

7UM515 Generator protection relay (Version V3)

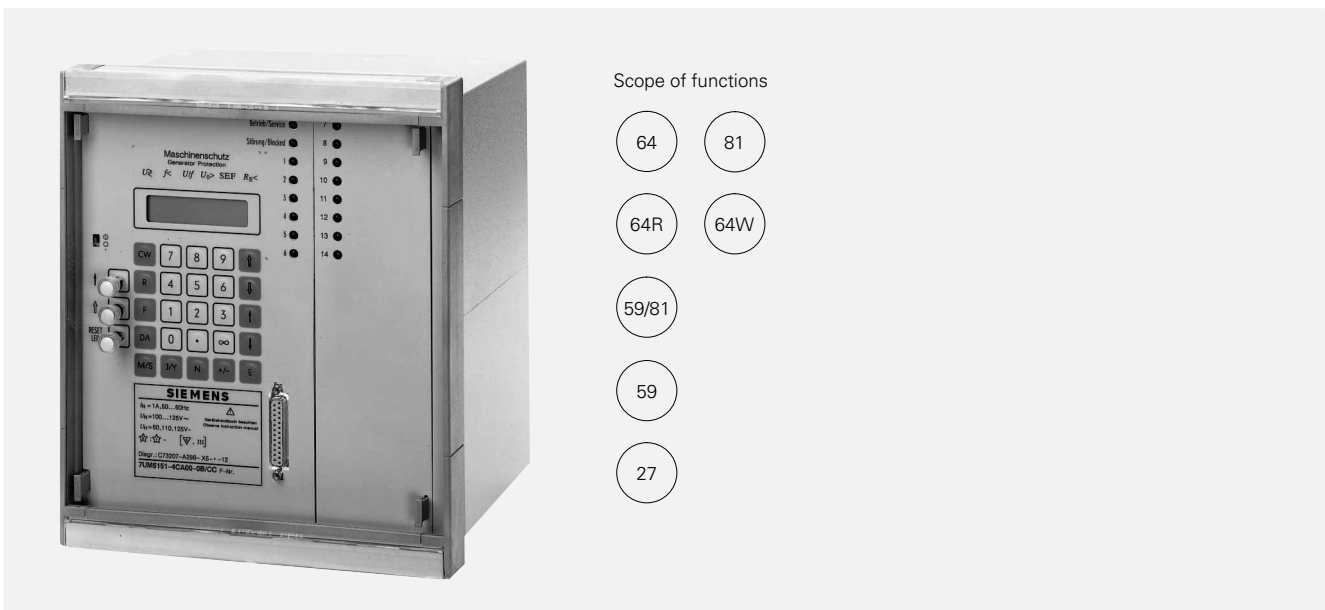


Fig. 1
7UM515 generator protection relay

Application

The 7UM515 unit is a numerical generator protection relay. It is a protection system for large generators which rounds off the 7UM511, 7UM512 and 7UT51 range. Some functions can be used to provide redundant protection.

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:

- 100 % stator earth-fault protection
- Sensitive rotor earth-fault protection
- Stator earth-fault protection (evaluation of the neutral voltage)
- Overexcitation protection
- Overvoltage protection
- Undervoltage protection
- Overfrequency protection
- Underfrequency protection
- Interturn 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 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 7UM515. 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 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 are 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 when the supply voltage is disconnected.

Self-monitoring

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

Generator Protection

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100% stator earth-fault protection (ANSI 64)

This protection function detects earth faults in the machine and all galvanically connected components of the station. The protection criterion is the phase-to-earth resistance. With this principle, earth faults can be detected at any point in the station, even at the machine neutral point. For the measurement, a 20 Hz AC voltage is fed into the primary equipment as a neutral voltage and the magnitude of the 20 Hz current is calculated. The protection function has an alarm stage and a tripping stage.

Independently of detection of the earth resistance, the protection function evaluates the magnitude of the 50 Hz current flowing. There is a further stage for earth faults with which the displacement voltage and therefore the evaluated current exceeds a certain magnitude.

Sensitive rotor earth-fault protection (ANSI 64R)

This protection function detects earth faults in the exciter circuit.

It can be adjusted to be sensitive and therefore detects high-resistance earth faults. To calculate the resistance, an auxiliary voltage is interposed between the field circuit and the earth potential. The current flowing is a measure of the earth resistance. To eliminate interference from currents flowing through the rotor-earth capacitance when the field voltage changes, the polarity auxiliary voltage is constantly reversed. With this principle, calculation of the resistance is also independent of the location of the earth fault.

