7UM512 Generator protection relay (Version V3)

Scope of functions

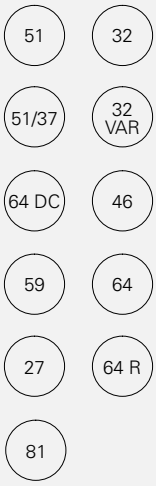

Fig. 1
7UM512 generator protection relay (V3)

Application

The 7UM512 unit is a numerical generator protection relay that provides a practical combination of protection functions for generators. The unit contains all the protection functions required for small generators, such as emergency generators or private power plants. The unit is also a module in comprehensive protection systems for large generators based on the 7UM51 range. The 7UM51 is supplemented by 7UT51 differential protection relays.

Construction

The unit is of compact construction and comprises all components for:

- Measured value acquisition and evaluation
- Operation and display
- Indication and command output
- Acquisition of binary signals
- Serial data transmission
- Auxiliary voltage supply

The unit is supplied with housings for flush and surface mounting. The model for panel flush mounting or cubicle mounting has rear connection terminals and can be supplied with or without a glass cover. The model for panel surface mounting has 100 screw terminals accessible from the front.

Functions

The unit contains the following integrated protection functions:

- Overcurrent–time protection (with undervoltage seal-in)
- Over/undercurrent protection
- DC voltage protection
- Single-phase overvoltage protection
- Single-phase undervoltage protection
- Overfrequency protection
- Underfrequency protection
- Active power protection
- Reactive power protection
- Unbalanced–load protection
- Stator earth-fault (directional) protection
- Direct coupling (for separate protection equipment)
- Tripping circuit monitoring

Measurement method

The influences of superimposed harmonics, high-frequency transients, transient DC current components and differing CT saturation levels is suppressed to a large degree by the use of a powerful microprocessor and complete digital signal processing (measured value acquisition, measured value conditioning and measured value processing).

Precise measurement of the current and voltage over a wide frequency range of 10 to 68 Hz is achieved by adapting the sampling rate.

Some protection functions make use of the symmetrical current component. A change in the phase sequence, which can occur when the direction of rotation is reversed in a pumped-storage power plant, is taken into account by the protection relay. The phase sequence is also signalled to the protection relay as a binary indication.

Serial interfaces

The relay is equipped with two serial interfaces. The interface at the front is suitable for connection of an AT-compatible personal computer. An operating and analysis software program DIGSI is available for convenient and clear setting, evaluation of fault records and data, as well as for commissioning. The interface on the rear of the unit is either an isolated V.24 interface or an 820-nm fibre-optic interface. It is used either as a system interface for connecting to the SINAUT LSA substation control and protection, i.e. to a protection data master unit (protocol acc. to VDEW/ZVEI recommendation, company-specific), or as an operating interface for connecting a PC.

Settings

All setting parameters can be input either via the integrated operator and display panel or via a personal computer. The operator is guided through the setting process. The parameters are written into non-volatile memories so that the settings remain secure even during interruption of the supply voltage.

7UM512 Generator protection relay (Version V3)

Self–monitoring

All important hardware and software components are monitored continuously. Any irregularities in the hardware or in the program sequence are immediately detected and alarmed. This significantly improves the security and the availability of the protection system.

Overcurrent–time protection (ANSI 51)

This stage is for use as short-circuit and standby protection for protection gear connected upstream, such as differential protection or distance protection.

An undervoltage stage provides the option of maintaining the overcurrent excitation if the current returns below the starting threshold and at the same time the voltage drops because the excitation system cannot be powered sufficiently.

Over/undercurrent protection (ANSI 51/37)

The undercurrent protection is versatile. It detects disconnected and interrupted lines or, when used as protection for large motors, mechanical faults in the driven machine that can cause the motor to be off-loaded. With this function, it is also possible to implement simple circuit-breaker protection.

The protection function can be ANDed or ORed with an input binary signal.

DC voltage protection (64 DC)

The protection function is designed for generators that are started with a frequency converter. It protects the generators (and the parts of the station that are galvanically connected with them) from DC voltage. The function can respond to violation either of an upper or a lower limit value.

Overvoltage protection (ANSI 59)

The protection prevents insulation faults due to an excessive voltage. The protection function evaluates a phase-to-phase voltage. It provides two stages.

