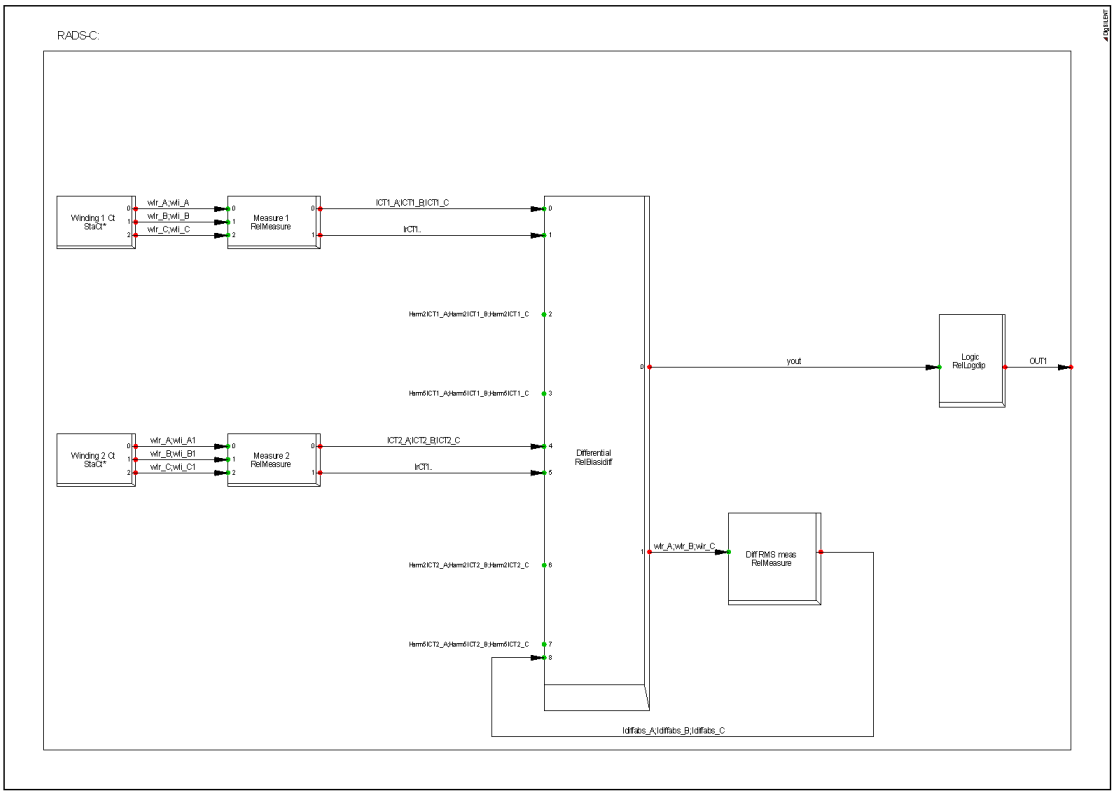


Figure 3.1: *DIgSILENT* Connection scheme of a 3 phase *Differential Protection* “RelBiasidiff”block.

The typical connection of a single phase *Differential Protection* “RelBiasidiff”block is showed in picture 3.2.

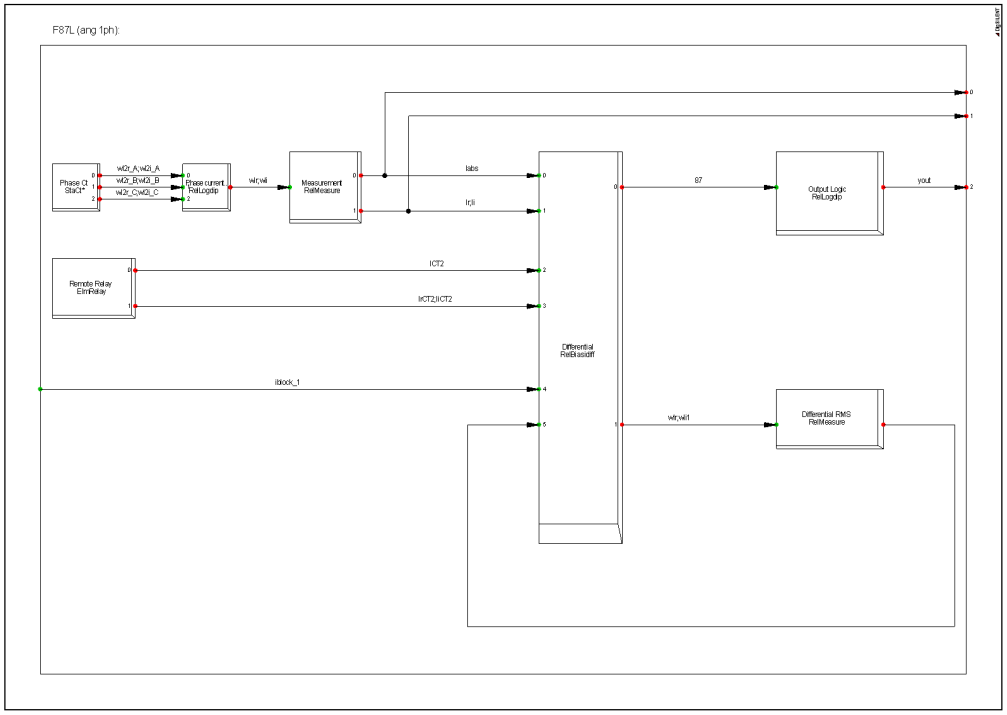


Figure 3.2: *DIgSILENT* Connection scheme of a single phase *Differential Protection*“RelBiasidiff”block.

The connection of a *Restricted earth fault* differential element is similar to the scheme showed in picture 3.3.

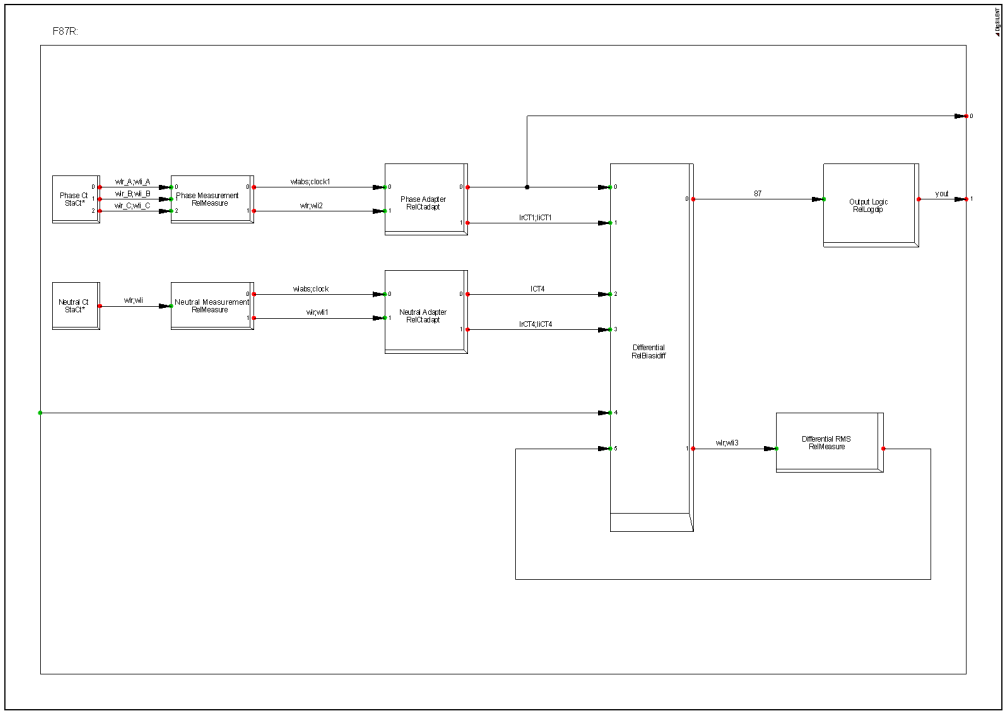


Figure 3.3: *DIgSILENT* Connection scheme of a restricted earth fault *Differential Protection* “RelBiasidiff”block.

To control a *Differential Protection*“RelBiasidiff ”block with a reclosing element (“RelRecl”object) the “iblock”input signal must be connected with an output signal of the reclosing element (*yblock_Toc**x*** with $1 <= x <= 5$ or *yblock_Logic**k*** with $1 <= k <= 16$) . Please read the“RelRecl”documentation for more details about the way to program a reclosing sequence.

