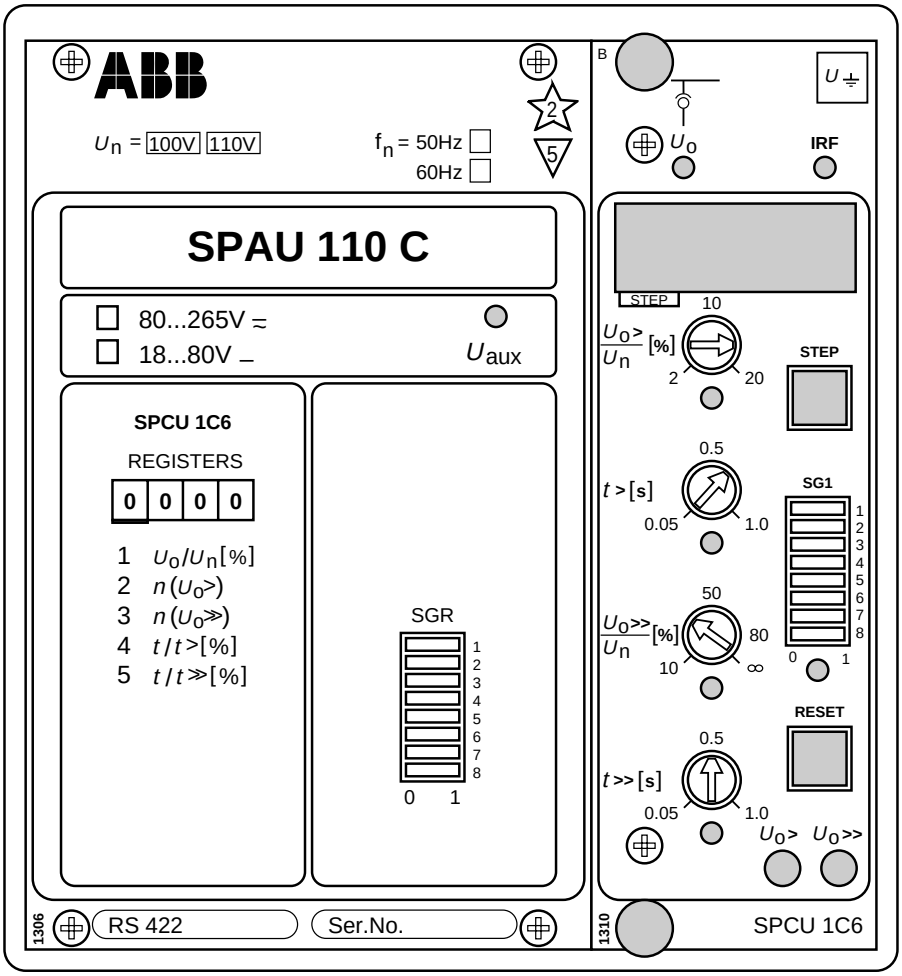
SPAU 110 C
Residual overvoltage relay

User´s manual and Technical description



ABB

1MRS 750607-MUM EN

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SPAU 110 C
Residual overvoltage relay

Data subject to change without notice

Contents

The complete user's manual for the residual overvoltage relay SPAU 110 C includes the following documents:

Residual overvoltage relay SPAU 110 C, general part	1MRS 750607-MUM EN
Residual voltage relay module SPCU 1C6	1MRS 750509-MUM EN
General characteristics of C-type relay modules	1MRS 750328-MUM EN

Features

Definite-time residual overvoltage earth-fault protection

Two independent operation stages, e.g. one for signalling and the other for tripping

Freely selectable output relay functions

Flexible adaptation to different protection applications

Digital display of setting values, residual voltage and recorded fault values

Data communications via serial interface

Continuous internal self-supervision with fault diagnosis

Application

The residual overvoltage relay SPAU 110 C is designed to be used for earth fault protection in isolated neutral, resistance earthed or reactance earthed systems. In resonant earthed systems relay starting can be used to control the switching device of the neutral resistor. The protection relay can also be used for the earth fault protection of generators and motors and for the unbalance protection of capacitor banks. The protection relay forms an integrated protection scheme, including two-stage earth fault protection and flexible trip and signal functions.

Description of function

The residual overvoltage relay SPAU 110 C is a secondary relay which is to be connected to the voltage transformers of the protected object. When a fault occurs, the residual overvoltage relay can be used for tripping a circuit breaker or for signalling an earth-fault only, as required by the protection application.

When the energizing voltage exceeds the set start value of the low-set voltage stage $U_0>$, the residual overvoltage relay starts. After the set operate time t> the low-set stage operates, if the fault still persists. The high-set voltage stage operates in the same way. When the measured voltage exceeds the set start value $U_0>>$, the high-set stage starts, and after the set time t>> the high-set stage operates, if the fault still persists.

Start information from the residual overvoltage relay is obtained as a contact function, which further can be used for controlling other cooperating protection relays, e.g. neutral current measuring earth fault relays.

The relay contains one optically isolated logic input to be controlled by an external control voltage. In the residual overvoltage relay the control input is used as a blocking input.

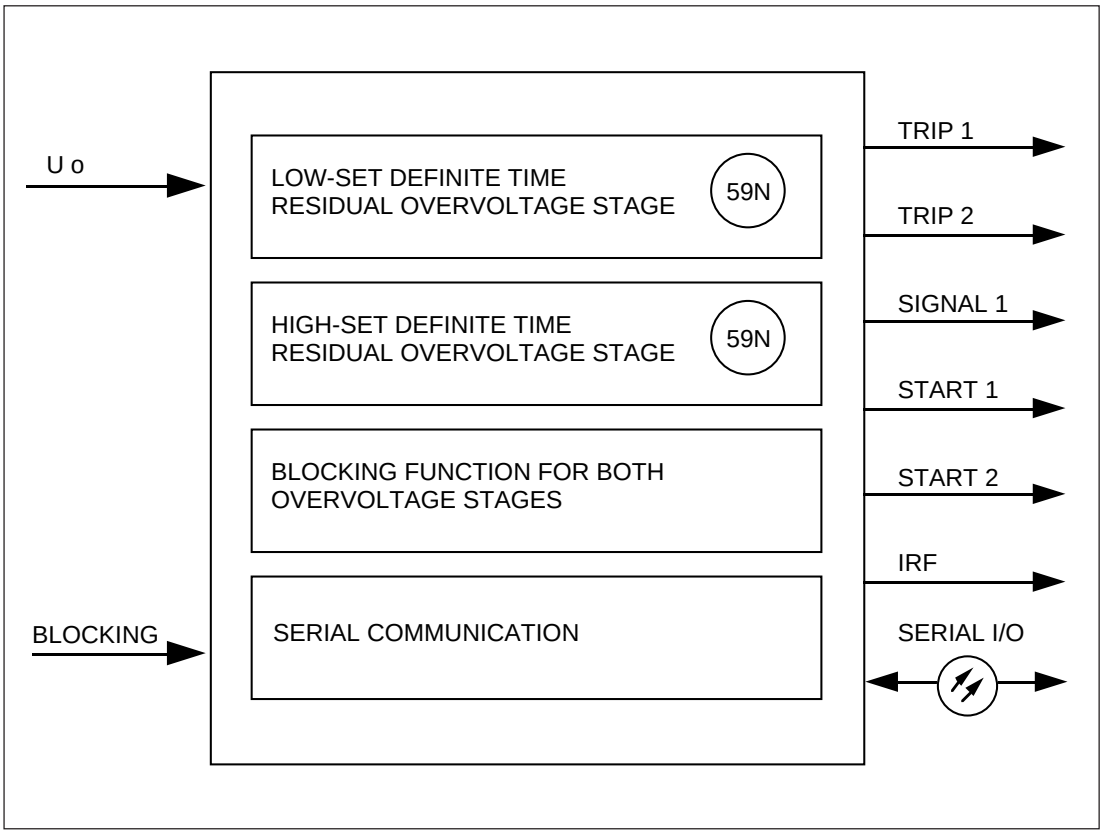


Fig. 1. Protection functions of the residual overvoltage relay SPAU 110 C. The encircled numbers refer to the ANSI (= American National Standards Institute) number of the concerned protection function.

Connections

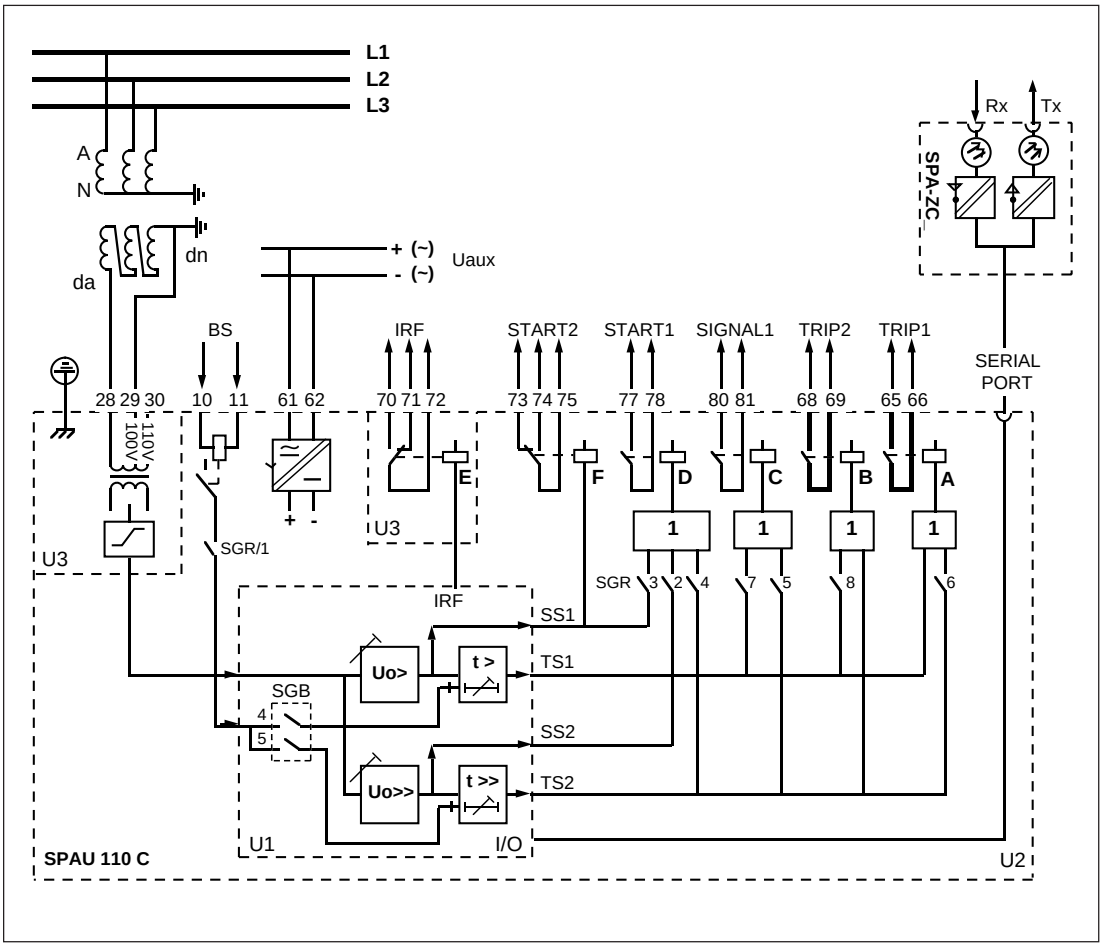


Fig. 2. Connection diagram for the residual overvoltage relay SPAU 110 C.

U_{aux}	Auxiliary supply voltage
A,B,C,D,E,F	Output relays
IRF	Self-supervision output
BS	Blocking signal
SS	Start signal
TS	Trip signal
SGR	Switchgroup for configuring trip and alarm signals
SGB	Switchgroup for configuring blocking signals
TRIP_	Trip output
SIGNAL1	Signal on relay operation
START_	Start information or relay operation
U1	Residual voltage relay module SPCU 1C6
U2	Power supply and I/O module SPTU 240S1 or SPTU 48S1
U3	I/O module SPTE 1E11
SERIAL PORT	Serial communication port
SPA-ZC_	Bus connection module
Rx/Tx	Receiver input Rx and transmitter output Tx of the bus connection module

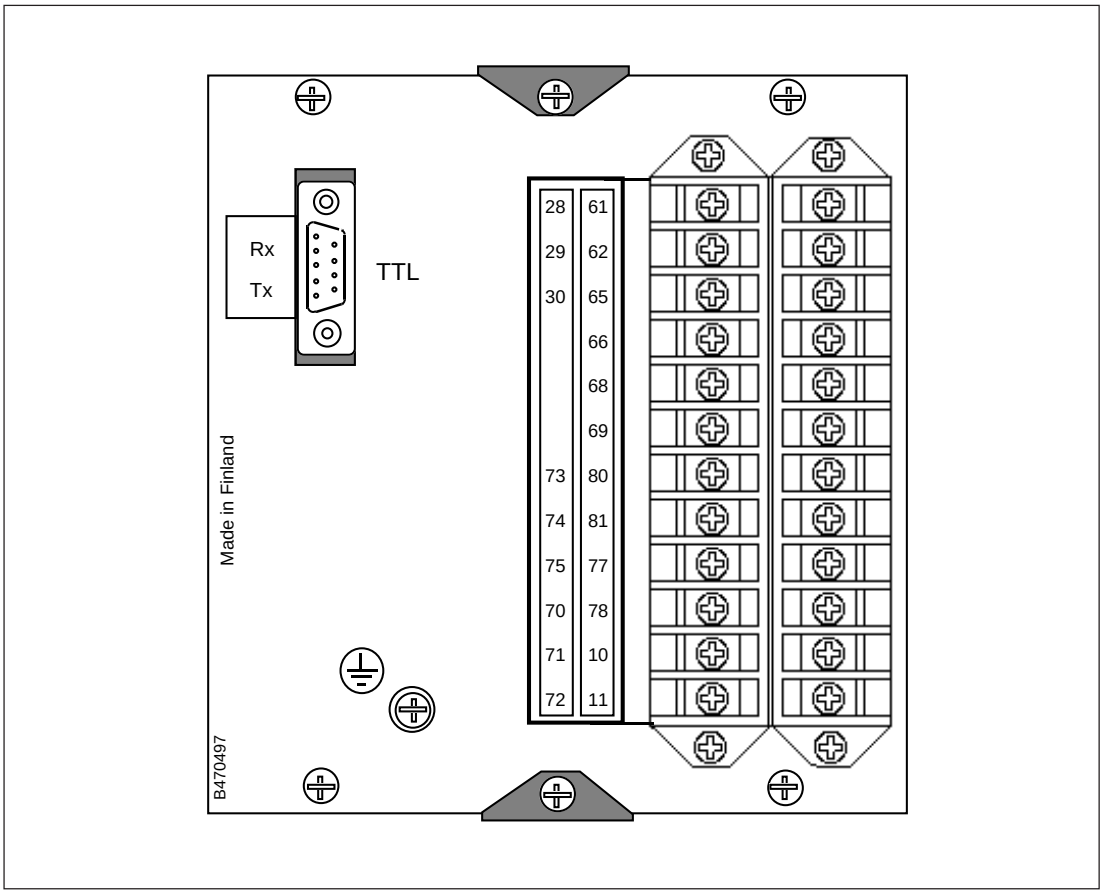


Fig.3. Rear view of residual overvoltage relay SPAU 110 C.