Stator earth-fault protection (evaluation of the displacement voltage) (ANSI 64)

With this protection function, the earth faults in the stator circuit of machines are detected by measuring the displacement voltage. The protection range achieved depends on the fault quantities present during operation. It can be up to 95% of the stator winding.

The function can be used redundantly for the earth-fault protection function. Because it has a separate voltage input, the function can also be assigned to any primary transformer.

Overexcitation protection (ANSI 59/81)

Overexcitation protection protects the transformers from excessive magnetic flux density, which causes saturation of the iron core, eddy currents and therefore thermal loading of the transformer. Power plant transformers are at risk if they are disconnected from the network at full load.

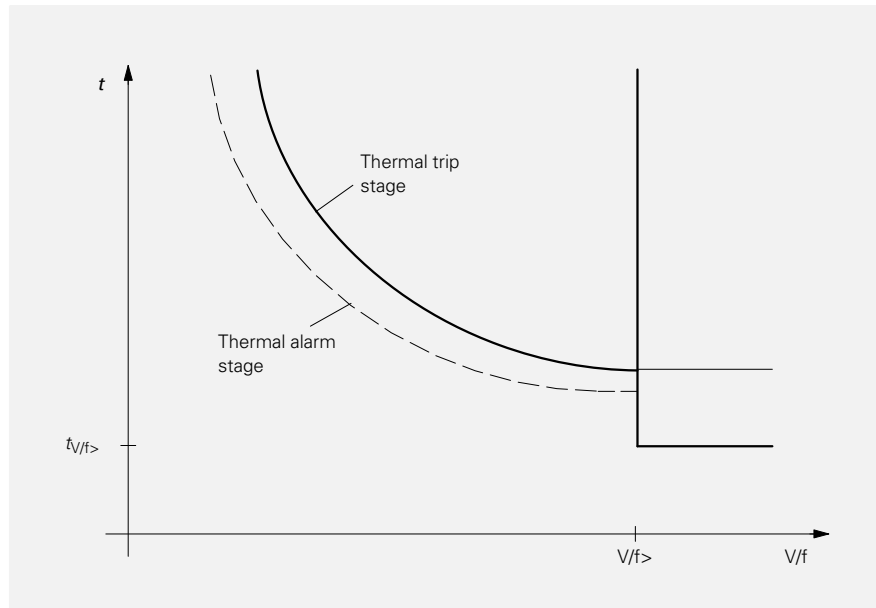


Fig. 2
Tripping characteristic of the overexcitation protection

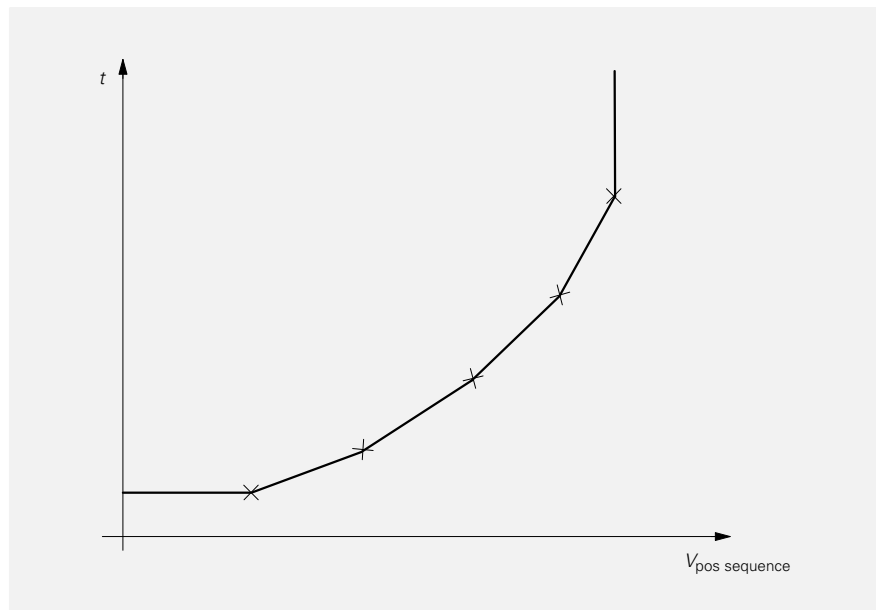


Fig. 3
Tripping characteristic of the undervoltage protection

The protection criterion is the quotient of the voltage and the frequency, which is proportional to the flux density. A replica of the thermal characteristics of the protected object is held in the protection relay using a mathematical homogeneous model. The characteristic curve of the protection relay can be adapted to the protected object by entering 6 points.