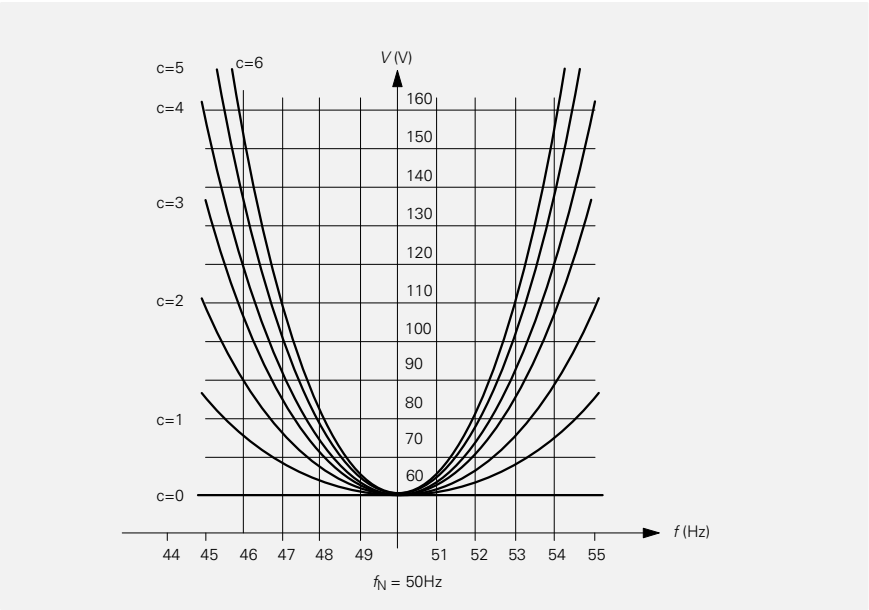

Fig. 2
Frequency-dependent undervoltage function (V_{set} < 60 V)

Undervoltage protection (ANSI 27)

Undervoltage protection compares a phase-to-phase voltage with a lower limit value. This function is used for asynchronous motors and pumped–storage motor-generators and prevents instability due to voltage.

To stabilize the voltage during a power deficiency, the undervoltage protection function can be used for load shedding. A further criterion for power deficiency in networks is a drop in the frequency below the nominal frequency. To combine the two criteria in a protection function, the response value of the undervoltage function can be made to depend on the frequency. If the network frequency then deviates from the nominal frequency, the undervoltage threshold is raised.

Frequency time protection (ANSI 81)

The 7UM512 protection relay contains two-stage frequency protection. Each stage can be used as either an overfrequency or underfrequency protection. The algorithm filters out the fundamental reliably even from distorted voltages and performs a fast and precise frequency calculation.

Active power protection (ANSI 32)

The protection relay can utilize as protection criterion either exceeding of the power output of a generator or exceeding of the power input (reverse power). The power is calculated by the 7UM512 protection relay from a phase-to-phase voltage and a phase current.

The monitoring of the power output of a generator can be useful for starting and shutting down generators. As reverse power protection, the function protects the driving steam turbines and is also used for service shutdown of the generator.

Reactive power protection (ANSI 32 VAR)

This protection function can be used as a single-stage underexcitation protection. It protects the generator from falling out of step because of underexcitation. The reactive power is calculated from a phase-to-phase voltage and a phase current.

7UM512 Generator protection relay (Version V3)

Unbalanced–load protection (ANSI 46)

Asymmetrical current loads of the three phases of a generator cause heating of the rotor because of the reverse field that arises.

This protection function detects an asymmetrical load on three-phase generators. It works on the principle of the symmetrical components and evaluates the negative system of phase currents. The heating in the generator is calculated in the protection relay. Separately settable warning and tripping stages compare the calculated overtemperature with the corresponding threshold values. Moreover, the unbalanced load of an independent stage to which a delay element has been added is evaluated.

Stator earth-fault protection (ANSI 64)

On generators operated in isolation, an earth fault results in the occurrence of a displacement voltage in the generator neutral point. In a unit connection, a displacement voltage is a sufficient, selective protection criterion. If a generator is galvanically connected with a busbar, the direction of the earth current flowing must also be evaluated for selective earth–fault detection. A directional earth–fault protection function is required.

The 7UM512 protection relay measures the displacement voltage with a special input on a voltage transformer at the generator neutral point or at the open delta winding of a voltage transformer. In this way, earth–fault protection for up to 95% of the stator winding of a generator operated in a unit connection is possible.

For the earth current, a separate current measuring input is also available. The stator earth–fault protection function can thus also function as a directional earth-fault protection. It is possible to switch between the two modes with a coupled external binary signal (circuit-breaker position).