Specification of input and output terminals

Terminals	Function
28-29	Residual voltage U_0 (U_n = 100 V)
28-30	Residual voltage U_0 (U_n = 110 V)
10-11	External blocking signal (BS)
61-62	Auxiliary power supply. When DC voltage is used the positive pole is connected to terminal 61.
65-66	Trip output 1 of stages U_0> and U_0>> (TRIP 1)
68-69	Trip output 2 of stages U_0> and U_0>> (TRIP 2)
80-81	Signal on tripping of U_0> and U_0>> stages (SIGNAL 1)
77-78	Signal on tripping of U_0>> stage, start of U_0> and U_0>> stages (START 1)
73-74-75	Start of U_0> stage (START 2). In normal conditions the contact interval 73-75 is closed. When the U_0> stage starts, the contact interval 74-75 closes.
70-71-72	Self-supervision (IRF) alarm output. In normal conditions the contact interval 70-72 is closed. When the auxiliary voltage is lost or an internal fault is detected the contact interval 71-72 closes.
⏚	Protective earth terminal

The protection relay is connected to the fibre optic data communication bus over the bus connection module SPA-ZC 17 or SPA-ZC 21.

The bus connection module is fitted to the D-type connector on the rear panel of the relay. The pre-mounted opto-connectors of the optical fibres are plugged into the counter connectors Rx and Tx on the bus connection module.

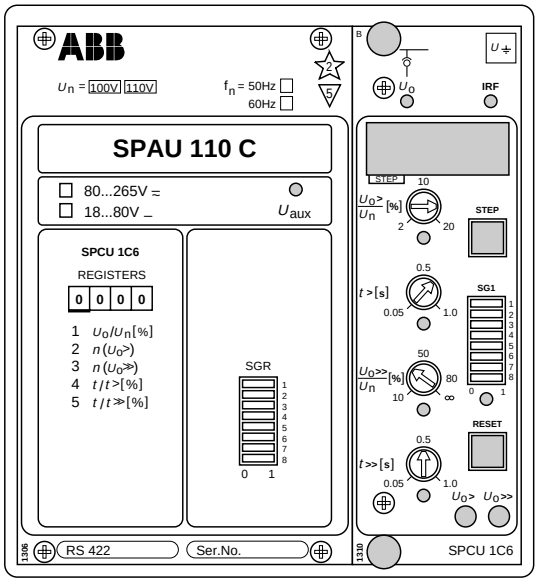
Configuration of output relays

The start signal of the U_0> stage is permanently wired to output relay F and the trip signal to output relay A. The trip signal of the U_0>> stage is permanently wired to output relay B. In addition, the following functions can be selected with the switches of the SGR switchgroup located on the front panel:

Switch	Function	Default settings	User's settings
SGR/1	Links the BS blocking signal to the residual overvoltage relay module	1	
SGR/2	Links the start signal of the U_0>> stage to output relay D	1	
SGR/3	Links the start signal of the U_0> stage to output relay D	1	
SGR/4	Links the trip signal of the U_0>> stage to output relay D	1	
SGR/5	Links the trip signal of the U_0>> stage to output relay C	1	
SGR/6	Links the trip signal of the U_0>> stage to output relay A	1	
SGR/7	Links the trip signal of the U_0> stage to output relay C	1	
SGR/8	Links the trip signal of the U_0> stage to output relay B	1	

The circuit breakers can be operated directly both via output relay A and output relay B. Thus the protection stages may have their own output relay or two separate circuit breakers can be controlled with one protection relay.

Operation indicators



1. Either voltage stage has its own start/operation indicator ($U_0>$ and $U_0>>$), located in the right bottom corner of the front panel of the relay module. Yellow light indicates that the concerned stage has started and red light that the stage has operated (tripped).

   With the SG2 switchgroup the start and trip indicators can be given a latching feature, which means that the LEDs remain lit, although the signal that caused operation falls below the set value. The indicators are reset with the RESET push-button. An unreset indicator does not affect the operation of the relay.

2. The yellow LED (U_0) above the display is lit when the measured residual voltage is shown on the display.

3. The red IRF indicator of the self-supervision system indicates that a permanent fault has been detected. The fault code appearing on the display once a fault has been detected should be recorded and notified when service is ordered.

4. The green U_{aux} LED on the front panel is lit when the power supply module operates properly.

5. The LED indicator below each one of the setting knobs is lit to indicate that the setting value displayed refers to the concerned setting knob.

6. The LED of the SG1 switchgroup is lit, when the checksum of the switchgroup is displayed.

The operation indicators, the SG2 selector switchgroup and the LEDs of the setting knobs are described more detailed in manual for the residual overvoltage relay module SPCU 1C6.

Combined power supply and I/O module

The power supply and I/O module (U2) is located behind the system front panel of the protection relay and can be withdrawn after removal of the system front panel. The power supply and I/O module incorporates the power source, the output relays, the control circuits of the output relays and the electronic circuitry of the external control input.

The power supply module is transformer connected, that is, the primary side and the secondary circuits are galvanically isolated. The primary side is protected by a slow 1 A fuse F1, placed on the PC board of the module. When the power source operates properly, the green U_{aux} LED on the front panel is lit.

The power supply and I/O module is available in two versions with different input voltage ranges:

- module SPTU 240 S1
  U_{aux} = 80...265 V ac/dc
- module SPTU 48 S1
  U_{aux} = 18...80 V dc

The permitted input voltage range of the power supply and I/O module inserted in the relay on delivery is marked on the system panel panel of the relay.

Technical data
(modified 2002-04)

Energizing inputs

	100 V	110 V
Terminals	28-29	28-30
Rated voltage U_n	100 V	110 V
Continuous voltage withstand	2 x U_n	2 x U_n
Power consumption at rated voltage	<0.5 VA	
Rated frequency f_n, acc. to order	50 Hz or 60 Hz	

Output contact ratings

Trip contacts	
Terminals	65-66, 68-69
Rated voltage	250 V ac/dc
Carry continuously	5 A
Make and carry for 0.5 s	30 A
Make and carry for 3 s	15 A
Breaking capacity for dc, when the control circuit time constant L/R ≤ 40 ms, at the control voltages	
- 220 V dc	1 A
- 110 V dc	3 A
- 48 V dc	5 A
Signalling contacts	
Terminals	70-71-72, 73-74-75, 77-78, 80-81
Rated voltage	250 V ac/dc
Carry continuously	5 A
Make and carry for 0.5 s	10 A
Make and carry for 3 s	8 A
Breaking capacity for dc, when the control circuit time constant L/R ≤ 40 ms, at the control voltages	
- 220 V dc	0.15 A
- 110 V dc	0.25 A
- 48 V dc	1 A

External control input (blocking)

Terminals	10-11
Control voltage level	18...265 V dc or 80...265 V ac
Current consumption at activated input	2...20 mA

Auxiliary supply voltage

Power supply and I/O modules and voltage ranges:	
- module SPTU 240 S1	80...265 V ac/dc
- module SPTU 48 S1	18...80 V dc
Power consumption under quiescent/operating conditions of relay	~4 W/~6 W

Residual overvoltage relay module SPCU 1C6

Low-set stage U_0>	
Start voltage U_0>	2...100% x U_n
Operate time t>	0.05...100 s
High-set stage U_0>>	
Start voltage U_0>>	2...80% x U_n and ∞, infinite
Operate time t>>	0.05...100 s

Data communication

Transmission mode	Fibre optic serial bus
Data code	ASCII
Selectable data transfer rates	300, 1200, 2400, 4800 or 9600 Bd
Fibre optic bus connection module, power supply from host relay	
- for plastic fibre cables	SPA-ZC 21 BB
- for glass fibre cables	SPA-ZC 21 MM
Fibre optic bus connection module, provided with integral power supply unit	
- for plastic fibre cables	SPA-ZC 17 BB
- for glass fibre cables	SPA-ZC 17 MM

Insulation Tests *)

Dielectric test IEC 60255-5	2 kV, 50 Hz, 1 min
Impulse voltage test IEC 60255-5	5 kV, 1.2/50 µs, 0.5 J
Insulation resistance measurement IEC 60255-5	>100 MΩ, 500 Vdc

Electromagnetic Compatibility Tests *)

High-frequency (1 MHz) burst disturbance test IEC 60255-22-1	
- common mode	2.5 kV
- differential mode	1.0 kV
Electrostatic discharge test IEC 60255-22-2 and IEC 61000-4-2	
- contact discharge	6 kV
- air discharge	8 kV
Fast transient disturbance test IEC 60255-22-4 and IEC 61000-4-4	
- power supply	4 kV
- I/O ports	2 kV

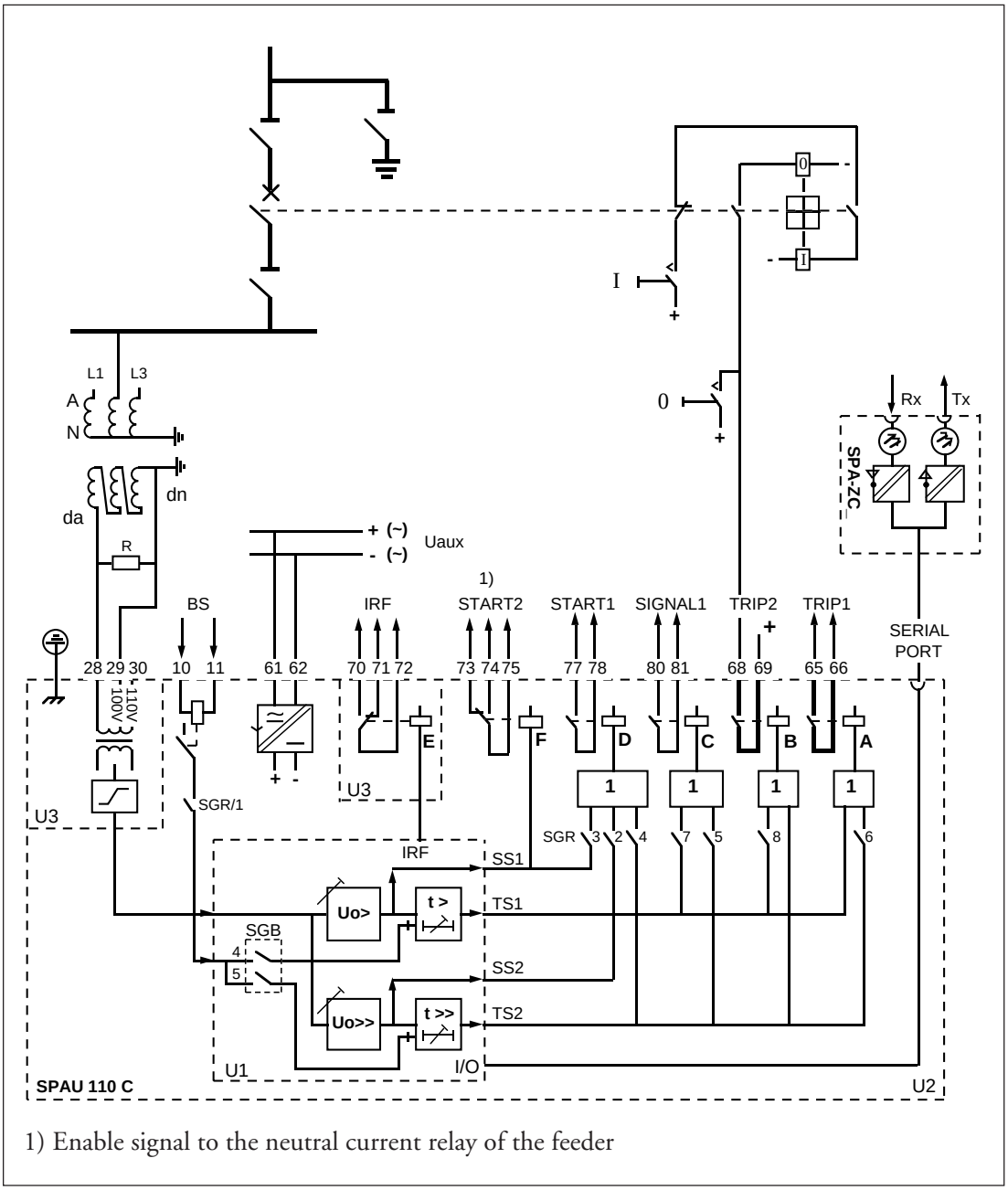
Environmental conditions

Specified ambient service temperature range	-10...+55°C
Long term damp heat withstand as per IEC 60068-2-3	<95%, +40°C, 56 d/a
Relative humidity as per IEC 60068-2-30	93...95%, +55°C, 6 cycles
Transport and storage temperature range	-40...+70°C
Degree of protection by enclosure at panel mounting	IP54
Weight of relay incl. flush mounting case	3.0 kg

*) The tests do not apply to the serial port, which is used exclusively for the bus connection module.

Applications

Example 1.
The residual overvoltage relay SPAU 110 C used for the earth fault protection of isolated neutral systems.



1) Enable signal to the neutral current relay of the feeder

Fig. 4. The residual overvoltage relay SPAU 110 C used for the earth fault protection of isolated neutral systems.

An earth fault somewhere in a galvanically connected power system causes residual voltage. For this reason the residual overvoltage relay SPAU 110 C is well adapted to be used as a general earth fault alarm relay that monitors a defined part of the power system.

The residual overvoltage relay SPAU 110 C measures the residual voltage from the open delta winding of the voltage transformers. This procedure provides a relatively good accuracy of measurement. The ferroresonances of the voltage transformers are suppressed by a resistor R incorporated in the open delta connection.

The low-set stage of the residual overvoltage relay indicates imminent earth faults. The residual voltage in a sound isolated neutral network is normally very small, even less than 1% of the maximum residual voltage value. Thus the low-set residual voltage stage can be given a low setting value.

The low-set stage can be used for enabling the neutral current measuring non-directional earth fault relays of the feeders. When an earth fault occurs on a feeder both the neutral current earth fault relay of the feeder and the low-set stage of the busbar system residual voltage relay have to start to enable tripping of the feeder circuit breaker. The enabling system prevents unnecessary operation of the neutral current earth fault relay at short circuits, when a motor is started or under normal service conditions. If a directional earth fault relay is used on the feeder, no enable signal is required.

The high-set stage is due to protect the busbar system and to serve as unselective back-up protection for the feeder erth fault protection. The setting of the back-up protection stage of the residual voltage relay must not be lower than that of the earth fault relays of the feeders. Also possible changes in the service preconditions should be considered.

The high-set stage also serves as earth fault protection for the infeeder, if the trip signal is routed to the HV side circuit breaker of the power transformer as well as to the LV side circuit breaker. The trip signal for the HV side circuit breaker can be taken, for instance, from the contacts 80-81 and be routed to the circuit breaker via an intermediate relay.

