



**POWERFACTORY**

# PowerFactory 2021

Technical Reference

ABB RED 615

PF2021

**POWER SYSTEM SOLUTIONS**  
MADE IN GERMANY

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November 15, 2019  
PowerFactory 2021  
Revision 924

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## 1 Model information

**Manufacturer** ABB

**Model** RED 615

**Variants** The ABB RED 615 PowerFactory relay model can be used to simulate the ABB RED 615 relay.

## 2 General description

The RED615 relay is a native IEC 61850 feeder protection IED for selective short-circuit, over-current and earth-fault protection. It is applicable to all types of radial isolated neutral networks, resistant earthed networks and compensated networks. The RED615 is part of a product family that will cover many protection applications for utility and industry customers. It is available with three (*A*, *B*, and *C*) alternative standard configurations.

The PowerFactory ABB RED 615 relay model simulates most of the protective elements available in all standard configurations. For each configuration the user must disable manually the protective functions non available for that configuration.

The ABB RED 615 PowerFactory relay model has been implemented trying to simulate the protective functions more commonly used.

The model implementation has been based on the information available in the manufacturer documentation [1] [2].

## 3 Supported features

### 3.1 Measurement and acquisition

It represents the interface between the power system and the relay protective elements. The currents flowing in the power system are converted by a block simulating the 3 phase CT and by a block simulating a single phase CT measuring the earth current; an additional single phase CT measures the neutral current and is used by the REF (*"Restricted Earth fault"* elements), a 3 phase CT located remotely is used by the other differential elements; the phase voltages are converted by a block simulating a 3 phases VT.

The secondary currents and voltages are then measured by a set of elements modeling the digital sampling of the relay.

#### 3.1.1 Available Units

- two 3ph current transformer (*"Ct-3p"* and *"Ct-3P(remote)"* block)
- two single phase current transformer (*"Ct-E/N"*, and *"Neutral Ct (REF)"* block)

- one 3ph voltage transformer ("Vt-3p" block)
- *Nine measurement elements ("Measure Ph", "Measure Seq", "Measure Ph (2nd harm)", "Measure Ph (5th harm)", "Measure Ph (remote)", "Measure Ph (remote 2nd harm)", "Measure Ph (remote 5th harm)", "Meas Neutral I (REF)", and "Meas Neutral I (REF 2nd harm)" block)*

### 3.1.2 Functionality

The "Ct-3p", "Ct-3P(remote)", "Ct-E/N" and the "Neutral Ct (REF)" block represent ideal CTs. Using the CT default configuration the current at the primary side are converted to the secondary side using the CT ratio. The CT saturation and/or its magnetizing characteristic are not considered. Please set the *"Detailed Model"* check box in the *"Detailed Data"* tab page of the CT dialog and insert the data regarding the CT burden, the CT secondary resistance and the CT excitation parameter if more accurate simulation results are required.

The measurement block simulate a DFT (*"Discrete Fourier Transform"*) filter using 20 samples per cycle. They can be classified in three categories

- Local measurement (*"Measure Ph", "Measure Seq", "Measure Ph (2nd harm)", and "Measure Ph (5th harm)" block*).
- Remote measurement used by the differential elements (*"Measure Ph (remote)", "Measure Ph (remote 2nd harm)", and "Measure Ph (remote 5th harm)" block*).
- REF measurement (*"Meas Neutral I (REF)", and "Meas Neutral I (REF 2nd harm)" block*).

### 3.1.3 Data input

The CT secondary rated current (1 or 5 A) value and the VT secondary voltage must be set in all the measurement blocks.

If no core CT is available please select the 3 phases CT also in the "Ct-E/N" slot: the earth current will be calculated assuming that an Holmgreen's connection of the phases is used.

## 3.2 Protective elements

A set of inverse time and definite time directional and non directional overcurrent elements is modeling the relay overcurrent protective functions. All the inverse characteristics available in the relay are available in the inverse time model blocks.

Two 3 phases differential element, one for the line differential logic and one for the transformer differential logic, and one restricted earth fault element model the relay differential protective functions. They are described in separated section of this document.

The set of overvoltage and undervoltage elements is simulating exactly the protective functions available in the relay.

A simplified reclosing feature implementation is also available.

