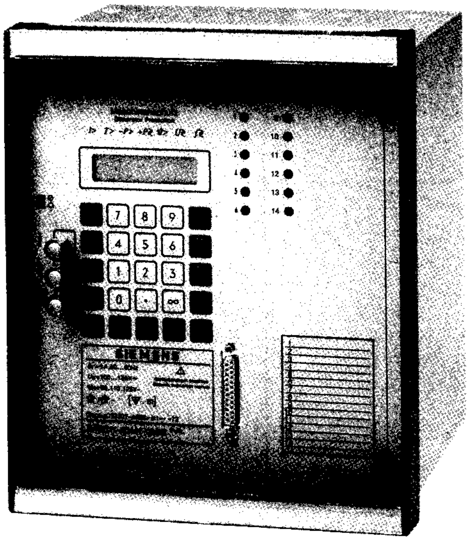
SIEMENS

Generator protection relay 7UM511



R-R2-002

Fig. 1
Generator protection relay 7UM511

Application

The 7UM511 is a digital generator protection relay which offers a practical combination of the most important protection functions.

It provides comprehensive and safe protection for smaller generators such as emergency diesel generator sets, run-of-the-river hydro plants, or private power stations.

Other units of the 7UM51 series provide additional protection functions for larger generators.

Furthermore, differential protection units 7UT512 and 7UT513 having the same design are available. These can likewise serve to protect transformers as well as generators or motors.

Construction

Within its compact construction, the device contains all the components required for:

- Capture and evaluation of measureands
- Operator panel with display field
- Event/alarm and command outputs
- Binary input option
- Serial interfaces
- Power supply converter.

The device can be supplied in two case variations. The variant for flush mounting or mounting in a cubicle has rear connection terminals. The model for surface mounting is supplied with 50 screw terminals accessible from the front.

Implemented functions/features

The following standard functions are implemented:

- Definite-time overcurrent protection
- Stator overload protection
- Underexcitation protection
- Overvoltage protection
- Undervoltage protection
- Overfrequency protection
- Underfrequency protection
- Reverse power protection
- Forward power monitor.

With the application of a powerful microprocessor and filtering and processing of digital values, the influence of starting and load currents, high frequency transients, transient DC current components and differing CT saturation can be suppressed to a large degree.

To ensure the operational readiness and correct measurement during frequency deviations (starts and stops) the device independently controls the sampling rate for the frequency range from 6 to 70 Hz.

Serial interface

The operator interface at the front can be used for connecting a PC. An additional isolated interface is provided for coupling to the substation control system LSA 678 or a central protection device.

An operator program DIGSI is available for AT-compatible PCs.

Settings

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

Self monitoring

All important hardware and software components are monitored continuously. Any irregularities in the hardware or program sequence are detected and alarmed. As a result, the security and availability of the protection are significantly improved.

Definite-time overcurrent protection

This protection function comprises two stages. The first stage generally serves as short-circuit and back-up protection for upstream relays such as, for example, differential protection or distance protection. The second stage can, for example, be employed as a high-speed trip for low-voltage generators or for constant voltage generators. A fourth current input is provided for low-voltage generators with neutral conductor in order to detect single-pole short-circuits (earth faults). Special algorithms in the measured value processing ensure that measurement errors, interference, harmonics and transient events are largely filtered out.

Stator overload protection

The thermal replica has the task of protecting the stator winding from excessively high continuous overload currents (see Fig. 2).

In order to correctly evaluate the influence of harmonics (3rd, 5th harmonic) the rms value of each phase current is calculated. The highest of the three values is squared and continuously fed into the thermal replica. Preload is thus considered. The ambient temperature is assumed as +40°C, however a temperature detector with a Pt 100 amplifier can also be connected.

Underexcitation protection

The load vector is calculated as a complex admittance from the stator values generator current and terminal voltage. With this, the influence of a widely fluctuating terminal voltage during pole slipping is considered in the correct physical sense. Measured value formation is obtained from the positive sequence vectors of current and voltage. This ensures that the protection operates correctly even with asymmetrical network faults (see Fig. 3).

Two characteristics for monitoring the steady-state and the dynamic stability limits can be set.

In order to quickly recognize a complete failure of the excitation, the magnitude of the excitation voltage is also supervised.