To get a current threshold value reference from another block the following operation must be performed :

- Inside the “TypBiasidiff ”dialogue set the “Ref. Current from”item with the link to the element from which the *Differential Protection*“RelBiasidiff ”element gets the reference value.
- Inside the “TypBiasidiff”dialogue set the “Current Range”unit equal to “p.u.”. Please note that if “Sec.A”is selected as the unit then the whole feature doesn’t work and the *Differential Protection*“RelBiasidiff”secondary amps threshold is used.

4 Logic

4.1 Single phase

4.1.1 Current Magnitude

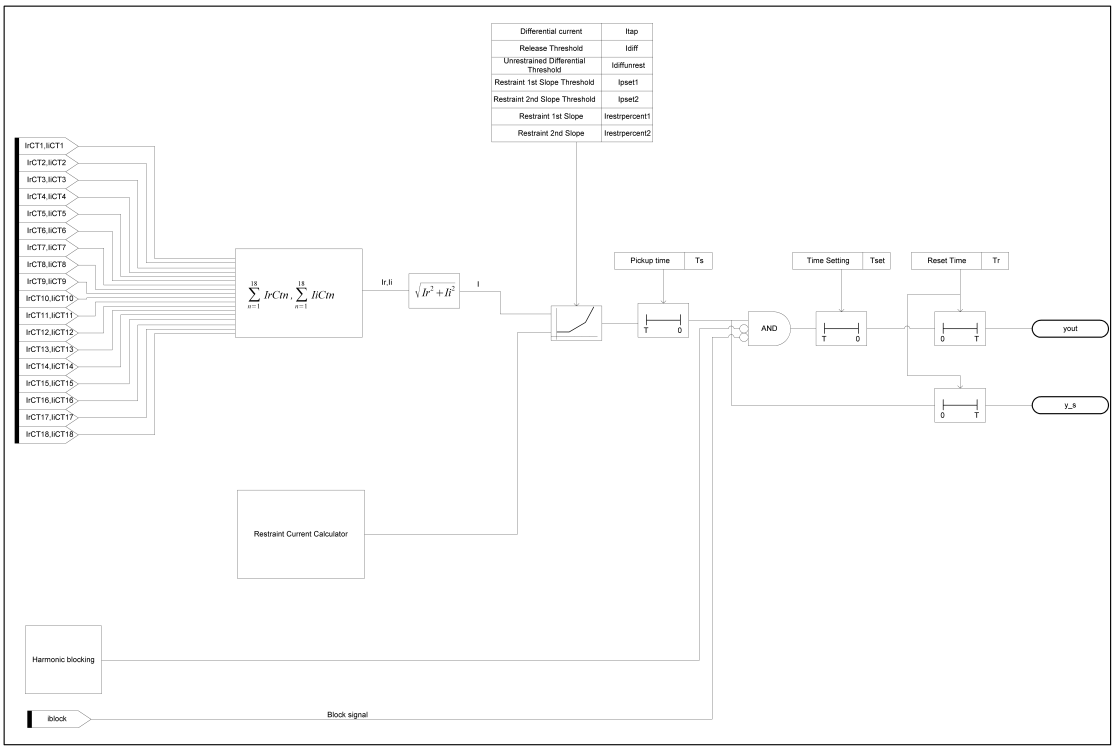
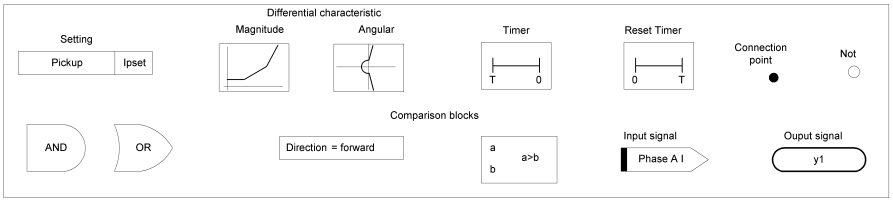


Figure 4.1: The *Differential Protection(RelBiasidiff)logic*



4.1.2 Current phase comparison

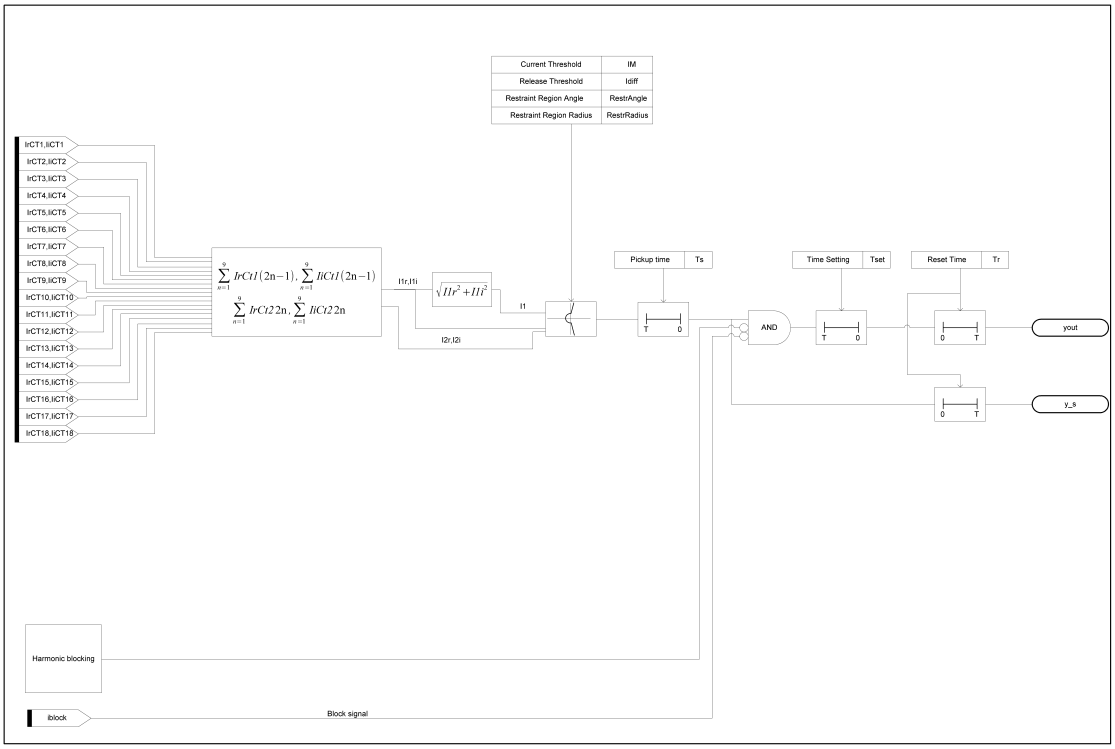
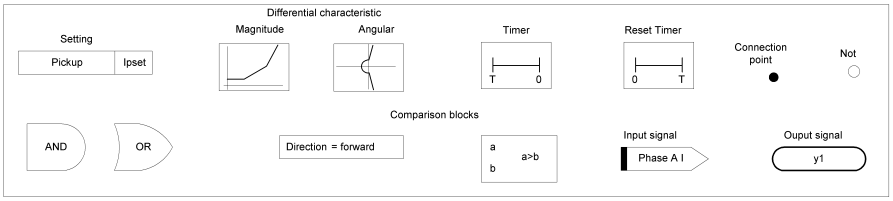


