

7UT512/513 differential protection relay (Version V3) for transformers, generators, motors and short lines

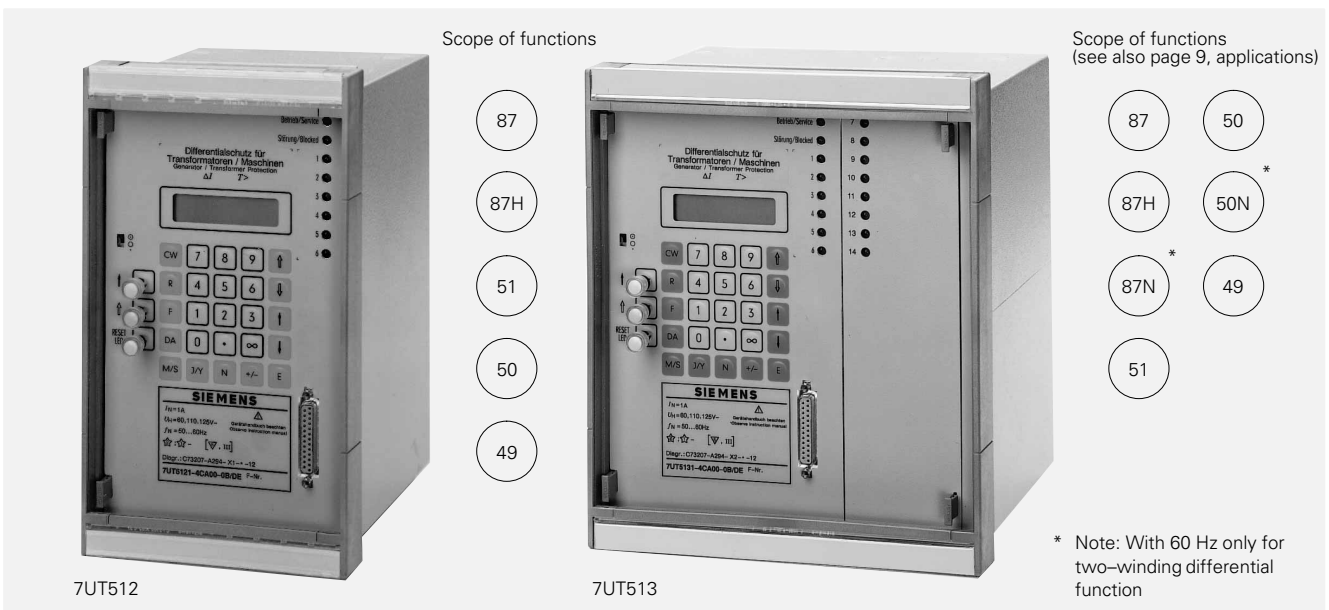


Fig. 1
7UT51 differential protection relays

Application

The 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. The particular application can be chosen by setting. In this way an optimal adaptation of the relay to the protected object can be achieved. The protection relay can be parameterized for use with three-phase and single-phase transformers. In addition to this, a thermal replica is integrated for the supervision of the ohmic losses in the plant. Two variants of the differential relay can be supplied:

The device 7UT512 with a compact design is suited for two-winding transformers as well as for motors or generators and short lines. A standby overcurrent-time protection and two thermal monitoring functions are also integrated.

The larger 7UT513 unit is used for two-winding and three-winding transformers, generators/motors and short two-end and three-end lines. Two thermal monitoring functions are integrated as additional functions. Moreover, as an alternative a standby definite-time/inverse-time overcurrent or a restricted earth fault (REF) or a tank protection function is available for one winding. The 7UT513 can also be used where the neutral point current of the transformer must be acquired or more inputs and outputs are required than are provided by the 7UT512.

The device can interface with conventional control systems or alternatively be integrated in the modern SINAUT LSA substation control system.

Construction

Within its compact construction, the device contains all the components required for capture and evaluation of measurands, operator panel and display field, alarm and command outputs, binary inputs, serial interfaces and power supply converter.

The device can be supplied in three case variations. The model for panel surface mounting is supplied with two-tier terminals accessible from the front. The variants for panel flush mounting or cubicle mounting have rear connection terminals and are available with or without glass cover.

Mode of operation

The 7UT51 differential protection units have a complete, digital analog value processing function ranging from sampling and digitizing the analog values to operating decisions for the circuit-breaker. Digital techniques in the measurement process extensively suppress the influence of switching currents (inrushes), high-frequency transients, transient DC current components and varying degrees of CT saturation.

Features

- 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
- Two-stage definite-time/inverse-time overcurrent standby protection for one winding. On the basis of the 7UT513 hardware, a restricted earth fault protection or a sensitive, definite time overcurrent for one starpoint (tank protection) is available as an alternative.
- Direct injection of two external open commands.
- Marshallable binary inputs, LEDs, alarm and tripping relays.
- Operational current measurement.
- Realtime clock and permanently stored operational and fault indications in the event of auxiliary voltage failure. Previous substation control interface (Siemens-specific) or IEC 870-5-103 VDEW interface (standard of the Association of German Power Utilities) up to 8 faults to the substation control and protection.
- Fault recording
- Commissioning aid.

Serial interfaces

The device has two serial interfaces.

The operator interface for the connection of an AT-compatible PC is arranged at the front. An operator program DIGSI is available for comfortable and easy setting, fault recording, evaluation and commissioning. On software version V3 and higher of the 7UT51, the unit can be operated via the substation control interface using the DIGSI V3 operating program.

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The substation control interface is a 820 nm fibre-optic interface for connecting to the SINAUT LSA substation protection system or other substation control system with IEC 870-5-103 standard interface. Alternatively this can be an isolated V.24/V.28 interface (RS 232C) (protocol either Siemens-specific or according to IEC-870-5-103 recommendation).

Settings

All setting parameters can be input by means of the integrated operator panel and display field or a PC under user control. The parameters are stored in a non-volatile memory, so that they cannot get lost even during interruption of the supply voltage.

Self monitoring

Hardware and software are monitored continuously and any irregularities are immediately detected and alarmed. As a result, the security, reliability and availability are significantly improved.

