



POWERFACTORY

PowerFactory 2021

Technical Reference

Sprecher SPRECON-E-P DS

POWER SYSTEM SOLUTIONS
MADE IN GERMANY

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1 Model information

Manufacturer Sprecher

Model SPRECON-E-P DS

Variants This PowerFactory relay model simulates a reduced set of the features present in the Sprecher SPRECON-E-P DS relay.

2 General description

The Sprecher SPRECON-E-P DS devices are one-box solutions for protection and control, which allow protection of primary equipment by simultaneously accomplishing control and monitoring functions in electric power systems.

The protection functions available in the devices provide selective short-circuit protection, ground fault protection, and overload protection in medium- and high-voltage systems.

The PowerFactory Sprecher SPRECON-E-P DS relay model simulates a subset of the protective features available in the relay and consists of a main relay model and the following sub relays:

- IL
- IE
- Ineg
- Overload
- CBF

The main relay contains the measurement and acquisition elements, the output element which operated the power breaker(s), the inrush restraint features, the reclosing element and the sub relays.

The model implementation has been based on the information available in the relay technical brochure and manual [1] [2] .

3 Supported features

3.1 Measurement and acquisition

It represents the interface between the power system and the relay protective elements.

The phase currents flowing in the power system are converted by a block which simulates the 3 phase CT and by a block which models a single phase CT detecting the earth current; the secondary currents are then measured in the relay model by six elements which simulate the digital sampling of the relay.

3.1.1 Available elements and input signals

The *Measurement and acquisition* feature consists of the following elements:

- One 3 phase current transformer ("Ct-3P" block).
- One neutral current transformer ("Ct-E/N" block).
- One 3 phase measurement element ("Measure Ph" block).
- One sequence measurement element ("Measure Sequence" block).
- Two 3 phase current harmonic measurement element ("Measure Ph 1st harmonic", and "Measure Ph 2nd harmonic" block).
- One single phase neutral measurement element ("Neutral measurement" block).
- One single phase harmonic neutral measurement element ("Neutral measurement 1st harmonic" block).

The following input signals can be used:

- *ExtBlock_L1A;B;C* (one for each phase) blocking the "IL>" element ("IL" subrelay).
- *ExtBlock_L2A;B;C* (one for each phase) blocking the "IL>>" element ("IL" subrelay).
- *ExtBlock_L3A;B;C* (one for each phase) blocking the "IL>>>" element ("IL" subrelay).
- *ExtBlock_L4A;B;C* (one for each phase) blocking the "IL>>>>" element ("IL" subrelay).
- *ExtBlock_E1* blocking the "IE>" element ("IE" subrelay).
- *ExtBlock_E2* blocking the "IE>>" element ("IE" subrelay).
- *ExtBlock_E3* blocking the "IE>>>" element ("IE" subrelay).
- *ExtBlock_E4* blocking the "IE>>>>" element ("IE" subrelay).
- *ExtBlock_neg* blocking the "Ineg" subrelay elements.
- *ExtBlock_overload* blocking the thermal image element ("Overload" subrelay).
- *ExtBlock_CBF* blocking the circuit breaker failure logic ("CBF" subrelay).

3.1.2 Functionality

The "Ct-3P" and the "Ct-E/N" 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 input current values are sampled by the "Measure Ph", the "Measure Sequence", the "Measure Ph 1st harmonic", the "Measure Ph 2nd harmonic", the "Neutral measurement", and the "Neutral measurement 1st harmonic" block at 20 samples/cycle. The values are processed by a DFT filter, operating over a cycle, which then calculates the voltage and current RMS values used by the protective elements.

3.1.3 Data input

The CT secondary rated current (1 or 5 A) value must be set in the "Measure Ph", in the "Measure Sequence", in the "Measure Ph 1st harmonic", in the "Measure Ph 2nd harmonic", in the "Neutral measurement", and in the "Neutral measurement 1st harmonic" block.

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 In rush restraint

The *In rush restraint* feature is part of the main relay and is connected to the IL, IE, and Ineg subrelay.