The switches of the residual overvoltage relay SPAU 110 C can be set as follows:

Switch	SG1/SPCU 1C6	SGB/SPCU 1C6	SGR
1	1 } t>= 5...100 s	0 Not in use	0 No blocking signal from feeders
2	1 }	0 Not in use	1 U_0>> start signal to output relay D
3	0 Not in use	0 Not in use	0 No U_0> start signal to output relay D
4	0 No latching	0 No blocking to t>	0 No U_0>> trip signal to output relay D
5	0 U_0>= 2...20%xU_n	0 No blocking to t>>	1 U_0>> trip signal to output relay C
6	0 U_0>>=10...80%xU_n	0 Not in use	0 No U_0>> trip signal to output relay A
7	1 } t>>= 0,5...10 s	0 Not in use	0 No U_0> trip signal to output relay C
8	0 }	0 Not in use	0 No U_0> trip signal to output relay B
Σ	67		

When the switches are set as above the output contacts of SPAU 110 C have the following functions:

Contact	Function
65-66	Signal on delayed operation of U_0> stage
68-69	Circuit breaker trip signal from U_0>> stage
80-81	Alarm signal on final trip of U_0>> stage
77-78	Start signal of U_0>> stage
70-71-72	Self-supervision signal
73-75	Blocking signal to the neutral current earth fault relay of the feeder
74-75	Start signal of U_0> stage, enable signal to the neutral current earth fault relay of the feeder

Example 2.
Earth fault protection of generators and motors.

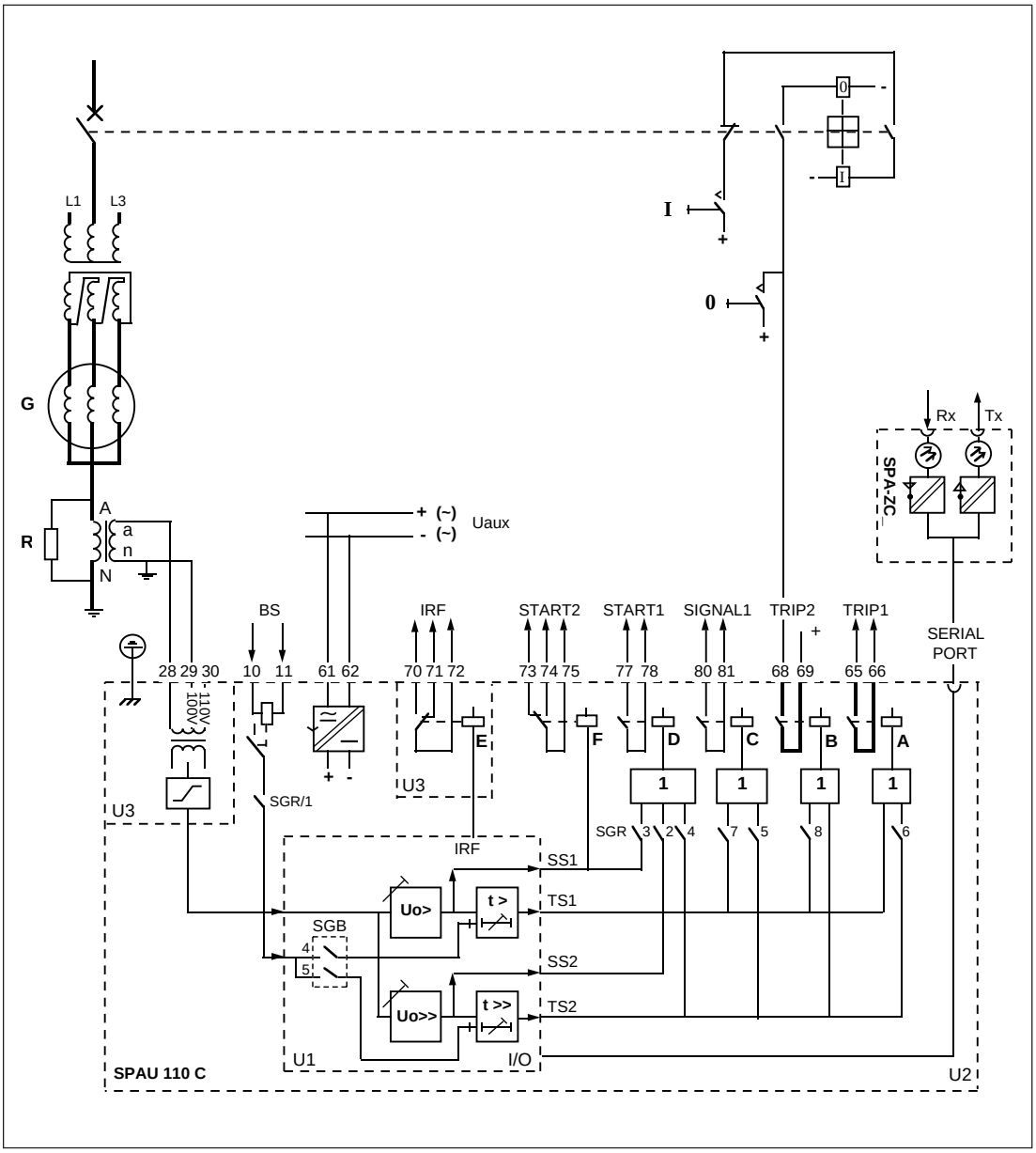


Fig. 5. Residual overvoltage relay SPAU 110 C used for the protection of a power generator.

Instead of using an open delta connection the residual voltage can be measured over a voltage transformer connected to the neutral, provided the neutral is available. In the case of a block connected generator the galvanically connected network is limited by the transformer, so a residual overvoltage relay alone will form a satisfactory earth fault protection. In the connection above the residual voltage relay operates on earth faults occurring in the stator winding of the generator or in the deltawinding of the transformer. The low-set stage can be used for earth fault signalling. Due to the risk of a double earth fault in the system, the high-set stage of the residual overvoltage protection should be tripping. The signal tripping the generator excitation is taken, for instance, from the contacts 77-78.

A resistor connected in parallel with the voltage transformer prevents HV side earth faults from reflecting via the capacitances over the block transformers to the LV side, where they could cause relay operations.

The switches of the residual overvoltage relay SPAU 110 C can be set as follows:

Switch	SG1/SPCU 1C6	SGB/SPCU 1C6	SGR
1	1 } t>= 0,5...10 s	0 Not in use	0 No blocking signal from feeders
2	0 }	0 Not in use	0 no U_0>> start signal to output relay D
3	0 Not in use	0 Not in use	0 No U_0> start signal to output relay D
4	0 No latching	0 No blocking to t>	1 U_0>> trip signal to output relay D
5	0 U_0>= 2...20%xU_n	0 No blocking to t>>	1 U_0>> trip signal to output relay C
6	0 U_0>>= 10...80%xU_n	0 Not in use	0 No U_0>> trip signal to output relay A
7	0 } t>>= 0.05...1.0 s	0 Not in use	0 No U_0>> trip signal to output relay C
8	0 }	0 Not in use	0 No U_0> trip signal to output relay B
Σ	1		

When the switches are set as above the output contacts of SPAU 110 C have the following functions:

Contact	Function
65-66	Signal on delayed operation of U_0> stage
68-69	Circuit breaker trip signal from U_0>> stage
80-81	Signal on final trip of U_0>> stage
77-78	Trip signal to excitation circuit breaker
73-74-75	Start signal of U_0> stage
70-71-72	Self-supervision signal

Example 3.
Unbalance protection of capacitor banks.

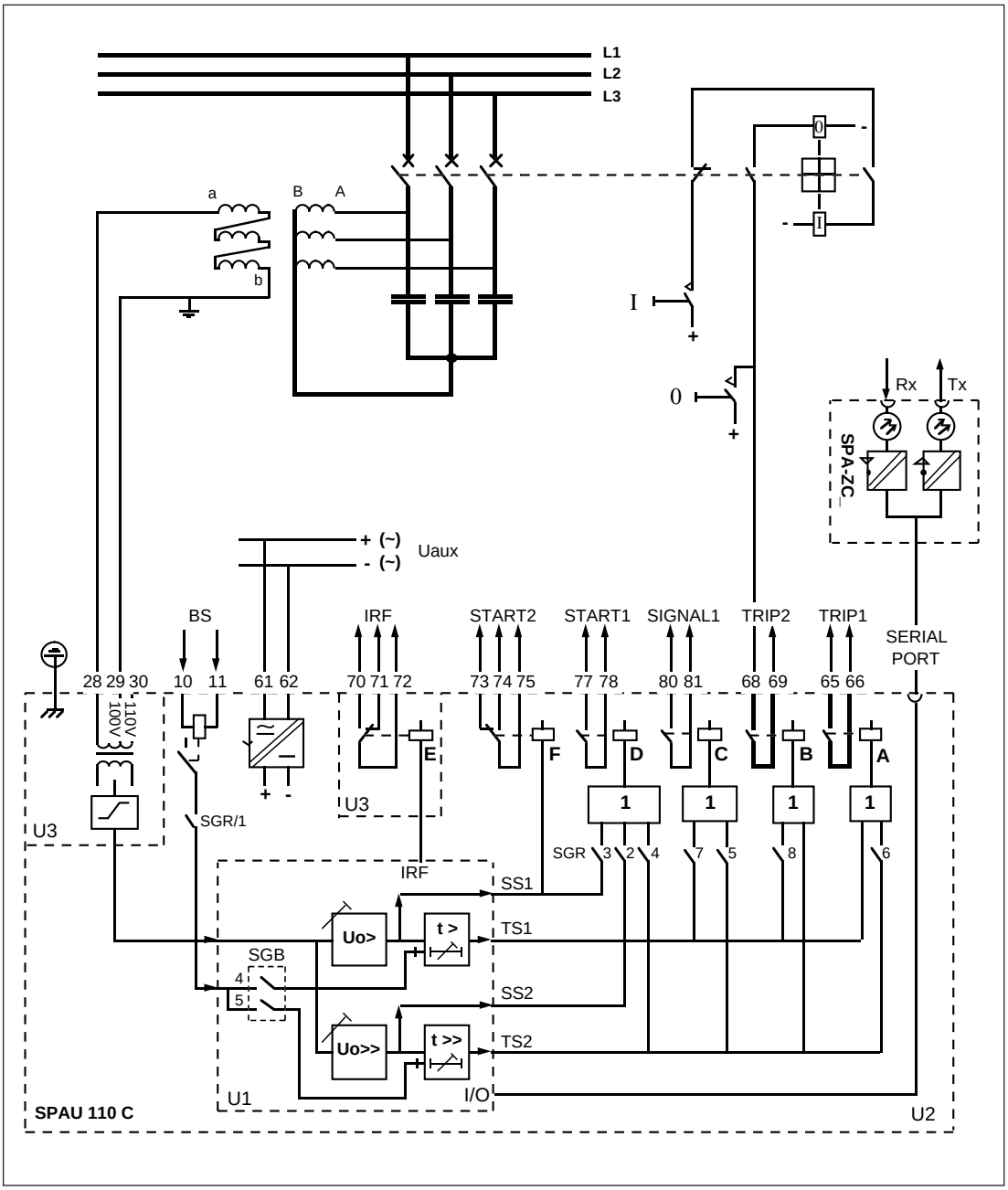


Fig. 6. Residual overvoltage relay SPAU 110 C used for unbalance protection of a capacitor bank.

The unbalance protection of a star-connected capacitor bank can also be implemented by using the open delta connection for measuring the unbalance voltage. The capacitor bank is composed of small units which are protected by internal fuses. Burning of one or more fuses causes unbalance, and to detect this unbalance the residual overvoltage relay SPAU 110 C is used. The function of the low-set stage of the relay is signalling and that of the high-set stage tripping. The relay setting is determined by the manufacturer of the capacitor bank, because the setting depends on the number of capacitor units connected in parallel and in series and their rated values.

The switches of the residual overvoltage relay SPAU 110 C can be set as follows:

Switch	SG1/SPCU 1C6	SGB/SPCU 1C6	SGR
1	1 } t>= 0.5...10 s	0 Not in use	0 No blocking signal from feeders
2	0 }	0 Not in use	1 U_0>> start signal to output relay D
3	0 Not in use	0 Not in use	0 No U_0> start signal to output relay D
4	0 No latching	0 No blocking to t>	0 No U_0>> trip signal to output relay D
5	0 U_0>= 2...20%xU_n	0 No blocking to t>>	1 U_0>> trip signal to output relay C
6	0 U_0>>= 10...80%xU_n	0 Not in use	0 No U_0>> trip signal to output relay A
7	0 } t>>=0.05...1 s	0 Not in use	0 No U_0> trip signal to output relay C
8	0 }	0 Not in use	0 No U_0> trip signal to output relay B
Σ	1		

When the switches are set as above the output contacts of SPAU 110 C have the following functions:

Contact	Function
65-66	Signal on delayed operation of U_0> stage
68-69	Circuit breaker trip from U_0>> stage
80-81	Alarm signal on final trip of U_0>> stage
77-78	Start signal of U_0>> stage
73-74-75	Start signal of U_0> stage
70-71-72	Self-supervision signal

Recorded data and fault analysis

The registers of the residual voltage relay module SPCU 1C6 provide a general view of the earth fault situations of the substation and of the behaviour of the network during normal service.

Register 1 records the maximum measured residual voltage as a multiple of the rated voltage of the relay energizing input. If the relay trips, the voltage at the moment of tripping is memorized. A new trip erases the old value and updates the register. The procedure is the same if a voltage measured exceeds the old value recorded.

The data of register 1 show how close the setting values are to actual values during normal operation, by comparing the residual voltage indicated by the relay with the setting value.

By using the information of register 1 it is also possible to determine the smallest fault resistance at which an earth fault extinguishes by itself or by auto-reclosures. By giving the low-set residual voltage stage a signalling function and by selecting an operate time that is equal to the final trip delay of the feeder earth fault relay, register 1 allows the smallest fault resistance, that caused operation, to be determined, when the total earth fault current of the galvanically connected network is known.

The relay should be reset after start, to prevent the updating level of the register from getting to high. Should the relay be linked to an event reporting unit, the residual voltage value on starting of the relay can be read and the registers can be reset, when the start signals reset. Thus the residual voltage value measured on starting of the relay is always known.

The number of times the different stages have started, registers 2 and 3, gives a picture of the occurrence and distribution of the earth faults in respect of the fault resistances of the earth faults. Frequent starts may indicate imminent earth faults, e.g. insulation faults or orther faults, that easily may develop to a total earth fault.

Registers 4 and 5 show the duration of the latest start situation of the stages, expressed in per cent of the set operate time. Any new start restarts the counter from zero. If the stage trips, the register will show 100 [%].

Registers 4 and 5 contain information on the duration of an earth fault , or, if final trip has been performed, the safety margin of the grading times of selective protection. Generally, the residual voltage does not disappear immediately after opening of the circuit breaker of the faulty feeder, so the start situation of the residual voltage relay may continue for a short time after the circuit breaker has opened.

Registers 1...5 are reset either by pressing the STEP and RESET push-buttons simultaneously or with a command, V102, over the SPA bus.

Testing

Testing should always be performed in accordance with national regulations.

The protection relay incorporates an IRF function that continuously monitors the internal state of the relay and produces an alarm signal on detection of a fault. According to the manufacturer's recommendations the relay should be submitted to primary testing at five years' intervals. These tests include the entire protection chain from the measurement transformers to the circuit breakers.