### 3.2.1 Available Units

- Four Three-phase non-directional overcurrent protection with definite-time or IDMT characteristic , low-stage and high-stage elements ("51P-1(1)", "51P-1(2)", "51P-2(1)" and "51P-2(2)" block)
- Two 3-phases non-directional overcurrent protection, definite time instantaneous-stage elements ("50P/51P (1)" and "50P/51P (2)" block)
- Two 3-phases directional overcurrent protection with definite-time or IDMT characteristic, low-stage elements ("67-1 (1)" and "67-1 (2)" block)
- One 3-phases directional overcurrent protection with definite-time or IDMT characteristic, high-stage element ("67-2" block)
- Four earth fault non-directional overcurrent protection with definite-time or IDMT characteristic, low-stage and high-stage elements ("51N-1(1)", "51N-1(2)", "51N-2(1)" and "51N-2(2)" block)
- One earth fault non-directional overcurrent protection, definite time instantaneous-stage elements ("50N/51N " block)
- Two negative sequence overcurrent protection elements ("46(1)", "46(2)" block)
- One phase discontinuity protection element ("46PD" block)
- One 3-phases thermal overload protection for cables element ("49F" block, simplified logic)
- Three residual overvoltage elements ("59G(1)", "59G(2)", "59G(3)" block )
- Three 3phases inverse time overvoltage elements ("59(1)", "59(2)", "59(3)" block )
- Three 3phases inverse time undervoltage elements ("27(1)", "27(2)", "27(3)" block )
- One positive sequence undervoltage element (47U+)
- One negative sequence overvoltage element(47O-)
- One automatic reclosing element("79" block). Please configure the "Tab page" of the "79" block to set the reclosing/lockup logic.

### 3.2.2 Functionality

The inverse time overcurrent elements support the following trip characteristics:

- ANSI Def time
- ANSI Ext. Inv.
- ANSI Mod. Inv.
- ANSI Norm. Inv.
- ANSI Very Inv.
- IEC Def time
- IEC Ext. inv.
- IEC Inv.
- IEC L.T. inv.
- IEC Norm. Inv.
- IEC S.T. inv.
- IEC Very Inv.
- L.T. V.Inv.
- L.T.E.Inv.
- L.T.Inv.
- Programmable
- RD-Type characteristic
- RI-Type characteristic

The relationship between current and time for "IEC Normal Inverse", "IEC Very Inverse", "IEC Extremely Inverse" and "IEC Long Time Inverse" complies with the BS 142.1966 and IEC 60255-3 standards. The "IEEE extremely inverse", "IEEE inverse" and "IEEE very inverse" characteristic complies with the IEEE C37.112 standards. The "RI-type" and "RD-Type" characteristic is a special characteristic used mainly in combination with existing mechanical relays. The inverse time overcurrent elements include an user configurable reset delay. The "Type of reset curve" is always "Def time reset".

Both the phase directional and the earth directional element use a "Phase angle" operation mode. The voltage memory has a fixed length equal to 30 cycles. The phase directional element uses as polarizing quantity the cross polarizing voltages.

Please configure the "Tab page" of the "79" block to set the reclosing/lockup logic.

The phase discontinuity protection will be disabled when all phase currents fall below  $0.1 \times CT$ . It is possible to block the tripping of the phase discontinuity element by applying a digital input signal to the relay.

The following relay input signals are available to block the protective elements:

- Block I> controlling 51P-1(1), 51P-1(2) , 67-1(1)

- *Block I>>* controlling 67-1(2), 67-2, 51P-2(1) and 51P-2(2)
- *Block I>>>* controlling 50P/51P(1) and 50P/51P(2)
- *Block Ie>* controlling 51N-1(1) and 67N-1(1)
- *Block Ie>>* controlling 50N-51N, 51N-1(2), 51N-2(1), 51N-2(2), 67N-1(2) and 67N-2
- *Block 46* controlling 46(1) and 46(1)

### 3.2.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table (the relay model parameter names are listed between brackets):

