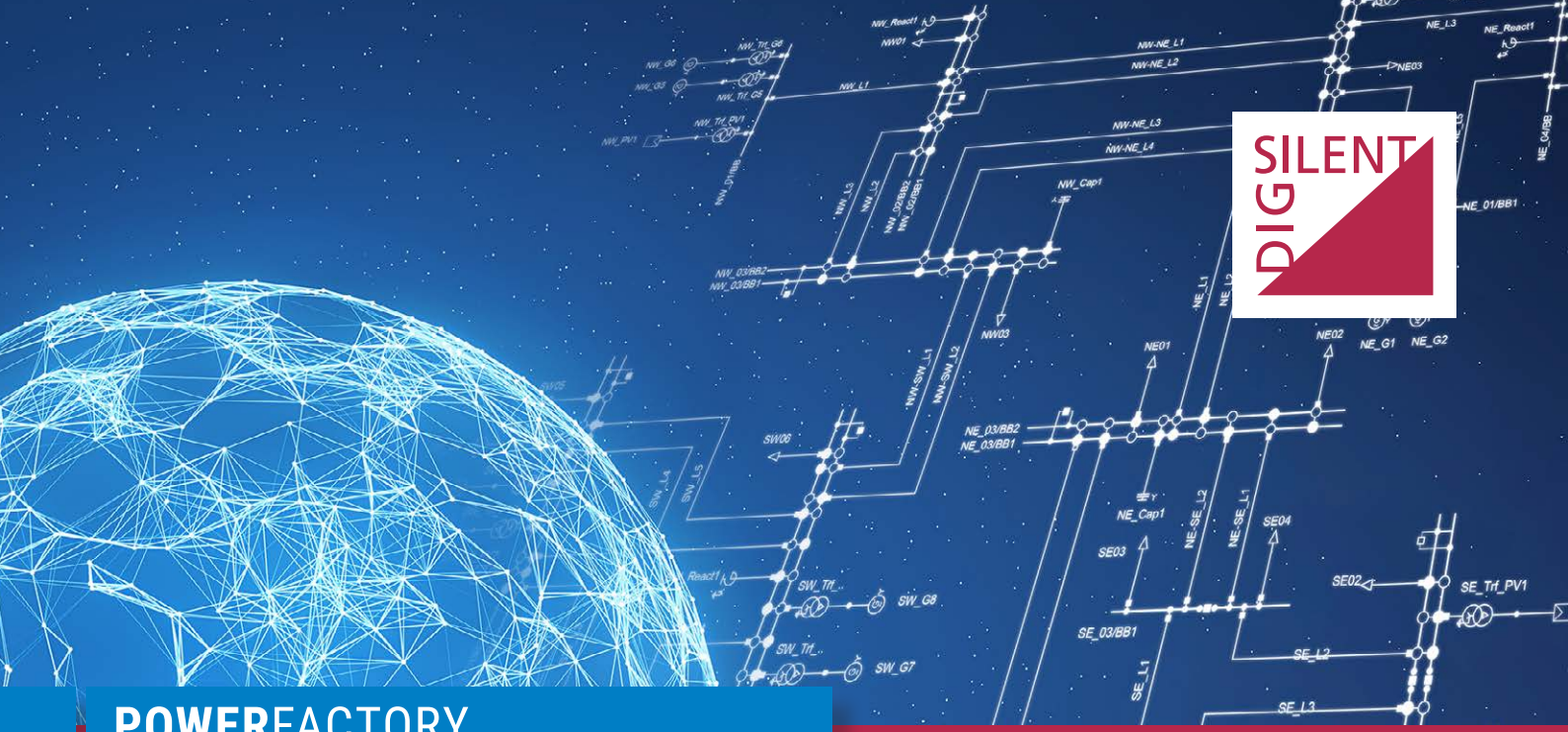

PowerFactory 2021

Technical Reference

Siemens 7SA8

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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

November 15, 2019
PowerFactory 2021
Revision 924

Contents

1 Model information

Manufacturer Siemens

Model 7SA8

Variants The Siemens 7SA8 PowerFactory relay models can be used to simulate a generic version of the Siemens 7SA8 relay family (i.e. Siemens 7SA82, 7SA84, 7SA87 etc). However please consider that, due to the high complexity of the relays, the models have been implemented with a reduced and simplified version of the available protective functions.

2 General description

The Siemens 7SA8 line distance protection terminal is a protective relay for EHV line distance protection applications. Additional protection functionality includes phase overcurrent, over/undervoltage, frequency, residual current and out of step functions.

The Siemens 7SA8 PowerFactory relay model consists of a main relay and 14 subrelays. Two model versions are available, one for each available rated current; the following model versions are provided:

- 7SA8 1A
- 7SA8 5A

The Siemens 7SA8 PowerFactory relay models have been implemented to simulate the most commonly used protective functions.

The main relay contains the measurement and acquisition units, a generic polarizing elements, the load encroachment element for the distance elements, the subrelays and the output logic. Seven different functional areas can be defined in the scheme:

- Measurement acquisition.
- Impedance calculation for the load encroachment feature.
- Impedance protection.
- Overcurrent ancillary elements.
- Voltage elements.
- Frequency elements.
- Output logic.

The model implementation has been based on the information available in the relay manual [**?**].

3 Features supported

3.1 Measurement and acquisition

The voltage and the current are measured by one three phase current transformer (*"Ct"* block), and one three phase voltage transformer (*"Vt"* block).
Three measurement units (*"Measurement"*, *"Meas Sequence"* and *"Delta Measure"* block) are fed by this CT and this VT.

An additional three phase/single phase current transformer (*"Ct-Mutual"* block) is measuring the zero sequence current contribution coming from a close line and is feeding a separate measuring unit (*"MeasI0mut"* block).

A separate measurement block is calculating the frequency using the Vt signals (*"Meas Freq"* block).