Overvoltage protection (ANSI 59)

The protection prevents insulation faults due to an excessive voltage. Overvoltage can be caused by a fault in the voltage controller or by maloperation.

This protection function evaluates the rms value of the fundamental component of the three voltages. It provides two stages.

Undervoltage protection (ANSI 27)

Undervoltage protection compares the positive-sequence component of the voltages with a lower limit value. This function is used for induction 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.

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The tripping time of the protection function is a function of the magnitude of the voltage measured. The characteristic used is entered by defining five points.

Frequency protection (ANSI 81)

The 7UM515 protection relay contains a four-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.

Interturn protection (ANSI 64W)

The principle of this protection function is shown in Fig. 2.

The protection criterion (for an interturn fault) which the 7UM515 evaluates is the neutral voltage of the phase-to-neutral voltages. The necessary sensitivity is achieved using a special input and digital filter algorithms.

Direct coupling

Direct coupling functions are functions of the 7UM515 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 7UM515 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 LC display or a PC. These include: Phase voltages (primary and secondary), the largest of the phase-to-phase voltages, the positive-sequence components of the voltages, frequency, neutral voltage, neutral voltage at the input of the interturn protection, 20 Hz voltage of the stator circuit, stator-earth resistance (secondary and primary), cycle duration of the rotor-earth voltage, amplitude of the rotor-earth voltage, rotor earth-fault measurement current (resistive component for measurement from unit; measurement current for rotating measured value transmission), charge of a pole reversal process (rotor earth fault), rotor-earth resistance, excitation V/f , overtemperature calculated from (over)excitation, and the thermal losses (overexcitation protection).

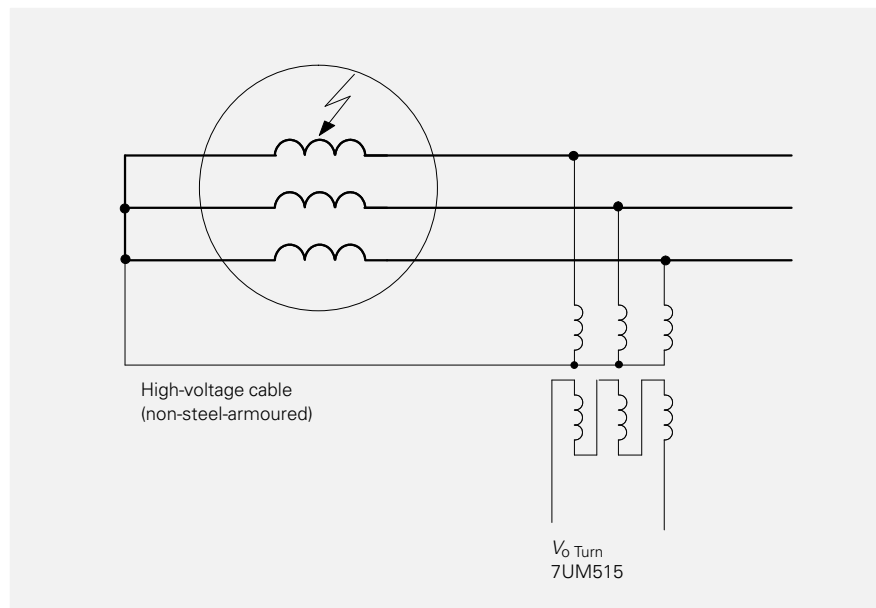


Fig. 4
Block diagram of interturn short-circuit protection

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 7UM515 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 annunciators 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

For user-specific output and display of indications, alarm relays and LEDs can be assigned as required. Information displayed with the LEDs can be stored so that a start or trip can be displayed after it has been released. Auxiliary voltage failure has no effect on the information stored.

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.

