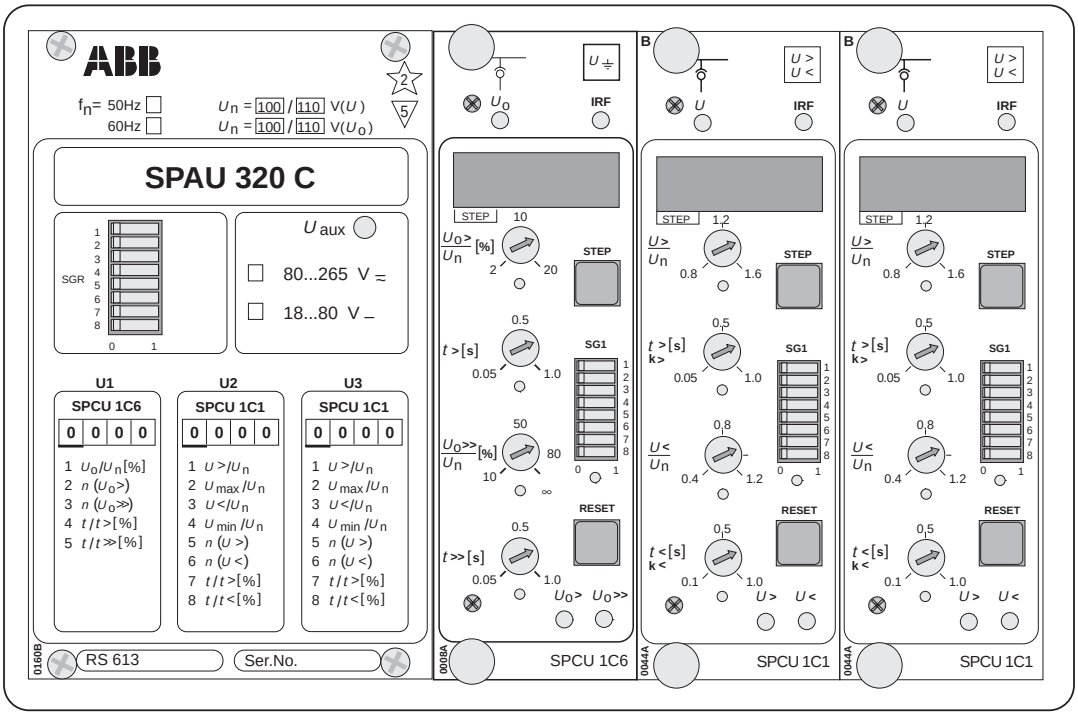
SPAU 320 C
Overvoltage, undervoltage and residual voltage relay

User´s manual and Technical description



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Contents

The complete manual for the voltage measuring relay SPAU 320 C includes the following submanuals:

Overvoltage, undervoltage and residual voltage relay, General part	1MRS 750726-MUM EN
Residual overvoltage relay module SPCU 1C6	1MRS 750509-MUM EN
Over- and undervoltage relay module SPCU 1C1	1MRS 750609-MUM EN
General characteristics of C-type relay modules	1MRS 750328-MUM EN

Features

- Supervision and protection relay primarily used for supervision of substation busbar voltages
- General-use voltage relay for applications requiring overvoltage or undervoltage supervision
- Flexible selection of appropriate operational features in various applications
- Local numerical display of setting values, measured values, recorded fault values, auto-diagnostic fault codes, etc.
- Serial interface for two-way data communication with substation level equipment via fibre-optic bus
- Powerful software support for setting and monitoring of the relay via a portable computer
- Continuous self-supervision of relay hardware and software with autodiagnosis for enhanced system reliability and availability
- Robust aluminium relay case with IP54 degree of protection by enclosure
- High immunity to electrical and electromagnetic interference
- CE marking according to the EC directive for EMC

Application

The overvoltage, under voltage and residual voltage relay SPAU 320 C is intended to be used for the supervision of the residual voltage as well as for the overvoltage and under voltage of the busbar system. The relay forms an integrated protection consisting of three measuring relay modules. The residual voltage of the busbar system is measured by the dual-stage overvoltage relay module SPCU 1C6. The overvoltage and undervoltage of the busbar system is supervised by two voltage relay modules SPCU 1C1, each of which is provided with an overvoltage and an undervoltage stage. By means of an optional bus connection module the relay can be connected to the fibre-optic SPA bus for serial data communication with substation level equipment.

Description of operation

When the residual voltage of the busbar system exceeds the setting value of the lower stage of the residual voltage module SPCU 1C6, the overvoltage stage starts and simultaneously starts the corresponding timing circuit. When the set time has elapsed, the module delivers a tripping signal. The higher stage of the residual voltage module operates in the same way. When the setting value of the stage has been exceeded it starts, simultaneously starting its timing circuit and performs tripping when the set time has elapsed.

When the voltage measured by the voltage relay module SPCU 1C1 exceeds the setting value of the overvoltage stage, the overvoltage stage starts and performs a tripping when the set time delay has elapsed. When the voltage measured by the module falls below the setting value of the undervoltage stage, the timing circuit of the undervoltage stage starts. When the set time delay has expired tripping is performed by the stage.

Since the protective relay comprises two identical voltage relay modules SPCU 1C1, the overvoltage and undervoltage protection of the busbar system can be implemented as a dual-stage protection.

To prevent unnecessary operations during an auto-reclose cycle, starting and tripping of the undervoltage stage of the overvoltage and undervoltage modules SPCU 1C1 can be blocked by turning switch SGl/5 on the front panel into the position 1. This measure prevents any operation of the U < stage, if the measured voltage falls below the value of 0.2 x U_n (see fig. 1) .

Tripping of the undervoltage stage alone may be blocked by linking an external blocking signal to the relay.

NOTE!
To enable the blocking function, switch 5 of switchgroup SGB on the PC board of the voltage relay module SPCU 1C1 has to be in position 1.

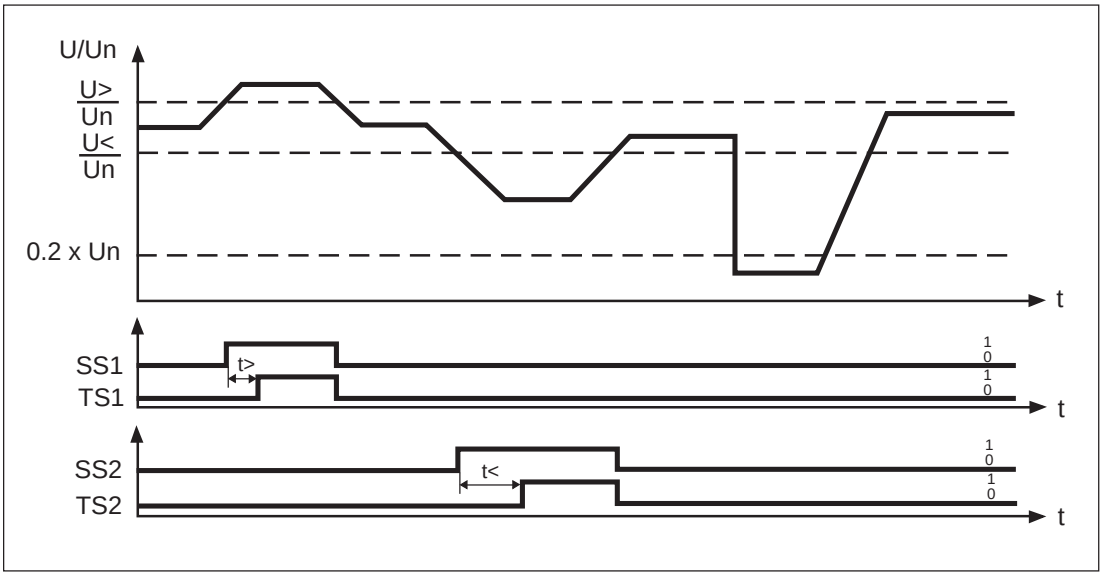


Fig. 1. Operating scheme for voltage relay module SPCU 1C1, when starting of the undervoltage stage is internally blocked