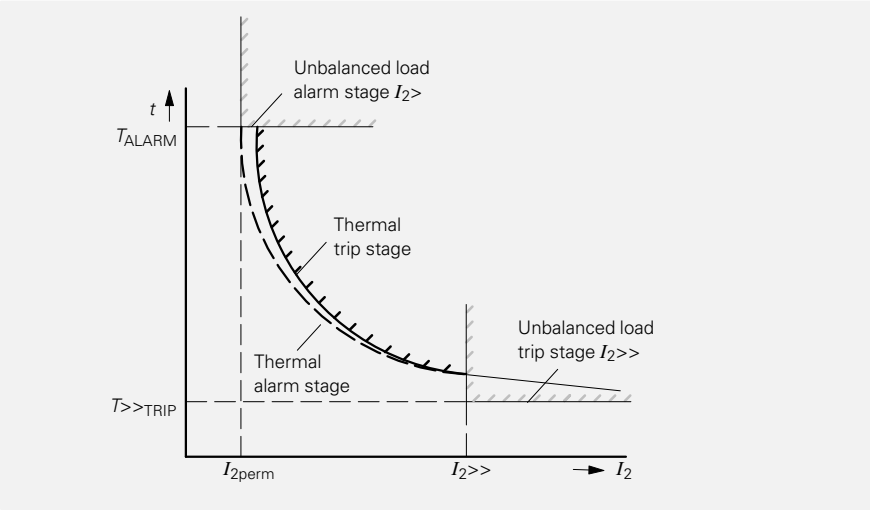

Fig. 3
Trip range of the unbalanced–load protection

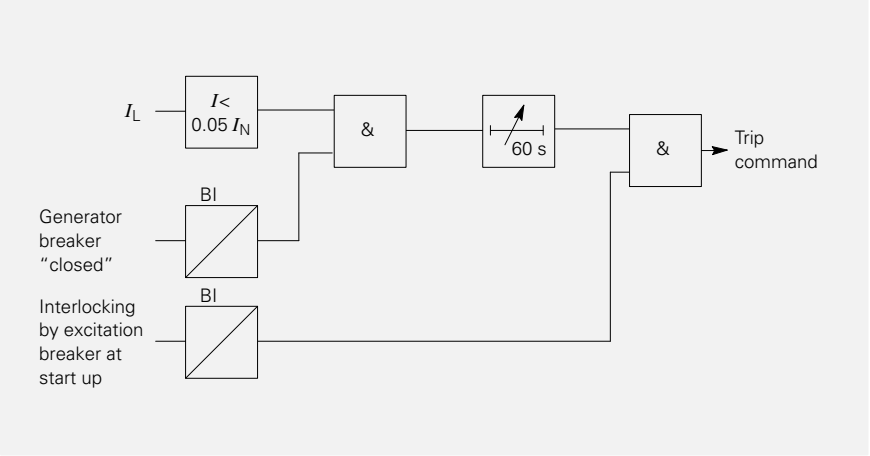

Fig. 4
Example: Automatic shutdown of idling generator

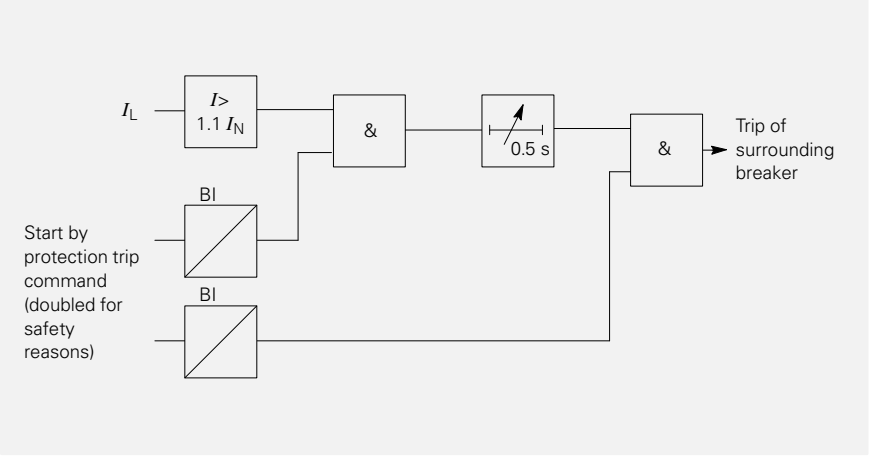

Fig. 5
Example: Circuit-breaker failure protection

7UM512 Generator protection relay (Version V3)

Rotor earth–fault protection (ANSI 64R)

This function is designed to detect earth faults in the exciter and uses an auxiliary AC voltage of approx. 45 V. The protection calculates the resistive component of the complex earth impedance from this auxiliary voltage and from the earth current flowing. This protection provides two stages. The high-impedance measuring stage can be used as an alarm, whereas the low-impedance measuring stage can be used to disconnect the generator. Interruptions in the measuring circuit are detected by the 7UM512 and can be signalled if required.

Direct coupling

Direct coupling functions are functions of the 7UM512 that are used for acquisition of binary information. This binary information is entered in the fault indication memory. Such information can actuate LEDs, alarm relays and command relays. Each "direct coupling" can delay the effect of the binary information by an individual timer. The "direct coupling" function is used for processing of information from the Buchholz relay or generator commands.

Tripping circuit monitoring

The 7UM512 protection relay is able to monitor two tripping circuits (circuit-breaker coils including incoming cables) for correct functioning.

Operational measurement

The values acquired and calculated by the unit can be displayed on the LD display or on a PC. These include: Conductor currents and voltages (both primary and secondary), earth current, neutral voltage, current positive-sequence component, frequency, active and reactive power, power factor, current-voltage angle, excitation voltage, negative-sequence component of the conductor currents overtemperature due to unbalanced load.

Fault recording

In the protection relay, instantaneous or rms values are implemented depending on your selection. The recording duration is up to 5 s for instantaneous values and up to 60 s for rms values. In the 7UM512 protection relay, primary values of up to eight faults can be stored. The total number depends on the duration of each fault and the parameterized longest recording duration. Setting a leading and trailing time and the start event (start on activation or on trip) permits adaptation to different requirements. The fault data can be transferred to the SINAUT LSA substation control and protection or to a PC and evaluated there.