One relay input signal (*"yExt"*) is present and can be used to implement a Permissive Underreach Transfer Trip logic (*"PUTT"*) or a Permissive Overreach Transfer Trip logic (*"POTT"*).

3.1.1 Available Units and Input Signals

- One three phase current transformer (*"Ct"* block).
- One three phase voltage transformer (*"Vt"* block).
- One three phase/single phase current transformer (*"Ct-Mutual"* block).
- One three phase measurement block calculating both the phase and voltage values (*"Measurement"* block).
- One three phase measurement block calculating the current and the voltage sequence values (*"Meas Sequence"* block).
- One three phase measurement block calculating the phase to phase currents and the phase to phase voltages (*"Delta Measure"* block).
- One single phase measurement block calculating the mutual zero sequence current (*"MeasI0mut"* block).
- One frequency measurement element (*"Meas Freq"* block).
- One relay input signal (*"yExt"* signal).

3.1.2 Functionality

The voltage and current input signals are sampled at 80 samples/cycle; for each signal the average values are calculated using groups of 4 samples; the average values are processed by a DFT filter operating over a cycle which calculates then the voltage and current values used by the protective elements.

The *"Delta Measure"* block calculates the current and voltage ph-ph values used by the phase-phase loop distance elements.

3.1.3 Data input

The nominal current and the nominal voltage values MUST be entered in all the measurement blocks.

3.2 Main Relay protective elements

The main relay hosts a set of subrelays containing the distance protective elements together with the ancillary, overcurrent, earth fault, voltage and frequency ancillary protection functions. Additional elements are the reclosing feature and a polarizing element calculating the impedance values used by the load encroachment element.

3.2.1 Available Units

- Four *"reactance method"* polygonal distance subrelays (*"Z1 RMD"*, *"Z2 RMD"*, *"Z3 RMD"*, and *"Z4 RMD"* block).
- Four *"reactance method"* mho distance subrelays (*"Mho1 RMD"*, *"Mho2 RMD"*, *"Mho3 RMD"*, and *"Mho4 RMD"* block).
- One *"classic method"* mho distance subrelay (*"Distance Circular Classic Method"* block)
- One *"classic method"* polygonal distance subrelay (*"Distance Polygonal Classic Method"* block)
- One polarizing element(*"Polarizing"* block).
- One load encroachment element (*"Load Area"* block).
- One reclosing element (*"Reclosing"* block).
- Two output logic blocks (*"Mho Logic"* and *"Polygonal & othersubrelay"* block).
- Three logic blocks (*"Z1 calc"*, *"Dir logic"*, and *"LoadEncBlockLogic"* block).

3.2.2 Functionality

Distance trip subrelays The Siemens 7SA8 PF relay model supports the mho and the polygonal distance characteristics both for the *Classic Method* and for the *Reactance Method*. The distance elements using the impedances calculated by the *Classic Method* can be found in the *"Distance Circular Classic Method"* and in the *"Distance Polygonal Classic Method"* block. A separated element is present for each distance zone for the mho and the polygonal element using the *Reactance Method*.

The polygonal and the impedance circle distance elements monitor both the phase and the ground loops; each loop is evaluated separately. All distance elements are directional and the direction can be set for each distance element. Independent timers are available for each distance element.

Starting element The Siemens 7SA8 relay model starting elements located in the impedance subrelays simulate the relay fault detection function using an element which combines with a fuzzy logic approach the following criteria:

- RMS current value.
- Delta Current Level.
- Delta Instantaneous Current value.
- Delta Current phasor.
- RMS voltage level.
- Delta Voltage level.
- Delta Instantaneous Voltage value.
- Delta Voltage phasor.
- Impedance.
- Symmetrical components angle.

Directional element The directional elements located in the impedance subrelays are based on the polarizing voltages calculated by the polarizing block(s) and on the phase currents. If a single phase-ground fault has been detected by the *Starting element* the directional element uses as operating current the currents calculated by the *Polarizing elements* adding to the phase currents the earth impedance compensation and the mutual compensation. The 3 phase loops and the 3 ground loops are evaluated separately.

The directional element uses the positive-sequence voltage for the respective fault loops.

Reclosing element The reclosing element can be set to trigger a variable number of reclosing attempts. Different dead times during the first reclosing attempt can be set depending upon the type of fault (single phase-grnd fault or other types of fault). Different dead times can be set for the first reclosing attempt and for the following attempts.

Polarizing elements The polarizing elements located in the subrelays calculate the voltage vectors used by the directional element taking care of the zero sequence current and of the *Earth Factor*. The operating current vectors are calculated including the mutual current contribution and the *Mutual Earth Factor*.

Please consider that the block is configured for *Series Compensated Lines*; it means that the polarizing voltages are calculated using a voltage memory which stores the voltage values sampled during the last 40 cycles and acts as a measurement delay. To guarantee the correct fault direction detection the actual polarizing voltage is calculated using the voltage samples stored 40 cycles before.

The polarizing block supports both the earth factor decouple representation and the polar representation.
The polarizing elements connected to the mho elements use two polarizing methods, an user configurable factor combine together the results of the two calculations.

3.2.3 Data input

Polarizing element :

Address	Relay Setting	Model block	Model setting	Note
_:2311:132	General:Substitute for I	Polarizing	Substitute for IF (IFsub)	In the *RMD* tab page
_:2311:134	General:Comp. angle zero seq.	Polarizing	Comp. angle zero seq. (CompAngle0)	In the *RMD* tab page
_:2311:135	Z #:Comp. angle neg. seq.	Polarizing	Comp. angle neg seq. (CompAngle2)	In the *RMD* tab page

Load encroachment :

Address	Relay Setting	Model block	Model setting	Note
_:2311:108	General:Angle load cutout	Load Area	R load (Ph-Ph) (philoadphph) R load (Ph-E) (philoadphe)	
_:2311:130	General:RF (ph-g)	Load Area	R load (Ph-E) (Rloadphe)	
_:2311:131	General:RF (ph-ph)	Load Area	R load (Ph-Ph) (Rloadphph)	

Reclosing :

Address	Relay Setting	Model block	Model setting	Note
_:1	AR zone #:Mode	Reclosing	Out of Service(outserv)	
_:102	AR zone #:Operate delay (1-phase)	Reclosing	Reclosing int 1 1Ph-Grnd faults (recltime11ph)	
_:103	AR zone #:Operate delay (multi-ph.)	Reclosing	Reclosing Interval 1 (recltime1)	

Directional element :

No user input is required.