3.2.1 Available elements and input signals

The *In rush restraint* feature consists of the following elements:

- One harmonic percentage calculation element ("Inrush calc" block).
- One minimum phase current detection element (" $>0.2I_n$ " block).
- One maximum phase current element ("Inrushrest. up to IL" block).
- One harmonic percentage threshold (" $I_{2f/1f} > (IL)$ " block).
- One restraint logic element ("Inrush Restraint" block).

3.2.2 Functionality

The *In rush restraint* feature allows to inhibit the phase, zero sequence and negative sequence element trip when an inrush condition has been detected. The ability to inhibit the trip can be enabled/disabled independently for each protective element.

The inrush detection is made calculating the ratio between the phase current 2^{nd} and 1^{st} harmonic.

The phase cross blocking can be enabled or disabled. A maximum value for the phase current ("6808 Inrushrest. up to IL") up to which the 2nd harmonic is weighted is also available.

For the phase overcurrent elements, when the cross blocking is disabled, the harmonics of all started phase currents must exceed the setting *6801 I2f/1f> (IL)* to result in blocking of the enabled phase current starts. When the cross blocking is enabled, exceeding the setting *6801 I2f/1f> (IL)* in one of the started phases is sufficient to block the starting and the tripping, independently of the harmonic content of the other phases.

For the zero sequence and negative sequence elements, the phase currents of phases >0.2 In are weighted for their harmonic content. Blockage of the zero or of the negative sequence current start comes if in one phase harmonics content is higher than the setting *6801 I2f/1f> (IL)*.

3.2.3 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
6800	Inrush Restraint	Inrush Restraint	Out of Service	In the "Basic data" tab page
6830	Inrushrest. IL	Inrush Restraint	ILCrossblock	In the "DIP Settings" tab page
6801	I2f/1f> (IL)	I2f/1f> (IL)	Pickup Current (Ipset)	
6808	Inrushrest. up to IL	Inrushrest. up to IL	Pickup Current (Ipset)	
6831	Inrushrest. IL>	Inrush Restraint	InrushrestILM (InrushrestILM)	In the "DIP Settings" tab page
6832	Inrushrest. IL>>	Inrush Restraint	InrushrestILMM (InrushrestILMM)	In the "DIP Settings" tab page
6833	Inrushrest. IL>>>	Inrush Restraint	InrushrestILMMM (InrushrestILMMM)	In the "DIP Settings" tab page
6834	Inrushrest. IL>>>>	Inrush Restraint	InrushrestILMMMM (InrushrestILMMMM)	In the "DIP Settings" tab page
6835	Inrushrest. IE>	Inrush Restraint	InrushrestIEM (InrushrestIEM)	In the "DIP Settings" tab page
6835	Inrushrest. IE>>	Inrush Restraint	InrushrestIEMM (InrushrestIEMM)	In the "DIP Settings" tab page
6835	Inrushrest. IE>>>	Inrush Restraint	InrushrestIEMMM (InrushrestIEMMM)	In the "DIP Settings" tab page
6835	Inrushrest. IE>>>>	Inrush Restraint	InrushrestIEMMMM (InrushrestIEMMMM)	In the "DIP Settings" tab page
6840	Inrushrest. Ineg>	Inrush Restraint	InrushrestInegM (InrushrestInegM)	In the "DIP Settings" tab page
6840	Inrushrest. Ineg>>	Inrush Restraint	InrushrestInegMM (InrushrestInegMM)	In the "DIP Settings" tab page

3.3 Reclosing

The purpose of the *Reclosing* feature is model, during the RMS and the EMT simulation, up to 5 shot 3-pole auto reclosures of the circuit breaker. It simulates a simplified version of the reclosing feature available in the Sprecher SPRECON-E-P DS relay.

3.3.1 Available elements

The *Reclosing* feature is modeled by the "Reclosing" block.

3.3.2 Functionality

The "Reclosing" block models during a simulation the following features:

- An user settable number of AR.
- Separated dead time for the first AR attempt and for the first reclosing attempt after an earth fault.
- User configurable reclosing/no reclosing logic for each overcurrent element.
- User configurable duration of the circuit breaker close command.
- User configurable reclosing sequence reclaim time.

