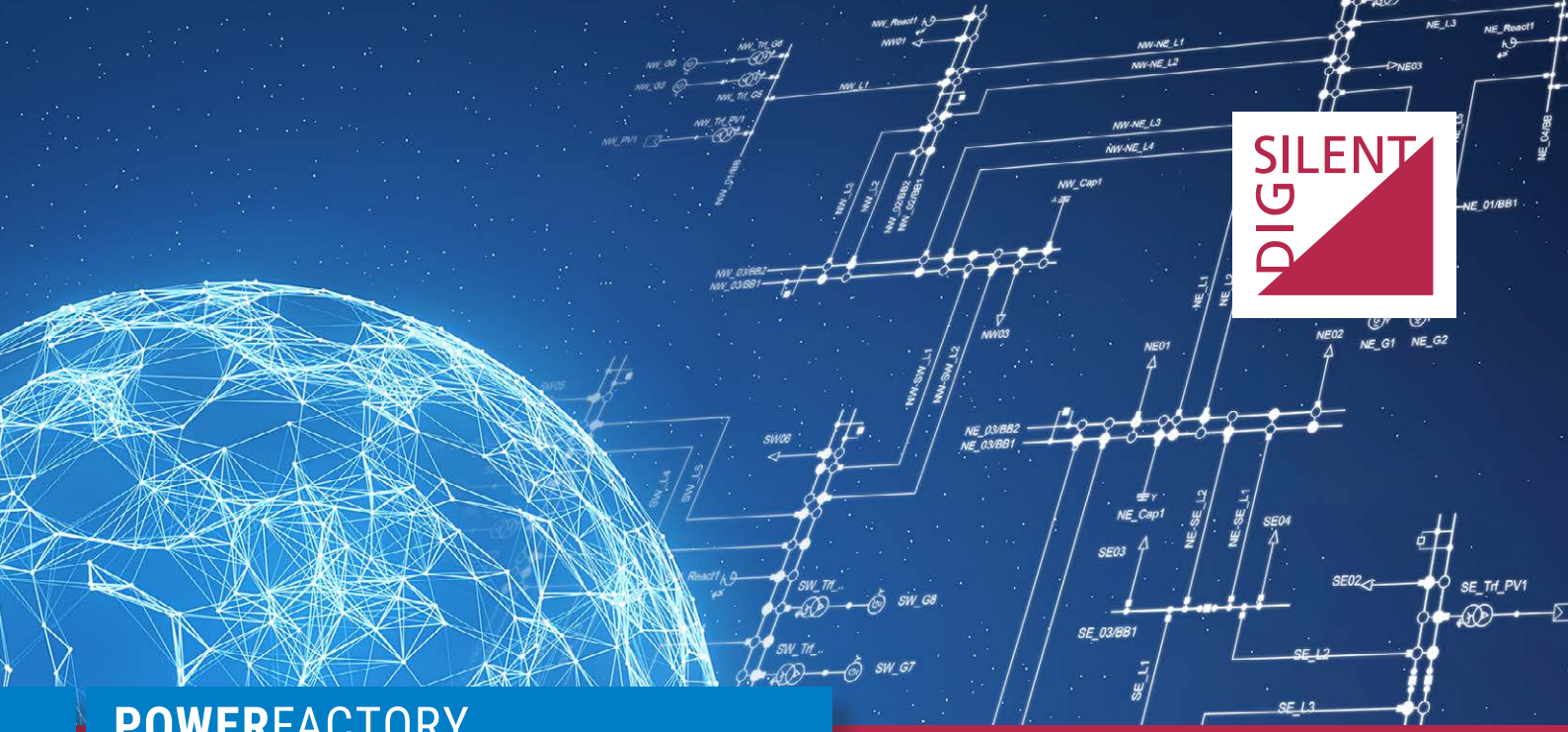

POWERFACTORY

PowerFactory 2021

Technical Reference

Siemens 7UT512

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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Contents

1 Model information

Manufacturer Siemens

Model 7UT512

Variants The Siemens 7UT512 PowerFactory relay model can be used to simulate the different firmware versions of the Siemens 7UT512/513 differential relays. The relay version used to implement the model is Siemens 7UT512 V3.0 . However please consider that the model has been implemented with a reduced set of the features available in the relays.