U>/U_n	Setting of the overvoltage stage
U</U_n	Setting of the undervoltage stage
SS1	Starting of the overvoltage stage
TS1	Tripping of the overvoltage stage
SS2	Starting of the undervoltage stage
TS2	Tripping of the undervoltage stage

Connections

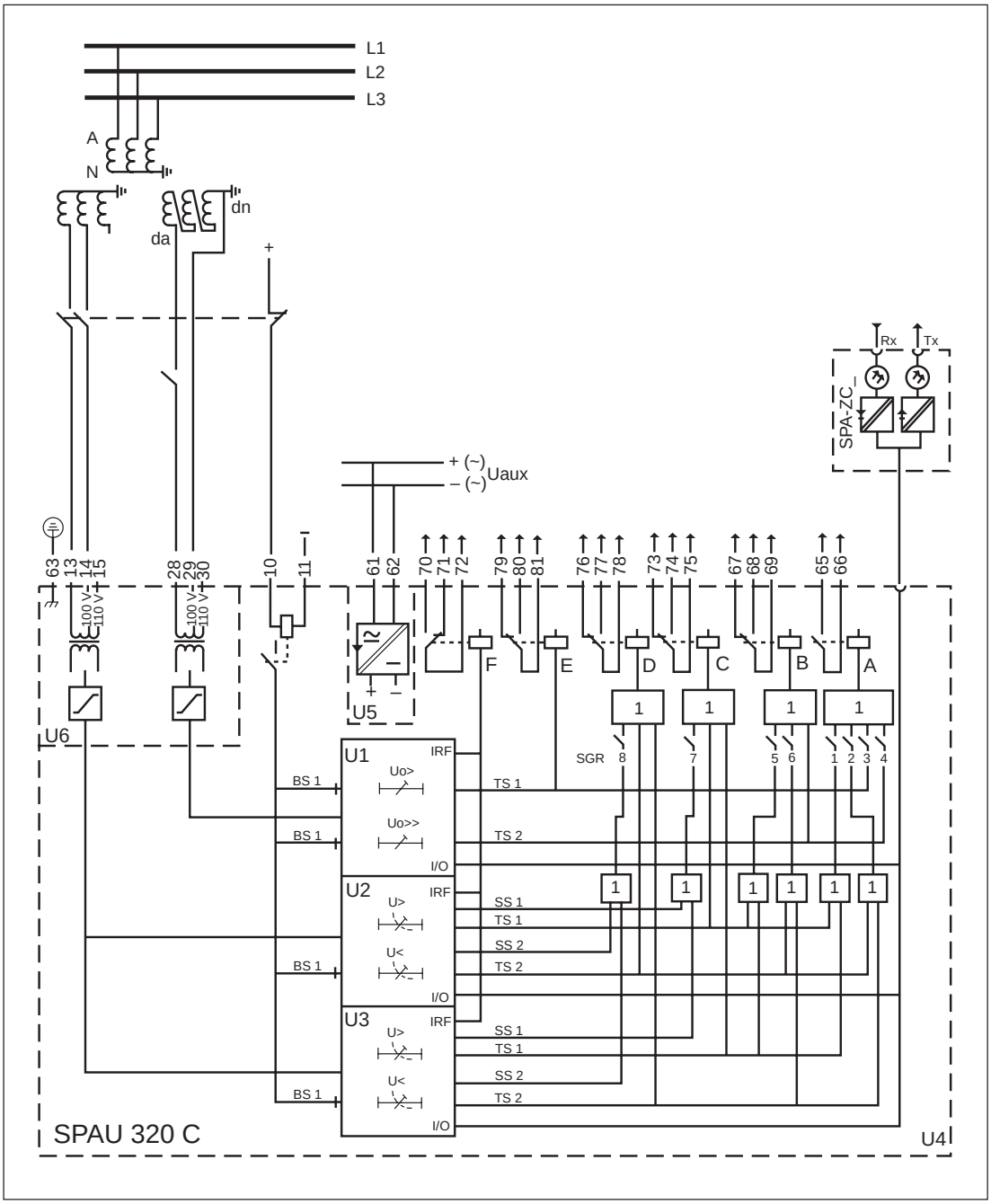


Fig. 2. Connection diagram for overvoltage, undervoltage and residual voltage relay SPAU 320 C.

U_{aux}	Auxiliary voltage
A, B, C, D, E, F	Output relays
IRF	Internal relay fault
SS1, SS2	Output signals for starting
TS1, TS2	Output signals for tripping
BS1	Blocking input signal
SGR	Switchgroup for tripping configuration
U1	Residual voltage relay module SPCU 1C6
U2, U3	Over- and under voltage relay module SPCU 1C1
U4	Output relay unit SPTR 6B3
U5	Power supply module
U6	Interface module SPTE 3B4
SPA-ZC_	Bus connection module
Rx/Tx	Serial communication interface

The voltage measured by the over- and undercurrent modules is connected to terminals 13-14 when the rated voltage of the secondary circuits is 100 V. If the rated voltage is 110 V, the voltage to be measured is connected to terminals 13-15.

The voltage measured by the residual voltage module is connected to terminals 28-29 or 28-30, depending on the rated voltage of the secondary circuits, 100 V or 110 V.

Tripping of the under voltage stage of the under voltage and overvoltage modules can be blocked by connecting an external blocking signal, BS1, to terminals 10-11.

The auxiliary supply voltage is connected to terminals 61-62. At d.c. auxiliary supply voltage the positive lead is connected to terminal 61. The level of the voltage to be applied on the terminals is determined by the power supply module used in the protection scheme. For further details see the description of the power supply module. The auxiliary voltage is marked on the front panel.

The tripping signals from the measuring modules are provided by output relay A. The signals to be linked to output relay A are selected by means of the switches SGR/1, 2, 3 and 4 at the front edge of the output relay module. Switch 1 is used for selecting the trippings of the overvoltage stage of the voltage modules SPCU 1C1 and switch 2 for selecting the trippings of the undervoltage stage. The tripping signals from the operating stages of the residual voltage module are programmed with switches 3 and 4.

Tripping of the high-set stage of the residual voltage module causes an alarm signal through output relay B. Further, the tripping signals from the overvoltage modules are linked to this output relay via switch SGR/5, and the tripping signals from the undervoltage stage via switch SGR/6.

Output relay provides an alarm signal at tripping of the overvoltage stage of both voltage modules SPCU 1C1. Further, the starting signals of these operating stages can be programmed to output relay C by means of switch SGR/7.

In the same way output relay D provides an alarm signal at tripping of the undervoltage stage of both overvoltage and undervoltage modules. Starting of the under voltage stages provides an alarm signal through switch SGR/8.

Tripping of the lower operating stage of the residual voltage module provides an alarm signal through output relay E.

Output relay F, terminals 70-71-72, operates as the output relay of the self-supervision system of the entire relay assembly. The relay operates on the closed circuit principle so that in normal service conditions the contact gap 70-72 is closed. If a fault is descovered by the self-supervision system, or if there is a failure in the auxiliary supply, the output relay drops off providing an alarm signal by closing the NC) contact 71-72.