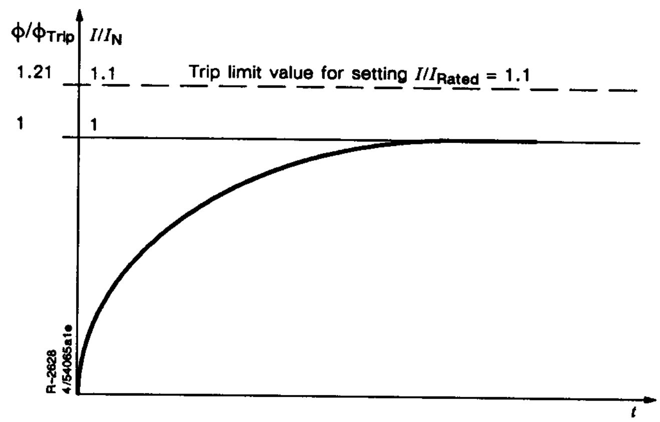


Fig. 2
Thermal replica: simulation of winding temperature Φ/Φ_{TRIP} computed from the operating current I

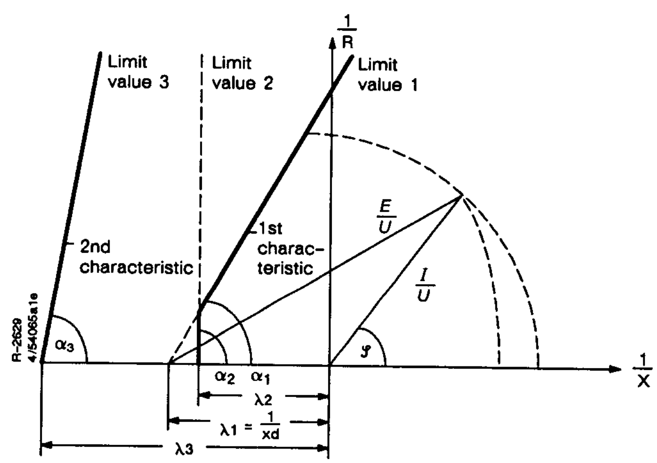


Fig. 3
Admittance diagram with response characteristics for steady-state and dynamic stability limits

Overvoltage protection

The positive sequence component of the voltage is calculated from the three phase-voltages. This makes the measurement procedure independent of the neutral point displacement which occurs during earth faults in an unearthed symmetrical three-phase system. The evaluation circuit consists of two independent voltage/time stages.

Undervoltage protection

An undervoltage protection is provided for generators which feed into an island network, for asynchronous generators as well as for pumped-storage hydroelectric power stations. Also in this case, the positive sequence component of the voltage is evaluated by a limit value monitor.

Frequency protection

Generators and connected consumers may only operate within a limited frequency range. By means of a comprehensive phase angle difference method and subsequent averaging, an extremely accurate frequency measurement is obtained. The chosen algorithm reliably filters out the fundamental wave even with voltage distortion. An underfrequency as well as an overfrequency stage are available.

Reverse power protection

Upon failure of the motive energy to a generator, the generator runs as a motor and receives the energy required to cover friction losses from the network. This condition represents an undesirable operating condition for the network as well as for the turbine and it must be terminated after a short time by tripping the network circuit-breaker. The active power is calculated from the positive sequence vectors of current and voltage. This ensures that asymmetrical network conditions do not cause measuring errors. A coupling input for the status of the trip valve controls the changeover of two time delay stages (long-time, short-time delay).

Forward power monitor

When, for example, with generators operating in parallel, the active power output of one machine becomes so small that other generators could take over this power, then it is often appropriate to shut down the lightly loaded machine. The criterion in this case is that the "forward" power supplied into the network falls below a certain set value.

In some applications it can also be desirable to output a control signal if the active power output exceeds a certain set value. Both possibilities have been provided.

External blocking of the forward power function has also been provided.

Trip matrix/trip circuits

The unit is equipped with five trip relays. These can be arbitrarily marshalled to the above-mentioned protection functions by means of parameterizing (software matrix).

Furthermore, each protection function can be switched "On" or "Off" via the operator panel. A third "Blocked" position permits commissioning of the unit with the local annunciations and the alarm relay circuits operative, however 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.

Disturbance records

If a fault is detected in the zone of protection, the individual events and the measured values are stored by the relay. The data in the disturbance record can be read via the serial interface. In order to analyze the fault, the data in the disturbance record may then be evaluated by means of a PC program or a central controller.