2 General description

The Siemens 7UT512/7UT513 differential protection relays are used for fast and selective isolation of short-circuits in transformers of all voltage levels and also in rotating electric machines and short lines. Between the available features it's worthwhile to mention the short-circuit protection for two and three-winding transformers with integrated vector group and ratio adaptation, restraint during inrush, overexcitation and CT-saturation, short-circuit protection for generators and motors with high setting sensitivity, overload protection with a thermal characteristic for 2 windings/2 terminations and the two-stage definite-time/inverse-time overcurrent standby protection for one winding.

The Siemens 7UT512 relay has been modeled using one PowerFactory relay model which includes the measurement and acquisition elements, the differential feature, with harmonic restraint and vector group/ratio compensation, some ancillary overcurrent and thermal image elements and the output logic.

The model implementation has been based on the information available in the relay documentation provided by the manufacturer and freely available [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 two elements modeling two 3 phase CTs and by one element modeling one single phase CT; the secondary currents are then measured by four elements modeling the digital filters of the relay.

3.1.1 Available Units

- Two 3 phase current transformers (”Wd_1 Ct” and ”Wd_2 Ct” block).
- One single phase current transformer (”Wd_1 Ct-3I0” block).
- Six measurement elements (”Measure 1”, ”Measure 2”, ”Meas_diff 2nd Harmonic”, ”Meas_diff 3rd Harmonic”, ”Meas_diff 4th Harmonic” and ”Meas_diff 5th Harmonic” block).

3.1.2 Functionality

The ”Wd_1 Ct”, the ”Wd_2 Ct” and the ”Wd_1 Ct-3I0” 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 currents are sampled at 12 samples/cycle.

Two measurement elements (”Measure 1” and ”Measure 2” block) are integrating the current converted by the CTs over a cycle, and the RMS values are provided to the differential element.

The measurement blocks calculate the harmonic components of the differential current calculated by the differential element using a DFT filter operating over a full cycle.

There is one measurement element for each 3 phase Ct, and 4 measurement elements for the differential current each of them is extracting an unique harmonic :

- ”Measure 1” (RMS value of the current converted by ”Wd_1 Ct”).
- ”Measure 2” (RMS value of the current converted by ”Wd_2 Ct”).
- ”Meas_diff 2nd Harmonic” (2^{nd} harmonic of the differential current).
- ”Meas_diff 3rd Harmonic” (3^{rd} harmonic of the differential current).
- ”Meas_diff 4th Harmonic” (4^{th} harmonic of the differential current).
- ”Meas_diff 5th Harmonic” (5^{th} harmonic of the differential current).

3.1.3 Data input

The CT secondary rated current (1 or 5 A) value must be set in the measurement elements (*”Nominal current”* parameter).

3.2 Protective elements

A differential element with an ancillary RMS calculation element simulates the relay differential features. Some auxiliary overcurrent and overload elements are also present in the model.

3.2.1 Available Units

- One 3 phase differential element (”Differential logic” block).
- Two current adapters for the differential element (”Winding 1 Adapter” and ”Winding 2 Adapter” block).
- One measurement element (”Diff RMS meas” block, ancillary to the differential element).
- One 3 phase inverse time overcurrent element (”Iph> ” block).
- Two 3 phase definite time overcurrent element (”I>” and ”I>>” block).
- One ground definite time overcurrent element (”Tank leakage prot” block, fed by the single phase CT).
- One thermal image element (”Thermal overload” block).