Trip matrix/trip circuits

The unit is equipped with five trip relays. These can be arbitrarily assigned to the above mentioned protection functions by parameterization (software matrix). Furthermore, each protection function can be switched "On" or "Off" via the operator panel. A third "Blocked" mode permits commissioning of the unit with the local annunciations and the alarm relay circuits operative, but without tripping of the circuit-breakers.

With the many parameterizing possibilities provided, testing of and alterations to the circuit-breaker operation can be performed during commissioning, as well as during normal operation without the need for rewiring.

Indication memory

The unit provides detailed data for the analysis of faults and for checking states during operation. All the indication fault memories listed below are protected against power supply failure.

- Time
  The unit has a battery-backed clock that can be synchronized with a binary signal or via the system interface. All indications are assigned a time and date.
- Fault indications
  The indications of the last three faults can be retrieved at any time.
- Operational indications
  All indications that are not directly associated with a fault are stored in the operational indication buffer.

Assignable alarm relays, LEDs and binary inputs

The alarm relays and LEDs can be freely assigned for user-specific output and display of indications. The storable LED displays are protected against power supply failure.

All binary inputs can be operated either as make circuits or as break circuits. They can also be assigned as defined by the user. The signal input at a binary input can be logically combined with several protection functions.

7UM512 Generator protection relay (Version V3)

Technical data

Input circuits	Rated current	1 or 5 A
	Rated voltage, can be parameterized	100 to 125 V AC
	Rated frequency, can be parameterized	50/60 Hz
	Thermal overload capability	
	in voltage path, continuous	140 V AC
	in current path, continuous	4 x I_N
	1 s	100 x I_N
	10 s	20 x I_N
	in earth current path, continuous	15 A
	1 s	300 A
	10 s	100 A
	DC voltage inputs, continuous	60 V DC
	Power consumption	
	in voltage path at V_N = 100 V	< 0.3 VA
	in current path at I_N = 1 A	< 0.1 VA
	at I_N = 5 A	< 0.5 VA
Voltage supply via integrated DC/DC converter	Rated auxiliary voltage V_{aux}	24, 48 V DC or 60, 110, 125 V DC or 220, 250 V DC
	Permissible tolerance of rated auxiliary voltage	– 20 to + 15 %
	Power consumption	max. 16 W
Setting ranges		
Overcurrent time protection (ANSI 51)	Current I>	0.1 x I_N to 8 x I_N
	Trip delay, resetting delay	0 to 32 s
	Reset ratio (settable)	0.9 to 0.99
	Response time	Approx. 40 ms
	Undervoltage seal-in V<	20 to 100 V
	Excitation hold time during undervoltage	0 to 32 s
	Reset ratio	1.05
Over/undercurrent protection (ANSI 51/37)	Current I><	0.05 to 8 A
	Trip delay, resetting delay	0 to 32 s
	Reset ratio for I>	0.95
	for I<	1.05
	Response time	Approx. 40 ms
DC voltage protection (V = ><) (ANSI 64 DC)	Voltage V = ><	0.1 to 8.5 V
	Trip delay, resetting delay	0 to 32 s
	Reset ratio V = >	Approx. 0.98
	V = <	1.1
	Response time for operating state 1	<60 ms
	0	<200 ms
Overvoltage protection (ANSI 59) (single phase)	Voltage V>, V>>	30 to 180 V
	Trip delay, resetting delay	0 to 32 s
	Reset ratio	Approx. 0.98
	Response time	Approx. 50 ms
Undervoltage protection (ANSI 27) (single phase, or optionally frequency-dependent)	Voltage V<	20 to 140 V
	Trip delay, reset delay	0 to 32 s
	Reset threshold (function of V–f characteristic)	2 to 6 V above response value
	Response time	Approx. 50 ms
Frequency protection (ANSI 81)	Number of steps	2
	Frequency f_1, f_2	40 to 65 Hz
	Trip delay, reset delay	0 to 32 s
	Reset difference	0.1 Hz
	Response time	Approx. 120 ms
	Undervoltage blocking V<	40 to 100 V
	Reset ratio of the blocking	1.05
Active power protection (ANSI 32) (reverse power protection)	Active power |P|> (with reference to S_N)	1 to 120 %
	Trip delay, reset delay	0 to 32 s
	Reset ratio	0.9 or 0.5 % of S_N
	Response time	≤ 190 ms
Reactive power protection (ANSI 32 VAR) (underexcitation protection)	Reactive power |Q|> (with reference to S_N)	1 to 120 %
	Trip delay, reset delay	0 to 32 s
	Reset ratio	0.9 or 0.5 % of S_N
	Response time	≤ 190 ms

7UM512 Generator protection relay (Version V3)

Technical data (continued)