Differential protection for transformers

When the 7UT51 is employed as fast and selective short-circuit protection for two respectively three-winding transformers the following properties apply:

- Tripping characteristic according to Fig. 3
- Vector group and ratio adaptation
- Depending on the treatment of the transformer neutral point, neutral current elimination can be with or without consideration of the neutral current. With the 7UT513, the neutral current at the neutral CT can be measured and considered in the treatment of this current, which increases sensitivity by one third for single-pole faults.
- Fast clearance of heavy internal transformer faults.
- Restrain of inrush current with 2nd harmonic. Cross-block function that can be limited in time.
- Restrain against over fluxing with a choice of 3rd or 5th harmonic stabilization is only active up to a settable value for the 50 Hz component of the differential current.
- Additional restrain for an external fault with current transformer saturation (CT-saturation detector).
- Insensitivity to DC current elements and current transformer faults due to the freely programmable response characteristic.
- The differential protection function can be externally blocked by means of a binary input.

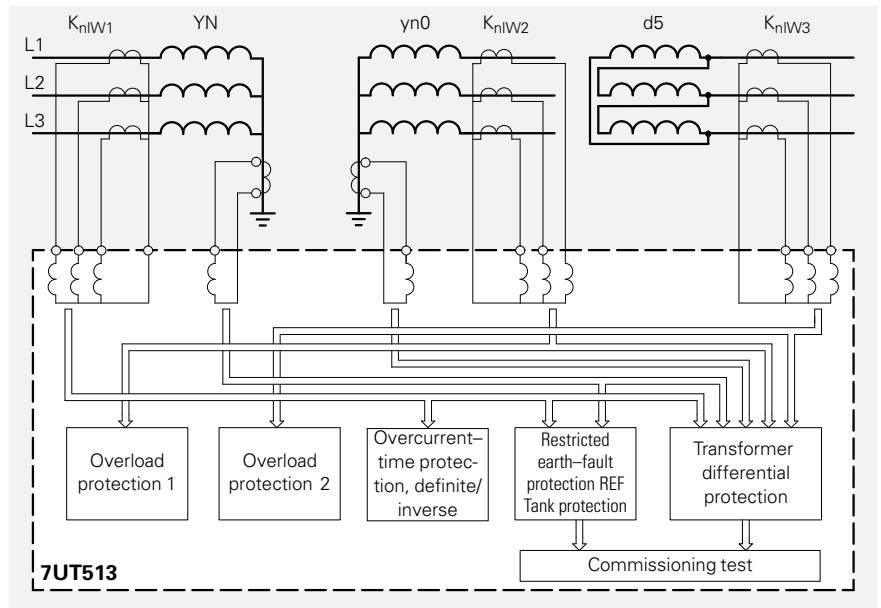


Fig. 2 Functions of the differential protection (DMT or REF)

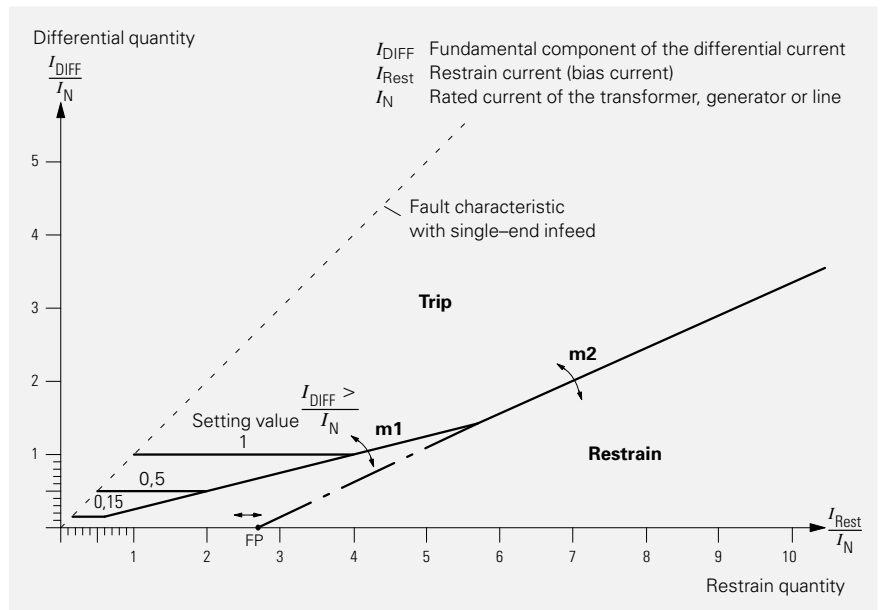


Fig. 3 Response characteristic with preset transformer parameters for two-phase faults

Differential protection for generators/ motors

When the 7UT51 is employed as fast and selective short-circuit protection for generators or motors the following properties apply:

- Tripping characteristic according to Fig. 3
- Short response times within one system cycle.
- Monitoring of the incoming lines for wire break (for short lines).
- Additional restrain for external faults with current transformer saturation.

Commissioning aids

The resolution of the display of the operational, restrain and differential currents is selected such that commissioning is possible using the low-voltage method without additional measuring instruments.

In addition to the absolute value of the operational currents, the phase angle of the currents between the windings is also displayed. Moreover, the protection function calculates the values of the differential and restrain current.

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Thermal overload protection

The thermal replica evaluates the largest phase current of a selectable set of CT secondary currents. The tripping characteristics (Fig. 4) are exponential functions according to IEC 255-8 standards and take into account the I^2R losses due to the particular operational current and the simultaneous cooling due to the coolant. In this way the tripping time during an overload condition takes the pre-load into consideration. An alarm stage can be set to operate before reaching the tripping condition.

Backup overcurrent-time protection for one winding or one end

As backup protection, overcurrent-time protection with a choice of definite-time or inverse-time characteristic is available. The definite-time and inverse-time protection has two stages, i.e. there is not only an overcurrent stage ($I >$) but also a high current stage ($I \gg$). Both stages can be blocked via the binary input. The response value of the standby protection is derived from the measured phase currents for one winding or one end.

Restricted earth fault protection (REF)

Restricted earth fault protection (REF) is used with earth transformer windings or coil arrangements with a common neutral point. The winding can be more sensitively protected by the measuring principle than by differential protection because the sum of the phase currents is compared with the measured zero current. For example, the interturn fault against earth, which is hardly noticeable in the differential current, can frequently be detected by the REF. With this method, the absolute value and phase angle of the fundamental of the zero current is compared with the absolute value and phase angle of the sum of the line currents. This results in a high degree of stability during equalization processes.

Tank protection monitors the current between earth and transformer tank mounted in an isolated fashion with a sensitive input winding. The response value can be set in a milliamperere range.

One of these functions can be set in the 7UT513 as an alternative to the standby protection. The sensitive measuring input of the tank protection is an ordering option (2 in the 13th position of the order number).

Note: For 60 Hz and three winding differential protection the REF and tank protection cannot be used parallel to the differential protection.