The secondary testing described in this manual is based on the relay's setting values during normal operation. If necessary, the secondary testing can be extended, for instance, by testing the protection stages with several different setting values.

As switch positions and setting values have to be altered during the test procedure the correct positions of switches and correct values of the relay during normal operation have to be recorded, for instance, on the reference card accompanying the relay.

To enable secondary testing the relay has to be disconnected from the pilot circuits, either at the disconnectable terminal blocks or by using the test adapter fitted on the relay. It is extremely important that the relay is disconnected from the residual voltade transformers. A possible trip signal wired from the residual voltage relay to the main circuit breaker should also be considered when the relay is tested.

When auxiliary voltage is connected to the protection relay, the relay performs a self-testing program, which excludes only the matching transformers and the contacts of the output relays. The operational condition of the relay is tested by means of an ordinary relay test set. The test includes the matching transformers, the output relays and the accuracy of the operate values.

Equipment required for testing:

- adjustable voltage transformer 0...260 V, 1 A
- isolating transformer 220/220 V
- voltmeter
- clock or timer for time measurement
- DC voltage source for auxiliary voltage supply
- switches and lamps
- supply and pilot wires
- multimeter

Note the rated voltage prior to connecting the pilot wires to the relay terminals, see "Specification of input and output terminals".

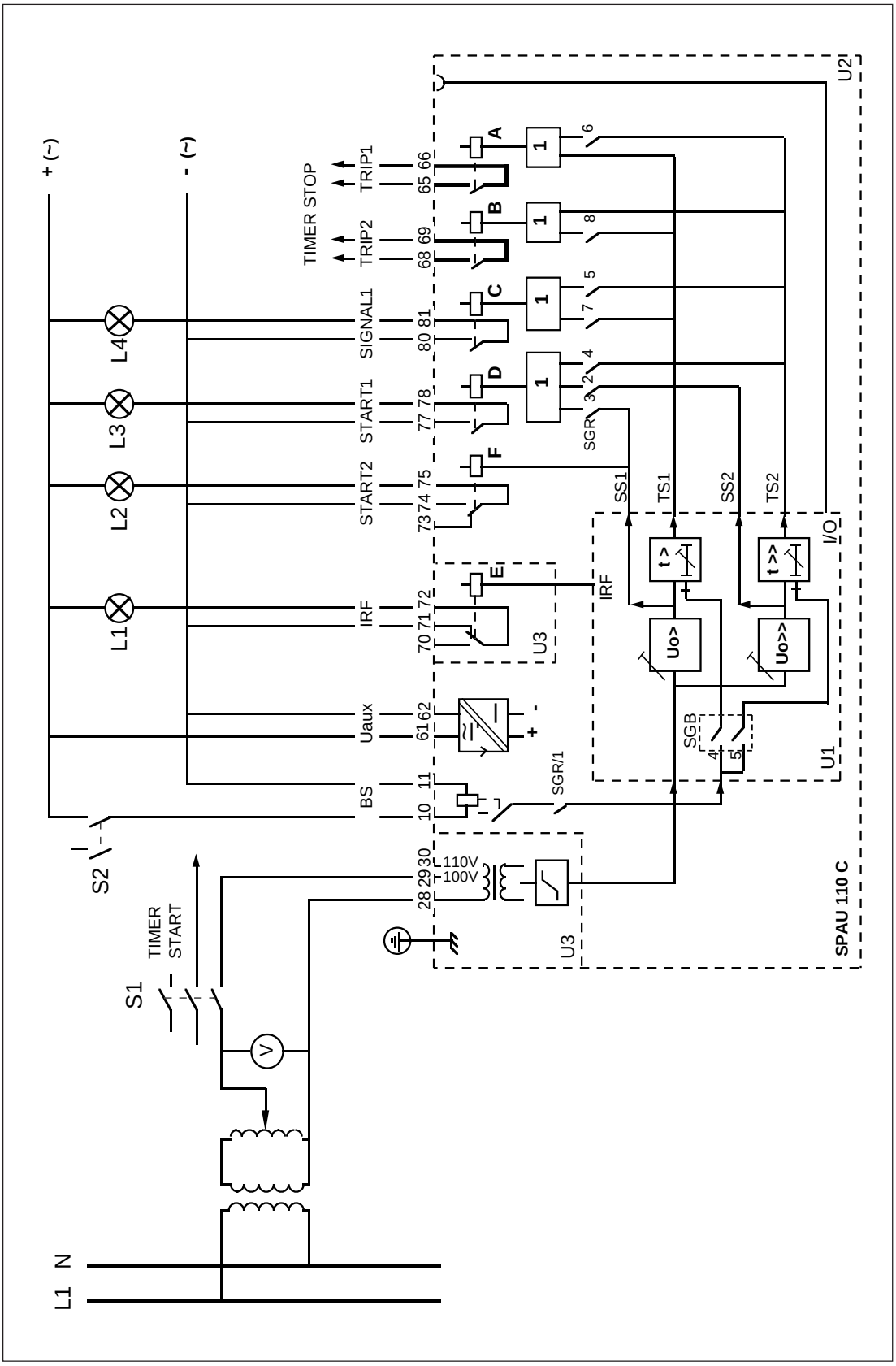


Fig. 7. Secondary test connection of residual overvoltage relay SPAU 110 C.

After finishing the test connection and setting the selector switches, connect the auxiliary voltage to the relay.

Testing of matching transformers

Apply voltage to the relay terminals and check that the voltage value indicated on the relay display is equal to the value measured by the voltmeter. The measurement can be made at the rated voltage of the relay.

Testing of low-set stage U_0>

Set the switches of the SGR switchgroup as follows before testing of the low-set stage:

Switch	Position
1	1
2	0
3	0
4	0
5	0
6	0
7	1
8	0

When the switches are set as above the output relays have the following functions

Output relays (terminals)	Function
A (65-66)	Trip signal of U_0> stage
B (68-69)	(Trip signal of U_0>> stage)
C (80-81)	Information on trip of U_0> stage
D (77-78)	Not in use
E (70-71-72)	Self-supervision signal
F (73-74-75)	Start signal of U_0>stage

Starting

Carry out the test according to Fig. 7. Close the S1 switch and raise the voltage slowly until the relay operates (L2 is lit). Then read the start voltage indicated on the voltmeter.

Operate time

Set the voltage to be fed to the relay for measuring the relay operate time at 2 x the set start value of stage U_0>. The clock is started by closing of switch S1 and stopped via contact 65-66 when output relay A operates.

The operation of output relay C is indicated by L4.

When the relay starts, the U_0> LED in the right bottom corner is lit with yellow light. When the relay trips, the light of the same LED turns red.

Blocking

Set switches 4 and 5 of switchgroup SGB and switch SGR/1 in position 1 (ON).

Close switch S2. Increase the test voltage until the relay starts, indicator U_0> turns yellow. Wait until the set operate time t> has elapsed. The low-set stage must not operate, i.e. the U_0> indicator must not turn red.

Testing of high-set stage U_0>>

Set the switches of the SGR switchgroup as follows before starting the test of the high-set stage:

Switch	Position
1	1
2	1
3	0
4	0
5	1
6	0
7	0
8	0

When the switches are set as above, the output relays have the following functions

Output relays (terminals)	Function
A (65-66)	(Trip signal of U_0> stage)
B (68-69)	Trip signal of U_0>> stage
C (80-81)	Information on trip of U_0>> stage
D (77-78)	Start signal of U_0>> stage
E (70-71-72)	Self-supervision signal
F (73-74-75)	(Start signal of U_0>stage)

The test procedure is the same as that of the low-set stage, but with the exception that when the operate times are measured, the clock is stopped via contact 68-69 on the operation of output relay B.

Testing of self-supervision output relay (IRF)

The function of the IRF LED and the output relay E, when the self-supervision alarm signal is activated, can be tested with the Trip test function described in the manual "General characteristics of C-type SPC relay modules". The operation of output relay E is indicated by the L1 lamp.

Maintenance and repair

When used under the conditions specified in the section "Technical data", the relay is practically maintenance-free. The relay modules include no parts or components sensitive to abnormal physical or electrical wear under normal operating conditions.

If the environmental conditions on site differ from those specified, as to temperature and humidity, or if the atmosphere around the relay contains chemically active gases or dust, the relay should be visually inspected during the relay secondary testing. The visual inspection should focus on:

- Signs of mechanical damage to relay case and terminals
- Dust inside the relay cover or case; remove carefully by blowing compressed air
- Signs of corrosion on terminals, case or inside the relay

If the relay fails in operation or if the operation values considerably differ from those mentioned in the relay specifications, the relay should be given a proper overhaul. Minor measures can be taken by personnel from the customer's instrument work-shop, but major measures involving the overhaul of the electronics are to be taken by the manufacturer. Please contact the manufacturer or his nearest representative for further information about checking, overhaul and calibration of the relay.

Note!
The protection relays contain electronic circuits which are liable to serious damage due to electrostatic discharge. Before removing a module, ensure that you are at the same electrostatic potential as the equipment by touching the case.

Note!
Static protective relays are measuring instruments and should be handled with care and protected against damp and mechanical stress, especially during transport.

Spare parts

Residual voltage relay module	SPCU 1C6
Combined power supply and I/O module	
- U_{aux} = 80...265 V ac/dc	SPTU 240 S1
- U_{aux} = 18...80 V dc	SPTU 48 S1
Case (including I/O module)	SPTK 1E11
I/O module	SPTE 1E11
Bus connection module	SPA-ZC 17_ or SPA-ZC 21_

Ordering numbers

Residual overvoltage relay without test adapter

SPAU 110 C	RS 422 010 -AA, CA, DA, FA

Residual overvoltage relay with test adapter RTXP 18

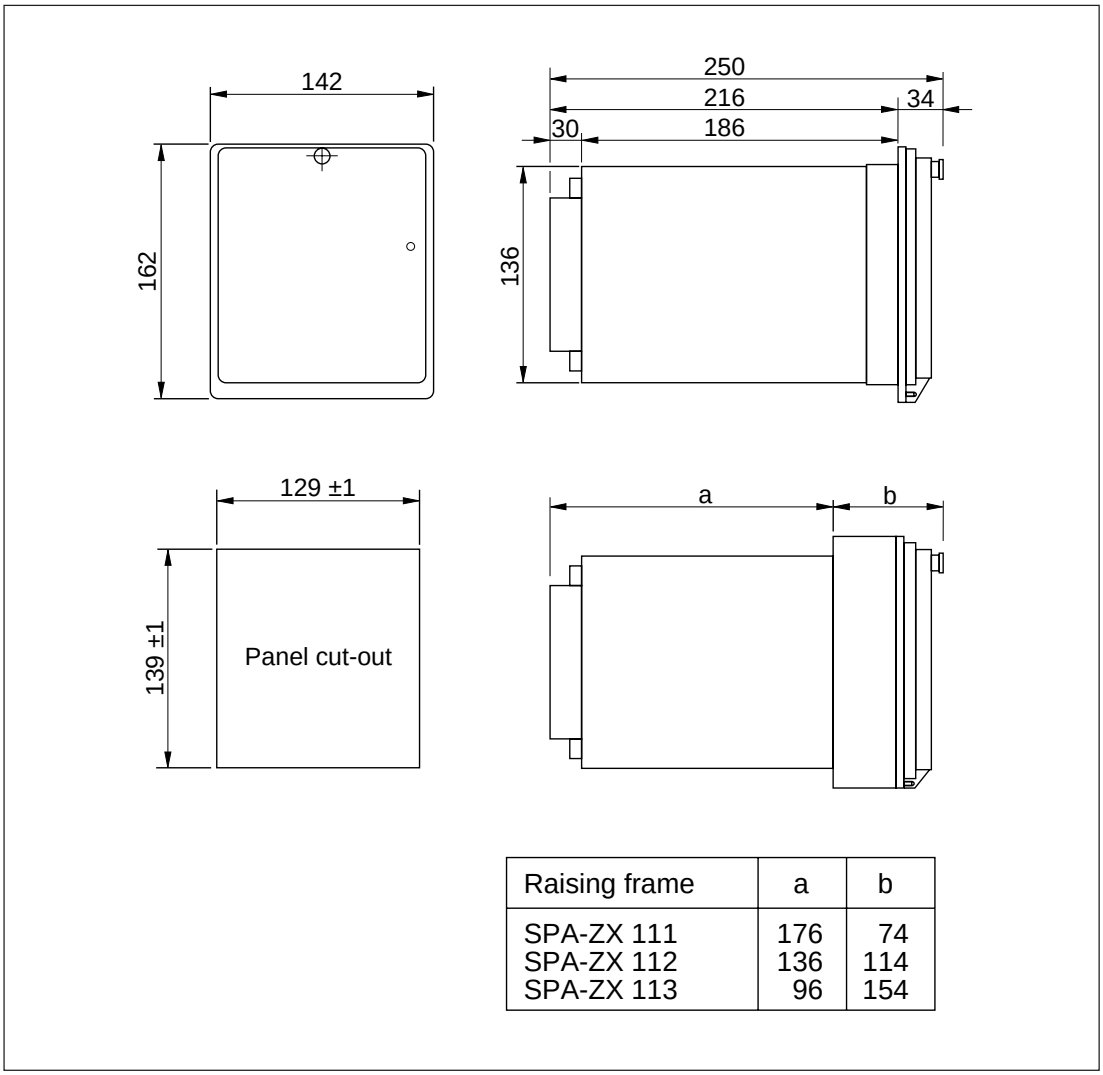
SPAU 110 C	RS 422 210 -AA, CA, DA, FA

The two last letters of the ordering number designate the rated frequency f_n and the U_{aux} voltage range of the relay as follows:

AA correspond to f_n = 50 Hz and U_{aux} = 80...265 V ac/dc
CA correspond to f_n = 50 Hz and U_{aux} = 18...80 V dc
DA correspond to f_n = 60 Hz and U_{aux} = 80...265 V ac/dc
FA correspond to f_n = 60 Hz and U_{aux} = 18...80 V dc

Dimensions and instructions for mounting

The relay case is basically designed for flush-mounting. The mounting depth can be reduced by the use of a raising frame: type SPA-ZX 111 reduces the depth behind the mounting panel by 40 mm, type SPA-ZX 112 reduces the depth by 80 mm and type SPA-ZX 113 reduces the depth by 120 mm. The relay can also be mounted in a case for surface mounting, type designation SPA-ZX 115.



Raising frame	a	b
SPA-ZX 111	176	74
SPA-ZX 112	136	114
SPA-ZX 113	96	154

Fig. 8. Dimensions of the residual overvoltage relay SPAU 110 C

The relay case is made of beige anodized aluminium section.

A rubber gasket fitted on the mounting collar provides an IP 54 degree of protection between relay case and mounting panel, when the relay is flush mounted.

The hinged cover of the relay case is made of a clear, UV stabilized polycarbonate, and provided with a sealable fastening screw. A gasket along the edge of the cover provides an IP54 degree of protection between the case and the cover.