The feeder protection is interfaced with the data transmission bus through a 9-pole, so called D-type connector located in the centre of the rear panel of the protective relay. By using a matching module, SPA ZC1, the protective relay can be linked to a fibre-optic bus. The terminals of the fibre-optic cables are connected to the counter terminals Rx and Tx on the matching module. The fibre-optic cables are linked from one protection to another as well as to the control data communicator, e.g. SACO 100M.

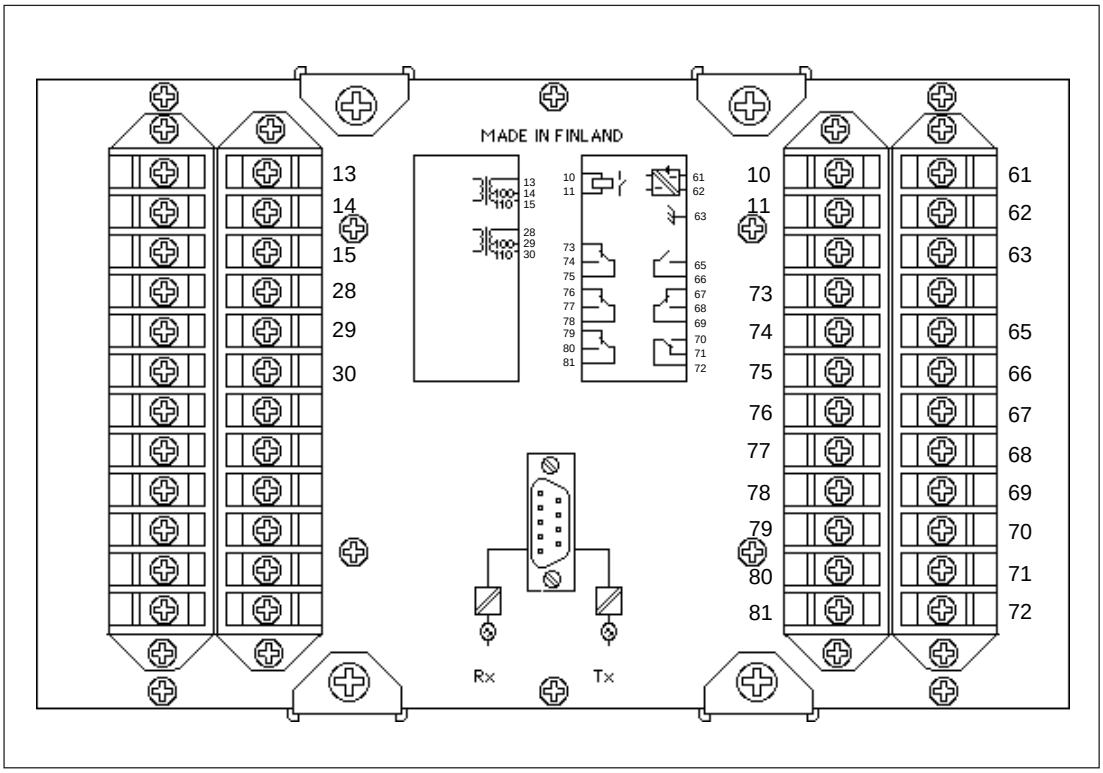


Fig. 3. Rear wiew of the overvoltage, undervoltage and residual voltage relay SPAU 320 C.

Operation indicators and push-buttons

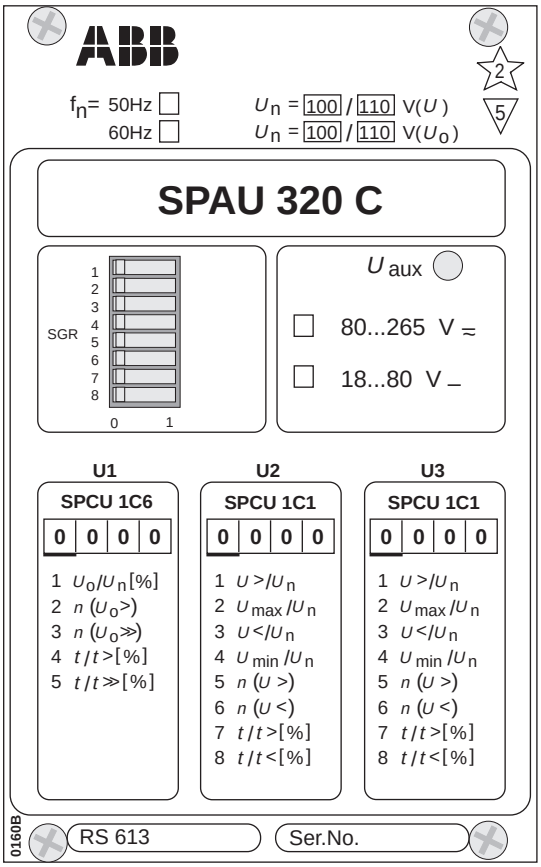


Fig. 4. System front panel of the overvoltage, undervoltage and residual voltage relay SPAU 320 C.

1. The green LED U_{aux} on the system panel is lit when the power supply of the relay is operating.

2. The relay modules are provided with two operating stages and each stage has its own yellow/red LED operation indicator. The operation indicator goes on with a yellow light when the operation stage starts and with a red light, if the stage delivers a tripping signal as well. The LED indicators can be given self-reset or manual reset mode of operation. Normally, when the stage resets, the red operation indicator remains lit after being switched on to indicate by which stage the tripping was initiated.

3. The front panels of both relay modules are provided with a numerical display for indication of measured and set values, two push-buttons marked STEP and RESET, a programming switchgroup SG1 for selection of relay functions and four setting knobs for operation values. The STEP push-button can be used for scanning through the measured and set values of the module and for presentation of the values concerned on the display of the module. The RESET push-button is used for resetting locally the red operation indicators for tripping. An unreset operation indicator does not affect the operation of the relay module and thus, the module is constantely operative.

4. The front panels of the relay modules are provided with a red LED used as a self-supervision alarm indicator IRF which indicates that the self-supervision system has detected a permanent fault in the protection relay. Further, the relay modules are provided with separate LED indicators on the front panel for indication of the measured residual and phase-to-phase voltages.

5. The cover of the protection relay case is made of transparent, UV-stabilized polycarbonate polymer and provided with three push-buttons for scanning of the relay parameters by means of the separate displays of the modules and the STEP push-buttons inside the cover. To enable resetting of the modules by means of the RESET push-buttons, the cover of the relay case must be opened using the locking screws for the case.

Detailed operation instructions are given in the manuals describing the individual relay modules and in the document "General characteristics of C-type relay modules".

Signal flow diagram and configuration switches

The internal signals of the overvoltage, undervoltage and residual voltage relay SPAU 320 C and the configuration switches are illustrated in fig. 5.

In certain applications it may be necessary to alter the factory settings of the configuration switches to obtain the required control signals and function of the protection relay.