Marshallable output relays/LEDs

In order to provide a user-specific output and indication of messages, they are marshalled.

On-load measurement

The on-load measuring values generated in the relay, such as current, voltage, frequency, power, exciter voltage, rotor angle, power factor and thermal loading can be read off the LCD display or PC.

Technical data

Input circuits	Rated current Rated voltage / Operating range Rated frequency / Operating range	1 or 5A 100, 110, 125 V AC / 80 to 140 V AC 50/60 Hz / 40 to 70 Hz
	Thermal overload capability – in voltage path, continuous – in current path, continuous	 140 V AC 4 × I_N
	Burden – in voltage path at U_N = 100 V – in current path at I_N = 1 A at I_N = 5 A	 < 0.3 VA < 0.1 VA < 0.5 VA
Voltage supply via integrated DC/DC converter	Rated auxiliary voltage U_H	24, 48 V DC or 60, 110, 125 V DC or 220, 250 V DC
	Permissible tolerance Power consumption	– 20 to + 15 % max. 15 W
Setting ranges **Definite-time overcurrent protection**	Current $I>$, $I\gg$ Time delay t_1, t_2	0.8 to 8 × I/I_N 0 to 60 s
	Earth path I_E Time delay t_E	0.1 to 8 × I/I_N 0 to 60 s
	Drop-out to pick-up ratio Min. response time	0.95 45 to 55 ms
Stator overload protection	K-factor (acc. to IEC 255-8.2) Thermal time constant T Alarm stage (referred to trip temperature)	0.9 to 1.5 30 to 32 400 s 70 to 100 % $\vartheta/\vartheta_{OFF}$
	Temperature rise at I_N Cooling medium temperature, fixed Input voltage proportional to cooling medium temperature	40 to 200°C 40°C 0 to 10 V DC
Underexcitation protection	Distance of the trip characteristic from the coordinate origin in the admittance plane λ_1, λ_2, λ_3	 0.25 to 3 p. u.
	Angle α_1, α_2, α_3 Time delay t_1, t_2, t_3	50 to 120° 0 to 60 s
	Drop-out to pick-up ratio Min. response time	0.95 60 ms
	Excitation voltage input (higher values via external voltage divider 10:1 or 20:1)	0.5 to 8 V DC
Overvoltage protection	Voltage $U>$, $U\gg$ Time delay t_1, t_2	80 to 180 V AC 0 to 60 s
	Drop-out to pick-up ratio Min. response time	0.98 40 ms
Undervoltage protection	Voltage $U_1<$ Time delay t	100 to 0 V AC 0 to 60 s
	Drop-out to pick-up ratio Min. response time	1.02 40 ms
Frequency protection	Frequency rise $f>$ Time delay t_1	40 to 69 Hz 0 to 60 s
	Frequency reduction $f<$ Time delay t_2	69 to 40 Hz 0 to 60 s
	Min. response time Undervoltage blocking	150 ms 120 to 10 V
Reverse power protection	Reverse power $-P>$ Time delay t_1, t_2 (open/closed trip valve)	0.5 to 30 % P/P_N 0 to 60 s
	Drop-out to pick-up ratio Min. response time	0.6 100 ms

Generator protection relay 7UM511

Technical data

Setting ranges		
Forward power monitor	Forward power + $P\gg$ Forward power + $P\ll$ Time delay $t\gg$, $t\ll$	1 to 120 % P/P_N 0.5 to 120 % P/P_N 0 to 60 s
	Drop-out to pick-up ratio Min. response time	0.9 100 ms
Pick-up tolerances under rated conditions	Current values Voltage values Frequency	≤ 3 % of set value ≤ 3 % of set value ≤ 25 mHz
	Thermal replica Power Admittance values Time values	≤ 5 % ≤ 5 % ≤ 5 % ≤ 10 ms
Operational measurement	Display of values for – current – voltage – frequency	 IL1, IL2, IL3, $I_{positive\ sequence}$, IE UL1 × √3, UL2 × √3, UL3 × √3, $U_{positive\ sequence}$ F
	– active power – reactive power – load angle – pole angle	P/SN Q/SN p. f. THETA
	– excitation voltage – overload – cooling medium temperature	U = ϑ/ϑ OFF ϑ K
Contacts	Potential-free trip contacts Switching capacity Make Break Permitted current, continuous 0.5 s	2 NO (total of 5 trip relays) 1000 W/VA 30 W/VA 5 A 30 A
	Switching voltage	250 V DC
	Alarm contacts Switching capacity Make/Break Permitted current Switching voltage	total of 13 alarm relays 20 W/VA 1 A 250 V DC
Displays	LED displays at the front of the unit	16
Inputs	Optocoupler, for 24 to 250 V DC operating voltage (interference suppression and pick-up threshold in auxiliary unit, Order No. 7XR84 00-0)	6
	Current consumption independent of voltage range	approx. 2.5 mA
Construction of unit	For panel surface mounting Weight approx.	Order No. 7XP20 40-1 11.5 kg
	For panel flush mounting, cubicle mounting Weight approx.	Order No. 7XP20 40-2 10 kg
	Degree of protection acc. to DIN 40 050	IP51