Generator Protection

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Technical data

Input circuits	Rated current Rated voltage, can be parameterized Rated frequency, can be parameterized Thermal overload capability in voltage paths in earth voltage path isolating amplifier Power consumption in voltage path at $V_N = 100\text{ V}$	1 or 5 A 100 to 125 V AC 50/60 Hz 140 V AC 140 V AC, 300 V AC for $\leq 30\text{ s}$ 60 V DC <0.3 VA
Voltage supply via integrated DC/DC converter	Rated auxiliary voltage V_{aux} Permissible tolerance of the rated auxiliary voltage Power consumption	24 V, 48 V DC or 60 V, 110 V, 125 V DC or 220 V, 250 V DC – 20 to + 15 % max. 20 W
Setting ranges 100 % stator earth-fault protection (ANSI 64)	Alarm stage $R_{SEF} <$ Trip stage $R_{SEF} <<$ Earth current stage $I_{SEF} >>$ Trip delay, reset delay Reset ratios Failure monitoring 20 Hz generator V_{20} I_{20} Correction angle	20 to 500 Ω 10 to 300 Ω 0.02 to 0.8 A 0 to 32 s Approx. 1.2 to 1.7 0.3 to 15 V 5 to 40 mA –30 to +30°
Sensitive rotor earth-fault protection (ANSI 64R)	Alarm stage R_E ALARM Tripping stage R_E TRIP Trip delay, reset delay Reset ratio Response time Response threshold of fault indication ¹⁾ $Q_C <$ Reset ratio ¹⁾ Permissible rotor-earth capacitance ¹⁾	5 to 80 k Ω 1 to 10 k Ω 0 to 32 s 1.25 1 to 1.5 s 0.01 to 1 mAs 1.2 or 0.01 mAs 0.15 to 4 μ F
Stator-earth fault protection (ANSI 64)	Neutral voltage $V >$ Trip delay, reset delay Reset ratio Response time	5 to 100 V 0 to 32 s 0.7 $\leq 50\text{ ms}$
Overexcitation protection (ANSI 59/81)	Overexcitation $V/f >$ Trip delay, reset delay Reset ratio Response time Characteristic value pairs for thermal characteristic V/f t Time factor V/f basic value (limit value for previous load acquisition)	1 to 1.5 V 0 to 32 s Approx. 0.98; Approx. 0.99 thermal alarm stage $\leq 250\text{ms}$ 1.02 to 1.6 1 to 98 s 1 to 8 0 to 1
Overvoltage protection (ANSI 59)	Voltage $V >$, $V >>$ Trip delay, reset delay Reset ratio Response time	30 to 180 V 0 to 32 s 0.98 $\leq 50\text{ ms}$
Undervoltage protection (ANSI 27)	Characteristic value pairs $V <$ t Reset delay Reset ratio Response time	20 to 100 V 0 to 32 s 0 to 32 s Approx. 1.05 Approx. 50 ms

1) Not for rotating measured-value transmission

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Technical data (continued)