3.3 Polygonal RMD subrelay

Four Polygonal RMD subrelay instances are implemented in the Siemens 7SA8 relay model.

3.3.1 Available Units

- Two polarizing elements (*"Polarizing"* and *"Polarizing Pos Sequence"* block).
- One starting element (*"Starting"* block).
- Two polygonal elements (*"Z"* and *"Z Pos Sequence"* block).
- One directional element (*"Dir-Z"* block).
- Two timers (*"ZT(multiph)"* , and *"ZT(1ph)"* block).
- Four logic block (*"3phLogic"*, *"Const"*, and *"Timer Logic"* block).
- One output element (*"Timer Output logic"* block).

3.3.2 Functionality

The subrelay contains separated polygonal elements for 3phase faults and for asymmetric faults; a directional element and a dedicated starting element are also present. Separated timers are used for single phase a multi phase faults.

3.3.3 Data input

The relationships between the relay settings (in this case just for zone 1)and the model parameters can be found in the following table (the relay model parameter names are listed between brackets):

Address	Relay Setting	Model block	Model setting	Note
_:14191:1	Z 1:Mode	Z1	Out of service (outserv)	
_:14191:109		Z Pos Sequence	Out of service (outserv)	
_:14191:102	Z 1:X reach	Z1	+X Reach (Xmax)	
_:14191:110	Z 1:Operate delay (1phase)	ZT(1ph)	Time Setting (Tdelay)	
_:14191:112	Z 1:Operate delay (multi-ph.)	ZT(multiph)	Time Setting (Tdelay)	
_:14191:130	Z 1:RF (ph-g)	Z1	+R Resistance(PH-E) (REmax)	
_:14191:131	Z 1:RF (ph-ph)	Z1	+R Resistance (Rmax)	
_:2311:102	V0> threshold value	Starting	Ue> grd (Ue)	
_:2311:101	Min. phase-current thresh	Starting	Iph> (Iphgs)	
_:14191:132	Z 1:Substitute for IF	Polarizing	Substitute for IF (IFsub)	In the *RMD* tab page
_:14191:134	Z 1:Comp. angle zero seq.	Polarizing	Comp. angle zero seq. (CompAngle0)	In the *RMD* tab page
		Polarizing Pos Sequence	Comp. angle zero seq. (CompAngle0)	In the *RMD* tab page
_:14191:135	Z 1:Comp. angle neg. seq.	Polarizing	Comp. angle neg seq. (CompAngle2)	In the *RMD* tab page
		Polarizing Pos Sequence	Comp. angle neg seq. (CompAngle2)	In the *RMD* tab page
_:14191:108	Z 1:Line angle	Polarizing	Line angle (Lineangle)	In the *Basic Data* tab page

Address	Relay Setting	Model block	Model setting	Note
_:14191:104	Z 1:Kr	Polarizing	Re/Rl (ReRl)	
_:14191:105	Z 1:Kx	Polarizing	Xe/Xl (XeXl)	

3.4 Mho RMD subrelay

This subrelay contains the impedance mho trip logic. Four Mho RMD subrelay instances are implemented in the Siemens 7SA8 relay model.

3.4.1 Available Units

- One polarizing elements (*"Polarizing"* block).
- One starting element (*"Starting Mho 1"* block).
- One mho element (*"Mho 1"* block).
- One directional element (*"Dir-Z"* block).
- Two timers (*"ZT(multiph) Mho 1"* , and *"ZT(1ph) Mho 1"* block).
- Four logic block (*"3phLogic"*, *"Const"*, and *"Timer Logic"* block).
- One output element (*"Timer Output logic"* block).

3.4.2 Functionality

The subrelay contains a mho elements with directional characteristic and a dedicated starting element. Separated timers are used for single phase a multi phase faults.

3.4.3 Data input

The relationships between the relay settings and the model parameters (in this case just for zone 1) can be found in the following tables (the relay model parameter names are listed between brackets):

Address	Relay Setting	Model block	Model setting	Note
_:1	Z (MHO) #:Mode	Mho 1	Out of service (outserv)	
_:109	Z (MHO) #:Directional mode	Mho 1	Tripping Direction (idir)	
_:102	Z (MHO) #:Zr impedance reach	Mho 1	Replica Impedance (Zm)	
_:112	Z (MHO) #:Operate delay (multi-ph.)	ZT(multiph) Mho 1	Time Setting (Tdelay)	
_:2311:102	V0> threshold value	Starting	Ue> grd (Ue)	
_:2311:101	Min. phase-current thresh	Starting	Iph> (Iphgs)	
_:14191:132	Z 1:Substitute for IF	Polarizing	Substitute for IF (IFsub)	In the *RMD* tab page
_:14191:134	Z 1:Comp. angle zero seq.	Polarizing	Comp. angle zero seq. (CompAngle0)	In the *RMD* tab page
_:14191:135	Z 1:Comp. angle neg. seq.	Polarizing	Comp. angle neg seq. (CompAngle2)	In the *RMD* tab page
_:14191:108	Z 1:Line angle	Polarizing	Line angle (Lineangle)	In the *Basic Data* tab page
_:14191:104	Z 1:Kr	Polarizing	Re/Rl (ReRl)	
_:14191:105	Z 1:Kx	Polarizing	Xe/Xl (XeXl)	
_:2311:114	Cross polarization(ph-ph)	Polarizing	2nd Polarising Factor(pol2k)	

3.5 Distance Circular Classic Method subrelay

The *"Distance Circular Classic Method"* relay model contains the distance elements using the impedances calculated using the traditional impedance calculation method. The subrelay is structured as an independent item with a starter, directional characteristic, load encroachment element , timers, recloser and output logic.