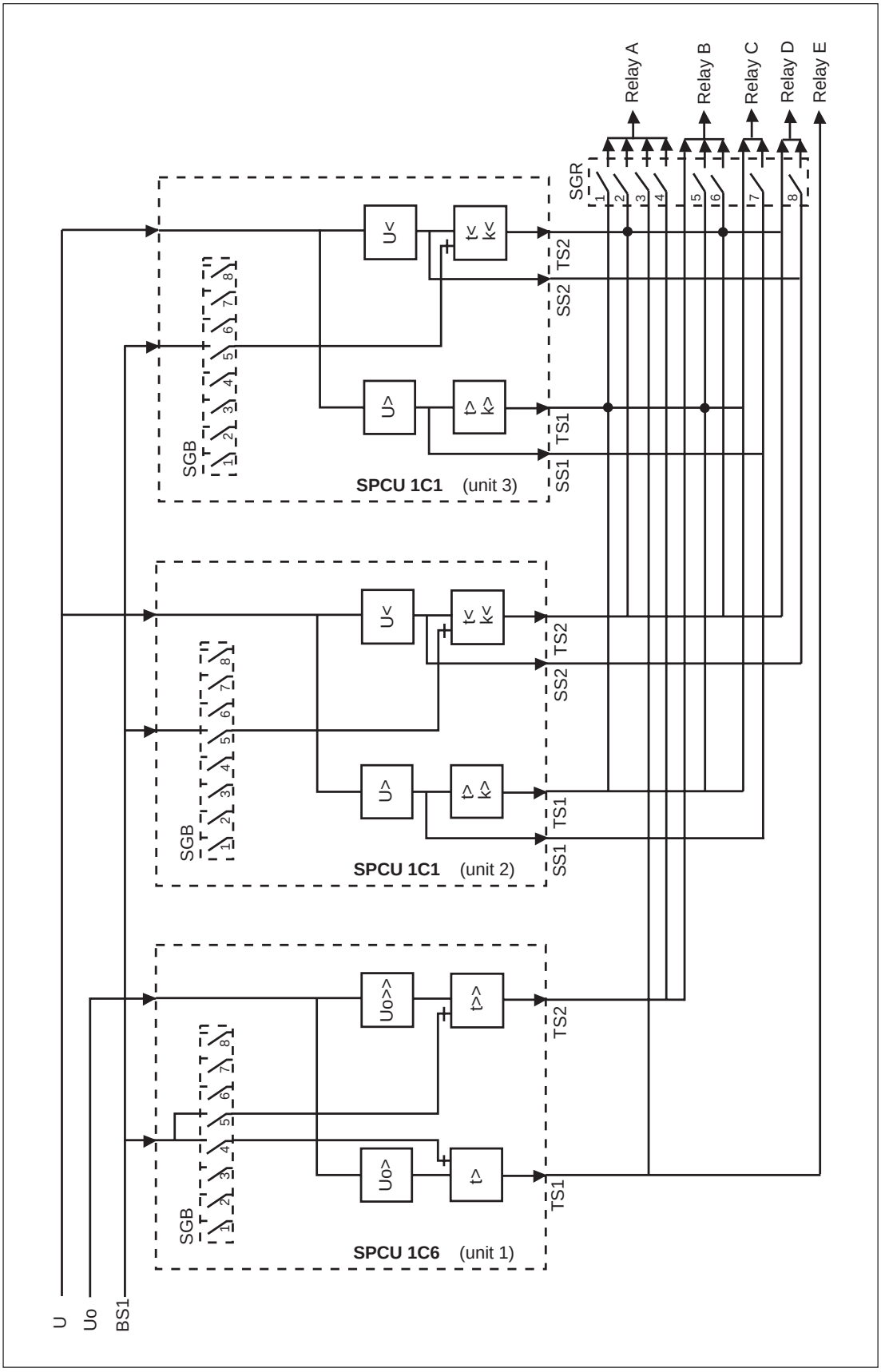


Fig. 5. Internal control signals between the relay modules of the overvoltage, undervoltage and residual voltage relay SPAU 320 C.

Configuration switches
(modified 2003-10)

The functions of the starting and tripping signals are programmed with switchgroup SGR, located at the front panel of the output relay module. The switches are programmed through an opening on the system panel.

The PC boards of the measuring relay modules contain the programming switchgroups SGB, the switches of which are used for programming the blocking signals applied on the modules of the protection SPAU 320 C.

The switches have the following functions:

Switch	Function
SGR/1	Links the tripping signal of stage U> of the over- and undercurrent modules to output relay A.
SGR/2	Links the tripping signal of stage U< of the over- and undercurrent modules to output relay A
SGR/3	Links the tripping signal of stage U_0> of the residual voltage module to output relay A.
SGR/4	Links the tripping signal of stage U_0>> of the residual voltage module to output relay A
SGR/5	Links the tripping signal of the U> stage of both under- and overvoltage modules to output relay B
SGR/6	Links the tripping signal of the U< stage of both under- and overvoltage modules to output relay B
SGR/7	Links the starting signal of the U> stage of both under- and overvoltage modules to output relay C
SGR/8	Links the starting signal of the U< stage of both under- and overvoltage modules to output relay D.

The SGB switches on the PC board of the residual voltage module SPCU 1C6 have the following functions:

Switch	Function
SGB/1	No function in SPAU 320 C. Has to be in position 0
SGB/2	No function in SPAU 320 C. Has to be in position 0.
SGB/3	No function in SPAU 320 C. Has to be in position 0.
SGB/4	Blocks the tripping of the U_0>> stage via signal BS1.
SGB/5	Blocks the tripping of the U_0>> stage via signal BS1.
SGB/6	No function in SPAU 320 C. Has to be in position 0.
SGB/7	No function in SPAU 320 C. Has to be in position 0.
SGB/8	No function in SPAU 320 C. Has to be in position 0.

The SGB switches on the PC boards of both over- and undercurrent modules have the following functions:

Switch	Function
SGB/1	No function in SPAU 320 C. Has to be in position 0
SGB/2	No function in SPAU 320 C. Has to be in position 0.
SGB/3	No function in SPAU 320 C. Has to be in position 0.
SGB/4	No function in SPAU 320 C. Has to be in position 0.
SGB/5	Blocks the U< stage via signal BSl.
SGB/6	No function in SPAU 320 C. Has to be in position 0.
SGB/7	No function in SPAU 320 C. Has to be in position 0.
SGB/8	No function in SPAU 320 C. Has to be in position 0.

Power supply module

The power supply module is located behind the system front panel of the relay together with the output relay module. The supply module is a separate relay module and can be withdrawn after removal of the system front panel. The power supply module produces the voltages required by the relay modules from the auxiliary supply voltage.

There are two types of power supply modules, differing only in input voltage:

SPGU 240 A1:
Nominal voltage U_n = 110/120/230/240 V ac
U_n = 110/125/220 V dc
Operative range U = 80...265 V ac/dc

SPGU 48 B2:
Nominal voltage U_n = 24/48/60 V dc
Operative range U = 18...80 V dc

The power supply type is marked on the system front panel.

The power supply module is a transformer connected, i.e. galvanically separated primary and secondary circuits, flyback type rectifier. The primary circuit is protected by a fuse F1, 1A (slow) in SPGU 240 A1 and 4A (fast) in SPGU 48 B2, which are located on the printed circuit board of the module.

When the power supply is on, a green LED indicator U_{aux} is lit on the system panel. The supervision of the supply voltages for the electronics is located on the regulating modules. The self-supervision alarm is given, if any of the secondary voltages differ more than 25% from the nominal value. Also, if the power supply module is missing, or if there is no auxiliary supply to the voltage regulator at all, an alarm is given.

Output relay module

The output relay module SPTR 6B3 is located behind the system front panel of the relay together with the power supply module. The output relay module forms its own withdrawable relay module after removal of the system front plate. The module contains all output relays, A...F, the control circuits of the relays as well as the electronic circuitry of the external control inputs.