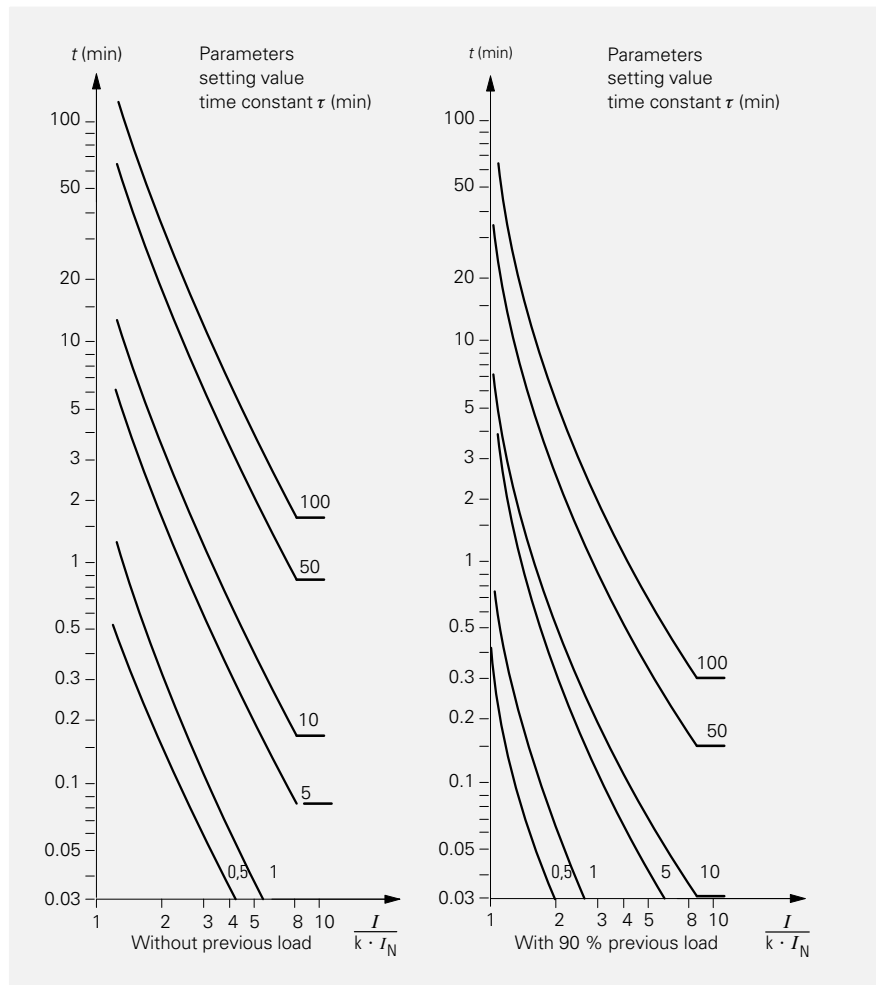


Fig. 4 Thermal overload trip-time characteristic

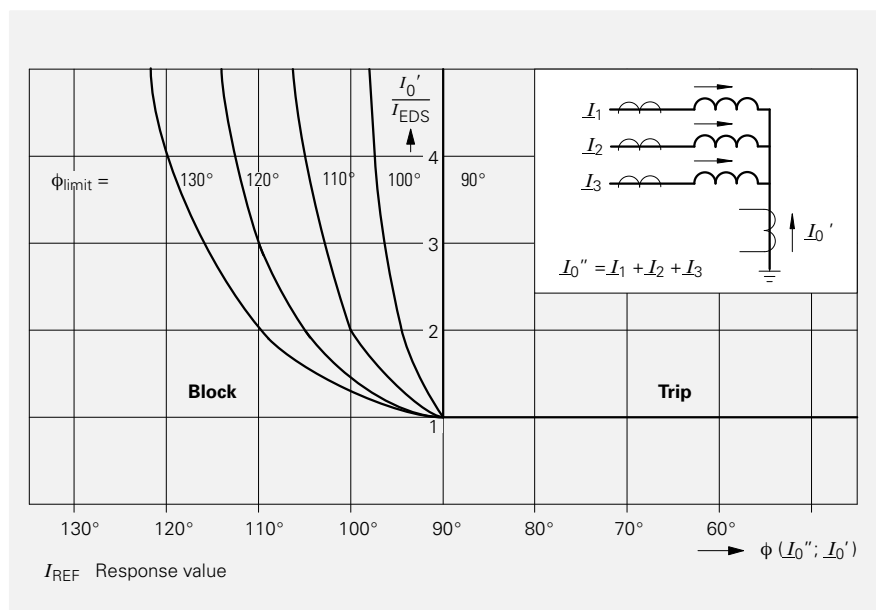


Fig. 5 Tripping characteristic as a function of the phase angle between I_0'' and I_0' at $I_0'' = I_0'$ ($180^\circ =$ external fault)

Differential Relays

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Marshallable event/alarm relays, LEDs, binary inputs

To enable user specific indication and/or output of alarms these are supplied fully marshallable. Individual events can be grouped together to form a group alarm.

Indications

The 7UT51 provides detailed data for the analysis of faults and to check states during operations. All indications subsequently listed are backed up in the event of a supply voltage failure.

- Clock time
The standard version contains a battery-backed clock that can be synchronized via the binary input or the substation control interface. A date and time are assigned to all indications with millisecond resolution.

- Fault indications
The last three fault indications are available for the faults stored in the unit.
- Operational indications
All indications that are not directly associated with the fault are stored in the operational indication buffer.

Fault recording

The sampling values of the currents measured at the transformer are stored if a fault occurs. It is also possible to initiate fault recording on energization so that, for example, an inrush current can be recorded during commissioning. The current can be transferred to a PC or read out via the SINAUT LSA substation control and protection. If the IEC 870–5–103 standard interface is used, up to eight fault recordings can be stored. The fault recording buffer is a ring buffer with a maximum length. The oldest fault being overwritten by each new fault.

Coupling of external binary signals

For the processing of external signals or commands such as reverse interlocking, Buchholz alarm, temperature limit monitoring, tank pressure switch etc. The associated events/alarms can be transmitted via the serial system interface to a central device such as for example a SINAUT LSA or a central data protection device via alarm or tripping relays and LED's for local indication.