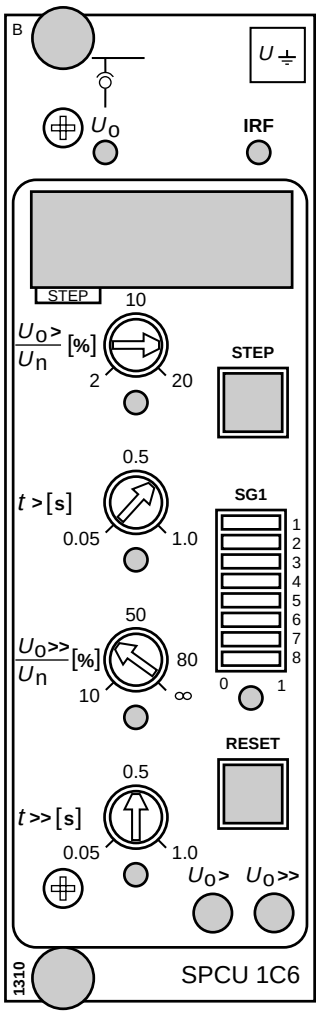
All input and output wires are connected to the screw terminal blocks on the rear panel. Each terminal is dimensioned for one max. 6 mm^2 wire or two max. 2.5 mm^2 wires. The D connector is intended for serial communications.

Information required with order

1. Quantity and type designation	15 SPAU 110 C unit
2. Order number	RS 422 010 -AA
3. Rated frequency	f_n = 50 Hz
4. Auxiliary voltage	U_{aux} = 110 V dc
5. Accessories	15 bus connection modules SPA-ZC 21 MM 2 fibre optic cables SPA-ZF MM 100 14 fibre optic cables SPA-ZF MM 5
6. Special requirements	-

SPCU 1C6
Residual overvoltage relay module

User´s manual and Technical description



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SPCU 1C6
Residual overvoltage relay module

Contents

Features

Low-set residual overvoltage stage U_0> with definite time operation characteristic, setting ranges 2...20% x U_n and 10...100% x U_n

High-set residual overvoltage stage U_0>> with definite time operation characteristic, setting ranges 10...80% x U_n or 2...16% x U_n

The operation of the high-set residual overvoltage stage can be set out of function by selecting the setting ∞, infinitive

Effective suppression of harmonics of the input energizing voltages

Local display of measured and set values as well as data recorded at the moment of a relay operation

Flexible selection of special operational features for particular applications

Continuous self-supervision of hardware and software. At a permanent fault the alarm output relay picks up and the other outputs are blocked.

Description of operation

The residual overvoltage relay module type SPCU 1C6 is used in a variety of different protection relay units where it constitutes a non-directional general earth-fault protection module which measures the residual voltage of the electrical power system.

The residual overvoltage module contains two overvoltage stages,that is a low-set stage U_0> and a high-set stage U_0>>.

The low-set or high-set voltage stage starts if the measured voltage exceeds the set start value of the stage concerned. When starting, the concerned stage delivers a starting signal SS1 or SS2 and simultaneously the operation indicator of the stage is lit with yellow colour. If the overvoltage situation lasts long enough to exceed the set operation delay, the stage that started also operates generating a trip signal, TS1 alt. TS2. The operation indicator of the stage that operated turns red. The start and operation indicators are provided with memory control, which means that they can be given the self-reset or the latching mode of operation. The latching indicators are reset with the RESET push-button on the front panel or by means of the command V101 or V102 via the serial port.

The tripping of the low-set overvoltage stage U_0> can be blocked by routing a blocking signal BTS1 to the low-set stage. Similarly, the tripping of the high-set stage U_0>> is blocked by a blocking signal BTS2. The blocking signals are routed by means of switchgroup SGB on the PC board of the relay module.

The setting range of the operation time t> of the low-set overvoltage stage U_0> is selected with switches SG1/1 and SG1/2. Three setting ranges are available.

Switches SG1/7 and SG1/8 are used for selecting the setting range for the operation time t>> of the high-set stage U_0>>. Three setting ranges are available.

The setting range of the start value of the low-set stage U_0> is selected with switch SG1/5. Two setting ranges are available, that is 2...20% x U_n and 10...100% x U_n.

The setting range of the start value of the high-set stage U_0>> is selected with switch SG1/6. Two setting ranges are available, that is 2...16% x U_n or 10...80% x U_n.

The operation of the two operating stages is provided with a so called latching facility, which means that the operation output is kept alerted, although the signal which caused the operation disappears. The latching function is selected with switch SG1/4. The latched output and the output relay can be reset in three different ways; (i) by pressing push buttons STEP and RESET simultaneously, (ii) via the serial inter-face using the command V101 or (iii) via the serial interface using the command V102. When alternative (ii) is used all recorded information is maintained but if the alternatives (i) or (iii) is used the recorded information is erased.

The residual voltage signal input is provided with an effective filter by means of which hamonics of the measured residual voltage is suppressed, see Fig. 1.

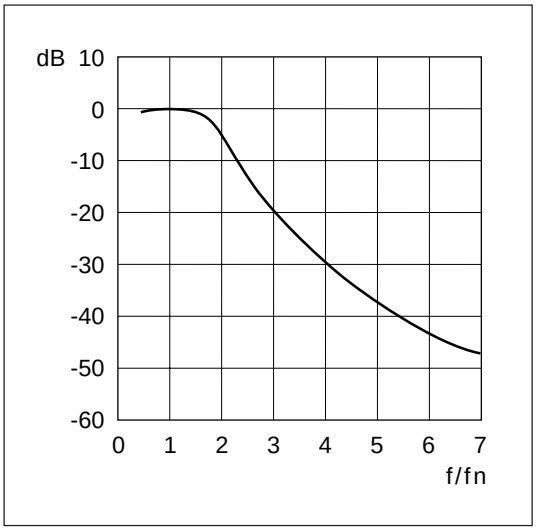


Fig. 1. Filter characteristics of the residual voltage input circuit.

Block diagram

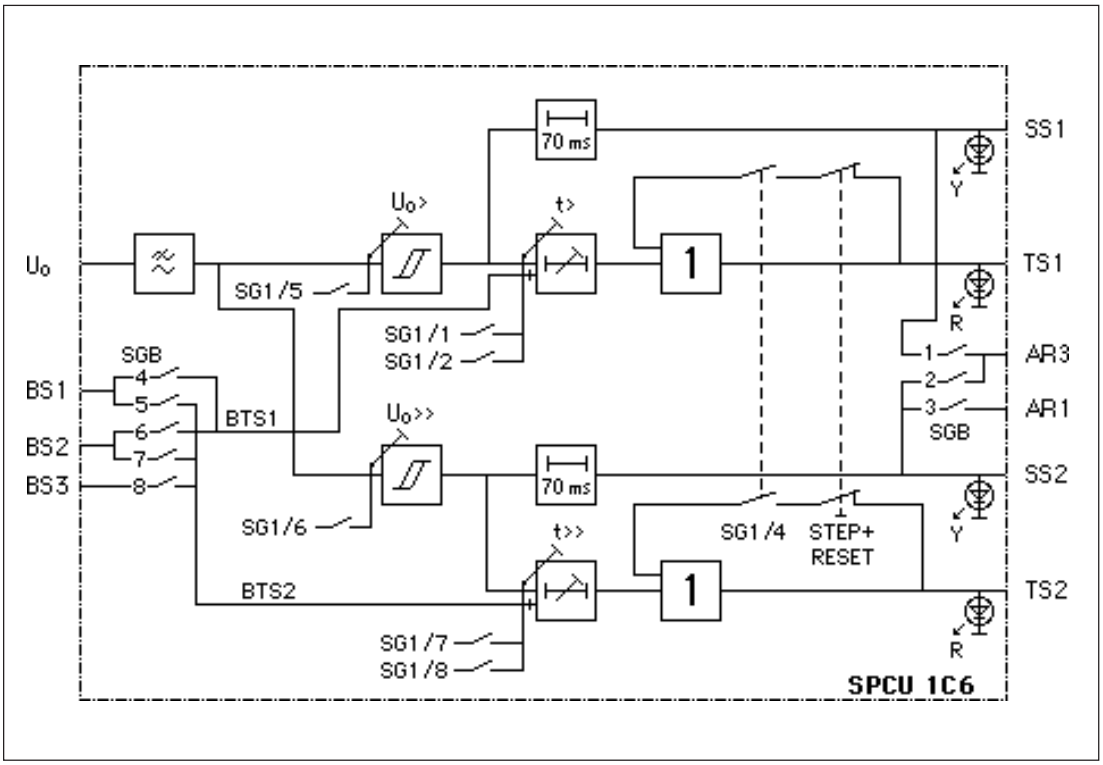


Fig. 2. Block schematic diagram of the residual overvoltage relay module SPCU 1C6.

U_0	Measured residual voltage
BS1, BS2, BS3	Incoming external blocking signals
BTS1	Blocking of tripping of stage U_0>
BTS2	Blocking of tripping of stage U_0>>
SG1	Selector switchgroup on the relay module front panel
SG2	Function selector switchgroup for the operation indicators
SGB	Selector switchgroup on the PC board for blocking signals
SS1	Start signal of stage U_0>
TS1	Trip signal of stage U_0>
SS2	Start signal of stage U_0>>
TS2	Trip signal of stage U_0>>
Y	Yellow indicator, starting
R	Red indicator, tripping

NOTE!
All input and output signals of the relay module are not necessarily wired to the terminals of every protection relay unit utilizing this module. The signals wired to the terminals are shown in the signal diagram in the manual of the concerned protection relay unit.

Front panel

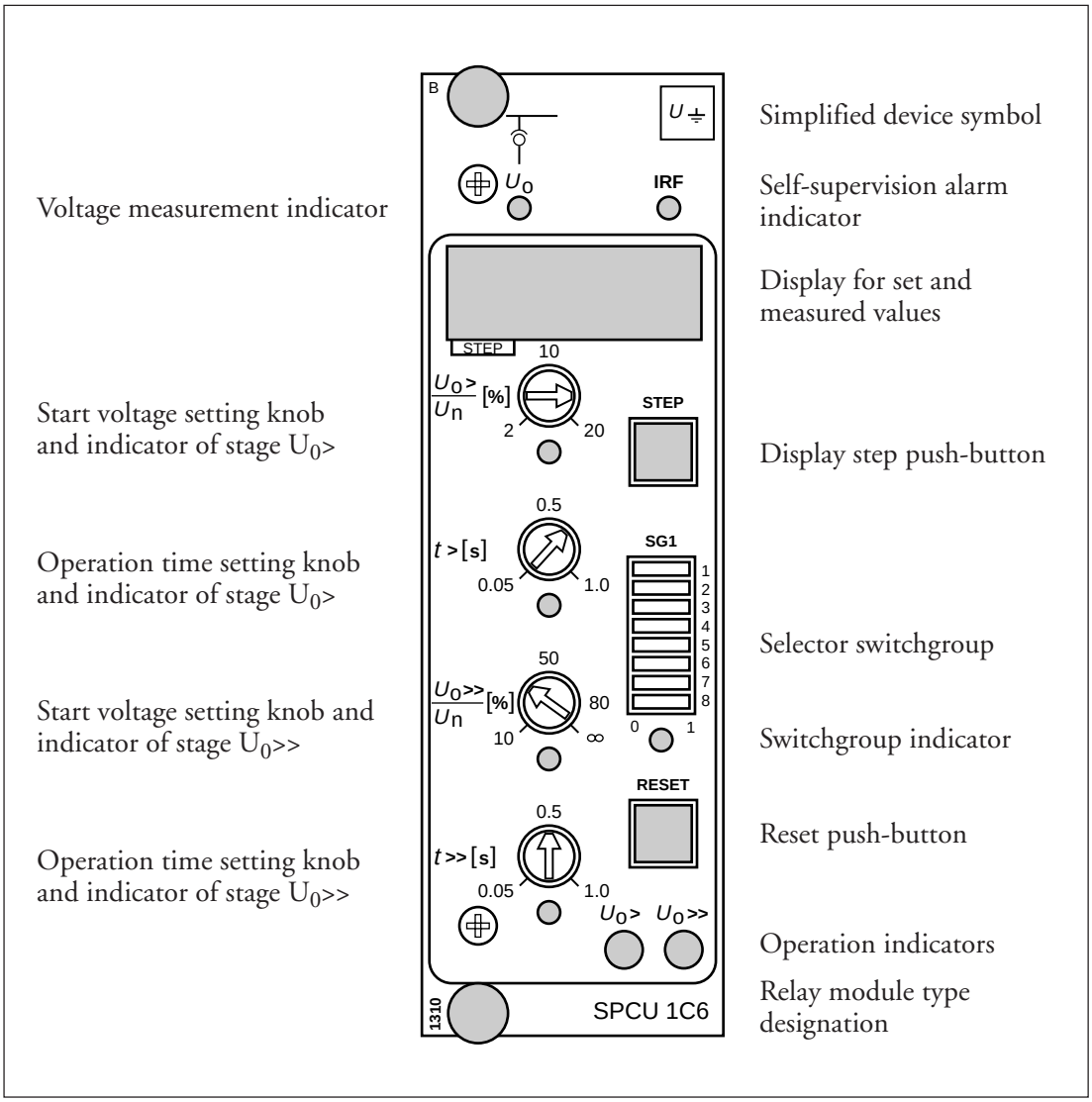


Fig. 3. Front panel of the residual overvoltage relay module SPCU 1C6.

Operation indicators

Both voltage stages have their own yellow/red LED indicators. Yellow light indicates starting of the concerned overvoltage stage and red light indicates that the overvoltage stage has operated.

The four LED indicators can, independently of one another, be given a non-latching or a latching mode of operation. The latching mode means that the indicator remains lit after being switched on, although the overvoltage stage, which controls the indicator, resets. If, for instance, the yellow start indicator is given the latching mode and the red indicator the non-latching mode, the yellow indicator is lit, when the stage starts, which then turns red if and when the stage operates. When the overvoltage stage resets only the yellow indicator remains lit. The indicators, which have been given the latching mode, are reset locally by pushing the RESET push-button or by remote control over the SPA bus using the command V102.

An unreset operation indicator does not affect the protective functions of the relay module.

The self-supervision alarm indicator IRF indicates that the self-supervision system has detected a permanent internal relay fault. The indicator is lit with red light shortly after the fault has been detected. At the same time the relay module puts forward a control signal to the self-supervision system output relay of the protection relay unit.

Additionally, in most fault cases, a fault code showing the nature of the fault appears on the display of the module. The fault code, consisting of a red number one (1) and a green three-digit code number, indicates what type of internal fault that has been detected. When a fault message appears, the fault code should be noted down for later use when relay overhaul or repair is to be carried out.

Settings

The setting values are shown by the three rightmost digits of the display. A LED indicator below the setting knob shows, when lit, which setting value is presented on the display.

$U_0>/U_n$	Start voltage value of the $U_0>$ stage, expressed as a percentage of the rated voltage of the energizing input used. The setting range is 2...20% x U_n when SG1/5 = 0, and 10...100% x U_n when SG1/5 = 1.
t> [s]	Operate time of the $U_0>$ stage, expressed in seconds. The setting range is determined by the position of switches SG1/1 and SG1/2. Selectable operate time setting ranges 0.05...1.00 s, 0.5...10.0 s and 5...100 s.
$U_0>>/U_n$	Start voltage value of the $U_0>>$ stage, expressed as a percentage of the rated voltage of the energizing input used. The setting range is 10...80% x U_n when SG1/6 = 0, and 2...16% x U_n when SG1/6 = 1. The setting ∞, infinite, (displayed as - - -) sets the high-set stage $U_0>>$ out of operation.
t>> [s]	Operate time of the $U_0>>$ stage, expressed in seconds. The required setting range, 0.05...1.00 s, 0.5...10.0 s or 5.00...100 s, is selected with switches SG1/7 and SG1/8.