Setting ranges (continued)			
Unbalanced–load protection (ANSI 46)	Alarm stage I_2> (with reference to I_N)		3 to 30 %
	Delay of warning		0 to 32 s
	Thermal time constant		100 to 2500 s
	Thermal alarm stage (with reference to the tripping overtemperature)		70 to 99 %
	Tripping stage I_2>> (with reference to I_N)		10 to 80 %
	Reset ratio		0.95
	Trip delay, reset delay		0 to 32 s
	Response time of the independent characteristic		≤ 60 ms
Stator earth-fault protection (ANSI 64)	Displacement voltage V_{earth}>		5 to 120 V
	Current I_{earth}>		2 to 100 mA
	Angle of the directional straight line		0 to 360°
	Reset ratio V_{earth} / I_{earth}		0.7/0.95
	Trip delay, reset delay		0 to 32 s
	Response time		≤ 60 ms
Rotor earth-fault protection (ANSI 64R)	Alarm stage R_{Alarm}<		3 to 30 kΩ
	Tripping stage R_{TRIP}<		1 to 5 kΩ
	Reset ratio		1.25
	Trip delay, reset delay		0 to 32 s
	Response time		≤ 80 ms
	Permissible rotor-earth capacitance		0.15 to 3 µF
Direct coupling	Number		4
	Trip delay t_1, t_2, t_3, t_4		0 to 32 s
	Reset delay t_1, t_2, t_3, t_4		0 to 32 s
	Response time		<15 ms
Switchover of the rotating field direction	Response time		200 ms (requirements: I < 0.1 x I_N and V < 0.1 x V_N)
Response tolerances under nominal conditions	Current		3 % of the setting value
	Voltage		3 % of the setting value
	Power		0.3 % of S_N or 3 % of the setting value
	Times		10 ms
Operational measured values	Voltage		$V_{PH1-PH2}$, V_0
	Current		I_{PH1}, I_{PH2}, I_{PH3}, $I_{pos.}$, I_0
	Power		P/S_N, Q/S_N
	Power factor		cos Φ
	Phase angle		Φ
	Unbalanced load	Reverse current	I_2
		Overtemperature	I_{2TH}
	DC voltage		V=
	Frequency		f
Fault data acquisition	Either instantaneous values (12 values per cycle) Or calculated values (one value per cycle)		v_{PH1}, v_{PH2}, v_{PH3}, i_{PH1}, i_{PH2}, i_{PH3}, V_{Err} $V_{pos.}$, $I_{pos.}$, I_{PH1}, I_{PH2}, I_{PH3}, I_E, cos Φ, $f - f_N$
Contacts	Potential-free trip contacts		3 x 2 NO, 2 x 1 NO (total of 5 trip relays)
	Switching capacity	make	1000 W/VA
		break	30 W/VA
	Permissible current	continuous	5 A
		0.5 s	30 A
	Switching voltage		250 V DC
	Alarm contacts		13
	Switching capacity	make/break	20 W/VA
	Permissible current		1 A
	Switching voltage		250 V DC
Displays	LED displays on the front of the unit		16
Inputs	Optocoupler, for 24 to 250 V DC		8
	Current consumption independent of voltage		approx. 2.5 mA
Construction	For panel surface mounting		in housing 7XP20 40–1
	Weight approx.		12 kg
	For panel flush mounting, cubicle mounting		in housing 7XP20 40–2
	Weight approx.		10.5 kg
	Degree of protection acc. to EN 60 529		IP 51

7UM512 Generator protection relay (Version V3)

Technical data (continued)