Technical data

Input circuits	Rated current I_N Rated frequency f_N , can be parameterized Overload capability current inputs, <table style="margin-left: 20px;"> <tr> <td style="text-align: right;">thermal</td> <td>continuous</td> <td></td> </tr> <tr> <td></td> <td>10 s</td> <td>$4 \times I_N$</td> </tr> <tr> <td></td> <td>1 s</td> <td>$30 \times I_N$</td> </tr> <tr> <td></td> <td></td> <td>$100 \times I_N$</td> </tr> <tr> <td style="text-align: right;">dynamic</td> <td>half cycle</td> <td>$250 \times I_N$</td> </tr> </table> Burden current inputs <table style="margin-left: 20px;"> <tr> <td></td> <td>at $I_N = 1 \text{ A}$</td> <td>$< 0.1 \text{ VA}$</td> </tr> <tr> <td></td> <td>at $I_N = 5 \text{ A}$</td> <td>$< 0.5 \text{ VA}$</td> </tr> </table>	thermal	continuous			10 s	$4 \times I_N$		1 s	$30 \times I_N$			$100 \times I_N$	dynamic	half cycle	$250 \times I_N$		at $I_N = 1 \text{ A}$	$< 0.1 \text{ VA}$		at $I_N = 5 \text{ A}$	$< 0.5 \text{ VA}$	1 or 5 A (commutable, for mixed 1 A/5 A primary CTs order a 5 A relay) 50, 60 or $16 \frac{2}{3} \text{ Hz}$
thermal	continuous																						
	10 s	$4 \times I_N$																					
	1 s	$30 \times I_N$																					
		$100 \times I_N$																					
dynamic	half cycle	$250 \times I_N$																					
	at $I_N = 1 \text{ A}$	$< 0.1 \text{ VA}$																					
	at $I_N = 5 \text{ A}$	$< 0.5 \text{ VA}$																					
DC voltage supply	Rated auxiliary voltage V_{aux} Permissible rated auxiliary voltage ranges Permissible max. ripple Power consumption of 7UT512 <table style="margin-left: 20px;"> <tr> <td style="text-align: right;">at rated auxiliary voltage</td> <td>quiescent</td> <td></td> </tr> <tr> <td></td> <td>energized</td> <td>approx. 9 W</td> </tr> <tr> <td style="text-align: right;">of 7UT513</td> <td>quiescent</td> <td>approx. 11 W</td> </tr> <tr> <td></td> <td>energized</td> <td>approx. 10 W</td> </tr> <tr> <td></td> <td></td> <td>approx. 15 W</td> </tr> </table> Stored energy time at $V_{aux} \geq 110 \text{ V}$	at rated auxiliary voltage	quiescent			energized	approx. 9 W	of 7UT513	quiescent	approx. 11 W		energized	approx. 10 W			approx. 15 W	24, 48 V or 60, 110, 125 V or 220, 250 V 19 to 56 V 48 to 144 V 176 to 288 V $\leq 12 \%$ $\leq 50 \text{ ms}$						
at rated auxiliary voltage	quiescent																						
	energized	approx. 9 W																					
of 7UT513	quiescent	approx. 11 W																					
	energized	approx. 10 W																					
		approx. 15 W																					
Binary inputs	7UT512 7UT513 DC operating voltage Current input	marshallable marshallable	2 5 24 to 250 V approx. 2.5 mA																				
Alarm contacts	Number of malfunction alarm relays not marshallable Number of alarm relays 7UT512 7UT513 Contacts per relay Switching capacity make/break Switching voltage Permissible current	marshallable marshallable	1 4 10 see connection diagrams 20 W/VA 250 V AC/DC 1 A																				
LED displays	Ready for operation Internal fault Marshallable LEDs 7UT512 7UT513	green red red red	1 1 6 14																				

Differential Relays

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Technical data (continued)

EMC-tests; emission (typ tests) Standard: EN 50081-2 (generic standard)	Conducted interference voltage, auxiliary voltage CISPR 11, EN 55011, class A and DIN VDE 0875 part 11, class A Interference field strength CISPR 11, EN 55011, class A and DIN VDE 0875 part 11, class A	150 kHz to 30 MHz 30 to 1 000 MHz
Climatic stress tests	permissible ambient temperature permissible humidity	during service during storage during transport -5 to +55 °C -25 to +55 °C -25 to +70 °C mean value per year ≤ 75 % relative humidity, on 30 days per year up to 95 % relative humidity, condensation not permissible
Mechanical stress tests IEC 255-21-1, IEC 68-2	permissible mechanical stress	during service during transport 10 to 60 Hz, 0,035 mm amplitude 60 to 500 Hz, 0,5 g acceleration 5 to 8 Hz, 7,5 mm amplitude 8 to 500 Hz, 2 g acceleration
Differential protection for transformers	Setting ranges Differential current $I_{DIFF} > I_N$ Steps 0.01 High current $I_{DIFF} \gg I_N$ Steps 0.1 Inrush stabilization I_{2fN}/I_{fN} Steps 1 % Overexcitation stabilization I_{5fN}/I_{fN} Steps 1 % Response times (single-sided infeed) at $I_{DIFF} \geq 1.5 \times$ set value $I_{DIFF} >$ at $16^{2/3}$; 50; 60 Hz at $I_{DIFF} = 1.5 \times$ set value $I_{DIFF} \gg$ at $16^{2/3}$; 50; 60 Hz at $I_{DIFF} = 5 \times$ set value $I_{DIFF} \gg$ at $16^{2/3}$; 50; 60 Hz Additional time delay for tripping Reset time Drop-out to pick-up ratio Tolerances Tripping characteristic Inrush stabilization Additional time delay Frequency range Accuracy	0.15 to 2 0.8 to 20 10 to 80 % 10 to 80 % (alternatively with 3 rd or 4 th harmonic) approx. 85; 35; 35 ms approx. 55; 25; 25 ms approx. 25; 17; 16 ms 0 to 60 ms approx. 100 ms approx. 0.7 ± 3 % of specified value for $I < 5 I_N$ ± 3 % of set value ± 1 % or 10 ms $0.95 \leq f/f_N \leq 1.05$ ≤ 1 % of tripping characteristic
Differential protection for transformers generators, motors and short lines	Setting range Differential current $I_{DIFF} > I_N$ Steps 0.01 Response times (single-sided infeed) at $I_{DIFF} \geq 1.5 \times$ set value $I_{DIFF} >$ at $16^{2/3}$; 50; 60 Hz at $I_{DIFF} = 5 \times$ set value $I_{DIFF} >$ at $16^{2/3}$; 50; 60 Hz Reset time Drop-out to pick-up ratio Tolerances tripping characteristic Frequency range Accuracy at 0.8 to $1.2 f_N$ Accuracy at 0.5 to 0.8 or 1.2 to $1.4 f_N$	0.05 to 1 approx. 70; 25; 25 approx. 25; 17; 15 to 17 ms approx. 100 ms approx. 0.7 ± 3 % of specified value for $I < 5 I_N$ $0.5 \leq f/f_N \leq 1.4$ ≤ 3 % of tripping characteristic ≤ 30 % of tripping characteristic
Overload protection	Setting ranges Factor k acc. to IEC 255.8 Steps 0.01 Time constant τ Steps 0.1 min Temperature alarm stage $\theta_{Alarm}/\theta_{Off}$ Trip temperature Current dependent alarm stage I_{Alarm} Thermal image Drop-out to pick-up ratio Tolerances Frequency range Accuracy	0.1 to 4 0.5 to 999.9 min 70 to 100 % $I_{Alarm} \geq I_{max} = k \cdot I_N$ $t = \tau \ln \frac{I^2 - I_{pre}^2}{I^2 - (k \cdot I_N)^2}$ θ/θ_{Alarm} approx. 0.99 θ/θ_{Off} approx. 0.99 I/I_{Alarm} approx. 0.99 Class 5 % acc. to IEC $0.95 \leq f/f_N \leq 1.05$ ≤ 1 % of tripping characteristic
Overcurrent-time protection, setting ranges Overcurrent-time protection, definite time	High set current phase $I \gg$ Overcurrent phase $I >$ Delay times $t_{>}$, t_{\gg} Tolerances Current pick-up value Time Release value times	$I/I_N = 0.1$ to 30 $I/I_N = 0.1$ to 30 0 to 32 s or inactive ± 3 % of the setting value ± 1 % or ± 10 ms approx. 35 ms