3.3.3 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
9900	Auto-Reclosing AR	Reclosing	Out of Service	In the "Basic data" tab page
9930	Number of AR Shots	Reclosing	Operations to lockout(oplockout)	
9950	AR Shots Earthfault	Reclosing	Operations to lockout(oplockout)	
9931	IL> AR Start	Reclosing	Logic (ilogic)	
9932	IL>> AR Start	Reclosing	Logic (ilogic)	In the "Logic" tab page.
9933	IL>>> AR Start	Reclosing	Logic (ilogic)	In the "Logic" tab page.
9934	IL>>>> AR Start	Reclosing	Logic (ilogic)	In the "Logic" tab page.
9935	IE> AR Start	Reclosing	Logic (ilogic)	In the "Logic" tab page.
9936	IE>> AR Start	Reclosing	Logic (ilogic)	In the "Logic" tab page.
9937	IE>>> AR Start	Reclosing	Logic (ilogic)	In the "Logic" tab page.
9938	IE>>>> AR Start	Reclosing	Logic (ilogic)	In the "Logic" tab page.
9945	First Dead Time(TD)	Reclosing	Reclosing interval 1 (recltime1)	In the "Basic data" tab page
9955	1stDeadTimeEarthfault	Reclosing	Reclosing int 1 1Ph-Grnd Faults (recltime11ph)	In the "Basic data" tab page
9912	Dead Time delayed R.	Reclosing	Reclosing interval 1 (recltime1) Reclosing interval 2 (recltime2) Reclosing interval 3 (recltime3) Reclosing interval 4 (recltime4) Reclosing interval 5 (recltime5)	In the "Basic data" tab page
9917	tcl Duration CBCLOSE	Reclosing	Closing command duration (closingcomtime)	In the "Basic data" tab page
9916	tr Reclaim Time AR	Reclosing	Reset Time (resettime)	In the "Basic data" tab page

3.4 IL subrelay

The *IL* subrelay contains the phase overcurrent protective logic.

3.4.1 Available Units

- One inverse time phase overcurrent element ("IL>" block).
- Three time defined phase overcurrent element ("IL>>", "IL>>>", and "IL>>>>" block).
- Twelve logic elements ("IL> ILx Phase Start", "IL>> ILx Phase Start", "IL>>> ILx Phase Start", "IL>>>> ILx Phase Start", "Corr.IL> by I0meas IL> value", "Corr.IL>> by I0meas IL>> value", "Corr.IL>>> by I0meas IL>>> value", "Corr.IL>>>> by I0meas IL>>>> value", "Blockage IL>", "Blockage IL>>", "Blockage IL>>>", and "Blockage IL>>>>" block).
- Four block combining the signals ("Or1", "Or2", "Or3", and "Or4" block).

3.4.2 Functionality

The phase starting logic of each phase overcurrent element can be set as

- independent of I_{max}
- only if $IL_x > 2/3 I_{max}$

The phase current monitored by each phase overcurrent element can be

- The RMS value of the sampled values
- The 1st harmonic RMS value

Please notice that the 1st harmonic RMS value is calculated only running an EMT simulation. For any other kind of calculation the *the RMS value of the sampled values* and the *1st harmonic RMS value* are identical.

The relay model can be configured to remove the zero sequence current from the phase currents. Each phase overcurrent element can be configured to ignore an external block input signal. An additional in rush block signal is also available for each overcurrent element.

The inverse time elements support the definite time characteristic and the following inverse time trip characteristics:

- Inverse
- Very Inverse
- Extremely Inverse
- Longtime inverse

The inverse time element trip characteristic equations comply with the IEC standard equations.