Figure 4.2: The *Differential Protection(RelBiasidiff)logic*



4.2 3 phase

4.2.1 Current Magnitude

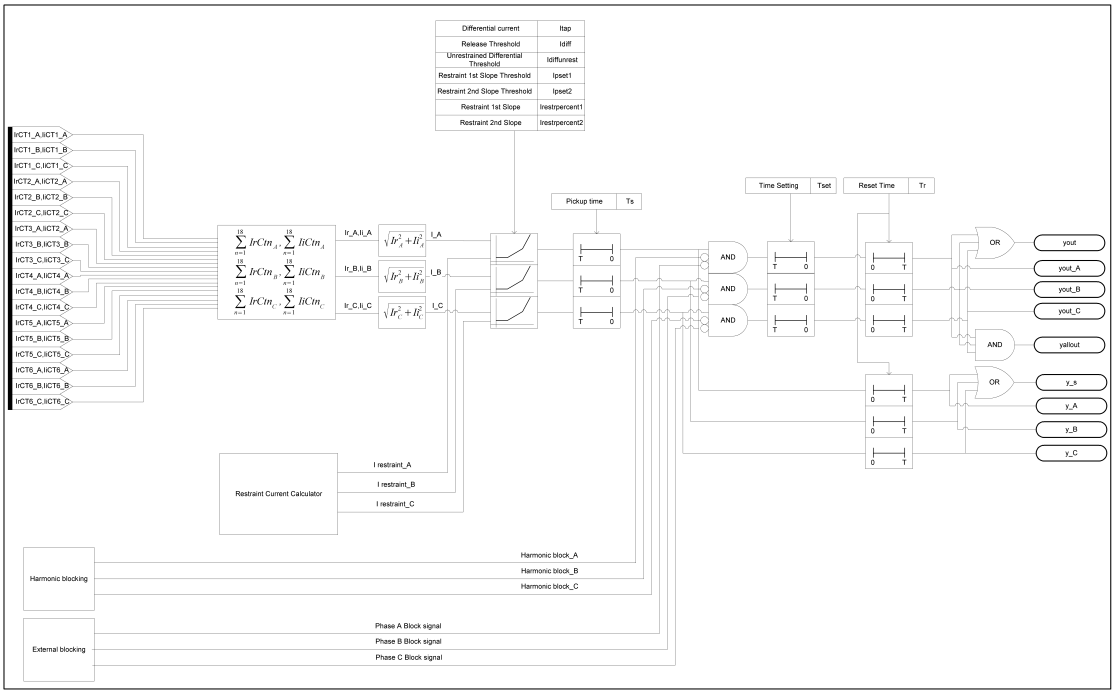
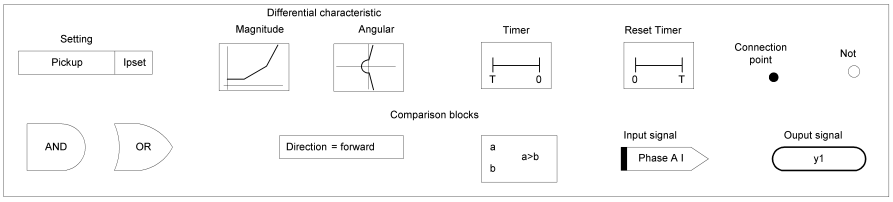


Figure 4.3: The *Differential Protection(RelBiasidiff)logic*



4.2.2 Current phase comparison

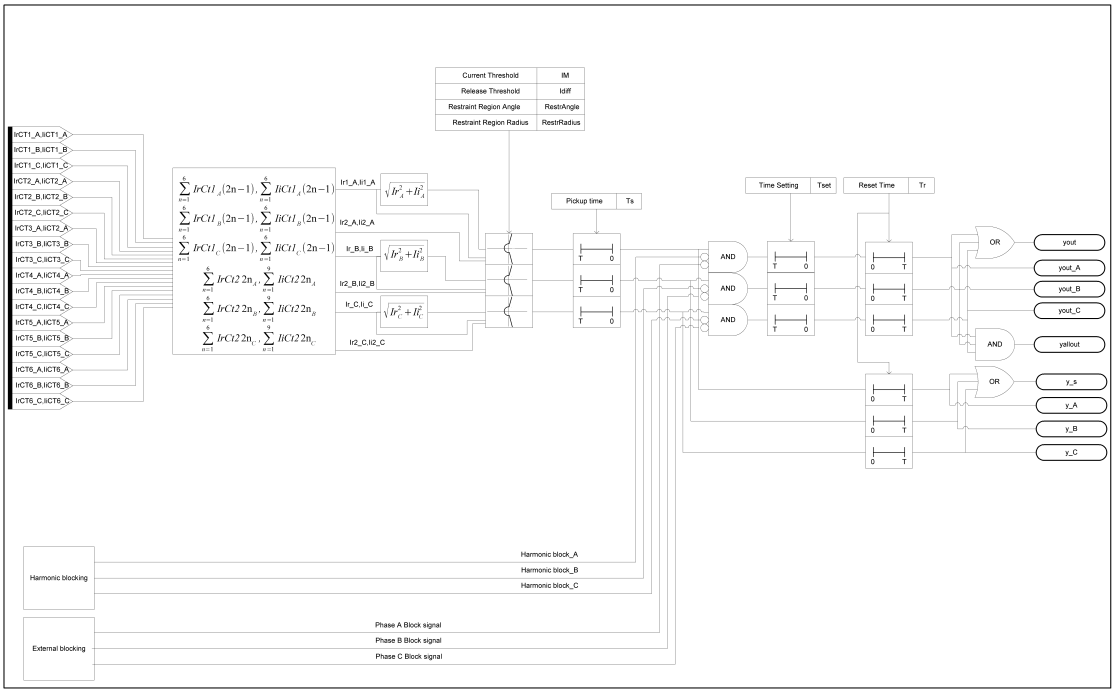
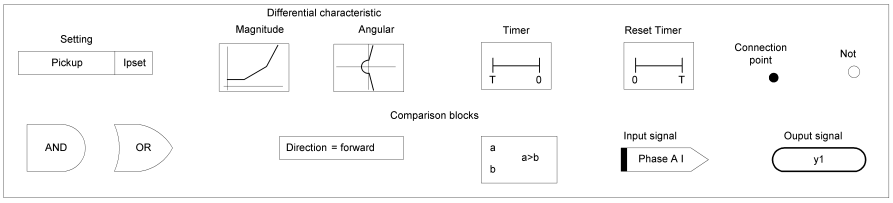


Figure 4.4: The *Differential Protection(RelBiasidiff)logic*



4.3 Current phase comparison logic

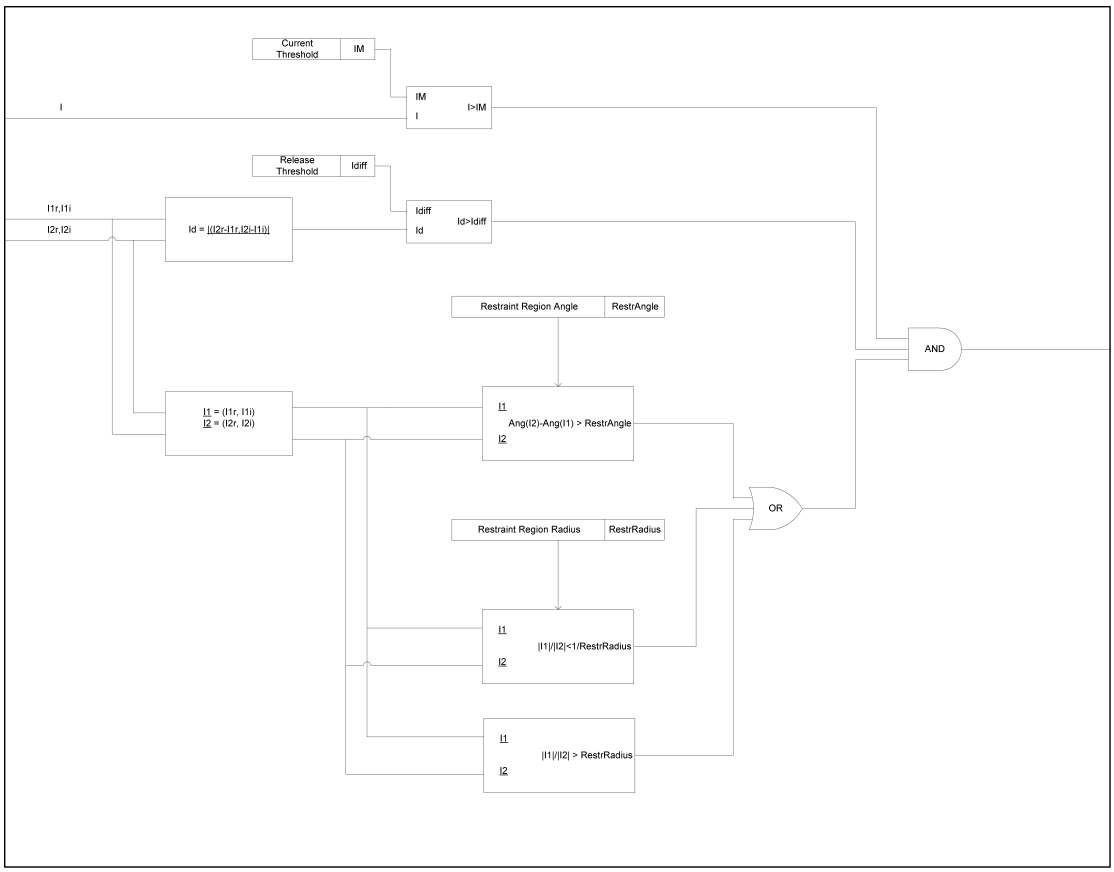
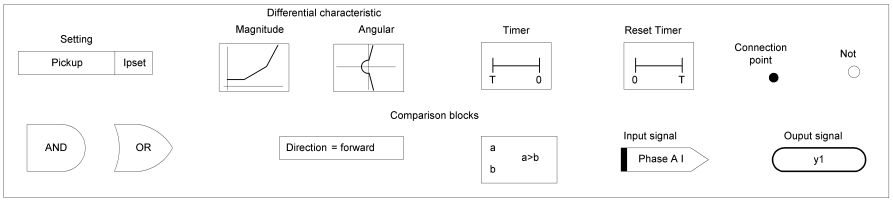