7UT512/513 differential protection relay (Version V3) for transformers, generators, motors and short lines

Technical data (continued)

Overcurrent–time protection, setting ranges (continued) Overcurrent–time protection, inverse time	Overcurrent phase Time multiplier t_p Energization threshold Characteristics according to IEC 255–4, Section 3.5.2 or BS142 Linear measuring range Tolerances Energization threshold Timing	$I_p/I_N = 0.1$ to 20 0.5 to 32 s $1.1 \times I_p$ $40 \times I_N$ $\pm 5\%$ $\pm 5\%$ for $2(I/I_p) < 20$ and $t_p = 1$ 30 ms
Setting ranges Restricted earth–fault protection Tank protection (normal) sensitive one stage definite time overcurrent for on star–point CT)	Response value I_{REF}/I_N Phase angle Response time for $5 \times I_{REF}$ at 50; 60 Hz Response value Sensitive, normal input transformer $I >$ Response time for $5 \times$ response value at $16^{2/3}$; 50, 60 Hz Delay time $t_d >$ Note: For three winding differential protection the REF and tank protection do not work parallel to differential protection	$I_{REF} = 0.05$ to 2 90 to 135° in steps of 10° approx. 25; 17 ms 10 to 1000 mA; 0.1 to $10 \times I_N$ approx. 25; 20; 20 ms 0 to 60 s
Measuring transducer/operational measurement	Load currents primary secondary tertiary with 7UT513 Measuring range Tolerance Overload protection values Winding temperature Measuring range Tolerance	$I_{L1}; I_{L2}; I_{L3}$ $I_{L1}; I_{L2}; I_{L3}$ $I_{L1}; I_{L2}; I_{L3}, I_{E1}, I_{E2}$ 0 to 240 % I_N $\leq 2\%$ of rated value θ/θ_{Off} calculated 0 to 240 % $\leq 3\%$ referred to θ_{Off}
Fault logging	Storage Fault recording on the high–voltage side on the low–voltage side tertiary (for 7UT513) Max. storage time at $16^{2/3}$; 50; 60 Hz Time resolution of the Instantaneous values at $16^{2/3}$; 50; 60 Hz	Up to last 8 faults $I_{L1}; I_{L2}; I_{L3}$ $I_{L1}; I_{L2}; I_{L3}$ $I_{L1}; I_{L2}; I_{L3}, I_{E1}, I_{E2}$ 15; 5; 4.1 s 5; 1.66; 1.39 ms

Differential Relays

7UT512/513 differential protection relay (Version V3) for transformers, generators, motors and short lines

Selection and ordering data

7UT512/513 differential protection relay	Order No. 7UT51 □ - □ B □ 1 - □ A 0
Application for Two-winding transformer or machine or short two-end line Two-winding/three-winding transformer or machine or short two-/three-line	↑ ↑ ↑ ↑ ↑ ↑ ↑ 2 3 1 2 4 5
Rated current at 50/60 Hz AC, 16 ^{2/3} 1 A 5 A	↑ 1 5
Rated auxiliary voltage 24, 48 V DC 60, 110, 125 V DC 220, 250 V DC	↑ ↑ ↑ 2 4 5
Construction For panel flush mounting or cubicle mounting For panel surface mounting For panel flush mounting or cubicle mounting, without glass cover	↑ ↑ ↑ C D E
Country-specific presetting German/English, 50 Hz (switchable for each parameter to 16 ^{2/3} and 60 Hz)	↑ 0
Additional functions Overcurrent-time protection, two overload functions (standard on 7UT512) Overcurrent-time protection or restricted earth-fault protection, two overload functions (standard on 7UT513) Overcurrent-time protection (phase) or normal/sensitive overcurrent (earth), two times overload protection (one sensitive measuring input for 7UT513)	↑ ↑ ↑ 0 1 2
Serial system interface Without Electric according RS 232 Fibre optic interface (820 nm)	↑ ↑ ↑ A B C

Operating program DIGSI¹⁾

DIGSI Version V3 for Windows, full version for 10 PC's and update for 3 years,	German English	7XS5020-0AA00 7XS5020-1AA00
DIGSI Version V3 for Windows, demo-/testversion,	German English	7XS5021-0AA00 7XS5021-1AA00