Address (IEC 61850)	Relay Setting	Model block	Model setting	Note
PHLPTOC1	Operation	51P-1(1)	Out of Service ("outserv")	Current Setting = Start Value * Start Value Multiplier
PHLPTOC1	Start Value	51P-1(1)	Current Setting ("Ipset")	
PHLPTOC1	Time multiplier	51P-1(1)	Time Dial ("Tpset")	"DT" curve only
PHLPTOC1	Operate delay time	51P-1(1)	Time Dial ("Tpset")	
PHLPTOC1	Time Adder	51P-1(1)	Time Adder ("Tadder")	
PHLPTOC1	Reset delay time	51P-1(1)	Reset Delay ("ResetT")	
PHLPTOC1	Operating Curve Type	51P-1(1)	Characteristic ("pcharac")	
PHLPTOC2	Operation	51P-1(2)	Out of Service ("outserv")	Current Setting = Start Value * Start Value Multiplier
PHLPTOC2	Start Value	51P-1(2)	Current Setting ("Ipset")	
PHLPTOC2	Time multiplier	51P-1(2)	Time Dial ("Tpset")	"DT" curve only
PHLPTOC2	Operate delay time	51P-1(2)	Time Dial ("Tpset")	
PHLPTOC2	Time Adder	51P-1(2)	Time Adder ("Tadder")	
PHLPTOC2	Reset delay time	51P-1(2)	Reset Delay ("ResetT")	
PHLPTOC2	Operating Curve Type	51P-1(2)	Characteristic ("pcharac")	
PHHPTOC1	Operation	51P-2(1)	Out of Service ("outserv")	Current Setting = Start Value * Start Value Multiplier
PHHPTOC1	Start Value	51P-2(1)	Current Setting ("Ipset")	
PHHPTOC1	Time multiplier	51P-2(1)	Time Dial ("Tpset")	"DT" curve only
PHHPTOC1	Operate delay time	51P-2(1)	Time Dial ("Tpset")	
PHHPTOC1	Time Adder	51P-2(1)	Time Adder ("Tadder")	
PHHPTOC1	Reset delay time	51P-2(1)	Reset Delay ("ResetT")	
PHHPTOC1	Operating Curve Type	51P-2(1)	Characteristic ("pcharac")	
PHHPTOC2	Operation	51P-2(2)	Out of Service ("outserv")	Current Setting = Start Value * Start Value Multiplier
PHHPTOC2	Start Value	51P-2(2)	Current Setting ("Ipset")	
PHHPTOC2	Time multiplier	51P-2(2)	Time Dial ("Tpset")	"DT" curve only
PHHPTOC2	Operate delay time	51P-2(2)	Time Dial ("Tpset")	
PHHPTOC2	Time Adder	51P-2(2)	Time Adder ("Tadder")	
PHHPTOC2	Reset delay time	51P-2(2)	Reset Delay ("ResetT")	
PHHPTOC2	Operating Curve Type	51P-2(2)	Characteristic ("pcharac")	
PHIPTOC1	Operation	50P/51P(1)	Out of Service ("outserv")	
PHIPTOC1	Start Value	50P/51P(1)	Pickup Current ("Ipset")	
PHIPTOC1	Time Setting ("Tset")	50P/51P(1)	Time Setting ("Tset")	
PHIPTOC2	Operation	50P/51P(2)	Out of Service ("outserv")	
PHIPTOC2	Start Value	50P/51P(2)	Pickup Current ("Ipset")	