Figure 4.5: The *Differential Protection(RelBiasidiff)logic*



4.4 Restraint Logic

4.4.1 Single phase

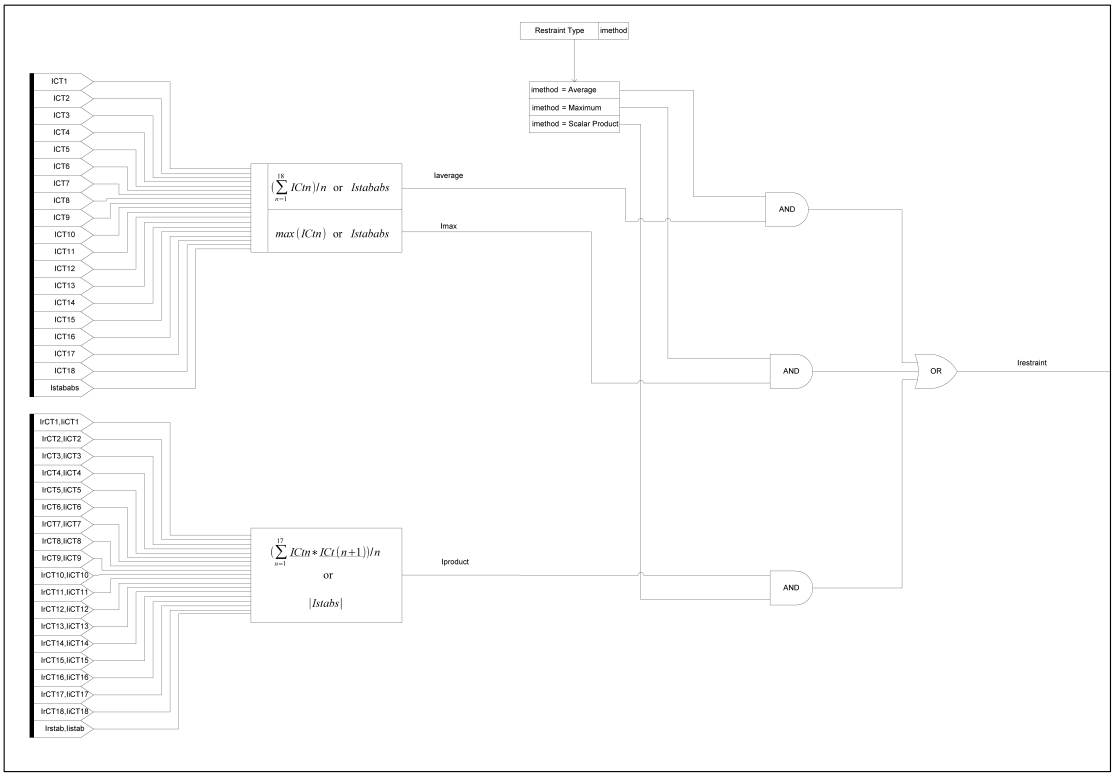
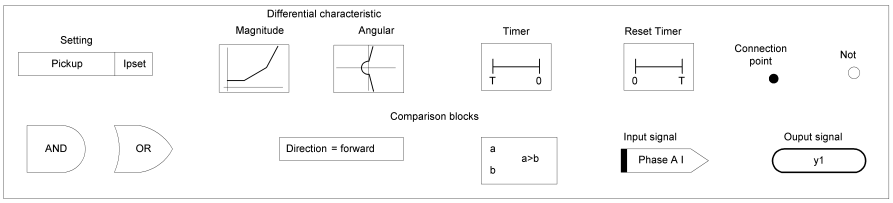


Figure 4.6: The *Differential Protection(RelBiasidiff) single phase Current Restraint logic*



4.4.2 3 phase

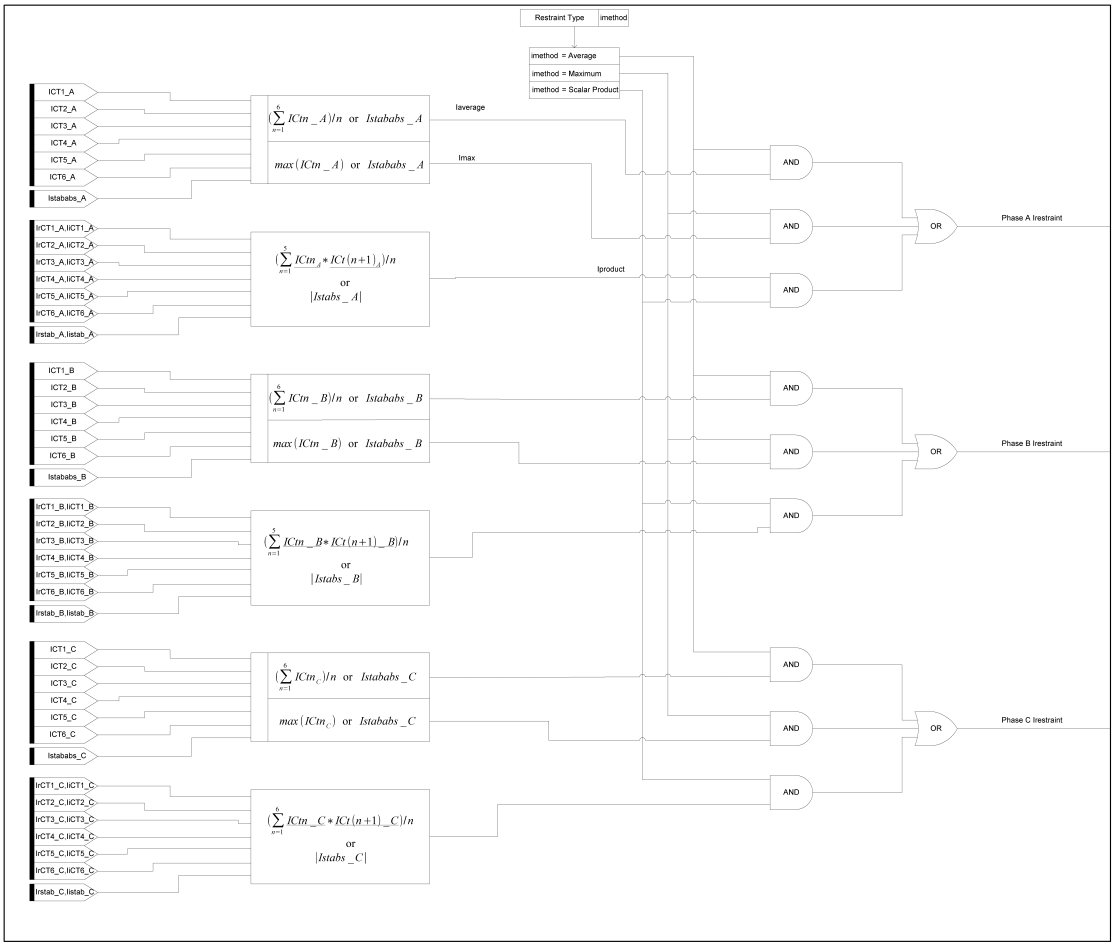
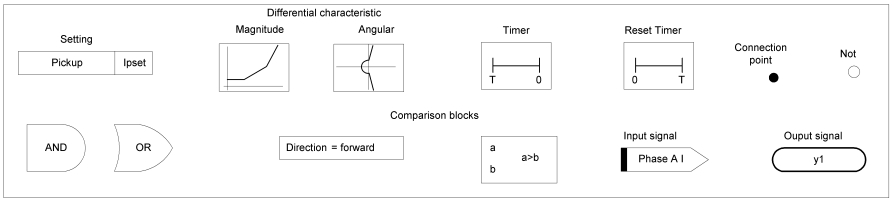


Figure 4.7: The *Differential Protection(RelBiasidiff) three phase Current Restraint logic*



4.5 Harmonic Blocking Logic

4.5.1 Single phase

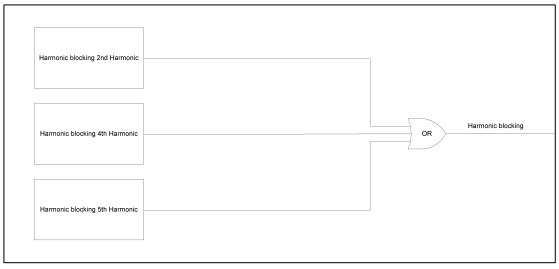


Figure 4.8: The *Differential Protection(RelBiasidiff) Harmonic Block logic*

“Harmonic blocking 2nd Harmonic”, “Harmonic blocking 4th Harmonic”, and “Harmonic blocking 5th Harmonic” are identical except for the processed harmonic. Here below (see Figure 4.9) the logic scheme of “Harmonic blocking 2nd Harmonic”.