Further, the checksum of the selector switchgroup SG1 is shown on the display when the LED indicator below the switchgroup is lit. By means of the displayed checksum and the checksum manually calculated the proper operation of the switchgroup SG1 can be verified. An example of how the checksum is calculated is shown in the manual "General characteristics of C type relay modules".

Selector switches

Additional functions required by individual applications are selected by means of the function selector switches of switchgroup SG1 located on the front panel. The numbering of the switches, 1...8, as well as the switch positions 0 and 1 are marked on the relay module front panel.

<table>
<tr><th>Switch</th><th>Function</th></tr>
<tr><td>SG1/1
SG1/2</td><td>Selection of setting range for the operate time t> of low-set stage $U_0>$.
<table>
<tr><th>SG1/1</th><th>SG1/2</th><th>Operate time t></th></tr>
<tr><td>0
1
0
1</td><td>0
0
1
1</td><td>0.05...1.00 s
0.5...10.0 s
0.5...10.0 s
5...100 s</td></tr>
</table></td></tr>
<tr><td>SG1/3</td><td>Not in use. Has to be set in position 0.</td></tr>
<tr><td>SG1/4</td><td>Selection of latching function for the tripping signals TS1 and TS2.

When SG1/4 = 0, the trip signals reset to the initial state (= the output relay drops off), when the measuring signal causing the operation falls below the set start voltage level. When SG1/4 = 1, the trip signals remain activated (= the output relay remains picked up), although the measuring signal falls below the set start voltage level. Then the trip signals are reset by pressing the push-buttons STEP and RESET simultaneously or with the commands V101 or V102 via the serial port.</td></tr>
<tr><td>SG1/5</td><td>Selection of setting range for the start voltage value of the low-set stage $U_0>$.

When SG1/5 = 0, the setting range is 2...20% x U_n.
When SG1/5 = 1, the setting range is 10...100% x U_n.</td></tr>
</table>

<table>
<tr><th>Switch</th><th>Function</th></tr>
<tr><td>SG1/6</td><td>Selection of setting range for the start voltage value of the high-set stage U_0>>.

When SG1/6 = 0, the setting range is 10...80% x U_n and ∞, infinite.
When SG1/6 = 1, the setting range is 2...16% x U_n and ∞, infinite.</td></tr>
<tr><td>SG1/7
SG1/8</td><td>Selection of setting range for the operate time t>> of the high-set stage U_0>>.
<table>
<tr><th>SG1/7</th><th>SG1/8</th><th>Operate time t>></th></tr>
<tr><td>0</td><td>0</td><td>0.05...1.00 s</td></tr>
<tr><td>1</td><td>0</td><td>0.5...10.0 s</td></tr>
<tr><td>0</td><td>1</td><td>0.5...10.0 s</td></tr>
<tr><td>1</td><td>1</td><td>5...100 s</td></tr>
</table></td></tr>
</table>

Switchgroup SG2 is a so called software switchgroup, which is located in the third submenu of switchgroup SG1. The mode of operation, i.e. self-reset or manually reset, of the LED indicators U_0> and U_0>> is determined by the switches of switchgroup SG2. The mode of operation can be separately set for each indicator. The mode of operation is set by means of the checksum, which can be calculated from the following table. Normally the start indications are self-reset and the operation indications manually reset.

Indicator	Manually reset	Factory default
Start indicator U_0>	1	0
Operation indicator U_0>	2	2
Start indicator U_0>>	4	0
Operation indicator U_0>>	8	8
Checksum	15	10

The PC board of the relay module contains a switchgroup SGB including switches 1...8. The switches 1...3 are used for selecting the starting signals, whereas switches 4...8 are used for routing the blocking signals to the voltage module in various protection relay units. Instructions for setting of switchgroup SGB are given in the user's manual of the different protection relay units.

Measured data

The measured values are displayed by the three rightmost digits on the display. The measured data to be displayed are indicated by a lit LED indicator.

Indicator	Measured data
U_0	Residual voltage measured by the relay module, expressed as a percentage of the rated voltage of the energizing input used.

Recorded information

The leftmost red digit displays the address number of the register, the rightmost three green digits display the recorded data.

Register/ STEP	Recorded data
1	Maximum residual voltage measured by the module, as a percentage of the rated voltage U_n of the used energizing input. If the module operates, the voltage value at the moment of operation is stored in the memory. Any new operation erases the old value and updates the register with the new value. The same thing happens if the measured voltage exceeds a previously recorded maximum value.
2	Number of starts of the low-set overvoltage stage U_0>, n (U_0>) = 0...255.
3	Number of starts of the high-set overvoltage stage U_0>>, n (U_0>>) = 0...255.
4	Duration of the latest start situation of stage U_0> as a percentage of the set operate time t>. Any new start resets the counter, which then starts counting from zero. When the stage has operated, the counter reading is 100.
5	Duration of the latest start situation of stage U_0>> as a percentage of the set operate time t>>. Any new start resets the counter, which then starts recounting from zero. When the stage has operated, the counter reading is 100.
0	Display of blocking signals and other external control signals. The rightmost digit indicates the state of the blocking inputs of the relay module. The following states may be indicated: 0 = no blockings 1 = operation of the U_0> stage blocked 2 = operation of the U_0>> stage blocked 3 = operation of both stages blocked In this register the second digit from he right is constantly zero. The leftmost digit indicates the state of the remote reset control input, if applicable. The following states may be indicated: 0 = remote reset control input not energized 1 = remote reset control input energized From this register it is possible to move on to the TEST mode, where the start and operation signals of the module can be activated one by one. For further details see manual "General characteristics of C type relay modules".
A	The address code of the protection relay module in the serial communication system. The serial communication is broken if the relay module is given the address code 0 (zero). Register A is provided with the following subregisters: 1. Selection of data transfer rate for the serial communication. Selectable values 300, 1200, 2400, 4800 and 9600 Bd. Default value 9600 Bd. 2. Bus communication monitor. If the relay module is connected to a serial communication system and the serial communication system is in operation the counter of the bus communication monitor will show the value 0 (zero). If the communication is broken the numbers 0…255 are scrolling in the counter. 3. Password required when changing relay module settings via remote control

Registers 1...5 are set to zero by pressing the push buttons STEP and RESET simultaneously or by remote control using the command V102. The register values are also erased if the auxiliary power supply of the module is interrupted. The address code of the relay module, the set data transfer rate of the serial communication and the password are not erased by a supply voltage interruption. Instructions for setting the address code and the data transfer rate are given in the manual "General characteristics of C type relay modules".

Menu chart

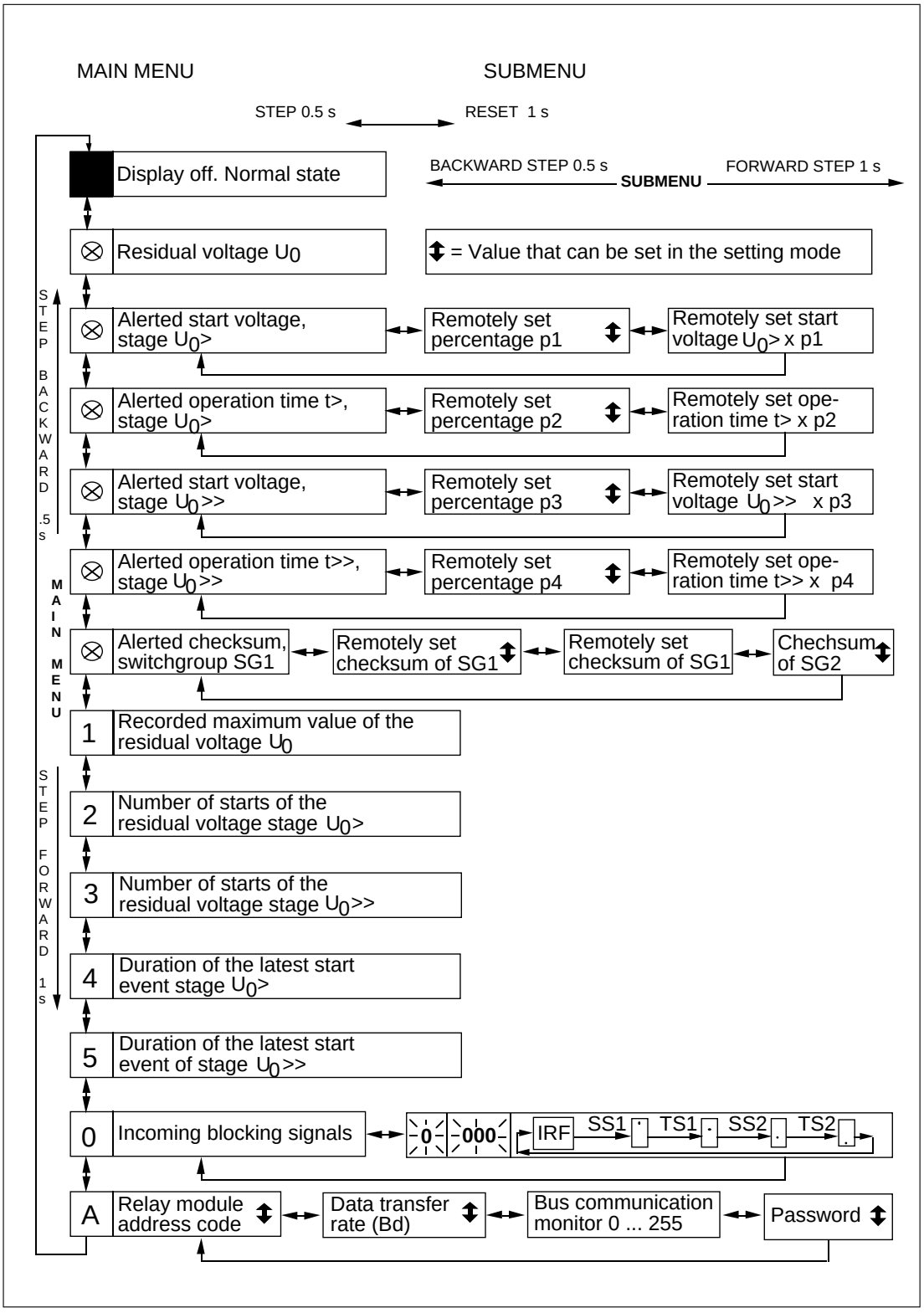


Fig. 4. Main menu and submenus of the residual overvoltage relay module SPCU 1C6.

The procedure for entering a submenu or a setting mode and configuring the module is described in detail in "General characteristics of C type relay modules".

Low-set overvoltage stage U_0>

Start voltage U_0>	2...20% x U_n or 10...100% x U_n
Start time, typically	70 ms
Operate time	0.05...1.00 s, 0.5...10.0 s or 5...100 s
Reset time	<100 ms
Drop-off/pick-up ratio, typically	0.96
Operate time accuracy	±2% of set value or ±40 ms
Operation accuracy	
- 10...100% x U_n	±3% of set value
- 2...20% x U_n	±5% of set value

High-set overvoltage stage U_0>>

Start voltage U_0>>	10...80% x U_n and ∞, infinite or 2...16% x U_n and ∞, infinite
Start time, typically	70 ms
Operate time	0.05...1.00 s, 0.5...10.0 s or 5...100 s
Reset time	<100 ms
Drop-off/pick-up ratio, typically	0.96
Operate time accuracy	±2% of set value or ±40 ms
Operation accuracy	
- 10...80% x U_n	±3% of set value
- 2...16% x U_n	±5% of set value

Serial communication parameters

Event codes

The substation level control data communicator is able to read, over the SPA serial bus, the event messages of the relay module, e.g. start and trip messages, from the residual overvoltage relay module SPCU 1C6. The events can be printed out in the format: time (ss.sss) and event code. The event codes of the relay module are E1...E8 , E50 and E51. Additional event codes relating to the data communication are generated by the data communication equipment.

The event codes E1...E8 and the events represented by these can be included in or excluded from the event reporting by writing, via the SPA bus, an event mask (V155) to the relay module. The event mask is a binary number coded to a decimal number. The event codes E1...E8 are represented by the numbers 1, 2, 4...128. The event mask is formed by multiplying the above numbers either with 0, event not included or 1, event included in reporting and by adding the products, see instructions for checksum calculation.

The event mask may take a value within the range 0...255. The default value of the residual overvoltage relay module SPCU 1C6 is 85, which means that any start or operation event is included in the reporting, but no resettings. The event codes E50...E54 and the events represented by these cannot be excluded from the reporting.

Event codes of residual voltage relay module SPCU 1C6:

Code	Event	Weighting coefficient	Default setting
E1	Starting of stage U_0>	1	1
E2	Starting of stage U_0> reset	2	0
E3	Tripping of stage U_0>	4	1
E4	Operation of stage U_0> reset	8	0
E5	Starting of stage U_0>>	16	1
E6	Starting of stage U_0>> reset	32	0
E7	Tripping of stage U_0>>	64	1
E8	Operation of stage U_0>> reset	128	0
	Default value of event mask V155		85

E50	Restart of microprocessor	*	-
E51	Overflow of event register	*	-
E52	Temporary interruption in the data communication	*	-
E53	No response from the relay module over the data communication bus	*	-
E54	The relay module responds again over the data communication bus	*	-

0 not included in the event reporting
1 included in the event reporting
* no code number, always included in event reporting
\- cannot be set

NOTE!
In the SPACOM system the event codes E52... E54 are generated by the station level control data communicator, e.g. type SRIO 1000M.

Data to be transferred over the serial bus

In addition to the event code data transfer, the input data (I data), output data (O data), setting values (S), memorized data (V data) and some other data can be read from the relay module over the serial communication bus. Further, part of the data can be changed over the SPA bus by separate commands. All data information is available in channel 0.