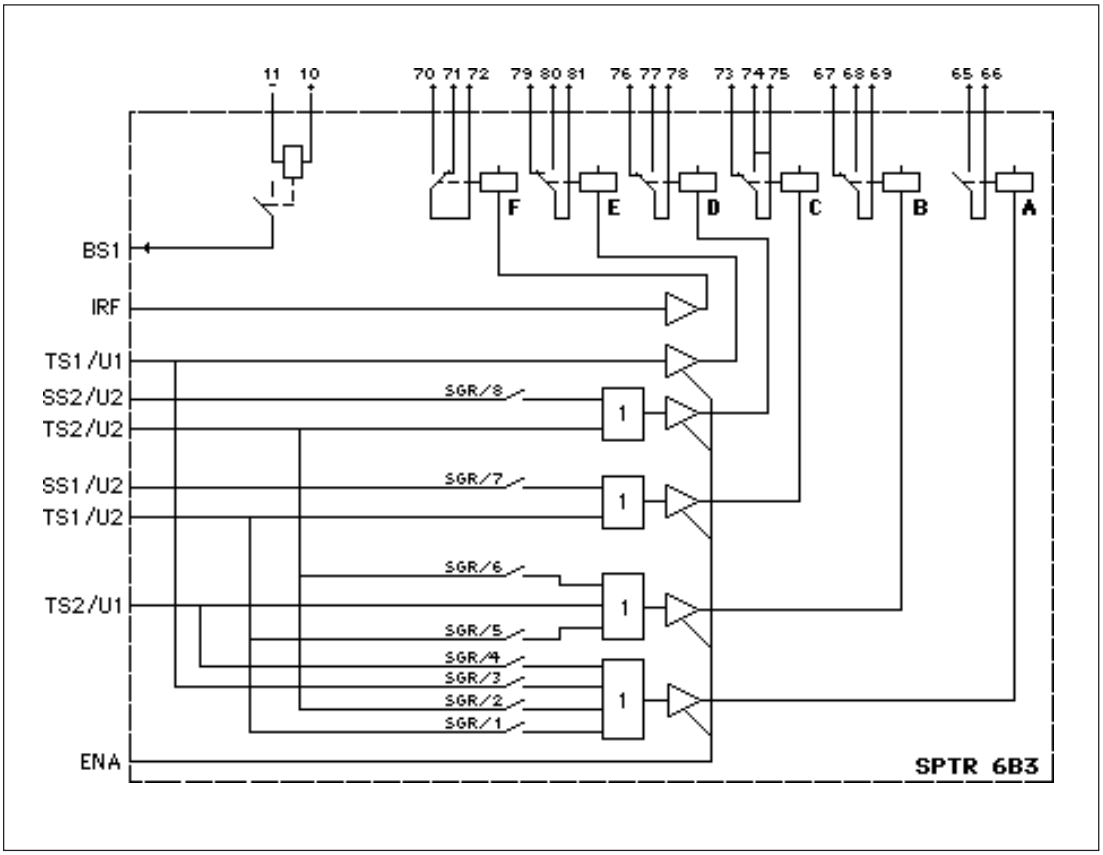


Fig. 6. Block diagram for the output relay module SPTR 6B3.

TS1/U1	Tripping signal of stage U_0>
TS2/U1	Tripping signal of stage U_0>>
SS1/U2	Starting signal of stage U>
TS1/U2	Tripping signal of stage U>
SS2/U2	Starting signal of stage U<
TS2/U2	Tripping signal of stage U<
BS1	External blocking input signal to stage U<
A	Tripping output relay A (heavy-duty) for all stages, U_0>, U_0>>, U> and U<
B	Alarm signal output relay B for stages U_0>>, U> and U<
C	Alarm signal output relay C for stage U>
D	Alarm signal output relay D for stage U<
E	Alarm signal output relay E for stage U_0>
F	Self-supervision output relay F
IRF	Self-supervision input signal
SGR	Switchgroup for programming of starting and tripping signals
ENA	Enable output signal from control circuits

The input and output signals of the output relay module are related to the fixed positions of the relay modules which cannot be changed in the relay housing. The output signals from each relay module and PC-board location are wired individually to the output relay module. It must be pointed out that the relay modules have to be plugged into the relay case as illustrated in the figure on the front page in order to secure that the connection diagram drawn for the relay assembly also would correspond to the physical function of the protective device.

Technical data
(modified 2002-04)

Energizing inputs

Rated voltage U_n	100/110 V
Continuous voltage withstand	1.7 x U_n
Burden at rated voltage	< 0.5 VA
Rated frequency f_n	50 Hz
Rated frequency on request	60 Hz

Contact outputs

Terminals	65-66
Rated voltage	250 V dc/ac
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 48/110/220 V dc	5 A/3 A/1 A
Alarm contacts	67-68-69 70-71-72 73-74-75 76-77-78 79-80-81
Rated voltage	250 V dc/ac
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 48/110/220 V dc	1 A/ 0.25 A/ 0.15 A

External control inputs

Terminals	10-11
Control voltage levels	18…265 V dc or 80…265 V ac
Current drain, typically	1 mA

Power supply module

Supply module, type SPGU 240 A1	80…265 V dc/ac
Supply module, type SPGU 110 B1	40…150 V dc (on request)
Supply module, type SPGU 48 B1	18…60 V dc
Power consumption under quiescent/ operating conditions	~10 W/~15

Residual overvoltage relay module SPCU 1C6

See "Technical data" in the document 1MRS 750509-MUM EN for the relay module.

Over- and undervoltage relay module SPCU 1C1

See "Technical data" in the document 1MRS 750609-MUM EN for the relay module.

Data communication

Transmission mode	Fibre-optic serial bus
Coding	ASCII
Data transfer rate, selectable	300, 1200, 2400, 4800 or 9600 Bd
Optical bus connection module powered from the host relay	
- for plastic-core cables	SPA-ZC 21 BB
- for glass-fibre cables	SPA-ZC 21 MM
Optical bus connection module powered from the host relay or from an external power source	
- for plastic-core 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

Service temperature range	-10...+55°C
Temperature dependence	<0.2%/°C
Transport and storage temperature range according to IEC 60068-2-8	-40...+70°C
Damp heat test according to IEC 60068-2-30	≤95%, 55°C, 6 cycles
Degree of protection by enclosure of flush mounting relay case according to IEC 60529	IP54
Weight of fully equipped relay	5.5 kg