### 3 Supported features

Address (IEC 61850)	Relay Setting	Model block	Model setting	Note
PHIPTOC2	Time Setting	50P/51P(2)	Time Setting ("Tset")	Current Setting = Start Value * Start Value Multiplier
DPHLPDOC1	Operation	67P-1(1)	Out of Service ("outserv")	
DPHLPDOC1	Directional mode	67P-1(1)	Tripping Direction ("idir")	
DPHLPDOC1	Start Value	67P-1(1)	Current Setting ("Ipset")	
DPHLPDOC1	Time multiplier	67P-1(1)	Time Dial ("Tpset")	"DT" curve only
DPHLPDOC1	Operate delay time	67P-1(1)	Time Dial ("Tpset")	
DPHLPDOC1	Time Adder	67P-1(1)	Time Adder ("Tadder")	
DPHLPDOC1	Reset delay time	67P-1(1)	Reset Delay ("ResetT")	
DPHLPDOC1	Operating Curve Type	67P-1(1)	Characteristic ("pcharac")	Current Setting = Start Value * Start Value Multiplier
DPHLPDOC2	Operation	67P-1(2)	Out of Service ("outserv")	
DPHLPDOC2	Directional mode	67P-1(2)	Tripping Direction ("idir")	
DPHLPDOC2	Start Value	67P-1(2)	Current Setting ("Ipset")	
DPHLPDOC2	Time multiplier	67P-1(2)	Time Dial ("Tpset")	"DT" curve only
DPHLPDOC2	Operate delay time	67P-1(2)	Time Dial ("Tpset")	
DPHLPDOC2	Time Adder	67P-1(2)	Time Adder ("Tadder")	
DPHLPDOC2	Reset delay time	67P-1(2)	Reset Delay ("ResetT")	
DPHLPDOC2	Operating Curve Type	67P-1(2)	Characteristic ("pcharac")	Current Setting = Start Value * Start Value Multiplier
DPHHPDOC1	Operation	67P-2(1)	Out of Service ("outserv")	
DPHHPDOC1	Directional mode	67P-2(1)	Tripping Direction ("idir")	
DPHHPDOC1	Start Value	67P-2(1)	Current Setting ("Ipset")	
DPHHPDOC1	Time multiplier	67P-2(1)	Time Dial ("Tpset")	"DT" curve only
DPHHPDOC1	Operate delay time	67P-2(1)	Time Dial ("Tpset")	
DPHHPDOC1	Time Adder	67P-2(1)	Time Adder ("Tadder")	
DPHHPDOC1	Reset delay time	67P-2(1)	Reset Delay ("ResetT")	
DPHHPDOC1	Operating Curve Type	67P-2(1)	Characteristic ("pcharac")	Current Setting = Start Value * Start Value Multiplier
DPHHPDOC2	Operation	67P-2(2)	Out of Service ("outserv")	
DPHHPDOC2	Directional mode	67P-2(2)	Tripping Direction ("idir")	
DPHHPDOC2	Start Value	67P-2(2)	Current Setting ("Ipset")	
DPHHPDOC2	Time multiplier	67P-2(2)	Time Dial ("Tpset")	"DT" curve only
DPHHPDOC2	Operate delay time	67P-2(2)	Time Dial ("Tpset")	
DPHHPDOC2	Time Adder	67P-2(2)	Time Adder ("Tadder")	
DPHHPDOC2	Reset delay time	67P-2(2)	Reset Delay ("ResetT")	
DPHHPDOC2	Operating Curve Type	67P-2(2)	Characteristic ("pcharac")	In the "Voltage polarizing"  tab page
DPHLPDOC1	Characteristic ("pcharac") angle	Dir phase	Max Torque Angle ("mtau")	
DPHLPDOC2				
DPHHPDOC1				
DPHHPDOC2				Operating Sector Angle=Max Forward Angle+Min Forward Angle = Max Reverse Angle+ Min Reverse Angle
DPHLPDOC1	Max Forward Angle	Dir phase	Operating Sector Angle ("phisec")	
DPHLPDOC2	Max Reverse Angle			
DPHHPDOC1	Min Forward Angle			
DPHHPDOC2	Min Reverse Angle			Current Setting = Start Value * Start Value Multiplier
EFLPTOC1	Operation	51N-1(1)	Out of Service ("outserv")	
EFLPTOC1	Start Value	51N-1(1)	Current Setting ("Ipset")	
EFLPTOC1	Time multiplier	51N-1(1)	Time Dial ("Tpset")	
EFLPTOC1	Operate delay time	51N-1(1)	Time Dial ("Tpset")	"DT" curve only
EFLPTOC1	Time Adder	51N-1(1)	Time Adder ("Tadder")	
EFLPTOC1	Reset delay time	51N-1(1)	Reset Delay ("ResetT")	
EFLPTOC1	Operating Curve Type	51N-1(1)	Characteristic ("pcharac")	
EFLPTOC2	Operation	51N-1(2)	Out of Service ("outserv")	