Selection and ordering data

	Order No.
Generator protection module	**7UM511□ - □□A00-0□**
Rated current at 50 to 60 Hz, 100 to 125 V AC	
1 A	**1**
5 A	**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	
Panel surface mounting	**B**
Panel flush mounting or cubicle mounting	**C**
Serial interface	
Isolated, hard-wired	**B**
Integrated optical fibre connection	**C**

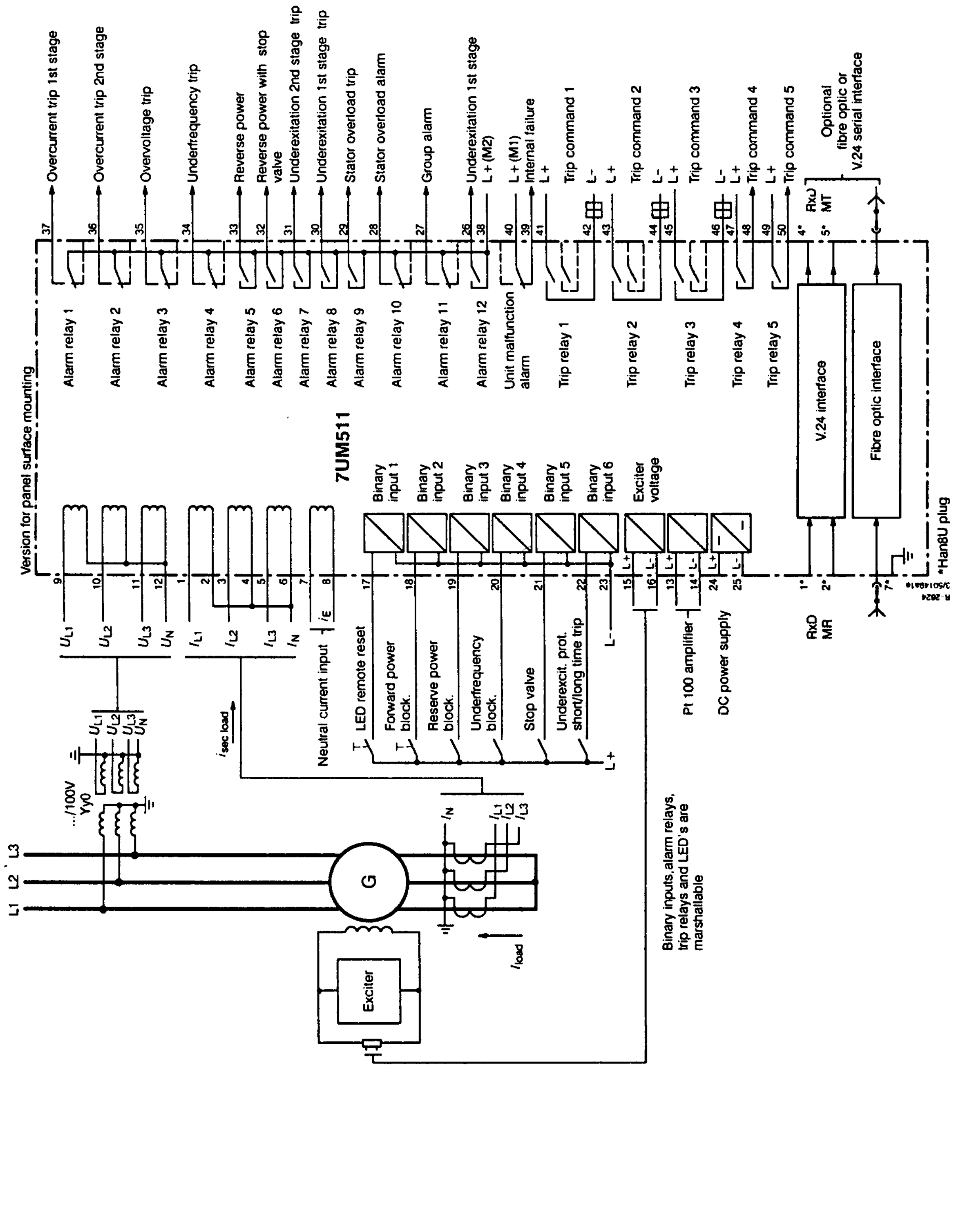


Fig. 4
Version for panel surface mounting

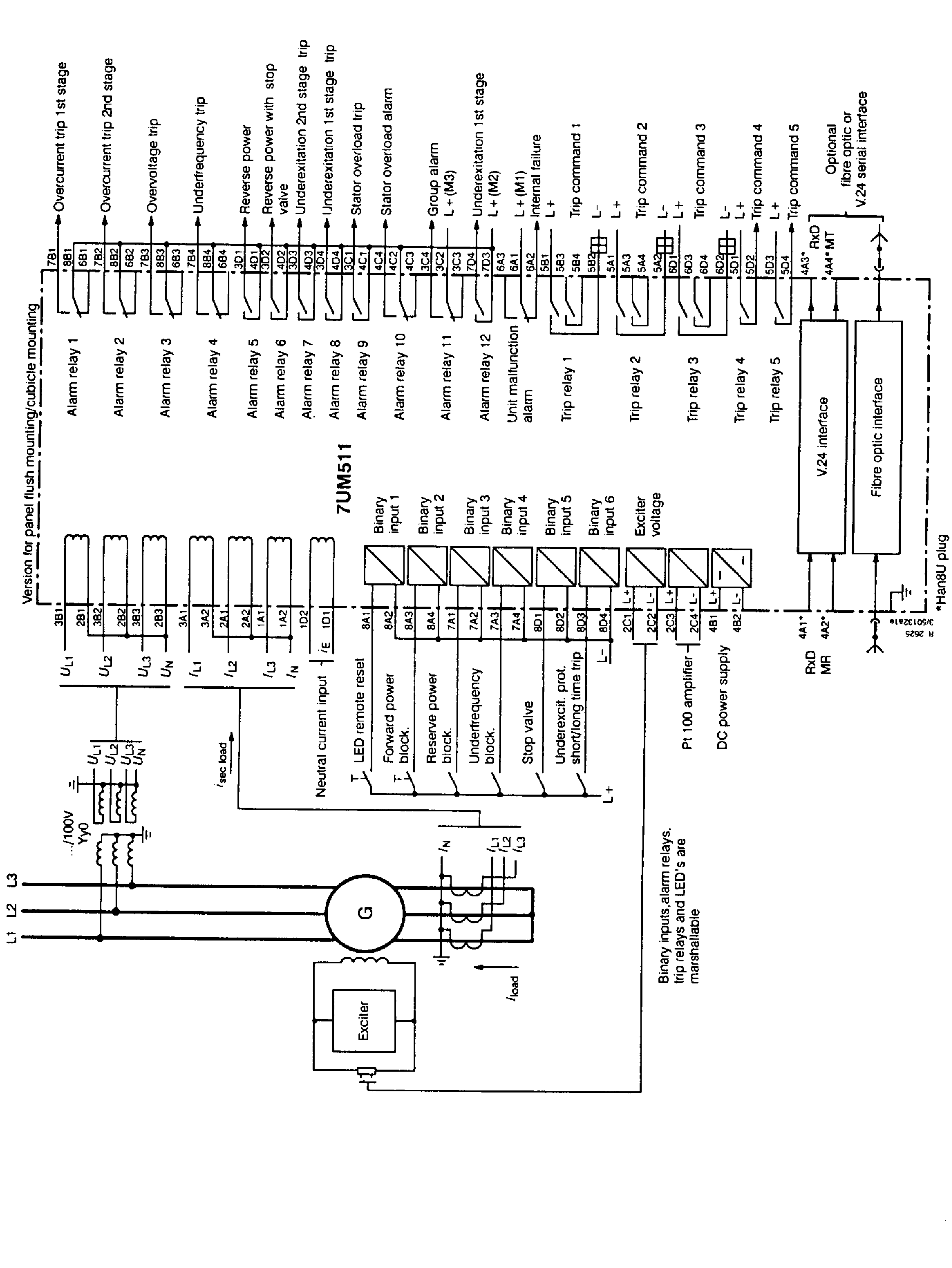


Fig. 5
Version for panel flush mounting, cubicle mounting