Serial interfaces	Operating interface		On the front, not isolated, suitable for connection to serial interface of a personal computer, 25-pole socket
	System interface		Isolated, suitable for coupling to central equipment
	Protocol		Siemens-specific or acc. to VDEW/ZVEI recommendation
	Error detection		Hamming distance $d = 4$
	Transfer rate		4800, 9600 or 19200 Bd
	Procedure		Asynchronous
	Connection electrical		Similar to V.24/V.28 to CCITT or RS232C to EIA, 2 kV isolation
	Distance		Up to 1000 m
	Connection fibre-optic cable		Two integrated FSMA plug connectors for FO connection
	Optical wavelength		820 nm
	Permissible line attenuation		Max. 8 dB for glass-fibre 62.5/125 µm
	Distance		Max. 2 km
CE–conformity, standards	This product is in conformity with the directives of the Council of the European Communities on the approximation of the laws of the Member States relating to the electromagnetic compatibility (EMC Council Directive 89/336/EEC) and concerning electrical equipment for use within specified voltage limits (low voltage directive 73/23/EEC). The product conforms with the international standard IEC 255 and the national standard DIN 57 435 part 303 (corresponding to VDE 0435 part 303). The relay is designed for use in an industrial environment, for installation in standard relay rooms and compartments so that with proper installation electro–magnetic compatibility (EMC) is ensured.		Conformity is proved by tests performed by Siemens AG in line with article 10 of the Council Directives in accordance with the generic standards EN 50081 and EN 50082 for the EMC directive 89/336/EEC and standard 60255–6 for the low voltage directive.
Insulation tests IEC 255-5, VDE 0435 Part 303	Voltage test (routine test) all circuits except the auxiliary voltage		2 kV (rms value), 50 Hz
	Voltage test (routine test), for auxiliary voltage only		DC 2.8 kV
	Impulse voltage test (type test), all circuits, class III		5 kV (peak value), 1.2/50 µs, 0.5 J, 3 positive and 3 negative impulses at intervals of 5 s
EMC–tests; immunity (type test) Standards: IEC 255–6, IEC 255–22 (international product standard) EN 50082–2 (generic standard) VDE 0435 part 303 (German product standard)	High frequency test with 1 MHz interference IEC 255–22–1, class III and VDE 0435 part 303, class III		2.5 kV (peak), 1 MHz, τ = 15 µs, 400 shots/s, duration 2 s
	Electrostatic discharge IEC 255–22–2, class III and IEC 1000–4–2, class III		4/6 kV contact discharge, 8 kV air discharge, both polarities, 150 pF, R_i = 330 Ω
	Radio–frequency electromagnetic field, non–modulated report IEC 255–22–3, class III		10 V/m, 27 to 500 MHz
	Radio–frequency electromagnetic field, amplitude modulated IEC 1000–4–3, class III		10 V/m, 80 to 1 000 MHz, AM 80 %, 1 kHz,
	Radio–frequency electromagnetic field, puls modulated ENV 50204, class III		10 V/m, 900 MHz, repetition frequency 200 Hz, duty cycle 50 %
	Fast transients IEC 255–22–4 class III, IEC 1000–4–4 class III		2 kV, 5/50 ns, 5 kHz, burst length = 15 ms, repetition rate 300 ms, both polarities, R_i = 50 Ω, duration 1 min
	Conducted disturbances induced by radio–frequency fields, amplitude modulated IEC 1000–4–6, class III		10 V, 150 kHz to 80 MHz, AM 80 %, 1 kHz
	Power frequency magnetic field IEC 1000–4–8, class IV IEC 255–6		30 A/m, continuous, 300 A/m for 3 s, 50 Hz 0.5 mT; 50 Hz
EMC–tests; emission (type test) Standard: EN 50081–2 (European generic standard for use in industrial environment)	Conducted interference voltage, auxiliary voltage CISPR 11, EN 55011 and VDE 0875 part 11		150 kHz to 30 MHz, group 1 class A
	Interference field strength CISPR 11, EN 55011 and VDE 0875 part 11		30 to 1 000 MHz, group 1 class A
Climatic conditions	Permissible ambient temperature	during service	– 5° to + 55°C
		limit operating temperature	– 20° to + 70°C
		during storage	– 25° to + 55°C
		during transport	– 25° to + 70°C
	Humidity class		Annual average ≤ 75 % relative humidity; on 30 days/year up to 95 % relative humidity; condensation not permissible
Mechanical stress tests IEC 255–21–1, IEC 68–2	Permissible mechanical stress	during service	10 Hz to 60 Hz: 0.035 mm amplitude 60 Hz to 500 Hz: 0.5 *g* acceleration
		during transport	5 Hz to 8 Hz: 7.5 mm amplitude 8 Hz to 500 Hz: 2 *g* acceleration

7UM512 Generator protection relay (Version V3)

Selection and ordering data

7UM512 Generator protection relay (version V3)	Order No. 7UM512 □ – □ □ B 0 1 – 0 □ B 0
Rated current at 50 to 60 Hz, 100 to 125 V AC	
1A	1
5A	5
Rated auxiliary voltage	
24 V, 48 V DC	2
60 V, 110 V, 125 V DC	4
220 V, 250 V DC	5
Construction	
for panel flush mounting or cubicle mounting	C
for panel surface mounting	D
for panel flush mounting or cubicle mounting without glass cover	E
Rear serial interface (suitable for station control and DIGSI operating program)	
electrical	B
optical	C

Accessories

Rotor earth-fault protection			
Series transformer 100/45 V AC	(W x H x D in mm)	135 x 170 x 85	**7XR8500–0**
Coupling device 2 x 4 μF		196 x 300 x 110	**7XR6000**
Series resistor		196 x 300 x 146	**3PP1336–0DZ013002**
Stator earth-fault protection			
Voltage divider 500/100 V		196 x 300 x 146	**3PP1336–1CZ0113001**
DC voltage protection			
Voltage divider 1 : 20 and 1 : 10		196 x 300 x 110	**3PP1326–0BZ012009**

Operation software

DIGSI program (suitable for all protection relays 7UM..., 7UT..., 7SJ..., 7SA..., ...)	German	**7XS5020–0AA00**
	English	**7XS5020–1AA00**
Test version:	German	**7XS5021–0AA00**
	English	**7XS5021–1AA00**
Connecting cables for protection relays (25-pin) – PC (9-pin); (other variations supplied on request)		**7XV5100–2**