3.5.1 Available Units

- One starting element (*"Starting"* block).
- Two polarizing elements (*"Polarizing Z1"*, and *"Polarizing Z1b-Z5"* block).
- Four impedance zone elements (*"Z1"*, *"Z2"* , *"Z3"* and *"Z4"* block).
- Height timers (*"TZ1"*, *"TZ1 1Pol"*, *"TZ2"*, *"TZ2 1Pol"*, *"TZ3"*, *"TZ4"*, *"T Directional"*, and *"T non Directional"* block).
- One load encroachment element (*"Load Area"* block).
- One directional element (*"Directional"* block).
- One output logic element (*"Distance Trip"* block).
- Height logic blocks (*"Z1 Trip"*, *"Z2 Trip"* , *"Z3 Trip"*, *"Z4 Trip"*, *"Directional Logic"*, *"Load Area Logic"*, *"Single Pole Trip"*, and *"Timer Start"* block).

3.5.2 Functionality

Starting The *"Starting"* unit holds the settings associated with distance fault detection and starts *"T Non Directional"* timer. Please note, that the visibility of the parameters in the dialogue may depend on the selected stating method.

Measurement value processing The two *"Polarizing"* units process the input values (e.g. by applying zero sequence compensation), calculate the input impedances for the starting unit and the zones, and hold the settings associated with fault current compensation. Please note, that the visibility of some parameters is controlled by the selected *"Z0/Z1"* method.

Zone settings The units *"Z1"-"Z4"* model the polygonal distance characteristics and start / release their associated timers *"TZ1"-"TZ4"*. For detailed information about the timer settings (including the setup of single-/multi-pole trips), please refer to the corresponding section.

Timer settings The timers *"TZ1"-"TZ4"*, *"T Directional"* and *"T Non Directional"* generate the tripping signals. The zone timers *"TZ1"-"TZ4"* can be started by the starting unit or by the zones (*"Timer Start"* logic). Separate timers for single-pole tripping are available modelled with *"TZ1"*, and *"TZ2"*. Whether or not single-pole tripping is available is controlled by the *"Single Pole Trip"* logic. Please note, that single-pole tripping only affects dynamic simulations (RMS/EMT).

Load encroachment The *"Load Area"* unit can be used to prevent the relay model from tripping under load conditions by blocking all zones plus the direction and non directional backup trip.

Automatic reclosure The *"Reclosing"* unit models the automatic reclosure by generating close commands after the respective delay times. The close commands are sent to the breaker associated with the *"Close Logic"* in the main relay. The zones *"Z1"-"Z3"* can be blocked after a number of reclosing attempts (configurable via the *"Logic"* tab).

Trip signal The trip signals are generated by the *"Distance Trip"* logic. Depending on the single-pole setting and the detected fault, these can either be *"per phase"* (yout_A, yout_B, yout_C) or a general 3-pole trip (yout) signal.

3.5.3 Data input

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

Starting :

Address	Relay Setting	Model block	Model setting	Note
_:101	Pickup Z<:Min. phasecurrent threshold	Starting	Minimum Iph> (Iphmins)	
_:101	Pickup V/I:Pickup program	Starting	Prog. U/I(iProgUI)	
_:103	Pickup V/I:Undervolt. ph-gnd at Iph>	Starting	Uphe (I>) (UpheIg)	
_:103	Pickup V/I/ϕ:Undervolt. ph-gnd at Iph>	Starting	Uphe (I>) (UpheIg)	
_:104	Pickup V/I:Undervolt. ph-ph at Iph>	Starting	Uphph (I>) (UphphIg)	
_:104	Pickup V/I/ϕ:Undervolt. ph-ph at Iph>	Starting	Uphph (I>) (UphphIg)	
_:105	Pickup I:O/C threshold Iph>>	Starting	Iph>> (Iphggs)	
_:105	Pickup V/I/ϕ:O/C threshold Iph>>	Starting	Iph>> (Iphggs)	
_:106	Pickup V/I:Undervolt. ph-gnd at Iph>>	Starting	Uphe (I>>) (UpheIgg)	
_:106	Pickup V/I/ϕ:Undervolt. ph-gnd at Iph>>	Starting	Uphe (I>>) (UpheIgg)	
_:107	Pickup V/I:Undervolt. ph-ph at Iph>>	Starting	Uphph (I>>) (UphphIgg)	
_:107	Pickup V/I/ϕ:Undervolt. ph-ph at Iph>>	Starting	Uphph (I>>) (UphphIgg)	
_:108	Pickup V/I/ ϕ :I ϕ >	Starting	Iphi> (Iphigs)	
_:109	Pickup V/I/ϕ:Undervolt. ph-gnd at Iϕ>	Starting	Uphe (I>) (UpheIgphi)	
_:110	Pickup V/I/ϕ:Undervolt. ph-ph at Iϕ>	Starting	Uphph (I>) (UphphIgphi)	
_:112	Pickup V/I/ϕ:ϕ>	Starting	phi>(phig)	
_:113	Pickup V/I/ϕ:ϕ<	Starting	phi<(phis)	
_:115	Pickup V/I:Op. delay forward pickup	T Directional	Time Setting (Tdelay)	
_:116	Pickup V/I:Op. delay non-dir. pickup	T non Directional	Time Setting (Tdelay)	

Measurement value processing :

Address	Relay Setting	Model block	Model setting	Note
_:105	Z #:Kr	Polarizing	Re/Rl (ReRl)	
		Polarizing Z1b-Z5	Re/Rl (ReRl)	
_:106	Z #:Kx	Polarizing	Xe/Xl (XeXl)	
		Polarizing Z1b-Z5	Xe/Xl (XeXl)	
_:107	Z #:K0	Polarizing	k0 (k0)	
		Polarizing Z1b-Z5	k0 (k0)	
_:108	Z #:Angle (K0)	Polarizing	Angle (phik0)	
		Polarizing Z1b-Z5	Angle (phik0)	