### 3 Supported features

Address (IEC 61850)	Relay Setting	Model block	Model setting	Note
EFLPTOC2	Start Value	51N-1(2)	Current Setting (" <i>Ipset</i> ")	Current Setting = Start Value * Start Value Multiplier
EFLPTOC2	Time multiplier	51N-1(2)	Time Dial (" <i>Tpset</i> ")	"DT" curve only
EFLPTOC2	Operate delay time	51N-1(2)	Time Dial (" <i>Tpset</i> ")	
EFLPTOC2	Time Adder	51N-1(2)	Time Adder (" <i>Tadder</i> ")	
EFLPTOC2	Reset delay time	51N-1(2)	Reset Delay (" <i>ResetT</i> ")	
EFLPTOC2	Operating Curve Type	51N-1(2)	Characteristic (" <i>pcharac</i> ")	
EFHPTOC1	Operation	51N-2(1)	Out of Service (" <i>outserv</i> ")	Current Setting = Start Value * Start Value Multiplier
EFHPTOC1	Start Value	51N-2(1)	Current Setting (" <i>Ipset</i> ")	
EFHPTOC1	Time multiplier	51N-2(1)	Time Dial (" <i>Tpset</i> ")	
EFHPTOC1	Operate delay time	51N-2(1)	Time Dial (" <i>Tpset</i> ")	
EFHPTOC1	Time Adder	51N-2(1)	Time Adder (" <i>Tadder</i> ")	
EFHPTOC1	Reset delay time	51N-2(1)	Reset Delay (" <i>ResetT</i> ")	"DT" curve only
EFHPTOC1	Operating Curve Type	51N-2(1)	Characteristic (" <i>pcharac</i> ")	
EFHPTOC2	Operation	51N-2(2)	Out of Service (" <i>outserv</i> ")	
EFHPTOC2	Start Value	51N-2(2)	Current Setting (" <i>Ipset</i> ")	
EFHPTOC2	Time multiplier	51N-2(2)	Time Dial (" <i>Tpset</i> ")	
EFHPTOC2	Operate delay time	51N-2(2)	Time Dial (" <i>Tpset</i> ")	"DT" curve only
EFHPTOC2	Time Adder	51N-2(2)	Time Adder (" <i>Tadder</i> ")	
EFHPTOC2	Reset delay time	51N-2(2)	Reset Delay (" <i>ResetT</i> ")	
EFHPTOC2	Operating Curve Type	51N-2(2)	Characteristic (" <i>pcharac</i> ")	
EFIPTOC1	Operation	50N/51N(1)	Out of Service (" <i>outserv</i> ")	Current Setting = Start Value * Start Value Multiplier
EFIPTOC1	Start Value	50N/51N(1)	Pickup Current (" <i>Ipset</i> ")	
EFIPTOC1	Time Setting	50N/51N(1)	Time Setting (" <i>Tset</i> ")	
EFIPTOC2	Operation	50N/51N(2)	Out of Service (" <i>outserv</i> ")	
EFIPTOC2	Start Value	50N/51N(2)	Pickup Current (" <i>Ipset</i> ")	
EFIPTOC2	Time Setting	50N/51N(2)	Time Setting (" <i>Tset</i> ")	"DT" curve only
DEFLPDEF1	Operation	67N-1(1)	Out of Service (" <i>outserv</i> ")	
DEFLPDEF1	Directional mode	67N-1(1)	Tripping Direction (" <i>idir</i> ")	
DEFLPDEF1	Start Value	67N-1(1)	Current Setting (" <i>Ipset</i> ")	
DEFLPDEF1	Time multiplier	67N-1(1)	Time Dial (" <i>Tpset</i> ")	
DEFLPDEF1	Operate delay time	67N-1(1)	Time Dial (" <i>Tpset</i> ")	"DT" curve only
DEFLPDEF1	Time Adder	67N-1(1)	Time Adder (" <i>Tadder</i> ")	
DEFLPDEF1	Reset delay time	67N-1(1)	Reset Delay (" <i>ResetT</i> ")	
DEFLPDEF1	Operating Curve Type	67N-1(1)	Characteristic (" <i>pcharac</i> ")	
DEFLPDEF2	Operation	67N-1(2)	Out of Service (" <i>outserv</i> ")	Current Setting = Start Value * Start Value Multiplier
DEFLPDEF2	Directional mode	67N-1(2)	Tripping Direction (" <i>idir</i> ")	
DEFLPDEF2	Start Value	67N-1(2)	Current Setting (" <i>Ipset</i> ")	
DEFLPDEF2	Time multiplier	67N-1(2)	Time Dial (" <i>Tpset</i> ")	
DEFLPDEF2	Operate delay time	67N-1(2)	Time Dial (" <i>Tpset</i> ")	
DEFLPDEF2	Time Adder	67N-1(2)	Time Adder (" <i>Tadder</i> ")	"DT" curve only
DEFLPDEF2	Reset delay time	67N-1(2)	Reset Delay (" <i>ResetT</i> ")	
DEFLPDEF2	Operating Curve Type	67N-1(2)	Characteristic (" <i>pcharac</i> ")	
DEFHPDEF1	Operation	67N-2	Out of Service (" <i>outserv</i> ")	
DEFHPDEF1	Directional mode	67N-2	Tripping Direction (" <i>idir</i> ")	
DEFHPDEF1	Start Value	67N-2	Current Setting (" <i>Ipset</i> ")	Current Setting = Start Value * Start Value Multiplier
DEFHPDEF1	Time multiplier	67N-2	Time Dial (" <i>Tpset</i> ")	
DEFHPDEF1	Operate delay time	67N-2	Time Dial (" <i>Tpset</i> ")	
DEFHPDEF1	Time Adder	67N-2	Time Adder (" <i>Tadder</i> ")	
DEFHPDEF1	Reset delay time	67N-2	Reset Delay (" <i>ResetT</i> ")	
DEFHPDEF1	Operating Curve Type	67N-2	Characteristic (" <i>pcharac</i> ")	"DT" curve only