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

Example 1.
Supervision of substation busbar system voltages

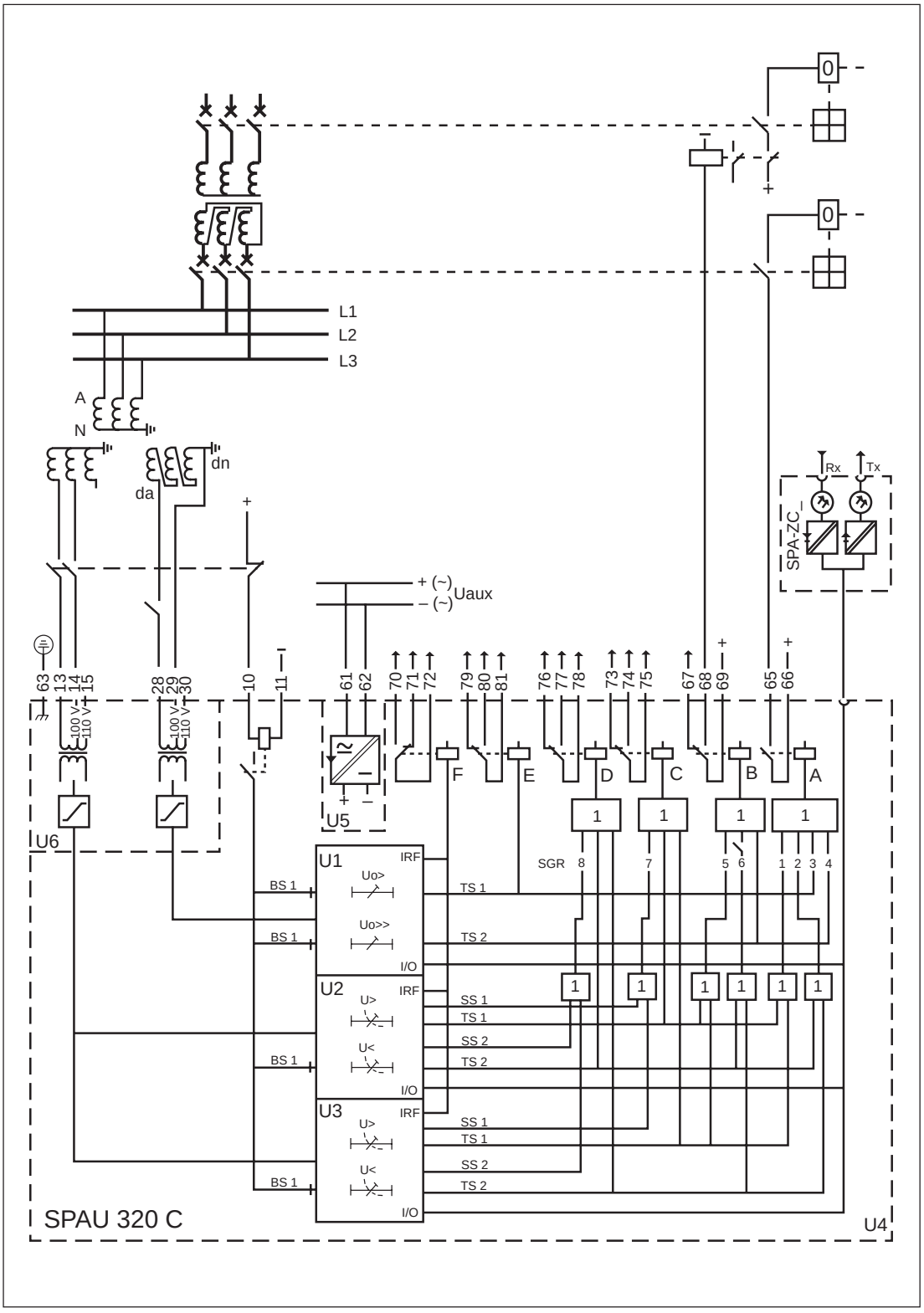


Fig. 7. SPAU 320C used for the supervision of the busbar system voltages of a substation.

The voltage module U1 (SPCU 1C6) measures the residual voltage of the open-delta winding of the voltage transformers of the busbar system. An earth-fault occuring in a section of a galvanically connected network, produces a residual voltage, the level of which is higher, the smaller the resistance of the earth-fault point.

The lower stage of the residual voltage module U1 can be given either a signalling or a tripping function. When the stage has a tripping function, as illustrated in fig. 7, the value of the starting voltage is set above the setting of the earth-fault relays of the feeders. Then the module acts as a back-up protection for the feeders and trips the circuit-breaker of the incoming cubicle, if, for some reason, the earth-fault protection of the feeder would not operate.

The higher stage of the module U1 has a tripping function. This stage is used mainly for the earth-fault protection of the busbar system and the back-up protection for the outgoing feeders at earth-faults with very low resistances. The higher voltage stage also operates as the earth-fault protection of the incoming cubicle, if the tripping signal is linked to the circuit-breaker of the overvoltage side of the supply transformer, see fig. 7. The same operating time is selected for both stages of the residual voltage module. The tripping signals from the two stages are received over output relay A, by means of switches SGR/3 and 4. In addition, the tripping signal of the higher stage is also received over output relay B. The alarm signal for earth-fault is provided by output relay E.

The voltage relay modules U2 and U3 (SPCU 1C1) measure the main voltage, thus operating as overvoltage and undervoltage protections. The operating principle of the protection is illustrated in fig. 8.

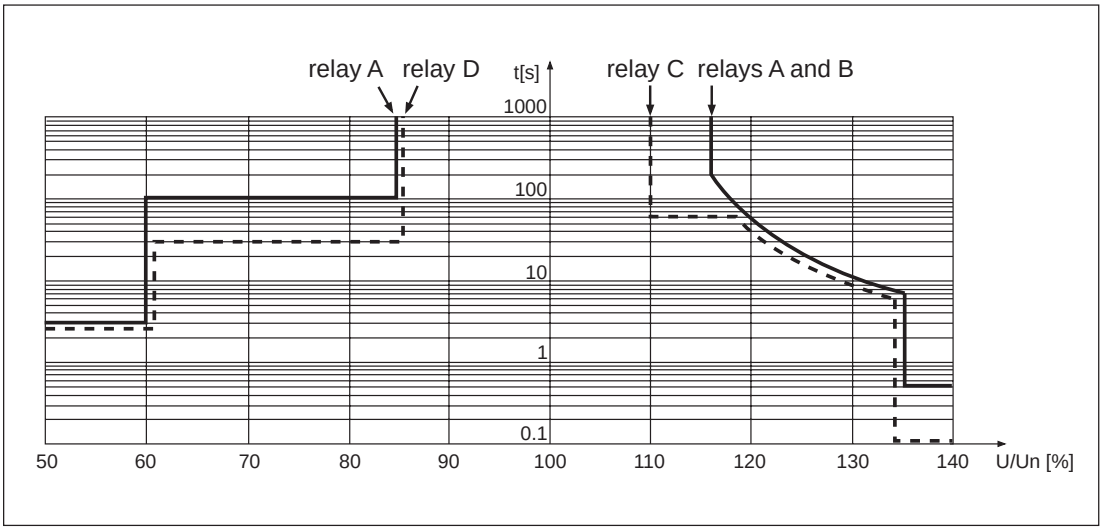


Fig. 8. Operating principle of the busbar system overvoltage and undervoltage protection.
(- - = alarm, – = tripping)

Setting example:

Module U2:
U> = 1.1 x U_n (inverse time, curve A)
U> starting time = 60 s
k> = 0.7

U< = 0.85 x U_n (definite time)
U< starting time = 30 s
t< = 100 s

Module U3:
U> = 1.35 x U_n (definite time)
U> starting time = 0.1 s
t> = 0.5 s

U< = 0.6 x U_n (definite time)
U< starting time = 30 s
t< = 3 s

The operation of the overvoltage protection may be based on the principle that when the voltage tends to be too high, an alarm signal is provided by the overvoltage stage of module U2, and when the voltage level continues to grow, the stage performs tripping. The overvoltage stage of module U3 operates as an instantaneous high-set stage.

The overvoltage withstand capability of the equipment to be connected to the network is reciprocally proportional to the magnitude of the overvoltage. This makes the inverse time characteristic well adapted for the overvoltage stage of module U2. At an inverse time mode of operation the protection provides an alarm signal when the voltage level reaches the set value. If the voltage exceeds the setting value by 6%, the relay performs tripping after a time delay depending on the overvoltage. The operating characteristic A allows a relatively low alarm limit to be selected, and yet, the operating time will be long enough for the voltage regulator to operate also at large voltage fluctuations. The operation of the instantaneous high-set stage is based on a definite time characteristic.