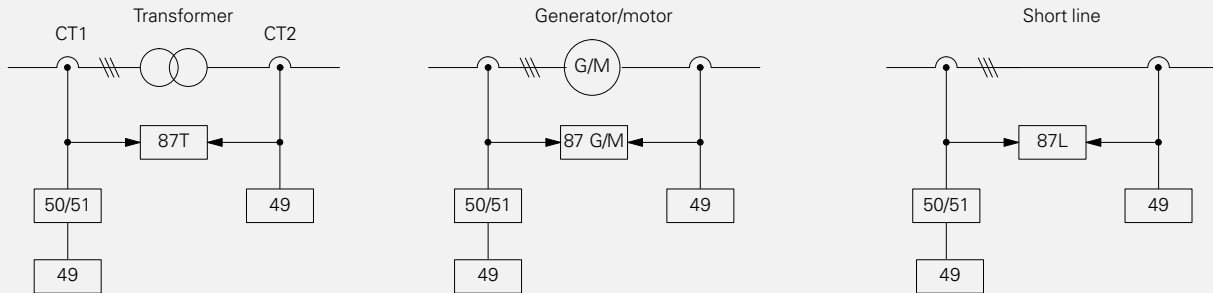
Documentation

English: Catalog LSA 2.2.4: 7UT512/513 (V3) Differential protection relay for transformers, generators, motors and short lines Manual: 7UT512/513 (V3) Numerical differential protection for transformers, generators, motors and short lines	E50001-K5722-A141-A2-7600 C53000-G1176-C99-2
German: Katalogblatt LSA 2.2.4: Differentialschutz 7UT512/513 (Version V3) für Transformatoren, Generatoren, Motoren und kurze Leitungen Handbuch: Digitaler Differentialschutz 7UT512/513 (Version V3) für Transformatoren, Generatoren, Motoren und kurze Leitungen	E50001-K5722-A141-A2 C53000-G1100-C99-2
Spanish: Catálogo LSA 2.2.4: Protección diferencial 7UT512/513 (version V3) para transformadores, generadores, motores y líneas cortas	E50001-K5722-A141-A2-7800

1) German and English available, other languages on request.

7UT512/513 differential protection relay (Version V3) for transformers, generators, motors and short lines

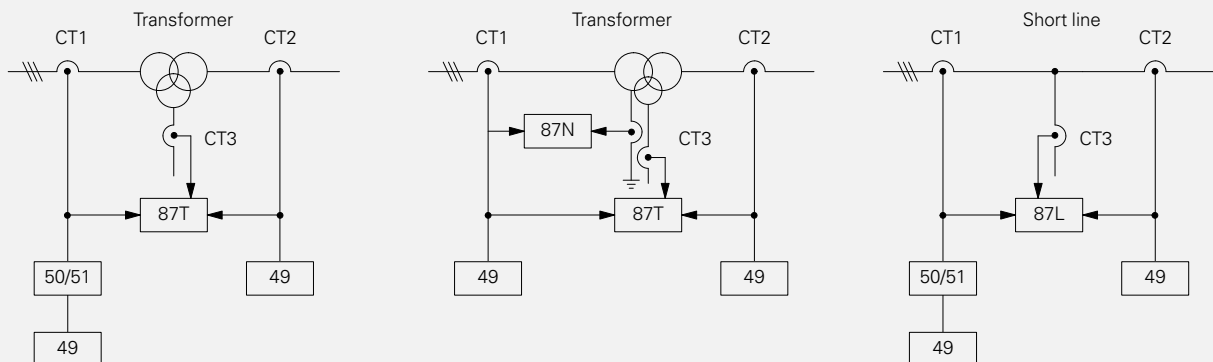
7UT512xx-xxBx-0xA0



Note:

(50/51) and (49) can freely be assigned to CT1 or CT2 of protected device. The 7UT512 selects the appropriate set of measured currents for each protection function depending on the above assignment.

7UT513xx-xxBx-1xA0

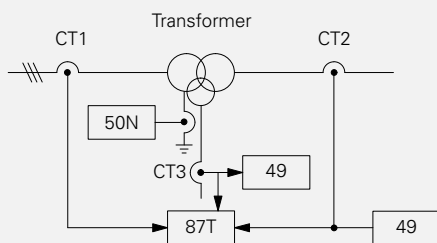


(50/51) and (49) can freely be assigned to CT1, CT2 or CT3.

(87N) and (49) can freely be assigned to CT1, CT2 or CT3.

(50/51) and (49) can freely be assigned to CT1, CT2 or CT3.

7UT513xx-xxBx-2xA0



(50N) is available as normal/sensitive function.
49 can freely be assigned to CT1, CT2 or CT3.

- 49 Thermal relay
- 50/51 Two step time overcurrent relay
- 50N Tank protection as single step definite time overcurrent relay (optional sensitive)
- 87N Restricted earth fault protection
- 87T Transformer differential relay

Fig. 6
Applications

7UT512/513 differential protection relay (Version V3) for transformers, generators, motors and short lines