Data	Code	Data direct.	Values
Input data			
Energizing input voltage	I1	R	0...250% x U_n
Blocking of operation of stage U_0>	I2	R	0 = no blocking 1 = operation of stage U_0> blocked
Blocking of operation of stage U_0>>	I3	R	0 = no blocking 1 = operation of stage I_0>> blocked
Output data			
Starting of stage U_0>	O1	R	0 = stage U_0> not started 1 = stage U_0> started
Operation of stage U_0>	O2	R	0 = stage U_0> not tripped 1 = stage U_0> tripped
Starting of stage U_o>>	O3	R	0 = stage U_0>> not started 1 = stage U_0>> started
Operation of stage U_0>>	O4	R	0 = stage U_0>> not tripped 1 = stage U_0>> tripped
Setting values			
Alerted start value of stage U_0>	S1	R	2...100% x U_n
Alerted operate time of stage U_0>	S2	R	0.05...100 s
Alerted start value of stage U_0>>	S3	R	2...80% x U_n 999 = ∞, infinite
Alerted operate time of stage U_0>>	S4	R	0.05...100 s
Alerted checksum of switchgroup SG1	S5	R	0...255
Start value of stage U_0>, set with the setting knob	S11	R	2...100% x U_n
Operate time of stage U_0>, set with the setting knob	S12	R	0.05...100 s
Start value of stage U_0>>, set with the setting knob	S13	R	2...80% x U_n 999 = ∞, infinite
Operate time of stage U_0>>, set with the setting knob	S14	R	0.05...100 s
Checksum of switchgroup SG1, set with the switches	S15	R	0...255
Remotely setting percentage of the start value of stage U_0>	S21	R, W	0...999%
Remotely setting percentage of the operate time of stage U_0> or time multiplier	S22	R, W	0...999%
Remotely set percentage for the start value of stage U_0>>	S23	R, W	0...999%
Remotely setting percentage for the operate time of stage U_0>>	S24	R, W	0...999%
Remotely set checksum of switchgroup SG1	S25	R, W	0...255

Data	Code	Data direct.	Values
Remotely set start value of stage U_0>	S31	R	2...100% x U_n
Remotely set operate time of stage U_0>	S32	R	0.05...100 s
Remotely set start value of stage U_0>>	S33	R	2...80% x U_n 999 = ∞, infinite
Remotely set operate time of stage U_0>>	S34	R	0.05...100 s
Remotely set checksum of switchgroup SG1	S35	R	0...255
Max. measured voltage or voltage at operation	V1	R	0...250% x U_n
Number of starts of stage U_0>	V2	R	0...255
Number of starts of stage U_0>>	V3	R	0...255
Duration of the latest start situation of stage U_0>	V4	R	0...100%
Duration of the latest start situation of stage U_0>>	V5	R	0...100%
Resetting of output relays and operation indicators	V101	W	1 = output relays and operation indicators reset
Resetting of output relays and operation indicators and erasing of recorded data	V102	W	1 = output relays and operation indicators reset and registers (codes V1…V5) erased
Remote control of settings	V150	R, W	0 = setting with knobs S11...S15 activated 1 = remote settings S31...S35 activated
Event mask word	V155	R, W	0...255, see section "Event codes"
Manual reset or self-reset mode of operation of the LED indicators	V156	R, W	0…15, see section "Selector switches"
Opening of password for remote settings	V160	W	1...999
Changing or closing of password for remote settings	V161	W	0...999
Activation of self-supervision function	V165	W	1 = self-supervision output is activated and the IRF indicator turns on in about 5 seconds, whereafter the self-supervision system and the IRF indicator reset
Internal fault code	V169	R	0…255
Data communication address of the relay module	V200	R	1...254
Program version	V205	R	070_

Data	Code	Data direct.	Values
Type designation of the relay module	F	R	SPCU 1C6
Reading of event register	L	R	Time, channel number and event code
Re-reading of event register	B	R	Time, channel number and event code
Reading of module status data	C	R	0 = normal state 1 = module been subject to automatic reset 2 = overflow of event register 3 = events 1 and 2 together
Resetting of module status data	C	W	0 = resetting
Time reading or setting	T	R, W	00.000...59.999 s

R = data to be read from the module
W = data to be written to the module

The data transfer codes L, B, C and T have been reserved for the event data transfer between the relay module and the control data communicator.

The event register can be read by the L command only once. Should a fault occur, for example, in the data transfer, it is possible, by using the B command, to re-read the contents of the event register once already read by means of the L command. When required, the B command can be repeated.

The setting values S1...S5 are the alerted set values currently used by the protection relay module. These values are set either by remote control or by means of the setting knobs. The values S11...S15 are set with the setting knobs and the selector switches. Variables S21...S25 are set as percentage values via remote control.

The settings S21...S25 allow reading or writing. A condition for writing is that the password V160, for remote setting has been opened. The variables S31...S35 contain the remote setting values.

When the values of the variables S21...S24 are to be changed, the variables can be given a percentage factor within the range 0...999. It is possible to alter a setting value beyond the setting ranges specified in the technical data of the relay module. However, the validity of the setting values are guaranteed only within the setting ranges specified in the technical data.

Activation of the self-supervision function (V165) prevents the relay module from operating as long as the self-supervision output is activated and the IRF indicator is lit.

Fault codes

Once the self-supervision system has detected a permanent relay fault, the IRF LED on the front panel of the module is lit, and at the same time the normally operated signal relay of the self-supervision system drops off.

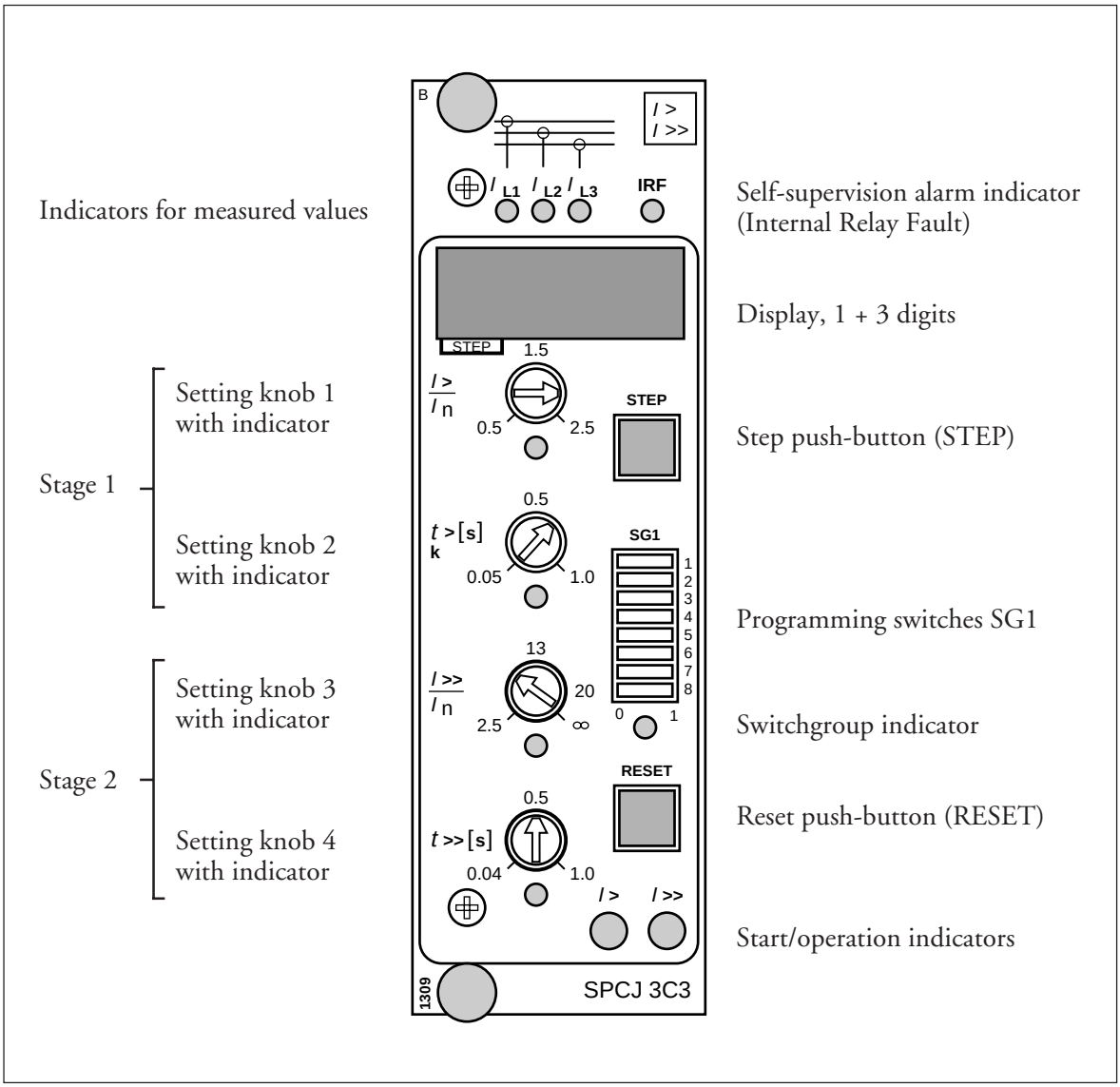
In most fault situations an auto-diagnostic fault code is shown on the relay display. The fault code cannot be reset. The fault code consists of a red digit one (1) and a green code number that indicates the fault type. The fault code should be recorded and stated when service is ordered.

The fault codes of the residual overvoltage relay module SPCU 1C6 are explained in the following table:

Fault code	Explanation
4	Faulty output relay path or missing output relay card
30	Faulty program memory (ROM)
50	Faulty working memory (RAM)
195	Too low a value in reference channel with multiplier 1
131	Too low a value in reference channel with multiplier 5
67	Too low a value in reference channel with multiplier 25
203	Too high a value in reference channel with multiplier 1
139	Too high a value in reference channel with multiplier 5
75	Too high a value in reference channel with multiplier 25
253	No interruptions from the A/D-converter

General characteristics of C-type relay modules

User´s manual and Technical description



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General characteristics of C-type relay modules

Contents

Push-buttons

The front panel of the relay module contains two push-buttons. The STEP button is used for stepping forward in the display and the RESET button for resetting the red indicators. Additionally, the push-buttons are used for certain settings, e.g. for setting the address of the relay module and the data transfer rate for the serial communication when the modules are used in relay packages provided with this quality. (See section Display).

Programming switches SG1

Part of the settings and the selections of the operating characteristics for the relay modules in various applications are made with the programming switches SG1 on the front panel. The indicator of the switchgroup glows when the checksum of the switchgroup is shown on the display. The checksum can be used for checking that the switches are properly set. Fig. 2 gives an example of calculating the checksum.

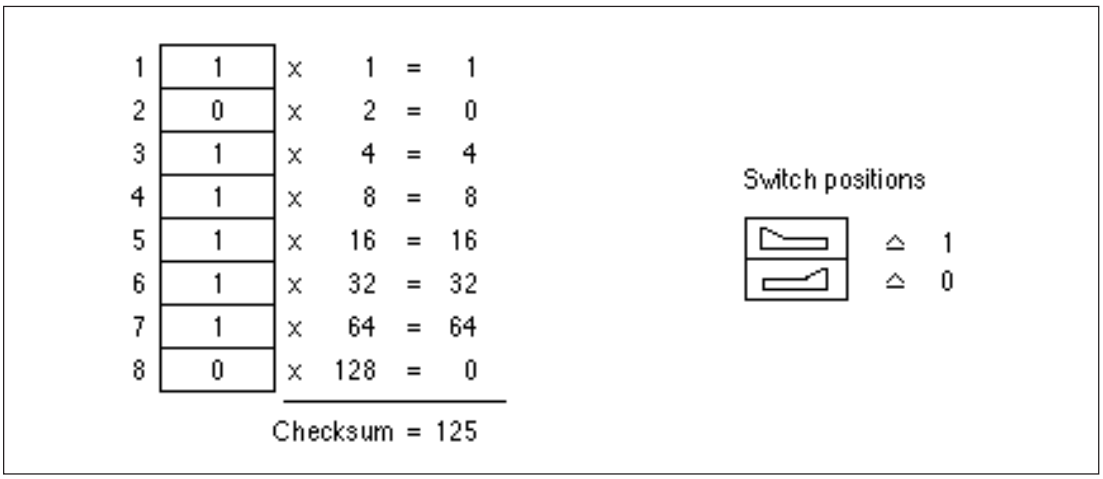


Fig. 2. Example of calculating the checksum of programming switchgroup SG1.

When the checksum calculated according to the example is equal to the checksum indicated on the display of the relay module, the switches are properly set.

The function of the programming switches of the individual measuring relay modules is specified in the description of the module concerned.

Setting knobs

Most of the operating values and operating times are set by means of the setting knobs on the front panel of the relay module. Each setting knob has its own (LED) indicator which glows when the concerned setting value is shown on the display.

If a setting knob is turned while the display is showing another measured or set value, the value being set automatically appears on the display. Simultaneously, the indicator for the concerned setting starts glowing.

In addition to the settings made with the setting knobs, most modules allow so called remote setting. This means that the settings made by means of the setting knobs of the module and the checksum of the programming switchgroup may be altered through an instruction over the serial communication bus. Remote setting is possible if the password in the register A is known, and the remote settings are not activated, i.e. parameter V150=0. The circumstance that the remote settings are activated is shown with a flashing light of the indicator of the setting knob, the value of which currently is being displayed.

Display

The measured and set values as well as the data recorded are shown on the display of the measuring relay module. The display consists of four digits. The three digits (green) to the right indicate the measured, set or stored value and the digit at the extreme left (red) the number of the register. The measured or set value displayed is indicated by a yellow LED indicator. The number of the register glows only when a stored value is displayed.

When the auxiliary voltage is connected to a measuring relay module, the module initially tests the display by stepping through the digits 1...9 for about 15 seconds. When the test is finished the display turns dark. The testing can be interrupted by pressing the STEP button. The protective functions of the module are operative throughout the testing.

Display main menu

All the data required during normal operating conditions are accessible from the main menu which presents the measured values in real-time, the normal setting knob settings as well as the most important memorized data.

The data to be shown in the main menu are selected to the display in a certain sequence by means of the STEP button. When pressing the STEP button for about one second, the display moves forward in the display sequence. When pressing it for about 0.5 seconds, the display moves backwards in the display sequence.

From a dark display only forward movement is possible. When keeping the STEP button depressed, the display is continuously moving in forward direction stopping for a while at the dark point.

Unless the display is switched off by stepping to the dark point, it remains activated for about 5 minutes from the last pressing of the STEP button and then goes out.

Display submenu

Less important values and values not very often set are displayed in the submenus. The number of submenus varies with different relay module types. The submenus are presented in the description of the concerned module.

A submenu is entered from the main menu by pressing the RESET button for about one second. When the button thereafter is released, the red digit (STEP) of the display starts flashing, indicating that one is in a submenu. Going from one submenu to another or back to the main menu follows the same principle as when moving from the main menu display to another; the display moves forward when pressing the STEP button for one second and backward when pressing it for 0.5 seconds. The return to the main menu has taken place when the red STEP display turns dark.

When entering a submenu from a measured or set value indicated by a LED indicator, the indicator remains glowing and the address window (STEP) of the display starts flashing. A flashing address window when no LED indicator is lit indicates that the submenu of a register has been entered.