3.4.3 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
207	SYSTEMSTAR	Starting	System Grounding (isysstar)	"Basic data" tab page
1100	IL> Start	IL>	Out of Service (outserv)	
1101	IL> Definite Time	IL>	Current Setting (Ipset)	
1102	IL> Inverse Time	IL>	Current Setting (Ipset)	
1111	tIL> Time	IL>	Time Dial (Tpset)	
1112	tL> Time Factor	IL>	Time Dial (Tpset)	
1113	tIL> max Time Delay	IL>	Max. Time (udeftmax)	
1132	IL> Timer Module	IL>	Characteristic (pcharac)	
1134	ILx> Phase Start	IL> ILx Phase Start	Greater2_3_Imax (Greater2_3_Imax)	In the "DIP Settings" tab page
1140	Value or IL>	Corr.IL> by I0meas IL> value	ILM_1stharmonic (ILM_1stharmonic)	In the "DIP Settings" tab page, set "on" to enable the 1st harmonic current
1141	Corr.IL> by I0meas	Corr.IL> by I0meas IL> value	Corr_ILM_by_I0meas (Corr_ILM_by_I0meas)	In the "DIP Settings" tab page, when "on" Star point current is removed from IL
1198	Blockage IL>	Blockage IL>	blockage_ILM (blockage_ILM)	In the "DIP Settings" tab page
1200	IL>> Start	IL>>	Out of Service (outserv)	
1201	IL>>	IL>>	Pickup Current (Ipset)	
1211	tIL>> Time	IL>>	Time Setting (Tset)	
1234	ILx>> Phase Start	IL>> ILx Phase Start	Greater2_3_Imax (Greater2_3_Imax)	In the "DIP Settings" tab page
1240	Value or IL>>	Corr.IL>> by I0meas IL>> value	ILMM_1stharmonic (ILMM_1stharmonic)	In the "DIP Settings" tab page, set "on" to enable the 1st harmonic current
1241	Corr.IL>> by I0meas	Corr.IL>> by I0meas IL>> value	Corr_ILMM_by_I0meas (Corr_ILMM_by_I0meas)	In the "DIP Settings" tab page, when "on" Star point current is removed from IL
1298	Blockage IL>>	Blockage IL>>	blockage_ILMM (blockage_ILMM)	In the "DIP Settings" tab page
1300	IL>>> Start	IL>>>	Out of Service (outserv)	
1301	IL>>>	IL>>>	Pickup Current (Ipset)	
1334	ILx>>> Phase Start	IL>>> ILx Phase Start	Greater2_3_Imax (Greater2_3_Imax)	In the "DIP Settings" tab page
1340	Value or IL>>>	Corr.IL>>> by I0meas IL>>> value	ILMMM_1stharmonic (ILMMM_1stharmonic)	In the "DIP Settings" tab page, set "on" to enable the 1st harmonic current
1341	Corr.IL>>> by I0meas	Corr.IL>>> by I0meas IL>>> value	Corr_ILMMM_by_I0meas (Corr_ILMMM_by_I0meas)	In the "DIP Settings" tab page, when "on" Star point current is removed from IL
1398	Blockage IL>>>	Blockage IL>>>	blockage_ILMMM (blockage_ILMMM)	In the "DIP Settings" tab page
1400	IL>>>> Start	IL>>>>	Out of Service (outserv)	
1401	IL>>>>	IL>>>>	Pickup Current (Ipset)	
1434	ILx>>>> Phase Start	IL>>>> ILx Phase Start	Greater2_3_Imax (Greater2_3_Imax)	In the "DIP Settings" tab page
1440	Value or IL>>>>	Corr.IL>>>> by I0meas IL>>>> value	ILMMMM_1stharmonic (ILMMMM_1stharmonic)	In the "DIP Settings" tab page, set "on" to enable the 1st harmonic current
1441	Corr.IL>>>> by I0meas	Corr.IL>>>> by I0meas IL>>>> value	Corr_ILMMMM_by_I0meas (Corr_ILMMMM_by_I0meas)	In the "DIP Settings" tab page, when "on" Star point current is removed from IL
1498	Blockage IL>>>>	Blockage IL>>>>	blockage_ILMMMM (blockage_ILMMMM)	In the "DIP Settings" tab page

3.5 IE subrelay

The *IE* subrelay contains the earth overcurrent protective logic.