3.2.2 Functionality

Differential :

The following features are available in the differential element (”Differential logic” block):

- Double bias current percentage restraint differential with user configurable differential threshold and user configurable restraint slope thresholds.
- Unrestrained differential with user configurable threshold.
- 2^{nd} harmonic restraint of the first differential with user configurable threshold.
- 3^{rd} or 4^{th} or 5^{th} harmonic restraint of the first differential with user configurable threshold.

The two current adapters get the vector values and the RMS values measured by ”Measure 1” and by ”Measure 2” and recalculate them taking care of the different CT ratios, voltage levels and CT winding connections.

The differential element calculates for each phase the average of the currents returned by the adapters (”Winding 1 Adapter” and ”Winding 2 Adapter” block). The average values are then used to calculate the differential threshold considering the user configurable double bias current percentage restrain.

The selection between the three available harmonic restraints (3^{rd} or 4^{th} or 5^{th} harmonic) is made in the ”n. Harmon” block dialog.

The measurement element (”Diff RMS meas” block) is used to calculate the RMS value of the differential current. The differential current vector components (or instantaneous values during the EMT simulation) are calculated by the differential element.

Overcurrent/overload :

The 3 phase inverse time overcurrent element (”Iph> ” block) supports the following inverse characteristics:

- normal inverse (listed as *7UT512 IEC 255-3 ph normal inverse*).
- very inverse (listed as *7UT512 IEC 255-3 ph very inverse*).
- extremly inverse (listed as *7UT512 IEC 255-3 ph extremly inverse*).

The inverse time trip characteristic equations comply with the IEC standard equations. The thermal image element (”Thermal overload” block) models an elemnt using the IEC 255-8 equation. Anyway please consider that the model isn’t supporting the ability to set the *Calculation method for thermal stage* (address 2406) , the *Current warning stage* (ad dress 2405), and the *Thermal warning stage* (address 2404).

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):

Differential :

Address	Relay Setting	Model block	Model Parameter	Note
1102	UN WIND 1	Winding 1 Adapter	Nominal Terminal Line-Line Voltage (LL-Volt)	
1104	IN CT WIN1	Winding 1 Adapter	Current Transformer Ratio (CTratio)	
1121	VECTOR GR2	Winding 1 Adapter	Transformer Group (trasfgroup)	
1122	UN WIND 2	Winding 2 Adapter	Nominal Terminal Line-Line Voltage (LL-Volt)	
1124	IN CT WIN2	Winding 2 Adapter	Current Transformer Ratio (CTratio)	
1601	DIFF PROT.	Differential	Out of Service (outserv)	
1603	I-DIFF>	Differential	Differential Current base threshold (Idiff)	
1604	I-DIFF>>	Differential	Unrestrained Differential threshold (Idiffunrest)	
1606	SLOPE 1	Differential	Restrain Percentage 1 (Irestepercent1)	
1607	BASE PT 2	Differential	Restraint Current 2nd Threshold (Ipset2)	
1608	SLOPE 2	Differential	Restrain Percentage 2 (Irestepercent2)	
1611	2nd HARMON	Differential	2nd Harmonic blocking threshold (H2threshold)	In the ”Harmonic blocking” tab page
1613	n. HARMON	n. HARMON	Activate_3rd_Harmonic Activate_4th_Harmonic Activate_5th_Harmonic	Set equal to 1 the relevant variable in the ”Logic” tab page
1614	n. HARMON	Differential	4th Harmonic blocking threshold (H4threshold)	In the ”Harmonic blocking” tab page
1616	IDIFFmax n	Differential	Harm blocking disabling threshold (hblckdisthr)	In the ”Harmonic blocking” tab page
1625	T-DELAY >	Differential	Time Setting (Tset)	In the model unique parameter shared with 1626