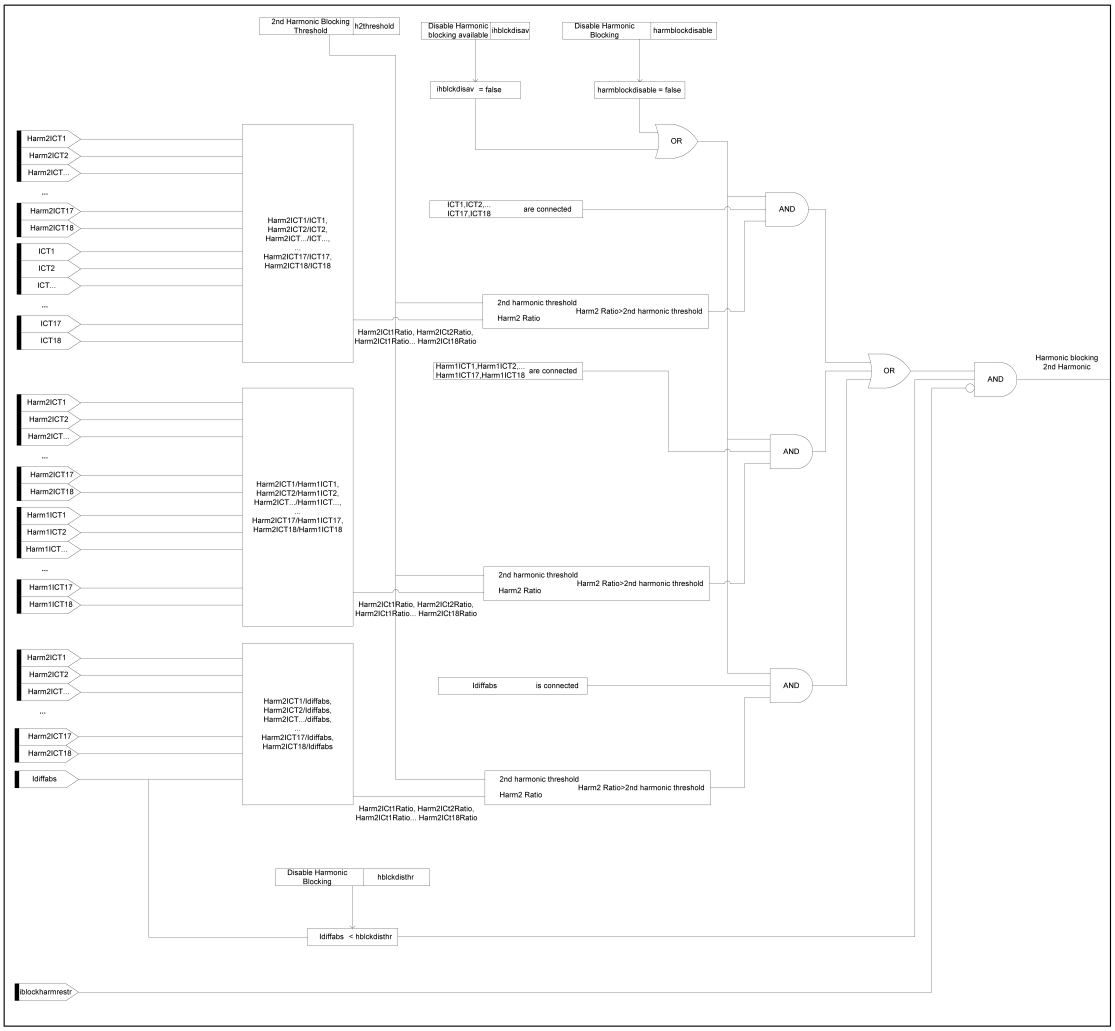


Figure 4.9: The *Differential Protection(RelBiasidiff)single phase 2nd Harmonic Block logic*

4.5.2 3 phase

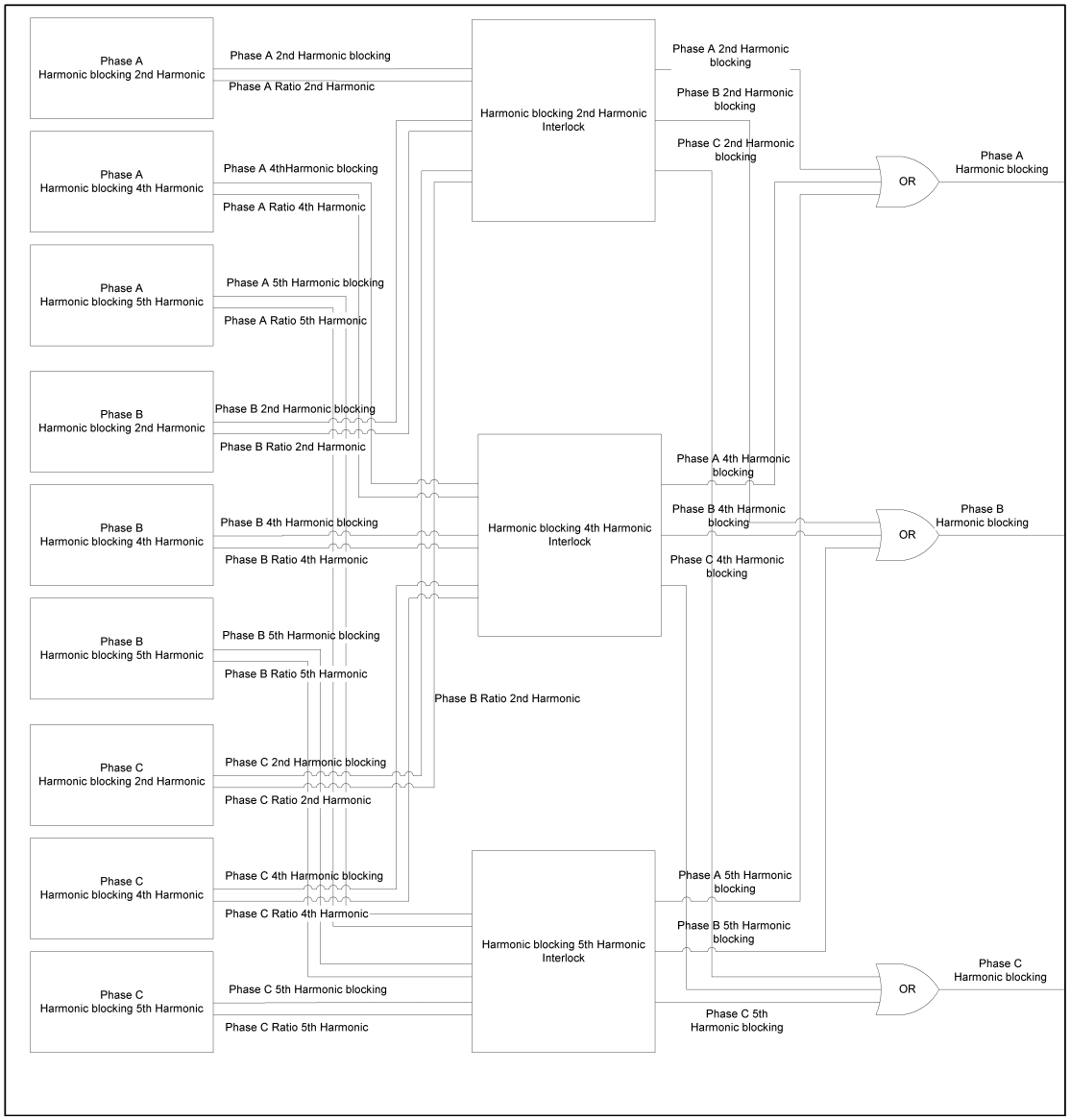
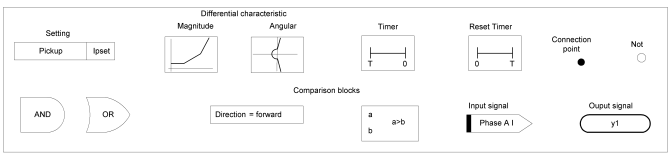