Setting ranges (continued) Frequency protection (ANSI 81)	Number of stages Frequency f_1, f_2, f_3, f_4 Number of measurement repetitions (one measurement requires a time of 3/f) Reset difference Response time Undervoltage blocking $V<$ Reset ratio of blocking	4 40 to 65 Hz 2 to 10 000 Approx. 20 mHz 100 ms + time for measurement 40 to 100 V 1.05
Interturn protection (ANSI 64W)	Displacement voltage $V_{win>}$ Trip delay, reset delay Reset ratio Response time	0.3 to 130 V 0 to 32 s Approx. 0.6 ≤ 50 ms
Direct coupling	Number Trip delay t_1, t_2, t_3, t_4 Reset delay t_1, t_2, t_3, t_4 Response time	4 0 to 32 s 0 to 32 s < 15 ms
Switchover of the rotating field direction	Response time	200 ms (requirements $I < 0.1 \times I_N$ and $V < 0.1 \times V_N$)
Response tolerances under nominal conditions	Stator earth-fault protection Rotor earth-fault protection Voltage (voltage and earth-fault protection) Voltage (interturn protection) Frequency at $f = f_N$ Times	Resistance Current Resistance 5 % or 2 Ω 3 % or 3 mA 5 % or 0.5 k Ω at $0.15 \mu\text{F} \leq C_E < 1 \mu\text{F}$ 10 % or 0.5 k Ω at $1 \mu\text{F} \leq C_E \leq 4 \mu\text{F}$ ≤ 3 % of the setting value or 1 V ≤ 3 % of the setting value or 0.1 V 10 mHz 1 % or 10 ms
Operational measured values	Display of the values Voltage Frequency Stator earth-fault protection Rotor earth-fault protection Overexcitation protection Frequency	$V_{PH1-N}, V_{PH2-N}, V_{PH3-N}, V_{max PH}, V_{POS}, V_0, V_{WIN}, f$ $V_{SEF rms}, I_{SEF rms}, R_{SEF}, R_{SE p}$ $T_g, V_g, I_g, Q_C, R_{REF}$ Cycle duration Voltage amplitude Measured current Charge Rotor-earth resistance Excitation (flux density) Overtemperature Thermal losses $V/f, V/f_{th}, th. loss, f$
Fault data acquisition	Either instantaneous values (12 values per cycle) Or calculated values (one value per cycle)	$V_{PH1-N}, V_{PH2-N}, V_{PH3-N}, V_0, V_{WIN}, V_{SEF}, I_{SEF}, V_{REF}, \sqrt{3} V_{POS}, V_{max PH}, V_0, V_W, V_{SEF}, I_{SEF}, R_{SEF}, f-f_N$
Contacts	Potential-free trip contacts Switching capacity make break Permissible current, continuous 0.5 s Switching voltage Alarm contacts Switching capacity make/break Permissible current Switching voltage	(3 x 2, 2 x 1) NO contacts (total of 5 TRIP relays) 1000 W/VA 30 W/VA 5 A 30 A 250 V DC 13 20 W/VA 1 A 250 V DC
Displays, signal inputs	LED displays on the front of the unit Optocoupler for 24 to 250 V DC Current consumption independent of voltage	16 8 Approx. 2.5 mA

Generator Protection

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Technical data (continued)

CE-conformity, standards	<p>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).</p> <p>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.</p>	<p>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.</p>						
Insulation tests IEC 255-5, VDE 0435 Part 303	<p>Voltage test (routine test) all circuits except the auxiliary voltage Voltage test (routine test), for auxiliary voltage only Impulse voltage test (type test), all circuits, class III</p>	<p>2 kV (rms value), 50 Hz</p> <p>DC 2.8 kV 5 kV (peak value), 1.2/50 μs, 0.5 J, 3 positive and 3 negative impulses at intervals of 5 s</p>						
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)	<p>High frequency test with 1 MHz interference IEC 255-22-1, class III and VDE 0435 part 303, class III</p> <p>Electrostatic discharge IEC 255-22-2, class III and IEC 1000-4-2, class III</p> <p>Radio-frequency electromagnetic field, non-modulated report IEC 255-22-3, class III</p> <p>Radio-frequency electromagnetic field, amplitude modulated IEC 1000-4-3, class III</p> <p>Radio-frequency electromagnetic field, puls modulated ENV 50204, class III</p> <p>Fast transients IEC 255-22-4 class III, IEC 1000-4-4 class III</p> <p>Conducted disturbances induced by radio-frequency fields, amplitude modulated IEC 1000-4-6, class III</p> <p>Power frequency magnetic field IEC 1000-4-8, class IV IEC 255-6</p>	<p>2.5 kV (peak), 1 MHz, $\tau = 15 \mu$s, 400 shots/s, duration 2 s</p> <p>4/6 kV contact discharge, 8 kV air discharge, both polarities, 150 pF, $R_1 = 330 \Omega$</p> <p>10 V/m, 27 to 500 MHz</p> <p>10 V/m, 80 to 1 000 MHz, AM 80 %, 1 kHz,</p> <p>10 V/m, 900 MHz, repetition frequency 200 Hz, duty cycle 50 %</p> <p>2 kV, 5/50 ns, 5 kHz, burst length = 15 ms, repetition rate 300 ms, both polarities, $R_1 = 50 \Omega$, duration 1 min</p> <p>10 V, 150 kHz to 80 MHz, AM 80 %, 1 kHz</p> <p>30 A/m, continuous, 300 A/m for 3 s, 50 Hz 0.5 mT; 50 Hz</p>						
EMC-tests; emission (type test) Standard: EN 50081-2 (European generic standard for use in industrial environment)	<p>Conducted interference voltage, auxiliary voltage CISPR 11, EN 55011 and VDE 0875 part 11</p> <p>Interference field strength CISPR 11, EN 55011 and VDE 0875 part 11</p>	<p>150 kHz to 30 MHz, group 1 class A</p> <p>30 to 1 000 MHz, group 1 class A</p>						
Climatic conditions	<p>Permissible ambient temperature</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%;"></td> <td style="width: 50%;">during service</td> </tr> <tr> <td></td> <td>during storage</td> </tr> <tr> <td></td> <td>during transport</td> </tr> </table> <p>Humidity class</p>		during service		during storage		during transport	<p>- 5° to + 55°C - 25° to + 55°C - 25° to + 70°C</p> <p>Annual average: ≤ 75 % relative humidity; on 30 days/year up to 95 % relative humidity; condensation not permissible</p>
	during service							
	during storage							
	during transport							
Mechanical stress tests IEC 255-21-1, IEC 68-2	<p>Permissible mechanical stress</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 50%;"></td> <td style="width: 50%;">during service</td> </tr> <tr> <td></td> <td>during transport</td> </tr> </table>		during service		during transport	<p>10 Hz to 60 Hz: 0.035 mm amplitude 60 Hz to 500 Hz: 0.5 g acceleration 5 Hz to 8 Hz: 7.5 mm amplitude 8 Hz to 500 Hz: 2 g acceleration</p>		
	during service							
	during transport							
Construction	<p>For panel surface mounting Weight</p> <p>For panel flush mounting, cubicle mounting Weight</p> <p>Degree of protection acc. to EN 60 529</p>	<p>in housing 7XP20 40-1 Approx. 12 kg</p> <p>in housing 7XP20 40-2 Approx. 10,5 kg</p> <p>IP 51</p>						