3.5.1 Available Units

- One inverse time earth overcurrent element ("IE>" block).
- Three time defined Earth overcurrent element ("IE>>", "IL>>>", and "IE>>>>" block).
- Eight logic elements ("Value for IE>", "Value for IE>>", "Value for IE>>>", "Value for IE>>>>", "Blockage IE>", "Blockage IE>>", "Blockage IE>>>", and "Blockage IE>>>>" block).
- Four block combining the signals ("Or1", "Or2", "Or3", and "Or4" block).

3.5.2 Functionality

The earth current monitored by the overcurrent elements can be

- The current measured by the neutral CT.
- The current calculated adding together the phase currents.

The RMS value of the earth current can be:

- The RMS value of the sampled values
- The 1st harmonic RMS value

Please notice that the 1st harmonic RMS value is calculated only running an EMT simulation. For any other kind of calculation the *the RMS value of the sampled values* and the *1st harmonic RMS value* are identical.

The IE> stage pickup value can be increased in dependence of the amount of the sum of those phase currents that have exceeded the pickup value IL>.

If all three phase currents are greater than IL>, the following applies:

$$IE' >= IE > + ks(IL1 + IL2 + IL3 - 3IL >)$$

If only two phase currents are greater than IL>, biasing is reduced:

$$IE' >= IE > + ks(ILX + ILY - 2IL >)$$

If only one phase current pickup is exceeded, the following remains:

$$IE' >= IE > + ks(ILX - IL >)$$

with

IE' >: biased pickup value of the earth fault current stage

IE >: set pickup value of the DT earth current stage *IE > "2101 IE > Definite Time"*

ks: setting of biasing factor *"2107 Biasing Factor"*

IL1, IL2, IL3, ILX, ILY: r.m.s. value of phase currents, x, y = [1, 2, 3]

IL >: Setting of phase current starting *"1101 IL > Definite Time"*

Each earth overcurrent element can be configured to start only if the "IL>" phase overcurrent element has started.

To model the *Earth Current Differential Protection (unbiased)*, the relay model can be configured to add together the phase current and the current measured by the neutral CT.

Each earth overcurrent element can be configured to ignore an external block input signal.

An additional in rush block signal is also available for each overcurrent element.

The inverse time elements support the definite time characteristic and the following inverse time trip characteristics:

- Inverse
- Very Inverse
- Extremely Inverse
- Longtime inverse

The inverse time element trip characteristic equations comply with the IEC standard equations.

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):

Address	Relay Setting	Model block	Model setting	Note
2100	IE> Start	IE>	Out of Service (outserv)	In the "Logic" tab page
2101	IE> Definite Time	IE>	Current Setting (Ipset)	
2102	IE> Inverse Time	IE>	Current Setting (Ipset)	
2103	IE> Definit.Time sens	IE>	Current Setting (Ipset)	
2105	IE> Definit.Time sens	IE>	Current Setting (Ipset)	
2106	IE> Inv. Time sens.	IE>	Current Setting (Ipset)	
2107	Biasing Factor	Earth Current Biasing	Ks (Ks)	
2108	IE> Inv. Time sens.	IE>	Current Setting (Ipset)	
2111	tIE> Time	IE>	Time Dial (Tpset)	
2112	tE> Time Factor	IE>	Time Dial (Tpset)	
2113	tIE> max Time Delay	IE>	Time Dial (Tpset)	
2132	IE> Timer Module	IE>	Characteristic (pcharac)	In the "DIP Settings" tab page
2133	Value for IE>	Value for IE>	UseI0meas (UseI0meas)	
2137	IE> Start	Blockage IE> - IE> Start	ILStart (ILStart)	In the "DIP Settings" tab page
2140	Value for IE>	Value for IE>	Use1stharmonic (Use1stharmonic)	In the "DIP Settings" tab page
2141	Corr.IE> by IEmeas	Value for IE>	Corr_IEMbyIEmeas(Corr_IEMbyIEmeas)	In the "DIP Settings" tab page
2198	Blockage IE>	Blockage IE> - IE> Start	Extblock (extblock)	In the "DIP Settings" tab page
2200	IE>> Start	IE>>	Out of Service (outserv)	
2201	IE>>	IE>>	Pickup Current (Ipset)	
2203	IE>> sensitive	IE>>	Pickup Current (Ipset)	
2205	IE>> sensitive	IE>>	Pickup Current (Ipset)	
2211	tIE>> Time	IE>>	Time Setting (Tset)	