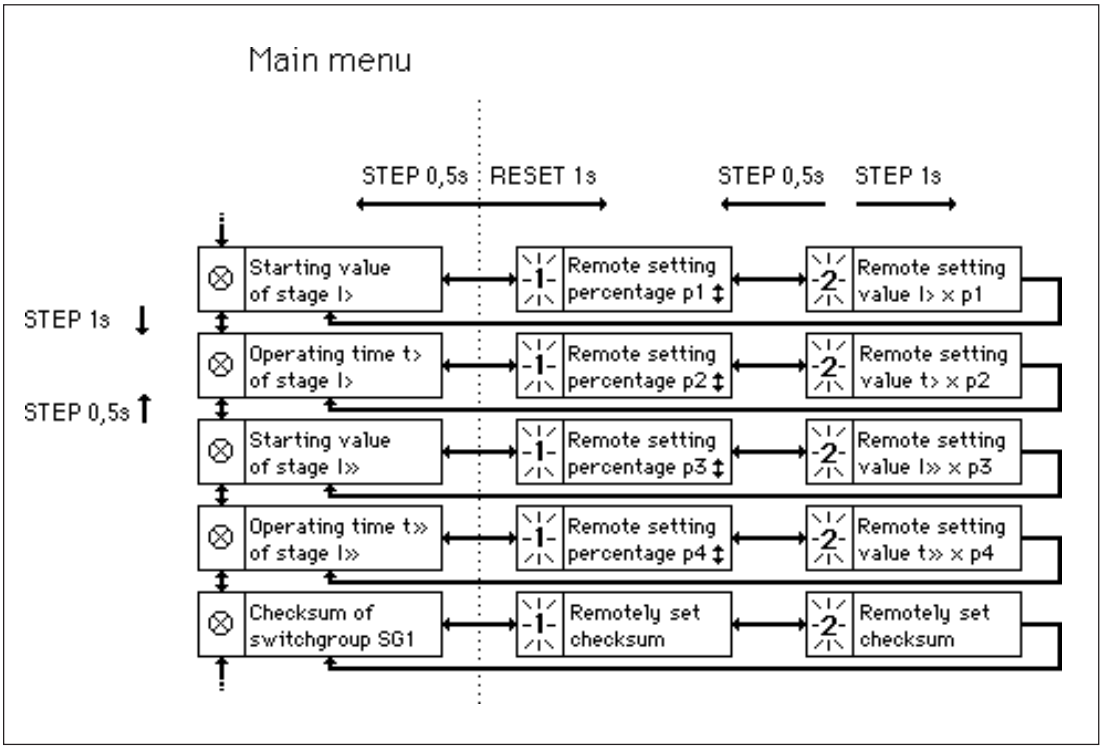


Fig. 3. Example of the main and submenus for the settings of the overcurrent relay module SPCJ 3C3. The settings made with the setting knobs are in the main menu and they are displayed by pressing the STEP button. In addition to the setting knob settings the main menu contains the measured current values as well as the registers 1…5, as well as 0 and A. The remote setting percentage and remote setting value are located in the submenus for the settings and are activated on the display by pressing the RESET button.

Setting mode

The registers of the main menu and the submenus also contain parameters to be set. The settings are made in the so called setting mode, which is accessible from the main menu or a submenu by pressing the RESET button, until the digit at the extreme right starts flashing (about 10 s). The flashing digit is set by means of the STEP button. The flashing is moved on from digit to digit by pressing the RESET button.

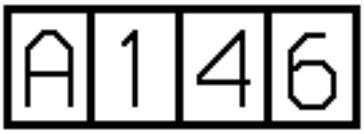
A set value is stored in the memory by pressing the push-buttons STEP and RESET simultaneously. In practice the RESET button must be pressed slightly in excess of the STEP button. Return from the setting mode to the main menu or submenu is possible by pressing (for about 10 s) the RESET button until the green digits on the display stop flashing. If the module is left in the setting mode, it will return automatically to the start condition after about 5 minutes.

The values to be set in the setting mode are for instance the address code of the relay module and the data transfer rate for the serial communication. Further the percentage values for the remote settings can be changed.

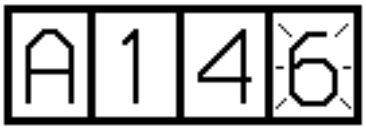
Example 1:

Function in the setting mode. Manual setting of the address code of a relay module and the data transfer rate for the serial communication. The initial value for the address code is 146.

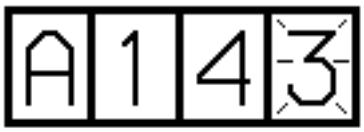
a)
Press push-button STEP until register address A appears on the display.



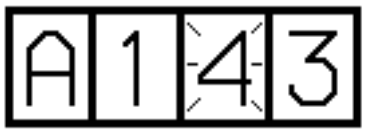
b)
Press the RESET button for about 10 s until the right most digit starts flashing.



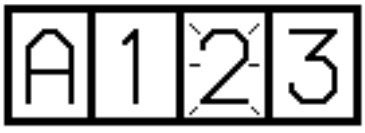
c)
Press the STEP button repeatedly to set the digit to the value desired.



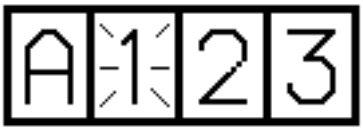
d)
Press the RESET button to make the middle of the green digits flash.



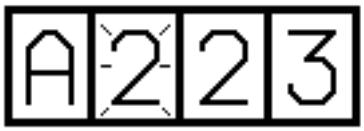
e)
Set the middle address digit by means of the STEP button.



f)
Press the RESET button to make the left most green digit flash.

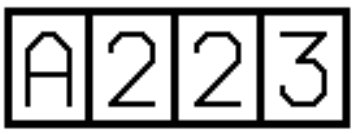


g)
Set the digit by means of the STEP button.



h)
Store the set address number in the memory of the relay module by pressing the RESET and STEP button simultaneously. At the moment the information enters the memory, the three green dashes flash in the display, i.e. A—.

i)
Leave the setting mode by pressing the RESET button for about 10 s, until the display stops flashing.



j)
Then enter submenu 1 of register A by pressing the RESET button for approx. one second. The register address A is then replaced by a flashing 1. This submenu is used for setting the data transfer rate of the serial communication.

k)
The data transfer rate for the serial communication is set and stored in the same way as the address, see sections b...i, except that the continuously glowing register address has been replaced by a flashing 1.

l)
After storing the data transfer rate for the serial communication you may return to the main menu of register A by pressing the STEP button for about 0.5 second.

Stored information

The parameter values measured at the moment when a fault occurs are recorded in the registers, in some modules also the setting values. The recorded data, except for some setting parameters, are set to zero by pressing the push-buttons STEP and RESET simul-taneously. The data in normal registers are erased if the auxiliary voltage supply to the relay is disrupted, only the set values and the number of autoreclosings are maintained in the registers at a voltage failure.

The number of the registers varies with different module types. The function of the registers are illustrated in the descriptions of the separate relay modules. Additionally, the system panel contains a simplified list of the data recorded by the various relay modules of the relay assembly.

All C-type relay modules are provided with two general registers: register 0 and register A.

Register 0 contains, in coded form, the information about e.g. external blocking signals and status information for the circuit breaker. The codes are explained in the descriptions of the relay modules.

Register A contains the address code of the relay module as required by the serial communication system. Example 1 on page 4 shows how the address code is altered. Submenu 1 of register A contains the data transfer rate value expressed in kilobaud for the serial communication.

Submenu 2 of register A contains a bus traffic monitor for the SPACOM system. If the protective relay, which contains the relay module, is linked to a system including the control data communicator and the data communication system is operating, the counter reading of the monitor will be zero. Otherwise the digits 1...255 are continuously rolling in the monitor.

Submenu 3 contains the password required for changing the remote settings. The address code, the data transfer rate for the serial communication and the password can be set manually or via the serial communication bus. For manual setting see example 1.

The start value for the address code and the password is 001 and that for the data transfer rate 9.6 kilobaud.

Trip-test mode

Register 0 also allows access to the so called Trip-test function, which allows the output signals of the relay module to be activated one by one. If the auxiliary relay module of the protection assembly is in place, the auxiliary relays will be included in the testing.

When pressing the RESET button for about 10 seconds, the three green digits to the right start flashing to indicate that the relay module is in test position. The indicators of the setting knobs indicate by flashing which output signal can be activated. The required output function is selected by pressing the RESET button for about 1 second, until the following LED indicator starts flashing.

The indicators of the setting knobs refer to the following output signals:

Setting knob 1	SS1	Starting of stage 1
Setting knob 2	TS1	Tripping of stage 1
Setting knob 3	SS2	Starting of stage 2
Setting knob 4	TS2	Tripping of stage 2
No indication	IRF	Self-supervision

The selected starting or tripping is activated by simultaneous pressing of the push-buttons STEP and RESET. The signal remains activated as long as the two push-buttons are being pressed.

The self-supervision output is activated by pressing the STEP button once when no setting knob indicator is flashing. The IRF output is activated in about 5 seconds after pressing of the STEP button, and resets after that. Simultaneously, the display returns to the main menu and performs the initial testing indicated by rolling digits 0...9 in the display several times.

The signals are selected in the order illustrated in fig. 4.

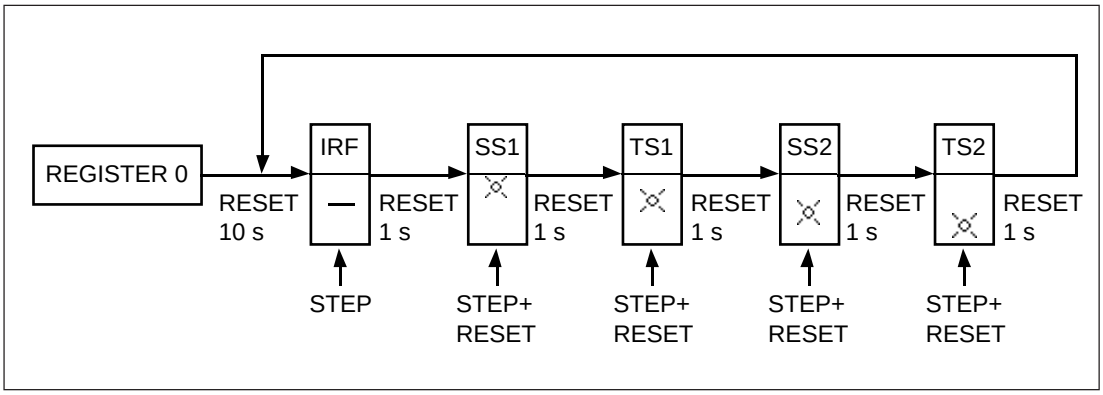


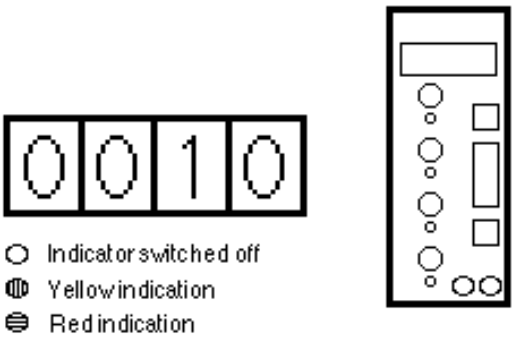
Fig. 4. Sequence order for selecting the output signals in the Trip-test mode.

If e.g. the indicator of the setting knob 2 (second from the top) is flashing, and the push-buttons STEP and RESET are being pressed, the signal TS1 (tripping of stage 1) is activated. Return to the main menu is possible at any stage of the Trip-test sequence scheme, by pressing the RESET button for about 10 seconds. If the module is left in the Trip-test mode, it will return automatically after approx. 5 minutes.

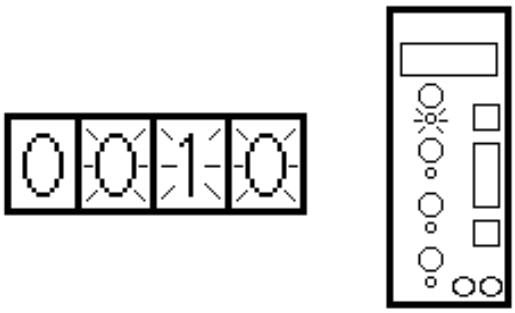
Example 2:

Trip-test function. Forced activation of the outputs is made as follows:

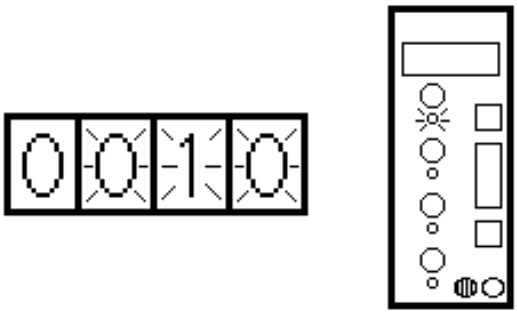
a)
Step forward on the display to register 0.



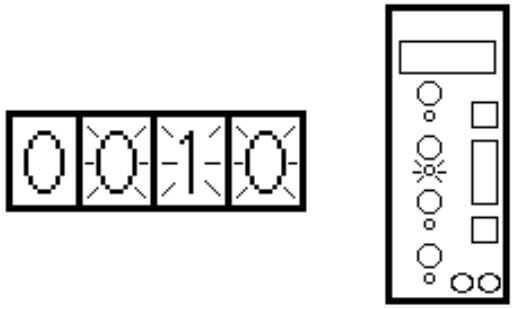
b)
Press the RESET button for about 10 seconds until the three green digits to the right and the LED indicator of the uppermost setting knob start flashing.



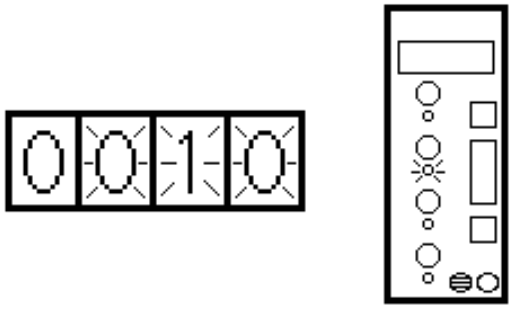
c)
Press the push-buttons RESET and STEP simultaneously. Then the starting of stage 1 (e.g. the I>-stage of the overcurrent module SPCJ 3C3) is activated and, simultaneously, the indicator of the stage starts glowing yellow.



d)
Press the RESET button for about 1 second until the indicator of the second setting knob starts flashing.



e)
Press the push-buttons RESET and STEP simultaneously to activate tripping of stage 1 (e.g. the I>-stage of the overcurrent module SPCJ 3C3). The indicator of the concerned stage starts glowing red.



f)
Starting and tripping of the second stage is activated in the same way as stage 1. The indicator of the third or fourth setting starts flashing to indicate that the concerned stage has been activated.

g)
To activate the self-supervision output step towards the test position, where no indicator is flashing. Press the STEP button once. In about 5 seconds the red IRF indicator starts glowing and the IRF output is activated. Shortly thereafter the indicator goes out and the output automatically resets. At the same time the module leaves the test position.

h)
It is possible to leave the trip test mode at any step of the sequence scheme by pressing the RESET button for about 10 seconds until the three digits to the right stop flashing.

Operation indicators

A measuring relay module is provided with two separate operating stages, each of which with its own yellow/red operation indicator on the lower part of the front plate of the relay module.

The operation indicator starts glowing yellow when the operating stage starts and red when a delayed tripping operates. The functions of the start and operation indicators are described in detail in the different protection relay module manuals.

Fault codes

In addition to the protective functions the relay module is provided with a self-supervision system which continuously supervises the function of the microprocessor, its program execution and the electronics.

When the self-supervision system has detected a permanent fault in the relay module, the red IRF indicator on the panel starts glowing soon after the fault was discovered. At the same time the module puts forward a signal to the self-supervision contact of the relay assembly.

In most fault situations a fault code, indicating the nature of the fault, appears on the display of the module. The fault code, which consists of a red digit (1) and a three digit green code number, cannot be removed from the display by resetting. When a fault occurs, the fault code should be recorded and stated when service is ordered.

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