### 3 Supported features

Address (IEC 61850)	Relay Setting	Model block	Model setting	Note
DEFLPDO1 DEFLPDO2 DEFHPDO1 DEFHPDO2	Characteristic angle	Dir Earth	Max Torque Angle (" <i>mtau</i> ")	In the " <i>Voltage polarizing</i> " tab page
DEFLPDO1	Max Forward Angle	Dir phase	Operating Sector Angle (" <i>phisec</i> ")	Operating Sector Angle=Max
DEFLPDO2	Max Reverse Angle			Forward Angle+Min Forward
DEFHPDO1	Min Forward Angle			Angle = Max Reverse Angle+
DEFHPDO2	Min Reverse Angle			Min Reverse Angle
NSPTOC1	Operation	46(1)	Out of Service (" <i>outserv</i> ")	
NSPTOC1	Start Value	46(1)	Current Setting (" <i>lpset</i> ")	Current Setting = Start Value * Start Value Multiplier
NSPTOC1	Time multiplier	46(1)	Time Dial (" <i>tpset</i> ")	
NSPTOC1	Operate delay time	46(1)	Time Dial (" <i>tpset</i> ")	"DT" curve only
NSPTOC1	Time Adder	46(1)	Time Adder (" <i>tadder</i> ")	
NSPTOC1	Reset delay time	46(1)	Reset Delay (" <i>resetT</i> ")	
NSPTOC1	Operating Curve Type	46(1)	Characteristic (" <i>pcharac</i> ")	
NSPTOC2	Operation	46(2)	Out of Service (" <i>outserv</i> ")	
NSPTOC2	Start Value	46(2)	Current Setting (" <i>lpset</i> ")	Current Setting = Start Value * Start Value Multiplier
NSPTOC2	Time multiplier	46(2)	Time Dial (" <i>tpset</i> ")	
NSPTOC2	Operate delay time	46(2)	Time Dial (" <i>tpset</i> ")	"DT" curve only
NSPTOC2	Time Adder	46(2)	Time Adder (" <i>tadder</i> ")	
NSPTOC2	Reset delay time	46(2)	Reset Delay (" <i>resetT</i> ")	
NSPTOC2	Operating Curve Type	46(2)	Characteristic (" <i>pcharac</i> ")	
PDNSPTOC1	Operation	46PD	Out of Service (" <i>outserv</i> ")	
PDNSPTOC1	Start Value	46PD	Pickup Current (" <i>lpset</i> ")	
PDNSPTOC1	Time Setting	46PD	Time Setting (" <i>tset</i> ")	
PHPTUV1	Operation	27 (1)	Out of Service (" <i>outserv</i> ")	
PHPTUV1	Start Value	27 (1)	Pickup Current (" <i>lpset</i> ")	
PHPTUV1	Time Setting	27 (1)	Time Dial (" <i>tpset</i> ")	
PHPTUV2	Operation	27 (2)	Out of Service (" <i>outserv</i> ")	
PHPTUV2	Start Value	27 (2)	Pickup Current (" <i>lpset</i> ")	
PHPTUV2	Time Setting	27 (2)	Time Dial (" <i>tpset</i> ")	
PHPTUV3	Operation	27 (3)	Out of Service (" <i>outserv</i> ")	
PHPTUV3	Start Value	27 (3)	Pickup Current (" <i>lpset</i> ")	
PHPTUV3	Time Setting	27 (3)	Time Dial (" <i>tpset</i> ")	
PHPTOV1	Operation	59 (1)	Out of Service (" <i>outserv</i> ")	
PHPTOV1	Start Value	59 (1)	Pickup Current (" <i>lpset</i> ")	
PHPTOV1	Time Setting	59 (1)	Time Dial (" <i>tpset</i> ")	
PHPTOV2	Operation	59 (2)	Out of Service (" <i>outserv</i> ")	
PHPTOV2	Start Value	59 (2)	Pickup Current (" <i>lpset</i> ")	
PHPTOV2	Time Setting	59 (2)	Time Dial (" <i>tpset</i> ")	
PHPTOV3	Operation	59 (3)	Out of Service (" <i>outserv</i> ")	
PHPTOV3	Start Value	59 (3)	Pickup Current (" <i>lpset</i> ")	
PHPTOV3	Time Setting	59 (3)	Time Dial (" <i>tpset</i> ")	
ROVPTOV1	Operation	59 G (1)	Out of Service (" <i>outserv</i> ")	
ROVPTOV1	Start Value	59 G (1)	Pickup Voltage (" <i>uset</i> ")	
ROVPTOV1	Time Setting	59 G (1)	Time Dial (" <i>tpset</i> ")	
ROVPTOV2	Operation	59 G (2)	Out of Service (" <i>outserv</i> ")	
ROVPTOV2	Start Value	59 G (2)	Pickup Voltage (" <i>uset</i> ")	
ROVPTOV2	Time Setting	59 G (2)	Time Dial (" <i>tpset</i> ")	
ROVPTOV3	Operation	59 G (3)	Out of Service (" <i>outserv</i> ")	
ROVPTOV3	Start Value	59 G (3)	Pickup Voltage (" <i>uset</i> ")	
ROVPTOV3	Time Setting	59 G (3)	Time Dial (" <i>tpset</i> ")	