3 Supported features

Address	Relay Setting	Model block	Model setting	Note
2233	Value for IE>>	Value for IE>>	I0meas (I0meas)	In the "DIP Settings" tab page
2237	IE>> Start	Blockage IE>> - IE>> Start	ILStart (ILStart)	In the "DIP Settings" tab page
2240	Value for IE>>	Value for IE>>	Use1stharmonic (Use1stharmonic)	In the "DIP Settings" tab page In the "DIP Settings" tab page
2241	Corr.IE>> by IEmeas	Value for IE>>	Corr_IEMMbyIEmeas(Corr_IEMMbyIEmeas)	In the "DIP Settings" tab page
2298	Blockage IE>>	Blockage IE>> - IE>> Start	Extblock (extblock)	In the "DIP Settings" tab page
2300	IE>>> Start	IE>>>	Out of Service (outserv)	
2301	IE>>>	IE>>>	Pickup Current (Ipset)	
2303	IE>>> sensitive	IE>>>	Pickup Current (Ipset)	
2305	IE>>> sensitive	IE>>>	Pickup Current (Ipset)	
2311	tIE>>> Time	IE>>>	Time Setting (Tset)	
2333	Value for IE>>>	Value for IE>>>	I0meas (I0meas)	In the "DIP Settings" tab page
2337	IE>>> Start	Blockage IE>>> - IE>>> Start	ILStart (ILStart)	In the "DIP Settings" tab page
2340	Value for IE>>>	Value for IE>>>	Use1stharmonic (Use1stharmonic)	In the "DIP Settings" tab page
2341	Corr.IE>>> by IEmeas	Value for IE>>>	Corr_IEMMMbyIEmeas(Corr_IEMMMbyIEmeas)	In the "DIP Settings" tab page
2398	Blockage IE>>>	Blockage IE>>> - IE>>> Start	Extblock (extblock)	In the "DIP Settings" tab page
2400	IE>>>> Start	IE>>>>	Out of Service (outserv)	
2401	IE>>>>	IE>>>>	Pickup Current (Ipset)	
2403	IE>>>> sensitive	IE>>>>	Pickup Current (Ipset)	
2405	IE>>>> sensitive	IE>>>>	Pickup Current (Ipset)	
2411	tIE>>>> Time	IE>>>>	Time Setting (Tset)	
2433	Value for IE>>>>	Value for IE>>>>	I0meas (I0meas)	In the "DIP Settings" tab page
2437	IE>>>> Start	Blockage IE>>>> - IE>>>> Start	ILStart (ILStart)	In the "DIP Settings" tab page
2440	Value for IE>>>>	Value for IE>>>>	Use1stharmonic (Use1stharmonic)	In the "DIP Settings" tab page
2441	Corr.IE>>>> by IEmeas	Value for IE>>>>	Corr_IEMMMMbyIEmeas(Corr_IEMMMMbyIEmeas)	In the "DIP Settings" tab page
2498	Blockage IE>>>>	Blockage IE>>>> - IE>>>> Start	Extblock (extblock)	In the "DIP Settings" tab page

3.6 Ineg subrelay

The *Ineg* subrelay contains the negative sequence protective logic.

3.6.1 Available Units

- One inverse time negative sequence overcurrent element ("Ineg>" block).
- One time defined negative sequence overcurrent element ("Ineg>>" block).
- One configuration interface element ("Blockage Ineg" block).
- One logic elements ("const" block).
- One output logic element ("Output Logic" block).

3.6.2 Functionality

The *Ineg* subrelay models a inverse time negative sequence overcurrent element and a definite time negative sequence overcurrent element. Each element can be blocked by an unique relay input signal and for each element the user can decide if the input block signal is active. In the "Blockage Ineg" block the *BlockageInegM* dip switch allows to ignore the input block signal for the "Ineg>" element and the *BlockageInegMM* dip switch inhibits the blocking for the "Ineg>>" element.