7UM515 Generator protection relay (Version V3)

Selection and ordering data

7UM515 generator protection relay	Order No. 7UM515 0 - □ □ B 0 1 - 0 □ A 0
Rated auxiliary voltage 24 V, 48 V DC 60 V, 110 V, 125 V DC 220 V, 250 V DC	↑ ↑ 2 4 4 5 5
Construction for panel surface mounting, with screw terminals for panel flush mounting or cubicle mounting for panel flush mounting or cubicle mounting without glass cover	B C E
Rear serial interface (suitable for station control and DIGSI operating program) electrical optical	B C

Accessories

Rotor earth-fault protection			
Series coupling unit, impulse generator (100/110 V AC; Weight 2.5 kg)	(W x H x D in mm)	298 x 220 x 253	7XT7000-0B
Coupling unit in housing 3PP1346	Insulation voltage	4.5 kV or 6 kV	7XR6002 7XR6003
Stator earth-fault protection			
20 Hz generator (100/110 V AC; weight 15 kg)	(W x H x D in mm)	390 x 222 x 312	7XT3110-1
Band-pass filter (weight 23 kg)		240 x 270 x 200	7XT3200-0
Miniature C.T. (weight 0.5 kg)		58 x 100 x 70	4NC1225-2CK20
Voltage divider 500 V/100 V		196 x 300 x 146	3PP1336-1CZ013001

Operation software

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

Documentation

German		
Katalogblatt LSA 2.5.4:	Maschinenschutz 7UM515 (Version V3)	E50001-K5752-A141-A2
Handbuch:	Maschinenschutz 7UM515	C53000-G1100-C111-1
English		
Catalog LSA 2.5.4:	7UM515 Generator protection (Version V3)	E50001-K5752-A141-A2-7600
Manual:	7UM515 Generator protection	C53000-G1176-C111-1