### 3 Supported features

Address (IEC 61850)	Relay Setting	Model block	Model setting	Note
PSPTUV1	Operation	47U+	Out of Service ("outserv")	Set "Operations to lock-out" = "Number of AR shots" + 1
PSPTUV1	Start Value	47U+	Pickup Voltage ("Uset")	
PSPTUV1	Time Setting	47U+	Time Dial ("Tpset")	
NSPTOV1	Operation	47O-	Out of Service ("outserv")	
NSPTOV1	Start Value	47O-	Pickup Voltage ("Uset")	
NSPTOV1	Time Setting	47O-	Time Dial ("Tpset")	
T1PTTR1	Operation	49	Out of Service ("outserv")	
T1PTTR1	Full load current	49	Current Setting ("Ipset")	
T1PTTR1	Time constant of stage	49	Time Dial ("Tpset")	
DARREC1	Number of AR shots	79	Operations to Lockout ("oplockout")	
DARREC1	CB Closing time	79	Closing Command Duration ("closingcomtime")	
DARREC1	Reclaim Time	79	Reset Time ("resetime")	
DARREC1	Dead time of shot 1	79	Reclosing Interval 1 ("re-cltime1")	
DARREC1	Dead time of shot 2	79	Reclosing Interval 2 ("re-cltime2")	
DARREC1	Dead time of shot 3	79	Reclosing Interval 3 ("re-cltime3")	
DARREC1	Dead time of shot 4	79	Reclosing Interval 4 ("re-cltime4")	

### 3.3 Differential elements

#### 3.3.1 Available Units

- One transformer differential element with Ct ratio adapters ("*87T*", "*87T CT ratio correction*", "*87T CT rc*" block).
- One line differential element with Ct ratio adapters and user configurable delay ("*87L*", "*87L delay*" "*87L CT ratio correction*", "*87L CT rc*" block).
- One restricted earth fault element ("*87NL*" block).
- One simplified restricted earth fault element with high threshold and time delay ("*87NHCalc*", and "*87NH*" block).
- Three ancillary measurement blocks ("*Diff RMS Measure 87L*", "*Diff RMS Measure 87T*", and "*Diff RMS Measure 87NL*" block).

#### 3.3.2 Functionality

The line differential logic implements a double I bias differential characteristic with 2nd harmonic restrain, unrestrained differential characteristic and CT ratio internal compensation. The CT ratio compensation is performed by the *ratio adapters*. The 2nd harmonic restrain can be disabled by the user. The user can set the differential characteristic first and second slope threshold and slope percentage. The trip can be delayed by an inverse characteristic ("*87L delay*" block) where the input quantity is the ratio between the RMS value of the phase differential currents and the differential threshold as calculated using the double slope differential characteristic.

The transformer differential logic implements a double I bias differential characteristic with 2nd and 5th harmonic restrain, unrestrained differential characteristic and CT ratio internal compensation. The CT ratio compensation is performed by the *ratio adapters*. The 2nd and 5th harmonic restrain can be disabled by the user. The user can set the differential characteristic first slope percentage and the second slope threshold.

The restricted earth fault implements a single I bias differential characteristic with 2nd harmonic restrain, unrestrained differential characteristic with inverse curve delayed trip.

#### 3.3.3 Data input

The relationships between the relay settings and the model parameters can be found in the following table:

Address	Relay Setting	Model block	Model setting	Note
LNPLDF	Restraint mode	87L	Disable Harmonic Blocking (" <i>harmblockdisable</i> ")	In the <i>Harmonic Blocking</i> tab page. Set <i>harmblockdisable</i> =1 when Restraint mode=1
LNPLDF	Minimum operate time	87L delay	Time Dial (" <i>Tpset</i> ")	
LNPLDF	CT ratio correction	87L CT ratio correction	Current Transformer Ratio (" <i>CTratio</i> ")	
LNPLDF	Operation	87L	Out of Service (" <i>outserv</i> ")	To be combined with the following setting
LNPLDF	High operate value	87L	Unrestrained Differential Threshold (" <i>ldiffunrest</i> ")	
LNPLDF	High Op value Mult	87L	Unrestrained Differential Threshold (" <i>ldiffunrest</i> ")	