The operation of the undervoltage protection may be based on the principle that the undervoltage stage of module U2 initially provides an alarm signal, and if the under voltage situation persists, it performs tripping. The undervoltage stage of module U3 operates as an instantaneous high-set stage.

The undervoltage stage starts in a short circuit situation as well. The best way of obtaining selectivity is to select a definite time characteristic for both the undervoltage protection and the short circuit protection. Another alternative is to use the inverse time characteristic for both undervoltage protection and short circuit protection.

Groundless operation of the undervoltage protection due to auto-reclosures is prevented by means of switch SG1 /5. When turning SG1 /5 into the position 1, the undervoltage stage is prevented from operating, if the voltage falls to less than 20% of U_n.

The tripping signals from the overvoltage protection are received over the output relays A and B, switches SGR/1 and 5, whereas the tripping signals from the undervoltage protection is received over output relay C, switch SGR/7. Output relay C also provides an alarm signal at overvoltage. The alarm signal for undervoltage is received over output relay D, switch SGR/8, as is the alarm signal for tripping.

Example 2. Supervision of substation busbar system voltages

Another example of how to arrange the supervision of the busbar system voltages is illustrated in fig. 9, where the supervision is based on the use of the residual voltage module SPCU 1C6 and only one overvoltage/undervoltage module SPCU 1C1 .

The lower stage of the residual voltage module U1 has been used as a signalling earth-fault protection, and thus the stage has been given a more sensitive setting than the earth-fault relays of the feeders. In this way also high resistance earth-faults are indicated. The alarm signal is received over output relay E.

The higher voltage stage of the residual voltage module has a tripping function. The higher stage operates as the back-up protection for the earth-fault protections of the outgoing feeders and as the earth-fault protection of the busbar system.

The tripping signals from the overvoltage and undervoltage protection and from the higher stage of the residual voltage module is linked only to the circuit-breaker of the undervoltage side of the supply transformer, via output relay A (switches SGR/1, 2 and 4). A common alarm signal for tripping is received from output relay B, switches SGR/5 and 6. This system is especially well adapted to be used with reporting systems with serial communication facilities. Then a detailed information about the function causing the tripping, including time markings, is provided by the substation level reporting system.

Information about starting of the overvoltage or undervoltage stage is received over the output relays C and D, switches SGR/7 and 8. By using short starting times, the output relays can be used for supervising the voltage regulator equipment. Output relay C prevents the tap-changer from stepping down and output relay D prevents it from stepping up.

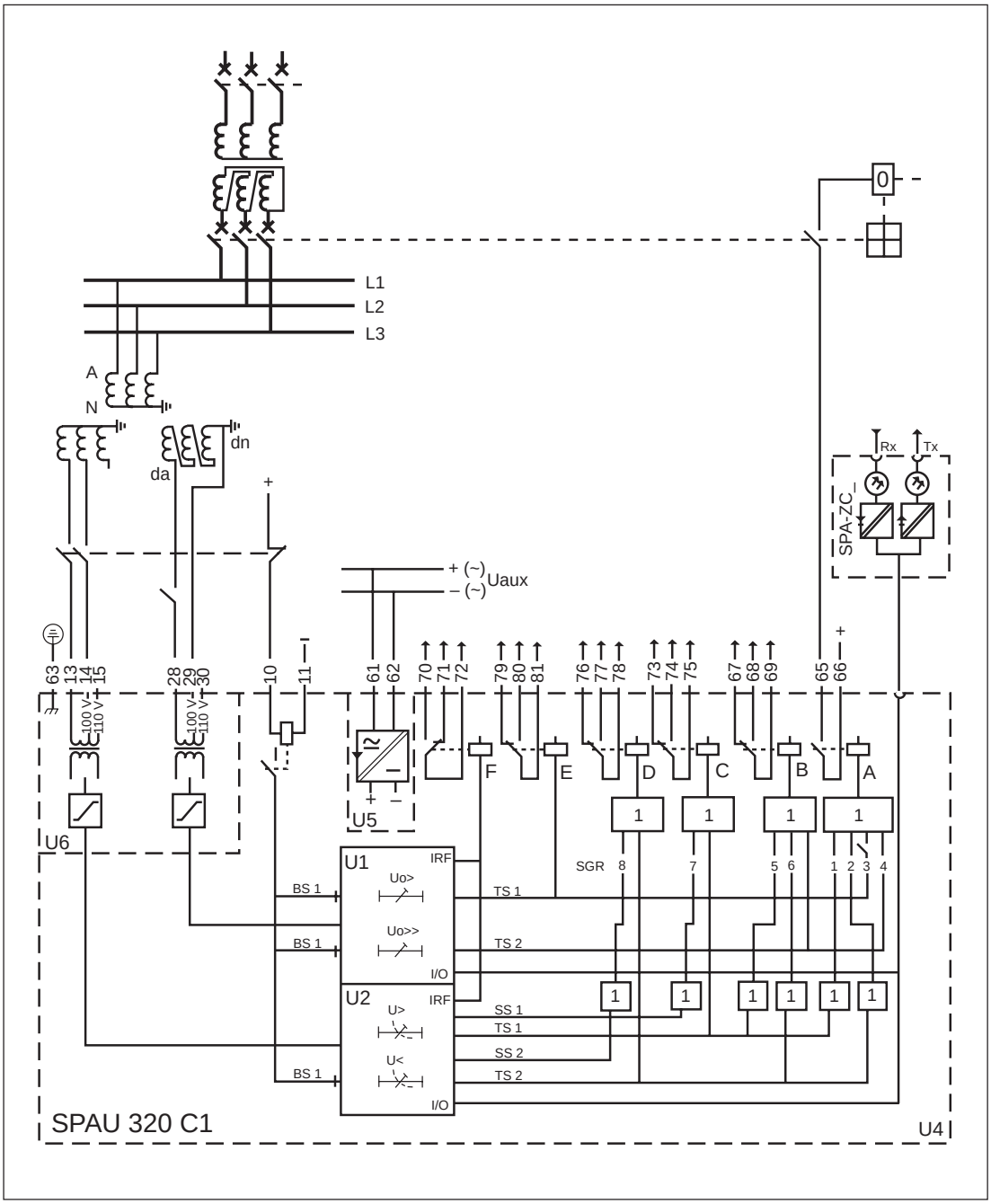


Fig. 9. SPAU 320 C1 used for the supervision of substation busbar system voltages.