The inverse time element supports the definite time characteristic and the following inverse time trip characteristics:

- Inverse
- Very Inverse
- Extremely Inverse
- Longtime inverse

The inverse time element trip characteristic equations comply with the IEC standard equations.

3.6.3 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
3100	Ineg> Start	Ineg>	Out of Service (outserv)	In the "DIP Settings" tab page
3198	Blockage Ineg>	Blockage Ineg	Blockage_InegM (Blockage_InegM)	
3132	Ineg> Timer Module	Ineg>	Characteristic (pcharac)	
3101	Ineg> Definite Time	Ineg>	Current Setting (Ipset)	
3102	Ineg> Inverse Time	Ineg>	Current Setting (Ipset)	
3111	tlneg> Time	Ineg>	Time Dial (Tpset)	
3112	tlneg> Time Factor	Ineg>	Time Dial (Tpset)	
3113	tlneg> max Time Delay	Ineg>	Max. Time (udeftmax)	
3200	Ineg>> Start	Ineg>>	Out of Service (outserv)	
3298	Blockage Ineg>>	Blockage Ineg	Blockage_InegMM (Blockage_InegMM)	In the "DIP Settings" tab page
3201	Ineg>>	Ineg>>	Pickup Current (Ipset)	
3211	tlneg>> Time	Ineg>>	Time Setting (Tset)	

3.7 Overload subrelay

The *Overload* subrelay contains the thermal image protective logic.

3.7.1 Available Units

- One thermal image element with selectable cooling logic ("Overload protection" block).
- Two thermal warning threshold elements ("Therm. Warn.Level 1", and "Therm. Warn.Level 2" block).
- One maximum allowed current threshold element ("OLoadProt. up to I_{max}" block).
- Two configuration interface elements ("O.loadProt. Current", and "Blockage therm. TRIP" block).
- Three logic elements ("const", "Max I logic", and "Imult" block).
- One output logic element ("Output Logic" block).

3.7.2 Functionality

The *Overload* subrelay implements a thermal replica with "memory", i.e. taking the preload into account in accordance with IEC 60255-8 or EN 60255-8. The r.m.s. values of the highest phase current or of the measured earth fault current are used. It's possible to insert a current threshold which permits limitation up to which current the replica is to be filled.

Three thermal image characteristics can be used:

- $\tau(I < I_{min})$ τ Single characteristic with identical warm-up and cooling time constant
- $\tau(I < I_{min}) C_f \tau$ Single characteristic with different cooling time constant, i.e. warming time constant multiplied by the cooling factor of the overload protection "4106 Cftherm standing" in dead state ($I < I_{min}$ = motor at standstill).
- $\tau(I > 1.18 \text{ kIn}) 600s$ Two-part warm-up characteristic. Part 1 is effective with preset warm-up time constant up to $I < 1.18 \text{ kIn}$. As of $I > 1.18 \text{ kIn}$, the warm-up time constant $\tau = 600 \text{ s}$ is used, so that tripping is ensured with approx. 110 s at $I = 1.36 \text{ kIn}$.

The overload trip logic is inhibited by the *extblock* input signal. The signal can be ignored setting equal to *off* the *BlockagethermTRIP* dip switch in the "Blockage therm. TRIP" block.

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
4100	Overload Protection	Overload protection	Out of Service (outserv)	In the "DIP Settings" tab page. Set the dip <i>on</i> to use the measured earth current
4137	O.loadProt. Current	O.loadProt. Current	MeasuredEarthCurrent (MeasuredEarthCurrent)	
4101	k Pickup Factor	Overload protection	Current Setting (Ipset)	
4102	tau therm.Timeconst.	Overload protection	Time Dial (Tpset)	
4111	OLoadProt. up to I _{max}	OLoadProt. up to I _{max}	Pickup Current (Ipset)	
4134	Characteristic	Overload protection	Characteristic (pcharac)	
4106	Cftherm standing	Overload protection	Reset Delay (ResetT)	
4131	Therm. Warn.Level 1	Therm. Warn.Level 1	Out of Service (outserv)	
4108	Therm. Warn.Level 1	Therm. Warn.Level 1	Pickup Current (Ipset)	
4132	Therm. Warn.Level 2	Therm. Warn.Level 2	Out of Service (outserv)	
4109	Therm. Warn.Level 2	Therm. Warn.Level 2	Pickup Current (Ipset)	In the "DIP Settings" tab page.
4196	Blockage therm. TRIP	Blockage therm. TRIP	BlockageThermTRIP (BlockageThermTRIP)	