Load encroachment :

Address	Relay Setting	Model block	Model setting	Note
_:103	General:RF (ph-g)	Load Area	R load (Ph-E) (Rloadphe)	
_:104	Pickup Z<:Angle load cutout (ph-g)	Load Area	PHI load (Ph-E) (philoadphe)	
_:106	General:RF (ph-ph)	Load Area	R load (Ph-Ph) (Rloadphph)	
_:107	Pickup Z<:Angle load cutout (ph-ph)	Load Area	PHI load (Ph-Ph) (phiload-phph)	

Zone settings :

Address	Relay Setting	Model block	Model setting	Note
_:101	Z #:Mode	Z#	Out of Service (outserv)	
_:102	Z #:X reach	Z#	+X Reach (Xmax)	
_:103	Z #:R (ph-g)	Z#	+R Resistance (PH-E) (RE-max)	
_:104	Z #:R (ph-ph)	Z#	+R Resistance (Rmax)	
_:109	Z #:Directional mode	Z#	Tripping Direction (idir)	
_:113	Z 1:Zone-inclination angle	Z#	+X Angle (beta)	

Timer settings :

Address	Relay Setting	Model block	Model setting	Note
_:110	Z #:Operate delay (1phase)	TZ# 1Pol	Time Setting (Tdelay)	
_:112	Z #:Operate delay (multiph.)	TZ# 1Pol	Time Setting (Tdelay)	

3.6 Distance Polygonal Classic Method subrelay

The *"Distance Polygonal Classic Method"* relay model contains the impedance polygonal elements using the traditional impedance calculation method.

3.6.1 Available Units

- One starting element (*"Starting"* block).
- Two polarizing elements (*"Polarizing Z1"*, and *"Polarizing Z1b-Z5"* block).
- Four impedance zone elements (*"Z1"*, *"Z2"* , *"Z3"* and *"Z4"* block).
- Height timers (*"TZ1"*, *"TZ1 1Pol"*, *"TZ2"*, *"TZ2 1Pol"*, *"TZ3"*, *"TZ4"*, *"T Directional"*, and *"T non Directional"* block).
- One load encroachment element (*"Load Area"* block).
- One directional element (*"Directional"* block).
- One output logic element (*"Distance Trip"* block).
- Height logic blocks (*"Z1 Trip"*, *"Z2 Trip"* , *"Z3 Trip"*, *"Z4 Trip"*, *"Directional Logic"*, *"Load Area Logic"*, *"Single Pole Trip"*, and *"Timer Start"* block).

3.6.2 Functionality

All functions, except the zone settings, behave like described in the corresponding section of the *"Distance Circular Classic Method"* sub-relay.

3.6.3 Data input

For the relationship between the relay settings and the model parameters please refer to the corresponding section of the *"Distance Circular Classic Method"* sub-relay except for the *Zone settings* section.

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

Address	Relay Setting	Model block	Model setting	Note
_:1	Z (MHO) #:Mode	Z#	Out of Service (outserv)	
_:102	Z (MHO) #:Zr impedance reach	Z#	Replica Impedance (Zma)	
_:109	Z (MHO) #:Directional mode	Z#	Tripping Direction (idir)	

3.7 Overcurrent subrelay

The Overcurrentsubrelay contains the overcurrent elements available in the Siemens 7SA8 relay.

3.7.1 Available Units

- One 3 phase inverse time overcurrent element (*"Ip>"* block).
- One ground inverse time overcurrent element (*"3I0p"* block).
- Two 3 phase definite time overcurrent elements (*"Iph>"* and *"Iph>>"* block).
- Two ground definite time overcurrent elements (*"3I0>"* and *"3I0>>"* block).
- One logic block (*"Operation Mode"* block).
- One output element opening the associated breaker (*"Overcurrent Trip"* block).

3.7.2 Functionality

The inverse time overcurrent elements can be configured with an *time dial* and with a *time additive* value. The *"Operation Mode"* logic block allows to disable the breaker operation triggred by the overcurrent elements:

The inverse time overcurrent elements support the following trip characteristics:

- IEC Extremely Inverse
- IEC Normal Inverse
- IEC Very Inverse
- IEC Long Inverse
- ANSI Definite Inverse
- ANSI Extremely Inverse
- ANSI Inverse
- ANSI Long Time Inverse
- ANSI Moderately Inverse
- ANSI Short Inverse
- ANSI Very Inverse

3.7.3 Data input

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

Address	Relay Setting	Model block	Model setting	Note
_:871:1	Inverse-T 1:Mode	3Ip>	Out of srvice (outserv)	
_:871:3	Inverse-T 1:Threshold	3Ip>	Current Setting (Ipsetr)	
_:871:8	Inverse-T 1:Type of character. curve	3Ip>	Characteristic (pcharac)	
_:871:101	Inverse-T 1:Time dial	3Ip>	Time Dial (Tpset)	
_:871:115	Inverse-T 1:Additional time delay	3Ip>	Time Adder (Tadder)	
_:841:1	Definite-T 1:Stage blocked	3Iph>	Out of service (outserv)	
_:841:3	Definite-T 1:Threshold	3Iph>	Pickup Current (Ipsetr)	
_:841:6	Definite-T 1:Operate delay	3Iph>	Time Setting (Tset)	
_:842:1	Definite-T 2:Stage blocked	3Iph>>	Out of service (outserv)	
_:842:3	Definite-T 2:Threshold	3Iph>>	Pickup Current (Ipsetr)	
_:842:6	Definite-T 2:Operate delay	3Iph>>	Time Setting (Tset)	
_:781:1	Inverse-T 1:Mode	3I0p	Out of srvice (outserv)	
_:781:3	Inverse-T 1:Threshold	3I0p	Current Setting (Ipsetr)	
_:781:8	Inverse-T 1:Type of character. curve	3I0p	Characteristic (pcharac)	
_:781:101	Inverse-T 1:Time dial	3I0p	Time Dial (Tpset)	
_:781:115	Inverse-T 1:Additional time delay	3I0p	Time Adder (Tadder)	
_:751:1	Definite-T 1:Stage blocked	3I0>	Out of service (outserv)	
_:751:3	Definite-T 1:Threshold	3I0>	Pickup Current (Ipsetr)	
_:751:6	Definite-T 1:Operate delay	3I0>	Time Setting (Tset)	
_:752:1	Definite-T 2:Stage blocked	3I0>>	Out of service (outserv)	
_:752:3	Definite-T 2:Threshold	3I0>>	Pickup Current (Ipsetr)	
_:752:6	Definite-T 2:Operate delay	3I0>>	Time Setting (Tset)	