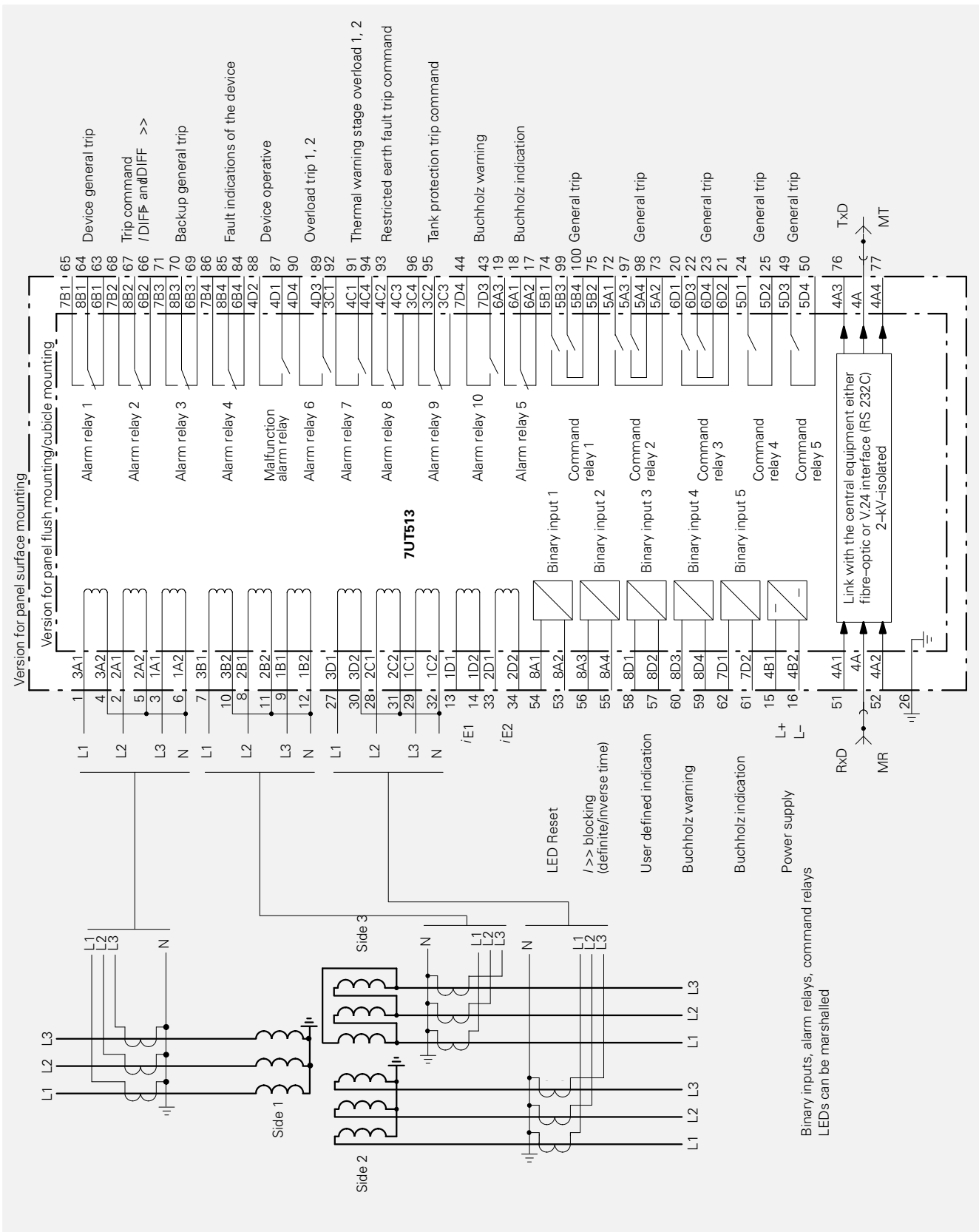


Fig. 8 Connection diagram for 7UT513 differential protection relay with overcurrent standby and two overload functions

Differential Relays

7UT512/513 differential protection relay (Version V3) for transformers, generators, motors and short lines

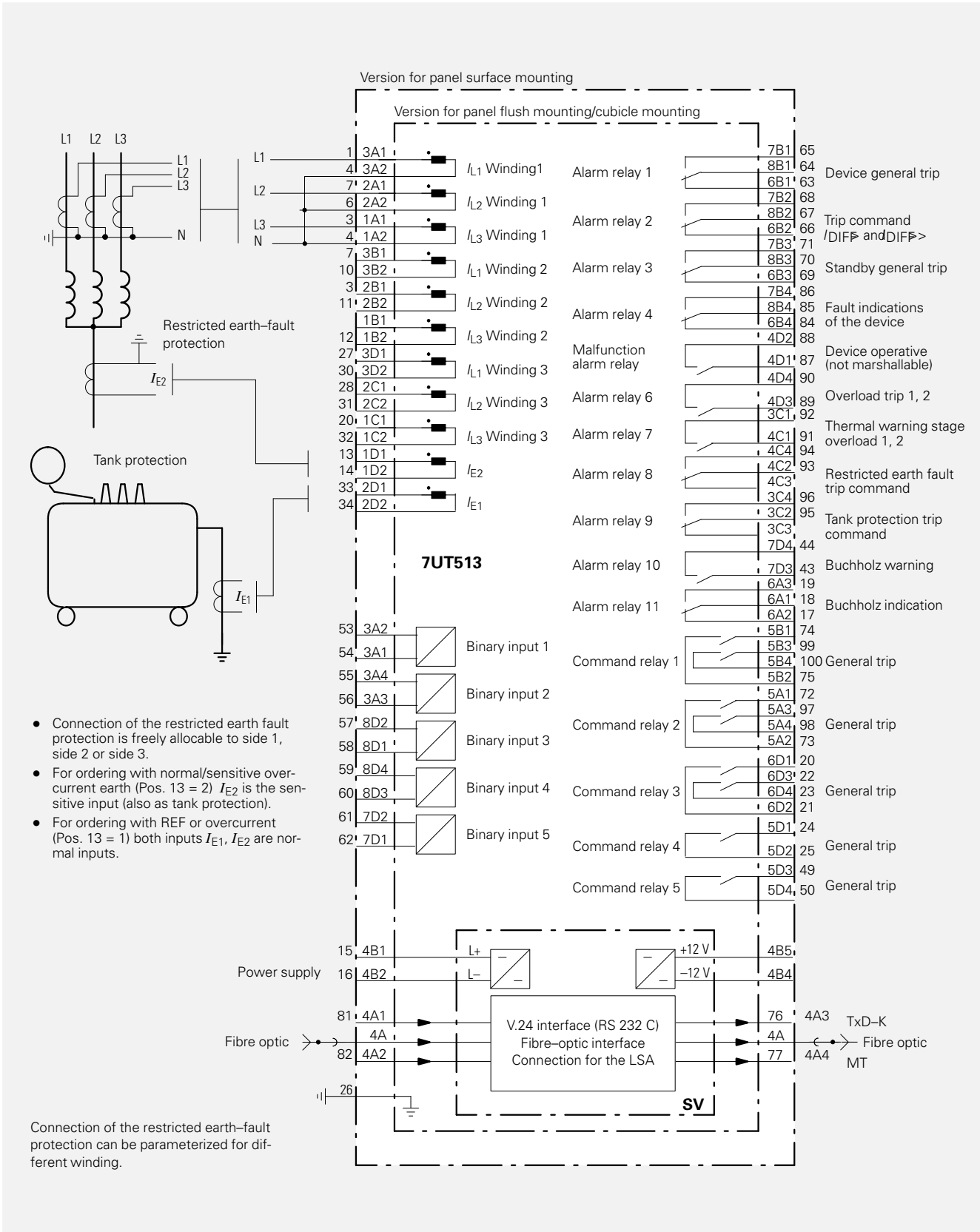


Fig. 9 Connection diagram for 7UT513 differential protection relay with restricted earth fault protection (low impedance) or sensitive/normal overcurrent (earth)