3.8 CBF subrelay

The *CBF* subrelay implements a simplified version of the circuit breaker failure logic.

3.8.1 Available Units and input signals

The *CBF* subrelay contains the following elements:

- One minimum current definite time threshold element ("IminCBF" block).
- One timer ("tCBF intern" block).
- One configuration interface element ("Blockage CBF" block).
- One output logic element ("Output Logic" block).

The following input signals are used

- *wtrip*: the trip input signals which is *on* when at least one protective element of the Sprecher SPRECON-E-P DS relay model is tripped.
- *labs_A*; *labs_B*; *labs_C*: the phase currents measured by the relay model.
- *extblock*: a relay input signal which can be used to inhibit the *CBF* logic.

3.8.2 Functionality

The *CBF* sub relay activates an output signal and operates the associated breaker when both the following conditions are verified:

- The trip input signal remains *on* for a time greater than "tCBF intern " (usually equal to the breaker operating time+ a safety margin).
- At least one phase of a 3 phase currents system remains always greater than "IminCBF" after that the trip signal became *on*.

The operation logic is inhibited by the *extblock* input signal. The signal can be ignored setting equal to *off* the *Blockage_CBF* dip switch in the "Blockage CBF" block.

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 block	Model setting	Note
9300	CB Fail.Protect. CBF	IminCBF	Out of Service (outserv)	In the "DIP Settings" tab page
9398	Blockage CBF	Blockage CBF	Blockage_ CBF	
9308	IminCBF	IminCBF	Pickup Current (Ipset)	
9311	tCBF intern	tCBF intern	Time Setting (Tdelay)	

3.9 Output logic

It represents the output stage of the relay; it's the interface between the relay and the power breaker.

3.9.1 Available elements and relay output signals

The trip logic is implemented by the "Trip Logic" block. 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.

The relay trip output signal is "yout", the relay closing command output signal is "yout1".

3.9.2 Functionality

The "Trip Logic" block collects the trip signals coming from the overcurrent protective elements and, when any protective element trips, operates the power breaker and the "yout" relay output contact.

The trip logic is user configurable and can be set in the "Logic" tab page.

The "Closing Logic" block is controlled by the closing signal coming from the "Reclosing" block and, when a reclosing attempt is initiated, triggers the closing command for the power breaker and operates the "yout1" relay output contact .

3.9.3 Data input

To disable the relay model ability to open the power circuit breaker simply disable the "Trip Logic" block.

To disable the relay model ability to close the power circuit breaker simply disable the "Closing Logic" block.

4 Features not supported

The following features are not supported:

- Capture of external earth-fault directions.
- Teleprotection (TP).
- Current annunciations (2x IL> an, 1x IE> an).
- CB TRIP by external signal.
- Phase-sequence reversal / direction.
- User configurable *Reset Ratio*.

5 References

- [1] Sprecher Automation Deutschland GmbH, Moellendorffstr. 47 10367 Berlin Germany. *SPRECON-E-P-DS6 SERIES ONE-BOX SOLUTIONS WITH COMBINED OVERCURRENT-TIME PROTECTION AND CONTROL*, 2007.
- [2] Sprecher Automation Deutschland GmbH, Moellendorffstr. 47 10367 Berlin Germany. *SPRECON-E-P DS6 PROTECTION AND CONTROL DEVICES OVERCURRENT-TIME PROTECTION User manual for the protection part Structure version 7604 94.2.903.21en from software version 2.06a 2012-10-10 Issue F*, 2012.