3.8 Voltage subrelay

The Voltagesubrelay contains the over and undervoltage elements available in the Siemens 7SA8 relay.

3.8.1 Available Units

- Two 3 phase definite time phase-phase overvoltage element (*"Uph-ph>*" and "*Uph-ph>>"* block).
- Two 3 phase definite time phase-ground overvoltage element (*"Uph-e>*" and "*Uph-e>>"* block).
- Two 3 phase definite time phase-phase undervoltage element (*"Uph-ph<*" and "*Uph-ph<< "* block).
- Two 3 phase definite time phase-ground undervoltage element (*"Uph-e<*" and "*Uph-e<< "* block).
- Two definite time negative sequence overvoltage element (*"U2>"* and *"U2>>"* block).
- Two definite time positive sequence overvoltage element (*"U1>"* and *"U1>>"* block).
- Two definite time positive sequence undervoltage element (*"U1<"* and *"U1<< "* block).
- Two definite time zero sequence overvoltage element (*"U0>"* and *"U0>>"* block).
- Eight logic blocks (*"Uph-ph>(>)"*, *"Uph-e>(>)"*, *"U1>(>)"*, *"U2>(>)"*, *"Uph-e<(<)"*, *"Uph-e>(>)"*, *"Uph-ph<(<)"*, and *"Uph-ph>(>)"* block).
- One output logic block (*"Voltage Trip"* block).

3.8.2 Functionality

Each voltage element can be disabled setting its *"Out of Service"* check box.
Each logic block allows to set the behaviour of relevant under/overvoltage blocks: to enable a 1^{st}step voltage block trip set the *"Tripg"* dip switch in the *"DIP Setting"* tab page equal to *on (high)*, to set it as *Alarm Only* and to inhibit the breaker operation put the dip switch equal to *off*. The same configuration can be used for the *"Tripgg"* dip switch to set the 2^{nd}step voltage block.

The couple of voltage blocks getting the phase-phase and the phase-gorund voltages can be configured with the same logic using the *"Tripll"* for the phase-phase voltage blocks and the *"Tripl"* dip switch for the phase-ground voltage blocks.

3.8.3 Data input

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

Address	Relay Setting	Model unit	Model parameter	Note
_:181:1	Definite-T 1:Mode	Uph-e>	Out of Service (outserv)	
		Uph-ph>	Out of Service (outserv)	
_:181:3	Definite-T 1:Threshold	Uph-e>	Pickup Voltage (usetr)	
		Uph-ph>	Pickup Voltage (usetr)	
_:181:6	Definite-T 1:Operate delay	Uph-e>	Time Delay(Tdel)	
		Uph-ph>	Time Delay(Tdel)	
_:182:1	Definite-T 2:Mode	Uph-e>>	Out of Service (outserv)	
		Uph-ph>>	Out of Service (outserv)	
_:182:3	Definite-T 2:Threshold	Uph-e>>	Pickup Voltage (usetr)	
		Uph-ph>>	Pickup Voltage (usetr)	
_:182:6	Definite-T 2:Operate delay	Uph-e>>	Time Delay(Tdel)	
		Uph-ph>>	Time Delay(Tdel)	
_:211:1	Stage 1:Mode	U1>	Out of Service (outserv)	
_:211:3	Stage 1:Threshold	U1>	Pickup Voltage (usetr)	
_:211:6	Stage 1:Operate delay	U1>	Time Delay(Tdel)	
_:212:1	Stage 2:Mode	U1>>	Out of Service (outserv)	
_:212:3	Stage 2:Threshold	U1>>	Pickup Voltage (usetr)	
_:212:6	Stage 2:Operate delay	U1>>	Time Delay(Tdel)	
_:301:1	Stage 1:Mode	U2>	Out of Service (outserv)	
_:301:3	Stage 1:Threshold	U2>	Pickup Voltage (usetr)	
_:301:6	Stage 1:Operate delay	U2>	Time Delay(Tdel)	
_:302:1	Stage 2:Mode	U2>>	Out of Service (outserv)	
_:302:3	Stage 2:Threshold	U2>>	Pickup Voltage (usetr)	
_:302:6	Stage 2:Operate delay	U2>>	Time Delay(Tdel)	
_:361:1	Stage 1:Mode	U0>	Out of Service (outserv)	
_:361:3	Stage 1:Threshold	U0>	Pickup Voltage (usetr)	
_:361:6	Stage 1:Operate delay	U0>	Time Delay(Tdel)	
_:421:1	Definite-T 1:Mode	Uph-e<	Out of Service (outserv)	
		Uph-ph<	Out of Service (outserv)	
_:421:3	Definite-T 1:Threshold	Uph-e<	Pickup Voltage (usetr)	
		Uph-ph<	Pickup Voltage (usetr)	
_:421:6	Definite-T 1:Operate delay	Uph-e<	Time Delay(Tdel)	
		Uph-ph<	Time Delay(Tdel)	
_:422:1	Definite-T 2:Mode	Uph-e<<	Out of Service (outserv)	
		Uph-ph<<	Out of Service (outserv)	
_:422:3	Definite-T 2:Threshold	Uph-e<<	Pickup Voltage (usetr)	
		Uph-ph<<	Pickup Voltage (usetr)	
_:422:6	Definite-T 2:Operate delay	Uph-e<<	Time Delay(Tdel)	
		Uph-ph<<	Time Delay(Tdel)	
_:511:1	Stage 1:Mode	U1<	Out of Service (outserv)	
_:511:3	Stage 1:Threshold	U1<	Pickup Voltage (usetr)	
_:511:6	Stage 1:Operate delay	U1<	Time Delay(Tdel)	
_:512:1	Stage 2:Mode	U1<<	Out of Service (outserv)	
_:512:3	Stage 2:Threshold	U1<<	Pickup Voltage (usetr)	
_:512:6	Stage 2:Operate delay	U1<<	Time Delay(Tdel)	