Dimension drawing in mm

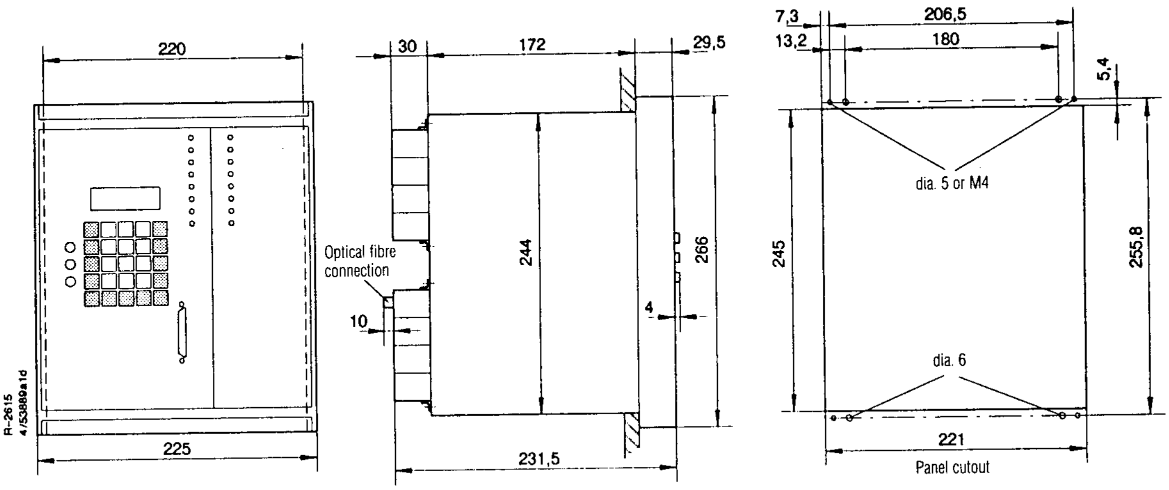


Fig. 6
Panel flush mounting, cubicle mounting

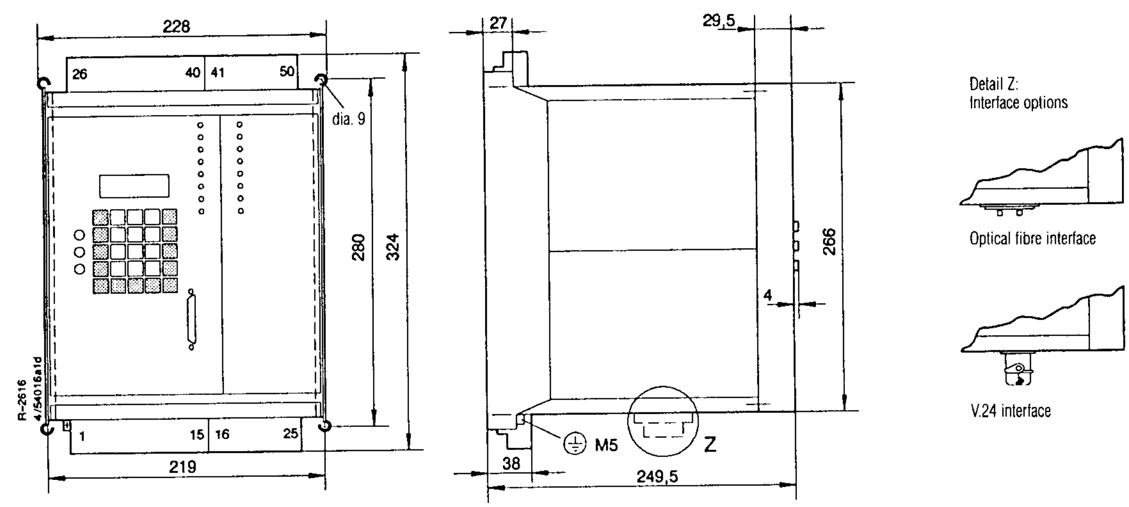


Fig. 7
Panel surface mounting

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