### 3 Supported features

Address	Relay Setting	Model block	Model setting	Note
LNPLDF	Low operate value	87L	Release Threshold ("ldiff")	In the <i>Harmonic Blocking</i> tab page in the <i>2nd Harmonic Blocking</i> frame
LNPLDF	End section 1	87L	Restraint Current 1st Threshold ("lpset1")	
LNPLDF	Slope section 2	87L	Restraint Percentage 1 ("lrestr-percent1")	
LNPLDF	End section 2	87L	Restraint Current 2nd Threshold ("lpset2")	
LNPLDF	Slope section 3	87L	Restraint Percentage 2 ("lrestr-percent2")	
LNPLDF	Operate delay time	87L	Time Setting ("Tset")	
LNPLDF	Time multiplier	87L delay	Time Dial ("Tpset")	
LNPLDF	Operating curve type	87L delay	Characteristic ("pcharac")	
LNPLDF	Start value 2.H	87L	Threshold ("H2Threshold")	In the <i>Harmonic Blocking</i> tab page in the <i>2nd Harmonic Blocking</i> frame
TR2PTDF	High operate value	87T	Unrestrained Differential Threshold ("ldiffunrest")	
TR2PTDF	Low operate value	87T	Release Threshold ("ldiff")	
TR2PTDF	Slope section 2	87T	Restraint Percentage 1 ("lrestr-percent1")	
TR2PTDF	End section 2	87T	Restraint Current 2nd Threshold ("lpset2")	
TR2PTDF	Start value 2.H	87T	Threshold ("H2Threshold")	
TR2PTDF	Start value 5.H	87T	Threshold ("H5Threshold")	
TR2PTDF	Operation	87T	Out of Service ("outserv")	In the <i>Harmonic Blocking</i> tab page in the <i>5th Harmonic Blocking</i> frame
TR2PTDF	Winding 1 type	87T CT ratio correction	Transformer Group ("trasf-group")	
TR2PTDF	Winding 2 type	87T CT ratio correction	Transformer Group ("trasf-group")	
TR2PTDF	CT ratio Cor Wnd 1	87T CT ratio correction	Current Transformer Ratio ("CTratio")	
TR2PTDF	CT ratio Cor Wnd 1	87T CT rc	Current Transformer Ratio ("CTratio")	
LREFPNDF	Operation	87NL	Out of Service ("outserv")	
LREFPNDF	Operate value	87NL	Release Threshold ("ldiff")	
LREFPNDF	Restraint mode	87NL	Disable Harmonic Blocking ("harmblockdisable")	
LREFPNDF	Start value 2.H	87NL	Threshold ("H2Threshold")	In the <i>Harmonic Blocking</i> tab page. Set harmblockdisable=1 when Restraint mode=1  In the <i>Harmonic Blocking</i> tab page in the <i>2nd Harmonic Blocking</i> frame
HREFPDIF	Operation	87NH	Out of Service ("outserv")	
HREFPDIF	Operate value	87NH	Current Setting ("lpset")	
HREFPDIF	Minimum operate time	87NH	Time Dial ("Tpset")	
HREFPDIF	Reset delay time	87NH	Reset Time ("ResetT")	

Please notice that the differential "*Restraint percentage 1*" (slope of the Slightly biased region) must be calculated manually taking care of the values of the "*Threshold current*" and of the "*Slightly biased region threshold*" relay setting.

### 3.4 Output logic

The output logic is implemented by the *"Trip Logic"* block located in the main relay.

#### 3.4.1 Available Units

- Trip Logic

#### 3.4.2 Output signals

- yout
- PO1
- PO2
- PO3
- PO4

Please notice that the type trip logic must be modified to allow the trip of the *PO2*, *PO3* and *PO4* signal.

#### 3.4.3 Functionality

The *"Trip Logic"* block is operating the breaker.

#### 3.4.4 Data input

No user input is required to configure the output logic feature.

Please disable the *"Trip Logic"* block located in the main relay to disable the relay model ability to open the power circuit.

## 4 Features not supported

### 4.1 Differential feature

The following features are not supported:

- Differential Slightly biased region threshold.
- Restricted earth fault CT ratio compensation.
- LNPLDF third slope.

## 5 References

- [1] ABB Automation Products AB, Substation Automation Products, SE-721 59 Vasteras, Sweden. *615 series Technical Manual Document ID: 1MRS756887 Issued: 2010-09-24 Revision: E Product version: 3.0*, 2010.
- [2] ABB Automation Products AB, Substation Automation Products, SE-721 59 Vasteras, Sweden. *Line Differential Protection and Control RED615 V 3.0 Product Guide Document ID: 1MRS756500 E Issued: 2010-09-07 Revision: E Product version: 3.0*, 2010.