3.9 Earthfault subrelay

The Earthfaultsubrelay models the zero sequence directional overcurrent elements available in the Siemens 7SA8 relay.

3.9.1 Available Units

- One inverse time zero sequence overcurrent element (*"3I0p"* block).
- Three definite time zero sequence overcurrent element (*"3I0>"*, *"3I0>>"*, and *"3I0>>>"* block).
- One zero sequence directional element (*"Directional (I0-U0)"* block).
- One negative sequence directional element (*"Directional (I2-U2)"* block).
- One apparent power directional element (*"Directional (S)"* block).
- One zero sequence current definite time threshold element (*"3I0p (U0inv)"*).
- One zero sequence voltage definite time threshold element (*"3U0> (U0inv)"*).
- One inverse time zero sequence overvoltage element (*"U0inv"* block).
- One timer (*"T rev (U0 inv)"* block).
- Five logic blocks (*"Directional Logic"*, *"Direction (U0inv)"*, *"Release U0 Inv"*, *"U0 Trip"*, and *"Earthfault Trip"* block).

3.9.2 Functionality

Three different directional logics are available and can be activated/deactivated using their *"Out of service"* check box.
The inverse time zero sequence overvoltage element is directional and is activated only when the zero sequence current is greater than the threshold set in the *"3I0p (U0inv)"* element and the zero sequence voltage is greater than the threshold set in the *"3U0> (U0inv)"* element.
An additional delayed back up trip logic uses the inverse time zero sequence overvoltage element no directional trip signal. The back up trip delay is set in the *"T rev (U0 inv)"* timer.

3.9.3 Data input

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

Address	Relay Setting	Model unit	Model parameter	Note
_:2311:101	General:Angle forward α	Directional (I0-U0)	Operating Sector Angle (phisec)	forward α = $\pi - phisec + mtau$
		Directional (I2-U2)	Operating Sector Angle (phisec)	
_:2311:102	General:Angle forward β	Directional (I0-U0)	Operating Sector Angle (phisec)	forward β = $mtau + phisec$
		Directional (I2-U2)	Operating Sector Angle (phisec)	

Address	Relay Setting	Model unit	Model parameter	Note
_:2311:103	General:Min. zero-seq. voltage V0	Directional (I0-U0)	Operating Voltage (upolur)	
_:2311:104	General:Min.3I0 f.increas.dir.sens.	Directional (I0-U0)	Operating Current (curopur)	
_:2311:106	General:Min. neg.-seq. current I2	Directional (I2-U2)	Operating Current (curopur)	
_:2311:107	General:Min. neg.-seq. voltage V2	Directional (I2-U2)	Operating Voltage (upolur)	
_:2311:108	General:Compensation angle	Directional (I0-U0)	Max Torque Angle (mtau)	
		Directional (I2-U2)	Max Torque Angle (mtau)	
		Directional (S)	Max Torque Angle (mtau)	
_:1	Inverse-T #:Mode	3I0p	Out of Service (outserv)	
_:115	Inverse-T #:Directional mode	3I0p	Tripping Direction (idir)	
_:101	Inverse-T #:Threshold	3I0p	Current Setting (Ipsetr)	
_:107	Inverse-T #:Time dial	3I0p	Time Dial (Tpset)	
_:132	Inverse-T #:Additional time delay	3I0p	Time Adder (Tadder)	
_:4861:1	Definite-T 1:Mode	3I0>	Out of Service (outserv)	
_:4861:3	Definite-T 1:Threshold	3I0>	Pickup Current (Ipsetr)	
_:4861:6	Definite-T 1:Operate delay	3I0>	Time Setting (Tset)	
_:4862:1	Definite-T 2:Mode	3I0>>	Out of Service (outserv)	
_:4862:3	Definite-T 2:Threshold	3I0>>	Pickup Current (Ipsetr)	
_:4862:6	Definite-T 2:Operate delay	3I0>>	Time Setting (Tset)	
_:1	V0 inverse-T #:Mode	U0inv	Out of Service (outserv)	
_:108	V0 inverse-T #:Directional mode	Direction (U0inv)	DiFwd, DirRev	In the *"Dip Settings"* tab page
_:102	V0 inverse-T #:V0> threshold value	3U0> (U0inv)	Pickup Voltage (Usetr)	
_:103	V0 inverse-T #:Min. zero-seq. volt. V0	U0inv	Input Setting (Ipsetr)	
_:104	V0 inverse-T #:Time delay directional	U0inv	Time Dial Tpset	
_:105	V0 inverse-T #:Stabiliz. w. phase current	3I0p (U0inv)	Pickup Current (Ipsetr)	
_:112	V0 inverse-T #:Time delay non-direct.	T rev (U0 inv)	Time Delay (Tset)	

3.10 Frequency subrelay

The Frequency subrelay contains the frequency elements available in the Siemens 7SA8 relay.

3.10.1 Available Units

- Four definite time over/underfrequency element (*"f1"*, *"f2"*, *"f3"* and *"f4"* block).
- One logic block (*"Frequency Trip"* block).