Documentation

German		
Katalogblatt LSA 2.5.3:	Maschinenschutz 7UM512 (Version V3)	**E50001–K5752–A131–A2**
Handbuch:	Maschinenschutz 7UM512 (Version V3)	**C53000–G1100–C110–1**
English		
Catalog LSA 2.5.3:	7UM512 Generator protection (Version V3)	**E50001–K5752–A131–A2–7600**
Manual:	7UM512 Generator protection (Version V3)	**C53000–G1176–C110–1**

7UM512 Generator protection relay (Version V3)

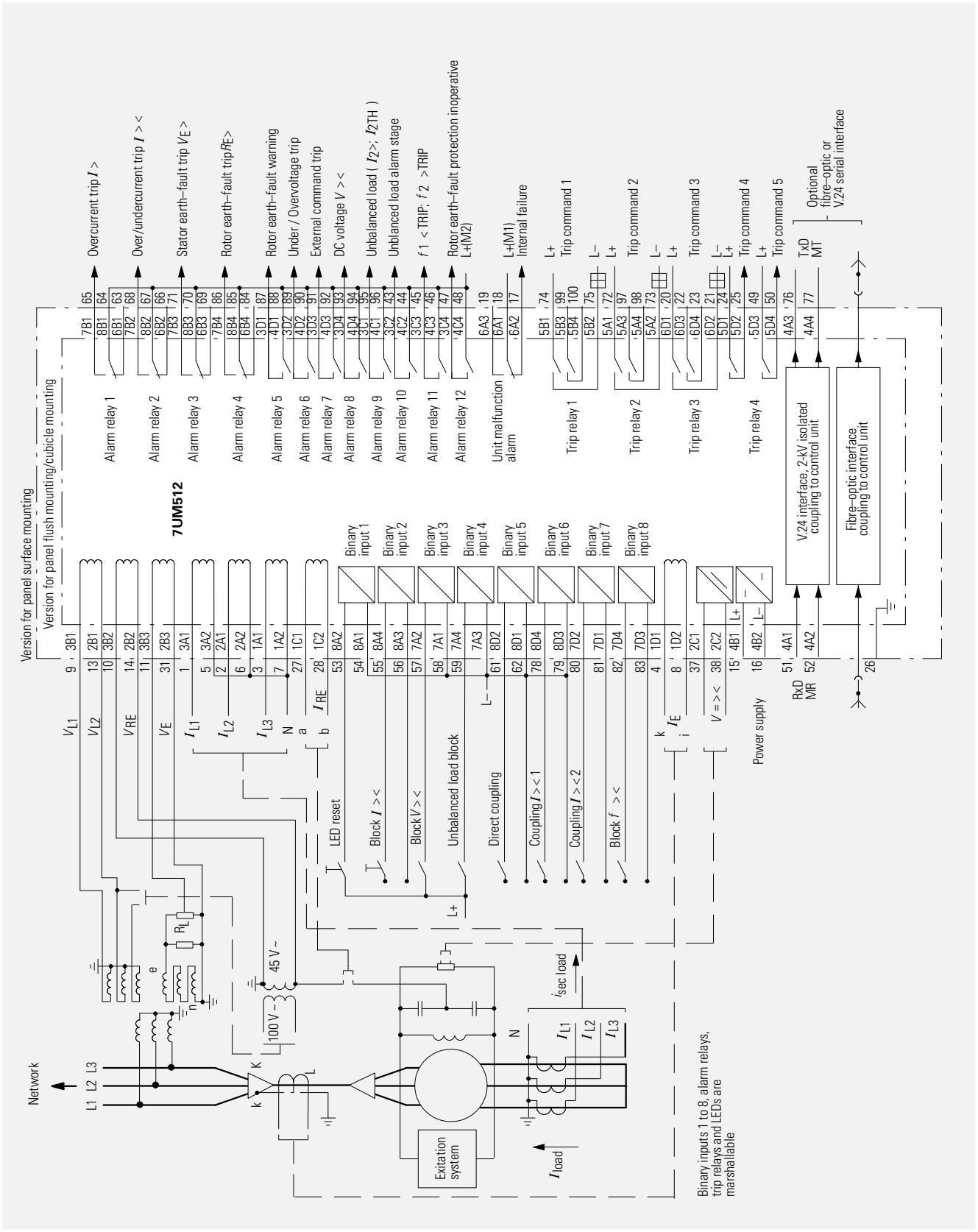

Fig. 6
Connection diagram for the 7UM512 generator protection relay (Version V2), from state of development EE