Generator Protection

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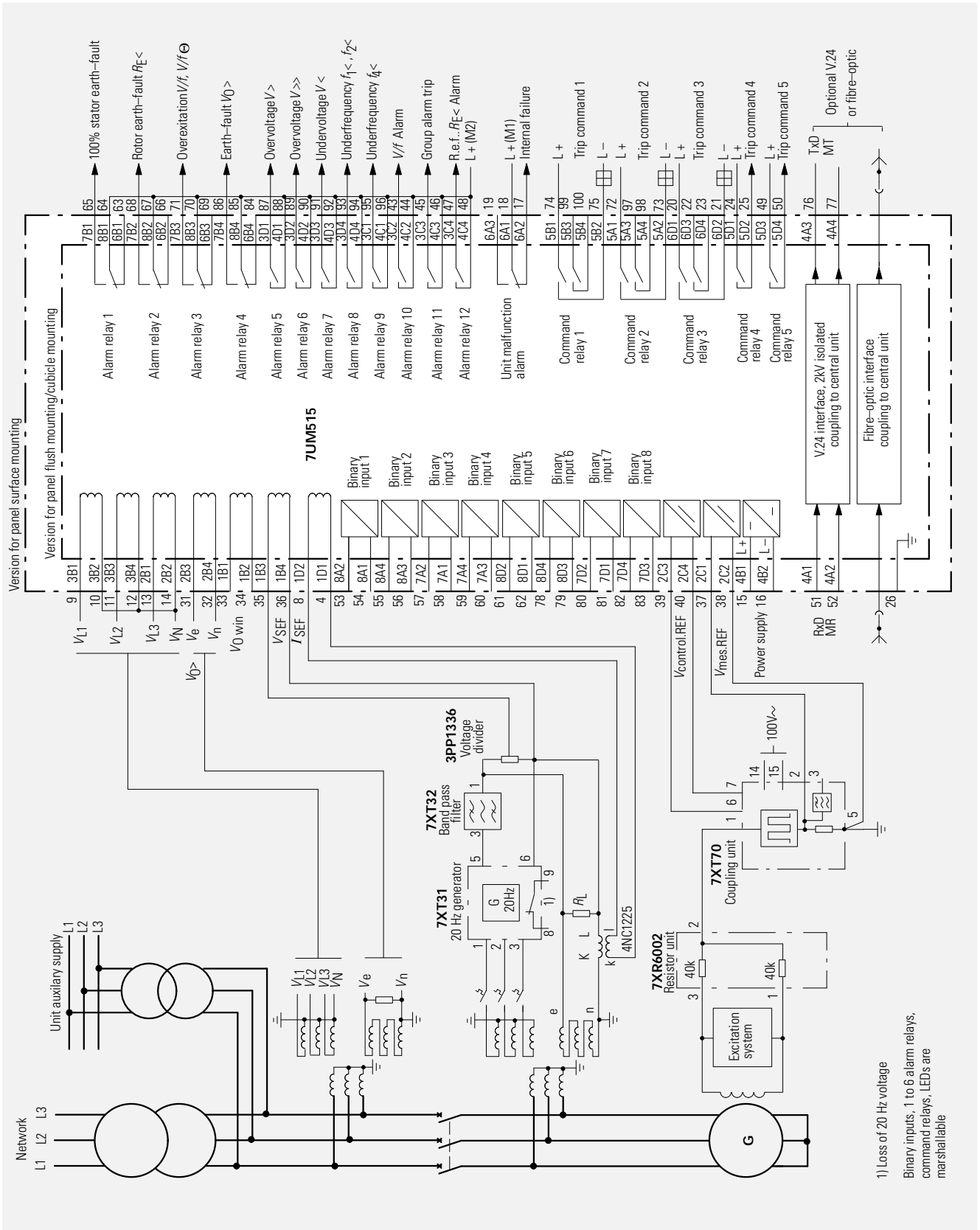