3.10.2 Functionality

Each frequency element can operate as undervoltage element, when set with a frequency threshold smaller than the system rated frequency, or as overvoltage element, when set with a frequency threshold greater than the system rated frequency.
The *"Frequency Trip"* block allows to configure the effect of the trip of each frequency element setting the relevant dip switch in the *"DIP Settings"* tab page.
Four dip switches are available: *"wf1"* associated to the *"f1"* element, *"wf2"* associated to *"f2"*, *"wf3"* associated to *"f3"*, and*"wf4"* associated to *"f4"*.
To configure an element to not trip the breaker and acts as *Alarm Only* set the relevant dip switch to *off*. Each frequency element operates the breaker when the the relevant dip switch is set to *on*.

3.10.3 Data input

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

Address	Relay Setting	Model unit	Model parameter	Note
31:1	Overfrequency Stage 1:Mode	f1	Out of Service (outserv)	
31:3	Overfrequency Stage 1:Threshold	f1	Frequency (Fset)	
31:6	Overfrequency Stage 1:Operate delay	f1	Time Delay (Tdel)	
32:1	Overfrequency Stage 2:Mode	f2	Out of Service (outserv)	
32:3	Overfrequency Stage 2:Threshold	f2	Frequency (Fset)	
32:6	Overfrequency Stage 2:Operate delay	f2	Time Delay (Tdel)	
61:1	Underfrequency Stage 1:Mode	f1	Out of Service (outserv)	
61:3	Underfrequency Stage 1:Threshold	f1	Frequency (Fset)	
61:6	Underfrequency Stage 1:Operate delay	f1	Time Delay (Tdel)	
62:1	Underfrequency Stage 2:Mode	f2	Out of Service (outserv)	
62:3	Underfrequency Stage 2:Threshold	f2	Frequency (Fset)	
62:6	Underfrequency Stage 2:Operate delay	f2	Time Delay (Tdel)	

3.11 Output logic

The output logic is the interface between the relay and the power system. A set of relay output signals can be used to simulate the control logics.

3.11.1 Available Units and Output Signals

The trip logic is implemented by the *"Mho Logic"* and by the *"Polygonal & Overcurrent Logic"* block located in the main relay. The *"Closing Logic"* block controlled by the reclosing feature (*"Reclosing"* block) has the purpose of generating a closing command for the power breaker when a reclosing attempt is triggered. Three phase, double phase and single phase trips can be triggered by the *"Polygonal & Overcurrent Logic"* block.

Five relay output signals are available:

- *yout* The *"Polygonal & Overcurrent Logic"* block output signal.
- *yout1* The *"Mho Logic"* block output signal.
- *yClose* The *"Distance Circular Classic Method"* subrelay closing output signal.
- *yClose1* The *"Distance Polygonal Classic Method"* subrelay closing output signal.
- *yout2* The *"Closing Logic"* block output signal.

3.11.2 Functionality

The *"Mho Logic"* and the *"Polygonal & Overcurrent Logic"* block located in the main relay are operating the breaker.

The *"Mho Logic"* block unique output signal *"yout1"* is used to operate the breaker. It can trigger only three phase trips.

The *"Polygonal & Overcurrent Logic"* block has been implemented with one independent output signal for each phase and with one three phase output signal. It can trigger three phase, two phase and single phase trips.

The *"Polygonal & Overcurrent Logic"* block implements the Permissive Underreach Transfer Trip logic (*"PUTT"*) and the Permissive Overreach Transfer Trip logic (*"POTT"*).
For this purpose the *"yExt"* relay input signal is used in accordance with the following logic:

A PUTT condition is declared and the breaker is operated when

- The PUTT logic is active (*"PUTT"* parameter, *"Plygonal & overcurrent Logic"* block).
- The PUTT input signal (*yExt*, which transfers the remote relay 1^{st} distance zone trip signal) is on.
- The 1^{st} extension distance zone (*Z1b*) has started.

A POTT condition is declared and the breaker is operated when

- The POTT logic is active (*"POTT"* parameter, *"Plygonal & overcurrent Logic"* block).

- The POTT input signal (*yExt*, which transfers the remote relay 1^{st} extension distance zone trip signal) is on.
- The 1^{st} extension distance zone (*Z1b*) has started.

3.11.3 Data input

Please disable the *"Mho Logic"* and the *"Polygonal & Overcurrent Logic"* block in the main relay to disable the relay model's ability to open the power circuit.

The *"yout_A"*, *"yout_B"*, *"yout_C"* and *"yout"* output signals of the *"Polygonal & Overcurrent Logic"* block can be configured to operate the breaker using the *"Tripping signal"* (*"sTripsig"*) parameter in the *"Basic Data"* tab page of the *"Polygonal & Overcurrent Logic"* block dialog. By default all of them are operating the breaker.

The single phase trip logic for the 1^{st} polygonal distance zone can be activated setting equal to *"TRIP"* the *"single_pole_trip"* parameter in the *"Logic"* tab page of the *"Polygonal & Overcurrent Logic"* block dialog. The 2^{nd} polygonal distance zone single phase trip can be set using the *"Z2single_pole_trip"* parameter. The two phases trip logic can be activated setting equal to *"TRIP"* the *"two_poles_trip"* parameter. By default the three phase trip logic is enabled.

To enable the PUTT logic set equal to TRIP the *"PUTT "* parameter, to enable the POTT logic set equal to TRIP the *"POTT "* parameter ; both of them can be found in the *"Logic"* tab page of the *"Polygonal & Overcurrent Logic"* block dialog. They are disabled (NOTRIP) by default.

4 Features not supported

The following features are not supported:

- Power swing detection.
- Out of step trip.
- Synchronism and voltage check.
- Fault location.
- User definable logic functions.
- Other teleprotection scheme (directional comparison, unblocking etc.).
- High current switch onto fault protection.
- Week infeed protection.
- Circuit breaker failure protection.
- Monitoring functions.

5 References