Dimension drawings in mm

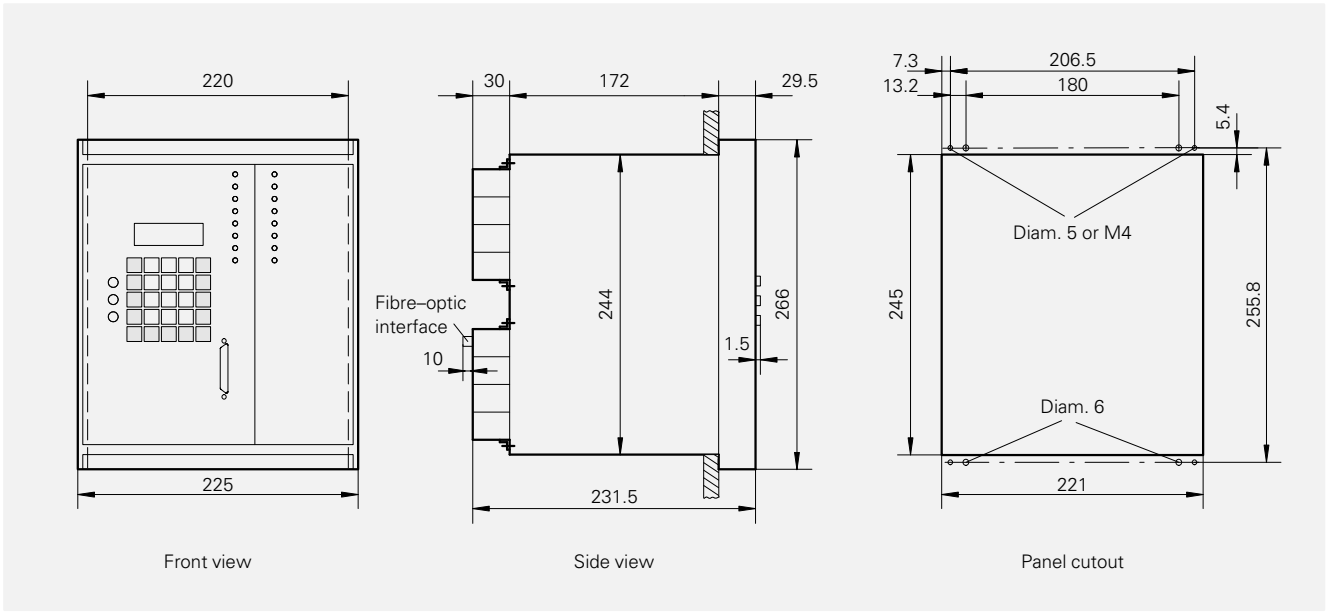

Fig. 7
7XP2040–2 housing (for panel flush mounting and cubicle mounting)

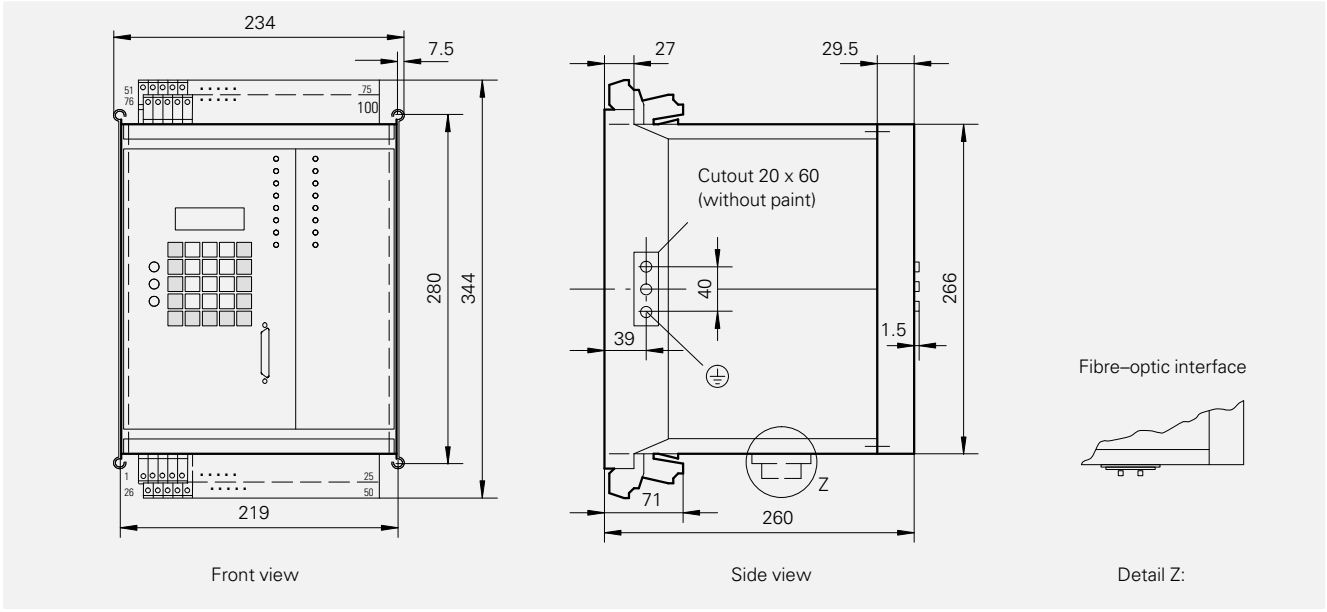

Fig. 8
7XP2040–1 housing (for panel surface mounting)

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Relevant are the criteria stated in the delivery note and the invoice.

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Dimensions

All dimensions in this catalog are given in mm.

Siemens online!

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http://www.ev.siemens.de

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