Figure 4.10: The *Differential Protection(RelBiasidiff)three phase Harmonic Blocking logic*



“Phase A Harmonic blocking 2nd Harmonic”, “Phase A Harmonic blocking 4th Harmonic”, “Phase A Harmonic blocking 5th”, “Phase B Harmonic blocking 2nd Harmonic”, “Phase B Harmonic blocking 4th Harmonic”, “Phase B Harmonic blocking 5th”, “Phase C Harmonic blocking 2nd Harmonic”, “Phase C Harmonic blocking 4th Harmonic”, and “Phase C Harmonic blocking 5th”, are identical except for the processed phase current (“Phase A” or “Phase B”or “Phase C”) and harmonic order (“2nd Harmonic”or “4th Harmonic”or “5th Harmonic”). In the following

picture (see Figure 4.11) the logic scheme for Phase A 2nd Harmonic is shown.

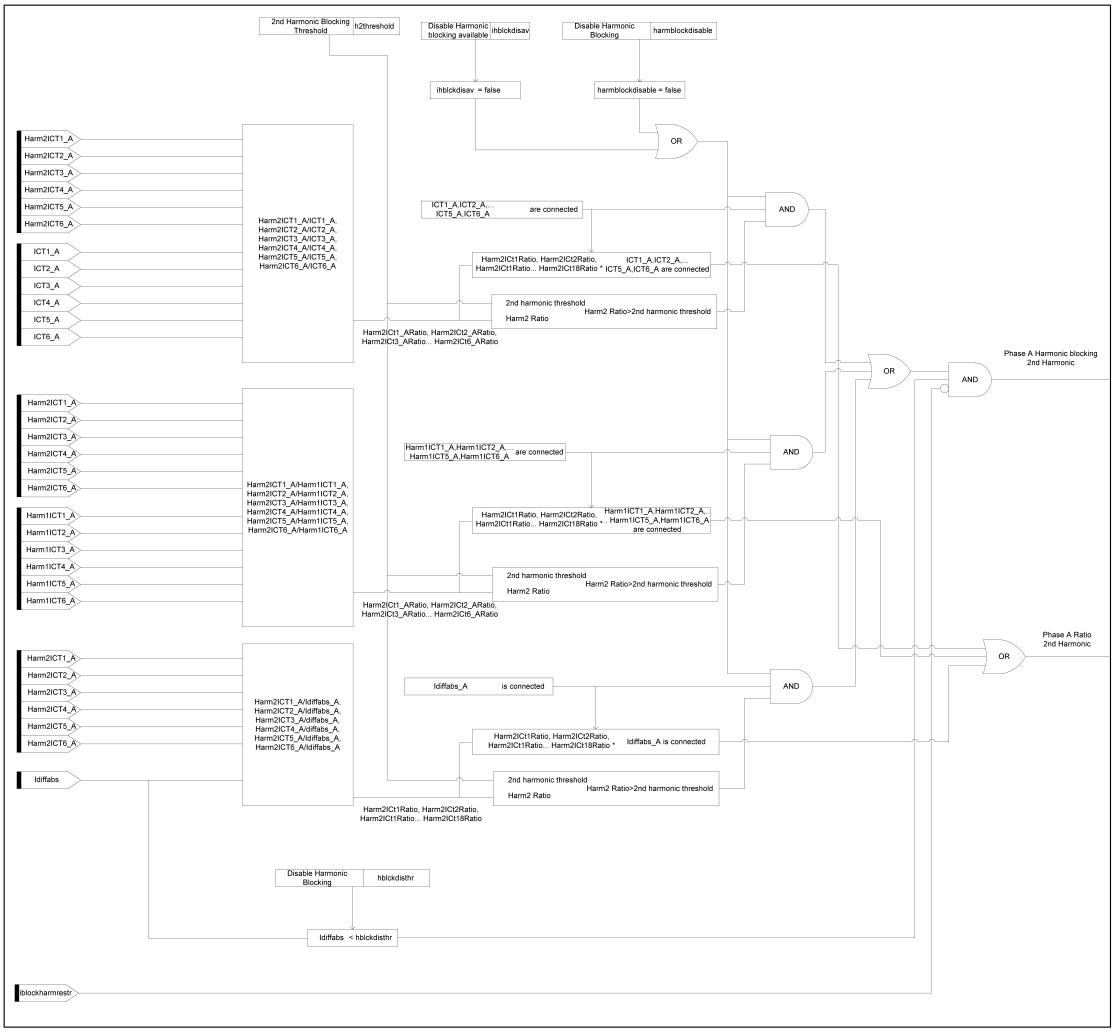
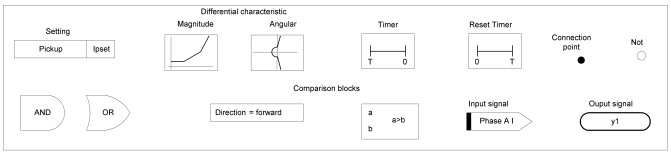


Figure 4.11: The *Differential Protection(RelBiasidiff)Phase A 2nd Harmonic Blocking logic*



"Harmonic blocking 2nd Harmonic Interlock", "Harmonic blocking 4th Harmonic Interlock", and "Harmonic blocking 5th Harmonic Interlock" are identical except for the harmonic order ("2nd Harmonic"or "4th Harmonic" or "5th Harmonic"). In the following picture (see Figure 4.12) the Interlock logic scheme for the 2nd Harmonic is shown.

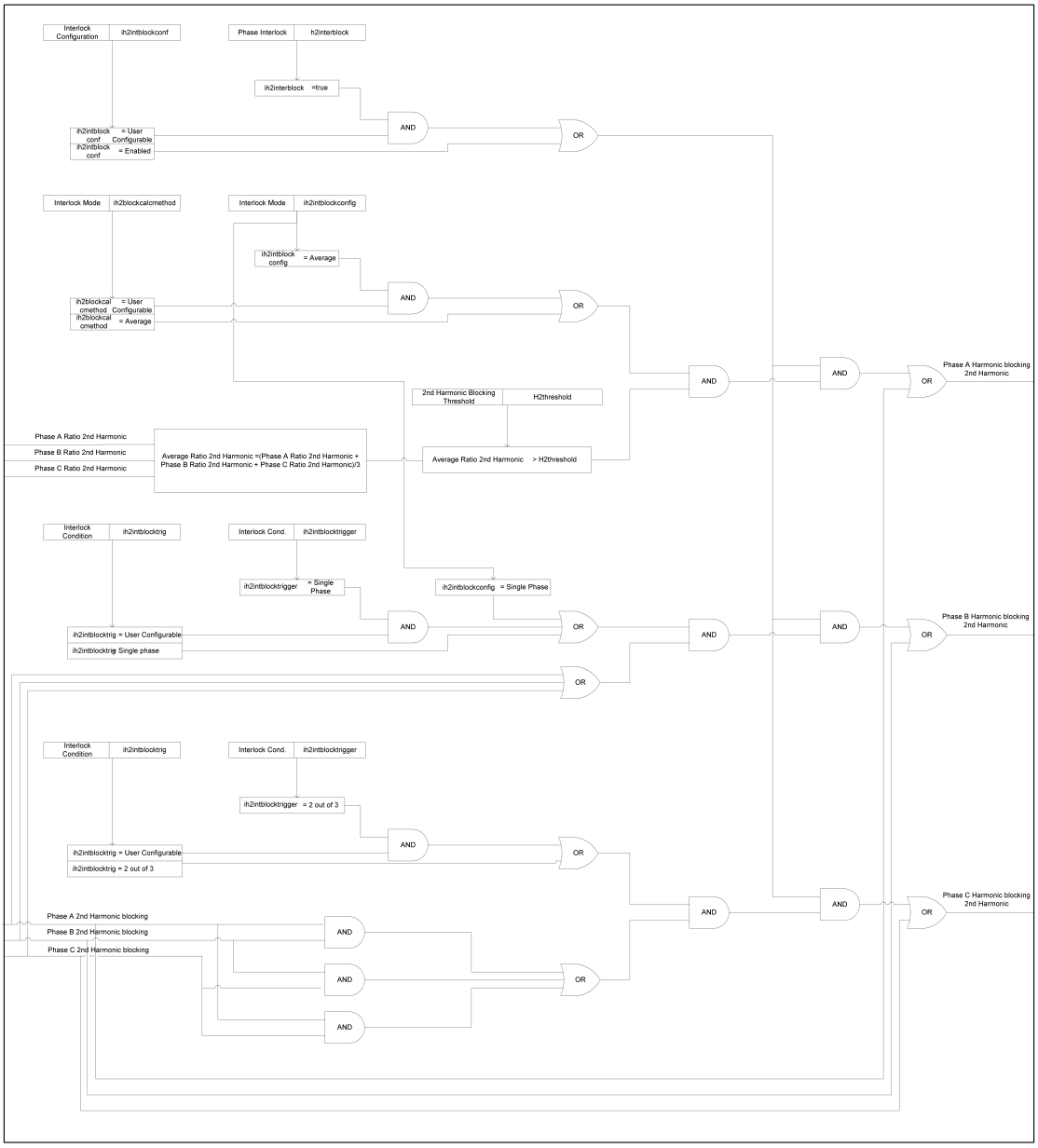
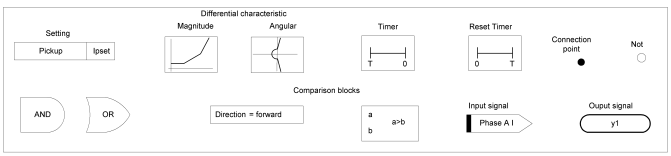