Dimension drawings in mm

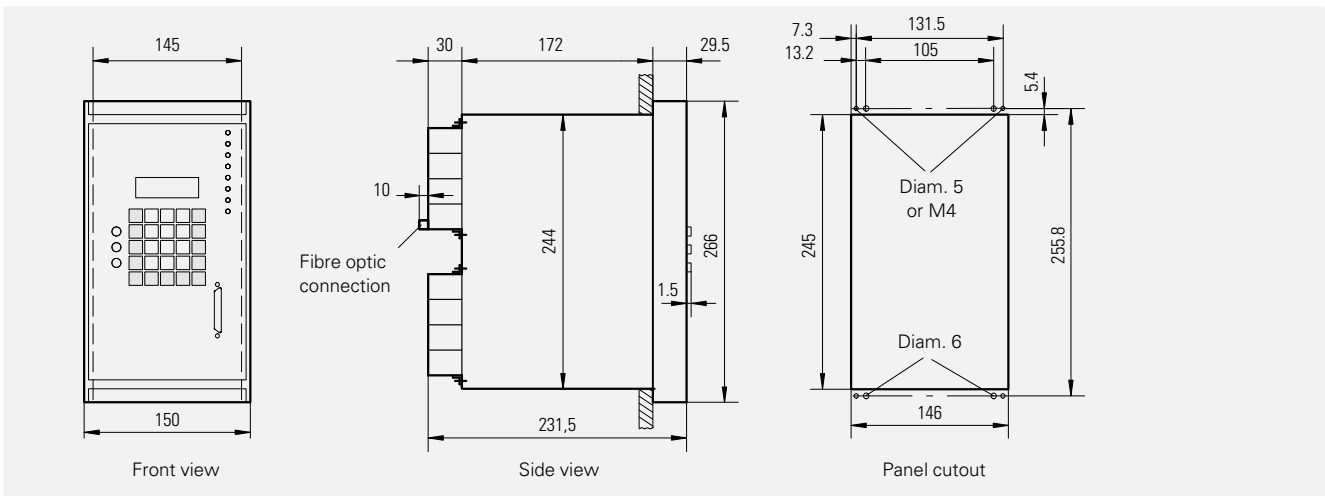


Fig. 10
7UT512 with housing 7XP2030-2 (for panel flush mounting or cubicle mounting)

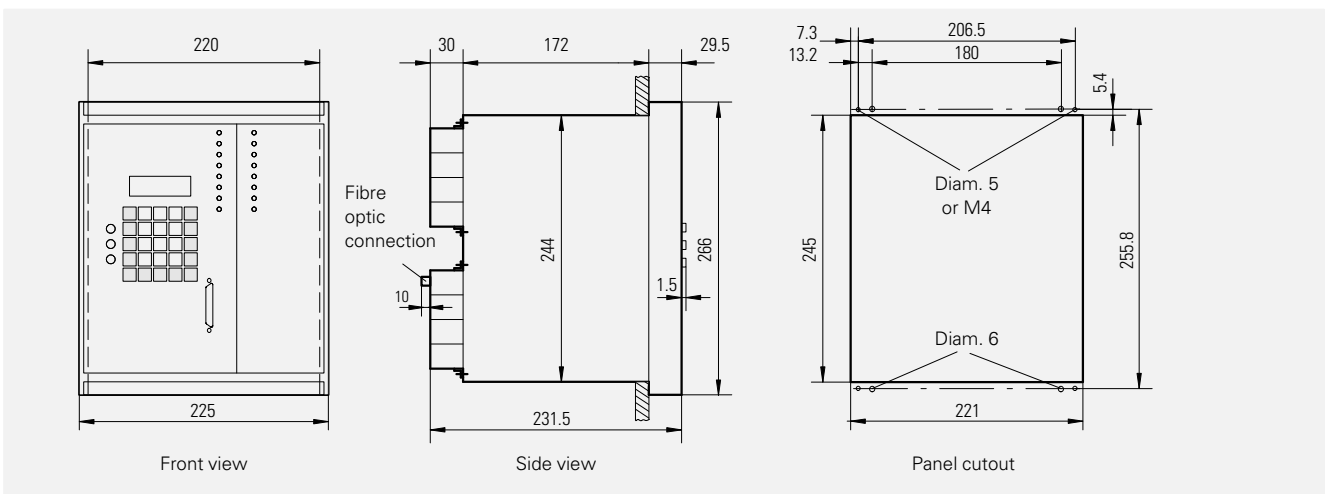


Fig. 11
7UT513 with housing 7XP2040-2 (for panel flush mounting or cubicle mounting)

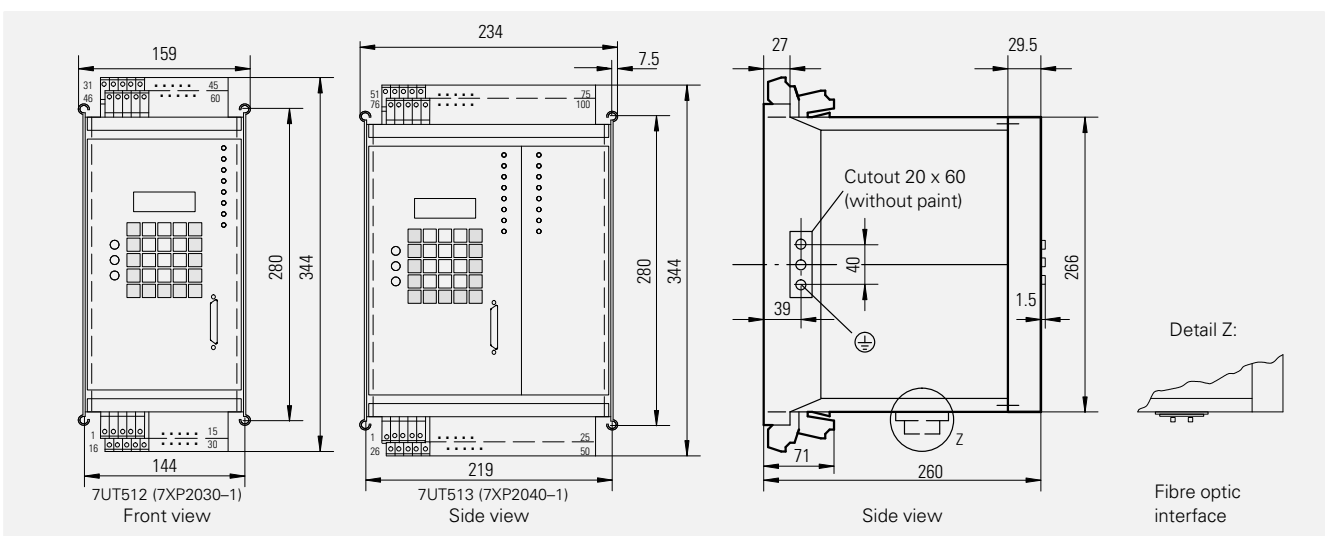


Fig. 12
7UT512/513 for panel surface mounting

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