Address	Relay Setting	Model block	Model Parameter	Note
1626	T-DELAY >>	Differential	Time Setting (Tset)	In the model unique parameter shared with 1625
1701	DIFF PROT.	Differential	Out of Service (outserv)	
1703	I-DIFF>	Differential	Differential Current base threshold (Idiff)	
1706	SLOPE 1	Differential	Restrain Percentage 1 (Irestepercent1)	
1707	BASE PT 2	Differential	Restraint Current 2nd Threshold (Ipset2)	
1708	SLOPE 2	Differential	Restrain Percentage 2 (Irestepercent2)	
1725	T-DELAY >	Differential	Time Setting (Tset)	
1801	DIFF PROT.	Differential	Out of Service (outserv)	
1803	I-DIFF>	Differential	Differential Current base threshold (Idiff)	
1806	SLOPE 1	Differential	Restrain Percentage 1 (Irestepercent1)	
1807	BASE PT 2	Differential	Restraint Current 2nd Threshold (Ipset2)	
1808	SLOPE 2	Differential	Restrain Percentage 2 (Irestepercent2)	
1825	T-DELAY >	Differential	Time Setting (Tset)	

Overcurrent/overload :

Address	Relay Setting	Model block	Model Parameter	Note
2101	BACKUP O/CI	I>>	Out of service (outserv)	
		I>	Out of service (outserv)	
		Iph>	Out of service (outserv)	
2103	I>>	I>>	Pickup Current (Ipsetr)	
2104	T-I>>	I>>	Time Setting (Tset)	
2111	CHARACT	Iph>	Characteristic (pcharac)	
2112	I>	I>	Pickup Current (Ipsetr)	
2113	T-I>	I>	Time Setting (Tset)	
2114	Ip	Iph>	Current Setting (Ipset)	
2115	T-Ip	Iph>	Time Dial (Tpset)	
2401	THERMAL OL	Thermal overload	Out of service (outserv)	
2402	K-FACTOR	Thermal overload	Current Setting (Ipset)	
2403	T-CONSTANT	Thermal overload	Time Dial (Tpset)	
2701	BACKUP O/CI	Tank leakage prot	Out of service (outserv)	
2703	I> TANK	Tank leakage prot	Pickup Current (Ipsetr)	
2704	T-I> TANK	Tank leakage prot	Time Setting (Tset)	

3.3 Output logic

It represents the output stage of the relay; it's the interface between the relay and the power breaker. A set of five relay output contacts is available and can be configured using any custom logic.

3.3.1 Available Units

- One output element (”Logic” block).

3.3.2 Functionality

The ”Logic” block gets the trip signals coming from the differential element and from the overcurrent elements; it operates the relay output contacts and the power breaker.

The following output contacts are available:

- OUT1
- OUT2
- OUT3
- OUT4
- OUT5

They are operated by any (differential element or overcurrent /overload elements) protection element trip. By default the behavior of these output contacts is identical. Any custom relay output logic can be inserted in the ”Logic” tab page of the ”Logic” block.

The relay output contact which operates the breaker is ”OUT1”.

3.3.3 Data input

To disable completely the relay model ability to open the power circuit breaker disable the ”Logic” block.

4 Features not supported

The following features are not supported:

- Winding 3.
- Restricted earth fault protection (optional 7UT513 only).
- Differential cross blocking feature.
- Unrestrained differential element independent time delay.
- External trip function 1 and 2.
- Overcurrent inverse time element reset time setting (address 2118).
- 2^{nd} time overload element.
- Overload element detailed model (calculation method, current & thermal warning stage).

5 References

[1] Siemens, P. O. Box 48 06, D-90026 Nurnberg, Germany. *7UT512/513 differential protection relay (Version V3) for transformers, generators, motors and short lines - Siemens LSA 2.2.4 . May 1996 Order No.: E50001-K5722-A141-A2-7600*, 1995.

[2] Siemens, Dept EV S SUP 21, D-13623 BERLIN, Germany. *Numerical Differential Protection Relay for Transformers, Generators, Motors, and Branch Points 7UT51 V3.0 Order n. C53000-G1176-C99-6*, 1995.