Fig. 5 Connection diagram of the 7UM515 generator protection relay

Dimension drawings in mm

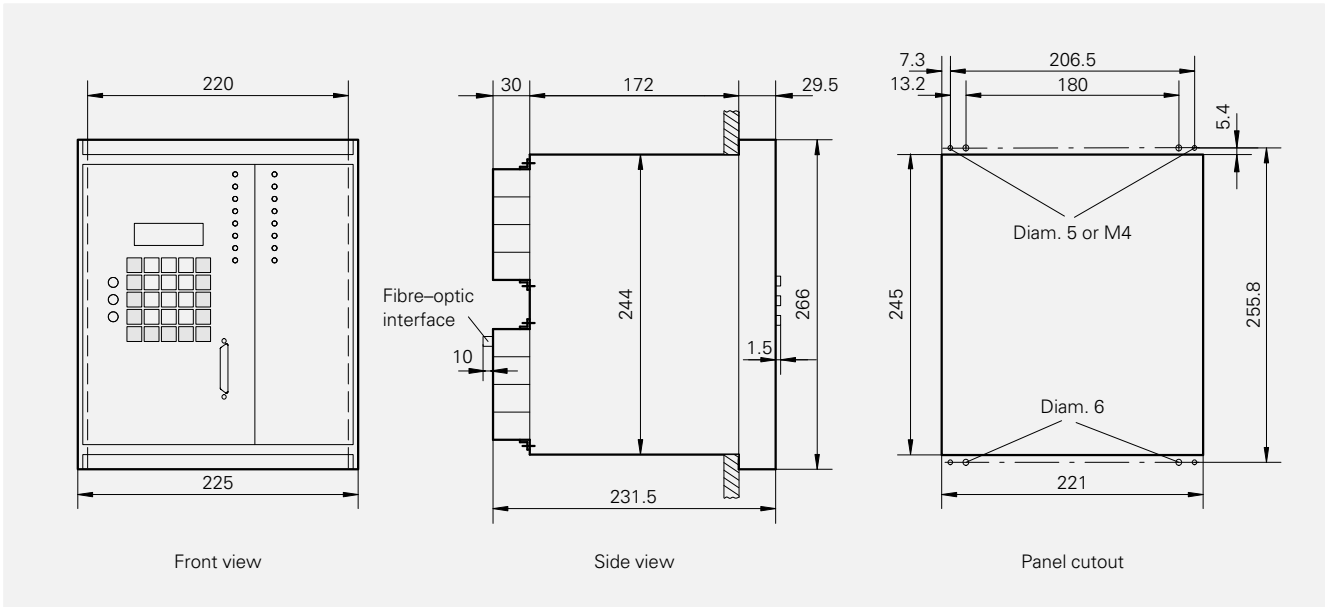


Fig. 6
7UM515 in 7XP2040-2 housing (for panel flush mounting and cubicle mounting)

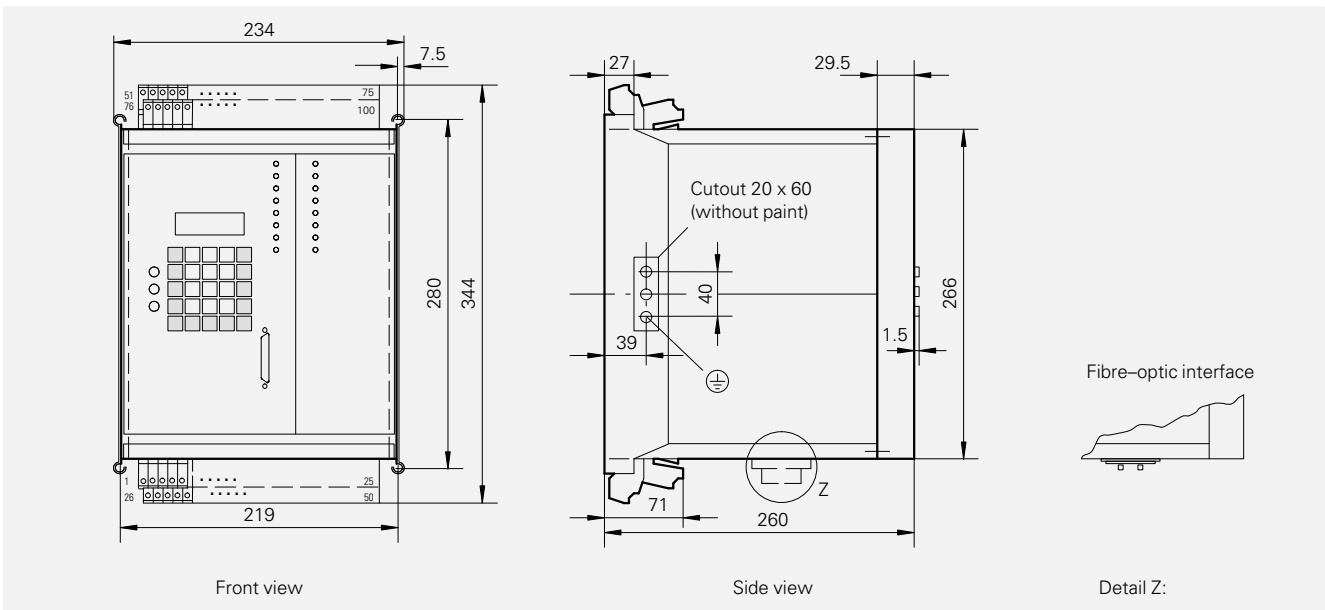


Fig. 7
7UM515 in 7XP2040-1 housing (for panel surface mounting)

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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.

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The Power Transmission and Distribution Group can also be found in the Internet:

<http://www.ev.siemens.de>

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