Figure 4.12: The *Differential Protection(RelBiasidiff) 2nd Harmonic Blocking Interlock logic*



A Parameter Definitions

A.1 Differential Protection Type (TypBiasidiff)

Table A.1: Input parameters of Biasidiff type (*TypBiasidiff*)

Parameter	Description	Unit
loc_name	Name assigned by the user to the block type	Text
atype	The differential block type (single phase or 3phase)	Text
pIref	Pointer to the block providing the current reference(optional)	Pointer
ptref	Pointer to the block providing the time reference(optional)	Pointer
imethod	Current Restraint type (Average, Maximum, Scalar Type)	Integer
islopetype	Restraint characteristic type (Standard, Independent 2nd slope, All slopes Independent, Transition Zone)	Integer
rItap	Range of the differential tap (a conventional I at which the other differential I can be referred)	Text
iunititap	Unit of the differential tap (p.u.,sec.A)	Integer
rIdiff	Range of the differential initial threshold	Text
iunitidiff	Unit of the differential (p.u.,sec.A,tap)	Integer
rIpset1	Range of the differential restrain 1st slope limit	Text
iunit1	Unit of the differential restrain 1st slope limit (p.u.,sec.A,tap,diff threshold)	Integer
ripset2	Range of the differential restrain 2nd slope limit	Text
iunit2	Unit of the differential restrain 2nd slope limit (p.u.,sec.A,tap,diff threshold)	Integer
rIrestrpercent1	Range of the restrain 1st slope percentage	Text
rirestrpercent2	Range of the restrain 2nd slope percentage	Text
rIdiffunrest	Range of the unrestrained differential threshold	Text
iunitidifunrest	Unit of the unrestrained differential threshold (p.u.,sec.A,tap,diff threshold)	Integer
rTset	Range of the differential trip time delay	Text
itunit	Unit of the differential trip time delay (s, cycles)	Integer
rIM	Range of the Current threshold in the phase comparison type	Text
rIdynM	Range of the Dynamic Current threshold in the phase comparison type	Text
rRestrAngle	Range of the Restraint Angle in the phase comparison type	Text
rRestrRadius	Range of the Restraint Radius in the phase comparison type	Text
Ihblckdisav	Boolean variable true if it possible for the user to disable the harmonic block	Y/N
rH2threshold	Range of the 2nd harmonic threshold for the harmonic blocking feature	Text
rH4threshold	Range of the 4th harmonic threshold for the harmonic blocking feature	Text
rH5threshold	Range of the 5th harmonic threshold for the harmonic blocking feature	Text
rhblckdisthr	Range of the Harmonic blocking disabling current threshold	Text
iunithblckdisthr	Unit of the Harmonic blocking disabling current threshold (p.u.,sec.A,tap,diff threshold)	Integer
ih2blockcalcmethod	2nd Harmonic Interlock Mode (Single Phase, Average, User Configurable)	Integer
ih4blockcalcmethod	4th Harmonic Interlock Mode (Single Phase, Average, User Configurable)	Integer
ih5blockcalcmethod	5th Harmonic Interlock Mode (Single Phase, Average, User Configurable)	Integer
ih2intblockconf	2nd Harmonic Interlock Configuration (Disabled,Enabled,User Configurable)	Integer
ih4intblockconf	4th Harmonic Interlock Configuration (Disabled,Enabled,User Configurable)	Integer
ih5intblockconf	5th Harmonic Interlock Configuration (Disabled,Enabled,User Configurable)	Integer
ih2intblocktrig	2nd Harmonic Interlock Condition:Single Phase:2 out of 3:User Configurable	Integer
ih4intblocktrig	4th Harmonic Interlock Condition:Single Phase:2 out of 3:User Configurable	Integer
ih5intblocktrig	5th Harmonic Interlock Condition:Single Phase:2 out of 3:User Configurable	Integer
rtap1	Range of Tap1 (Schweitzer relays)	Text
rtap2	Range of Tap2 (Schweitzer relays)	Text
rtap3	Range of Tap3 (Schweitzer relays)	Text
rtap4	Range of Tap4 (Schweitzer relays)	Text
rtap5	Range of Tap5 (Schweitzer relays)	Text
rtap6	Range of Tap6 (Schweitzer relays)	Text
rmaxpower	Range of Maximum rated power (Schweitzer relays)	Text
iincTs	Are the timers including the pick up time?	Y/N
Ts	Pick up time, its the time spent measuring the currents in the load flow, short circuit calculation and in the RMS simulation.	Seconds
Tlt	Trip loop time (time spent by the software routines to process the signals; it is present in any kind of tripping time calculation)	Seconds

Table A.1: Input parameters of Biasidiff type (*TypBiasidiff*)

Parameter	Description	Unit
Tr	Reset time, (delay with which the block reset the trip outputs after that the differential current went below the trip threshold * Kr)	Seconds
Kr	Reset ratio	Real number

A.2 Differential Protection Element (RelBiasidiff)

Table A.2: Input parameters of Biasidiff element (*RelBiasidiff*))

Parameter	Description	Unit
loc_name	Name assigned to the user to the block element	Text
Itap	Differential tap (a conventional I at which the other differential I can be referred)	pu
Itapr	Differential tap (a conventional I at which the other differential I can be referred)	Secondary Amperes
Idiff	Differential initial threshold	pu
Idiffr	Differential initial threshold	Secondary Amperes
Idiffr2	Differential initial threshold	Itap
Ipset1	Differential restrain 1st slope limit	pu
Ipset1r	Differential restrain 1st slope limit	Secondary Amperes
Ipset1r2	Differential restrain 1st slope limit	Itap
Ipset1r3	Differential restrain 1st slope limit	Differential threshold
Ipset2	Differential restrain 2nd slope limit	pu
Ipset2r	Differential restrain 2nd slope limit	Secondary Amperes
Ipset2r2	Differential restrain 2nd slope limit	Itap
Ipset2r3	Differential restrain 2nd slope limit	Differential threshold
IM	Current threshold in the phase comparison type	pu
IMr	Current threshold in the phase comparison type	Secondary Amperes
IdynM	Dynamic Current threshold in the phase comparison type	Amperes/pu/Itap
IdynMr	Dynamic Current threshold in the phase comparison type	Amperes/pu/Itap
RestrAngle	Restraint Angle in the phase comparison type	Degrees
RestrRadius	Restraint Radius in the phase comparison type	Amperes/pu/Itap
Irestrpercent1	Restrain 1st slope percentage	%
Irestrpercent2	Restrain 2nd slope percentage	%
Idiffunrest	Unrestrained differential element threshold	pu
Idiffunrestr	Unrestrained differential element threshold	Amperes
Idiffunrestr2	Unrestrained differential element threshold	Itap
Idiffunrestr3	Unrestrained differential element threshold	Differential threshold
Tset	Differential trip time delay	Seconds
Harmblockdisable	Boolean variable used to disable the harmonic block	Y/N
hblckdisthr	The harmonic blocking disabling current threshold	pu
hblckdisthrr	The harmonic blocking disabling current threshold	Secondary Amperes
hblckdisthrr2	The harmonic blocking disabling current threshold	Itap
hblckdisthrr3	The harmonic blocking disabling current threshold	Differential threshold
H2threshold	2nd harmonic threshold for the harmonic blocking feature	%
H4threshold	4th harmonic threshold for the harmonic blocking feature	%
H5threshold	5h harmonic threshold for the harmonic blocking feature	%
h2interblock	Flag to enable/disable the 2nd harmonic Phase Interlock	Y/N
i2intblockconfig	2nd harmonic interlock mode (Single Phase, Average)	Integer
i2intblocktrigger	2nd harmonic interlock condition (available when i2intblockconfig is Single phase)	Integer
h4interblock	Flag to enable/disable the 4th harmonic Phase Interlock	Y/N
i4intblockconfig	4th harmonic interlock mode (Single Phase, Average)	Integer
i4intblocktrigger	4th harmonic interlock condition (available when i2intblockconfig is Single phase)	Integer
h5interblock	Flag to enable/disable the 5th harmonic Phase Interlock	Y/N
i5intblockconfig	5th harmonic interlock mode (Single Phase, Average)	Integer
i5intblocktrigger	5th harmonic interlock condition (available when i2intblockconfig is Single phase)	Integer
tap1	Tap 1 (Schweitzer relay)	Secondary Amperes
tap2	Tap 2 (Schweitzer relay)	Secondary Amperes
tap3	Tap 3 (Schweitzer relay)	Secondary Amperes
tap4	Tap 4 (Schweitzer relay)	Secondary Amperes
tap5	Tap 5 (Schweitzer relay)	Secondary Amperes
tap6	Tap 6 (Schweitzer relay)	Secondary Amperes
maxpower	Max Rated Power (Schweitzer relay)	MVA

B Signal Definitions

B.1 Single phase

Table B.1: Input/output signals of the single phase Biasidiff element (*CalBiasidiff1p*)

Name	Description	Unit	Type	Model
ICTx[1]	Current Transformer x[1] current RMS value	Secondary Amperes	IN	Any
IrCTx[1]	Current Transformer x[1] current instantaneous value real part	Secondary Amperes	IN	Any
IiCTx[1]	Current Transformer x[1] current instantaneous value imaginary part	Secondary Amperes	IN	Any
Harm2ICTx[1]	Current transformer x[1] 2nd harmonic (EMT only)	Secondary Amperes	IN	Any
Harm4ICTx[1]	Current transformer x[1] 4th harmonic (EMT only)	Secondary Amperes	IN	Any
Harm5ICTx[1]	Current transformer x[1] 5th harmonic (EMT only)	Secondary Amperes	IN	Any
Iblockharmrestr	Signal to block the harmonic blocking feature	Seconds (or 1/0 RMS/EMT simulation)	IN	Any
Idiffabs	Differential current RMS value	Secondary Amperes	IN	Any
Istababs	Restraint current RMS value (to calculate the differential threshold)	Secondary Amperes	IN	Any
Irstab	Restraint current instantaneous value real part (to calculate the differential threshold)	Secondary Amperes	IN	Any
Iistab	Restraint current instantaneous value imaginary part (to calculate the differential threshold)	Secondary Amperes	IN	Any
yout	Differential trip signal	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
y_s	Differential start signal	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
Irdiff	Differential current instantaneous value real part	Secondary Amperes	OUT	Any
Iidiff	Differential current instantaneous value imaginary part	Secondary Amperes	OUT	Any

B.2 3 phase

Table B.2: Input/output signals of 3 Biasidiff element (*CalBiasidiff*)

Name	Description	Unit	Type	Model
ICTy[2]_A	Current Transformer y[2] phase A current RMS value	Secondary Amperes	IN	Any
ICTy[2]_B	Current Transformer y[2] phase B current RMS value	Secondary Amperes	IN	Any
ICTy[2]_C	Current Transformer y[2] phase C current RMS value	Secondary Amperes	IN	Any
IrCTy[2]_A	Current Transformer y[2] phase A current instantaneous value real part	Secondary Amperes	IN	Any
IrCTy[2]_B	Current Transformer y[2] phase B current instantaneous value real part	Secondary Amperes	IN	Any
IrCTy[2]_C	Current Transformer y[2] phase C current instantaneous value real part	Secondary Amperes	IN	Any
IiCTy[2]_A	Current Transformer y[2] phase A current instantaneous value imaginary part	Secondary Amperes	IN	Any
IiCTy[2]_B	Current Transformer y[2] phase B current instantaneous value imaginary part	Secondary Amperes	IN	Any
IiCT1y[2]_C	Current Transformer y[2] phase C current instantaneous value imaginary part	Secondary Amperes	IN	Any

[1] x = 1,2,3,...,17,18
[2] y = 1,2,...,5,6

Table B.2: Input/output signals of 3 Biasidiff element (*CalBiasidiff*)

Name	Description	Unit	Type	Model
Harm2ICTy^2_A	Current transformer y^{2}phase A 2nd harmonic (EMT only)	Secondary Amperes	IN	Any
Harm2ICTy^2_B	Current transformer y^{2}phase B 2nd harmonic (EMT only)	Secondary Amperes	IN	Any
Harm2ICTy^2_C	Current transformer y^{2}phase C 2nd harmonic (EMT only)	Secondary Amperes	IN	Any
Harm4ICTy^2_A	Current transformer y^{2}phase A 4th harmonic (EMT only)	Secondary Amperes	IN	Any
Harm4ICTy^2_B	Current transformer y^{2}phase B 4th harmonic (EMT only)	Secondary Amperes	IN	Any
Harm4ICTy^2_C	Current transformer y^{2}phase C 4th harmonic (EMT only)	Secondary Amperes	IN	Any
Harm5ICTy^2_A	Current transformer y^{2}phase A 5th harmonic (EMT only)	Secondary Amperes	IN	Any
Harm5ICTy^2_B	Current transformer y^{2}phase B 5th harmonic (EMT only)	Secondary Amperes	IN	Any
Harm5ICTy^2_C	Current transformer y^{2}phase C 5th harmonic (EMT only)	Secondary Amperes	IN	Any
Iblockharmrestr	Signal to block the harmonic blocking feature	Seconds (or 1/0 RMS/EMT simulation)	IN	Any
Idiffabs_A	Differential current phase A RMS value	Secondary Amperes	IN	Any
Idiffabs_B	Differential current phase B RMS value	Secondary Amperes	IN	Any
Idiffabs_C	Differential current phase C RMS value	Secondary Amperes	IN	Any
Istababs_A	Restraint current phase A RMS value (to calculate the differential threshold)	Secondary Amperes	IN	Any
Istababs_B	Restraint current phase B RMS value (to calculate the differential threshold)	Secondary Amperes	IN	Any
Istababs_C	Restraint current phase C RMS value (to calculate the differential threshold)	Secondary Amperes	IN	Any
Irstab_A	Restraint current phase A instantaneous value real part (to calculate the differential threshold)	Secondary Amperes	IN	Any
Irstab_B	Restraint current phase B instantaneous value real part (to calculate the differential threshold)	Secondary Amperes	IN	Any
Irstab_C	Restraint current phase C instantaneous value real part (to calculate the differential threshold)	Secondary Amperes	IN	Any
Iistab_A	Restraint current phase A instantaneous value imaginary part (to calculate the differential threshold)	Secondary Amperes	IN	Any
Iistab_B	Restraint current phase B instantaneous value imaginary part (to calculate the differential threshold)	Secondary Amperes	IN	Any
Iistab_C	Restraint current phase C instantaneous value imaginary part (to calculate the differential threshold)	Secondary Amperes	IN	Any
yout	Differential trip signal	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
yout_A	Differential phase A trip signal	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
yout_B	Differential phase B trip signal	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
yout_C	Differential phase C trip signal	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
yallout	Differential all phases trip signal	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
y_s	Differential start signal	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
y_A	Differential phase A start signal	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
y_B	Differential phase B start signal	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
y_C	Differential phase C start signal	Seconds (or 1/0 RMS/EMT simulation)	OUT	Any
Irdiff_A	Differential current phase A instantaneous value	Secondary Amperes	OUT	Any

Table B.2: Input/output signals of 3 Biasidiff element (*CalBiasidiff*)

Name	Description	Unit	Type	Model
Irdiff_B	Differential current phase B instantaneous value	Secondary Amperes	OUT	Any
Irdiff_C	Differential current phase C instantaneous value	Secondary Amperes	OUT	Any

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