Example 3.
Supervision of distribution switch-gear busbar system voltages in industrial plants

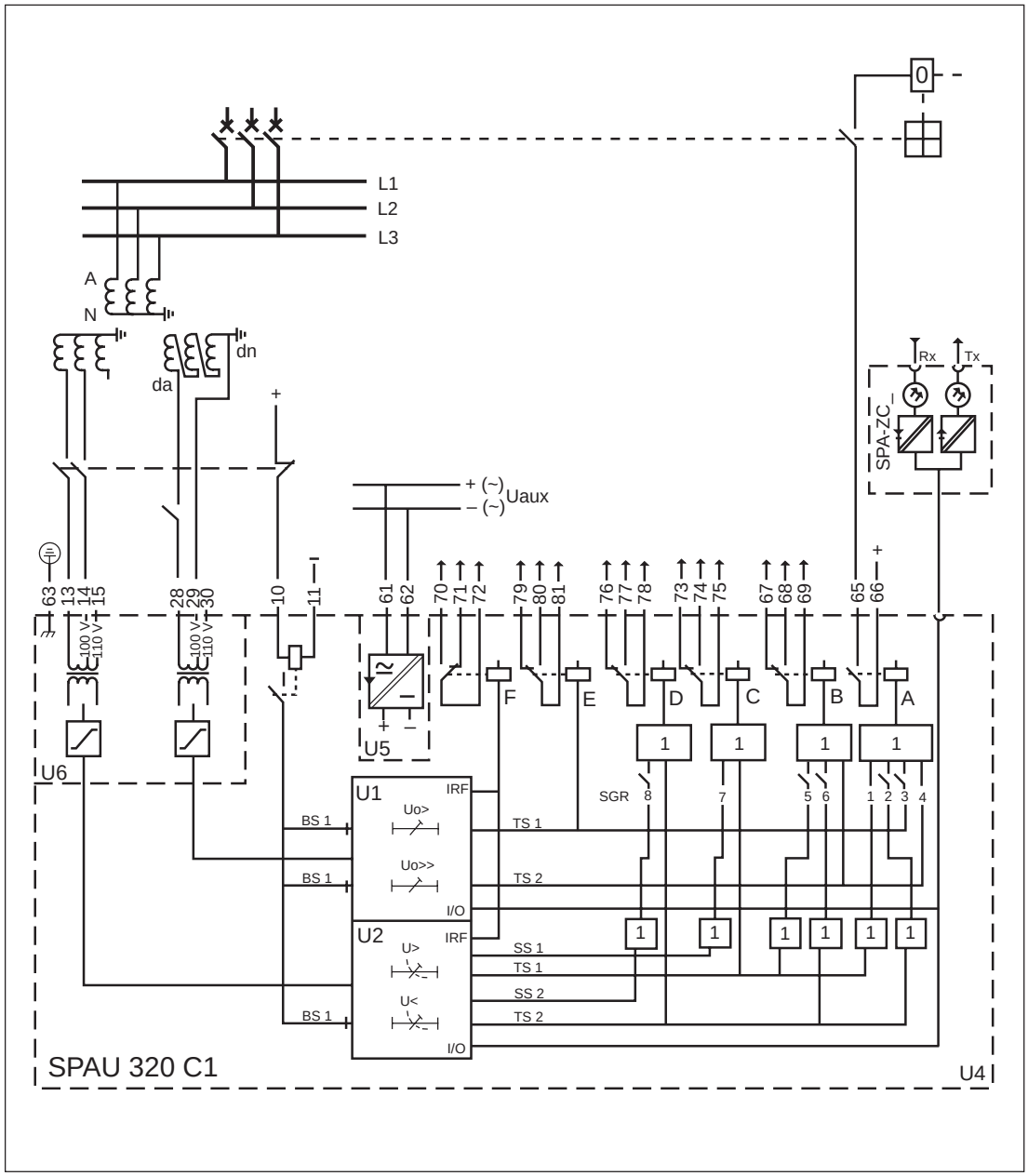


Fig. 10. SPAU 320 C1 used for the supervision of distribution switchgear busbar system voltages in an industrial plant.

The residual voltage module U1 measures the residual voltage in the open-delta winding of the voltage transformers. The lower stage of the residual voltage module may be used for releasing the neutral current relays of the feeders. When an earth-fault occurs in a feeder, both the neutral current relay of the feeder and the lower stage of the residual voltage relay of the busbar system must start to enable tripping of the circuit-breaker. In this manner groundless operations of the neutral current relay are avoided in short-circuit situations, at motor start-ups or in normal service conditions.

The higher stage of the residual voltage module U1 is used for the earth-fault protection of the busbar system and for the back-up protection of the feeder protections. In order to make the protection operate selectively, the setting values are selected above the setting values of the feeder relays.

The overvoltage stage of the U2 module operates as the overvoltage protection for motors, transformers and similar equipment connected to the busbar system. The operation of the stage can be given an inverse time characteristic, in which case the use of curve B allows a relatively high starting value to be set, without causing too long a tripping time at high overvoltages.

The undervoltage stage of module U2 opens the circuit-breakers of the motors connected to the busbar system, and so the motors are prevented from starting simultaneously when the voltage returns. To avoid motor trippings at short voltage interruptions, the operating time of the undervoltage stage is to be longer than the dead time of an auto-reclose sequence.

To prevent unnecessary tripping of the undervoltage protection at tripping of a miniature circuit-breaker, a blocking voltage is applied on the relay, over the auxiliary contact of the miniature circuit-breaker. Then switch 5 of switchgroup SGB on the PC board of the overvoltage and under voltage module must be in the position 1.

Output relay A operates as the tripping relay of the circuit-breaker of the incoming cubicle. The relay is controlled by the higher stage of the residual voltage relay by means of switch SGR/4 and by the overvoltage protection by means of switch SGR/1. Output relay B provides an alarm signal when tripping has been caused by earth-fault, and output C provides an alarm signal at tripping due to overvoltage and starting of the overvoltage stage, switch SGR/7. Output relay D is used for disconnecting motors in an undervoltage situation and output relay E for releasing the earth-fault relays of the feeders.

Analysis of disturbances

The data stored in the registers of the measuring modules provides useful information about the behaviour of the network both in a normal service situation and at disturbances.

The registers 2 and 4 of the overvoltage/undervoltage module SPCU 1 C1 show the normal fluctuation range of the busbar voltage. Registers 5 and 6 show the frequency of the occurrence of a large voltage fluctuation, that is how often the voltage relay module has started.

The information stored in the registers 1 and 3, and 7 and 8 contributes to the analysis of the situation at a disturbance. Information about the voltage level occurring in a fault situation and how close to tripping the voltage relay was is recorded in the registers.

A general view of the situation when an earth-fault occurs in a substation is provided by the registers of the residual voltage module SPCU 1C6. Registers 2 and 3 show the number of startings of the different stages and, further, the distribution of the earth-faults with regard to the fault resistances.

The smallest fault resistance, at which the earth-fault is extinguished by itself or due to auto-reclose functions may be determined on the basis of the information in register 1. By using the lower stage of the residual voltage module for a signalling function and by setting the operating time at the same value as the delay for the final tripping of the feeder earth-fault relay the fault resistance of the fault that caused tripping can be determined by means of register 1, as the total earth-fault current of the galvanically connected network is known.

Data on the duration of the earth-fault or the safety margin for the time gradings of the selective protections is received from registers 4 and 5.

Maintenance and repair

When the overvoltage, undervoltage and residual voltage relay SPAU 320 C is operating under the conditions specified in "Technical data", the relay requires practically no maintenance. The voltage relay includes no parts or components that are sensitive to physical or electrical wear under normal operating conditions.

Should the temperature and humidity at the operating site differ from the values specified, or the atmosphere contain chemically active gases or dust, the relay should be visually inspected in association with the secondary testing of the relay. This visual inspection should focus on:

- Signs of mechanical damage to relay case and terminals
- Collection of dust inside the relay case; remove with compressed air
- Signs of corrosion on terminals, case or inside the relay

If the relay malfunctions or the operating values differ from those specified, the relay should be overhauled. Minor measures can be taken by the customer but any major repair involving the electronics has to be carried out by the manufacturer. Please contact the manufacturer or his nearest representative for further information about checking, overhaul and recalibration of the relay.

The protection relay contains circuits sensitive to electrostatic discharge. If you have to withdraw a relay module, ensure that you are at the same potential as the module, for instance, by touching the case.

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

Spare parts

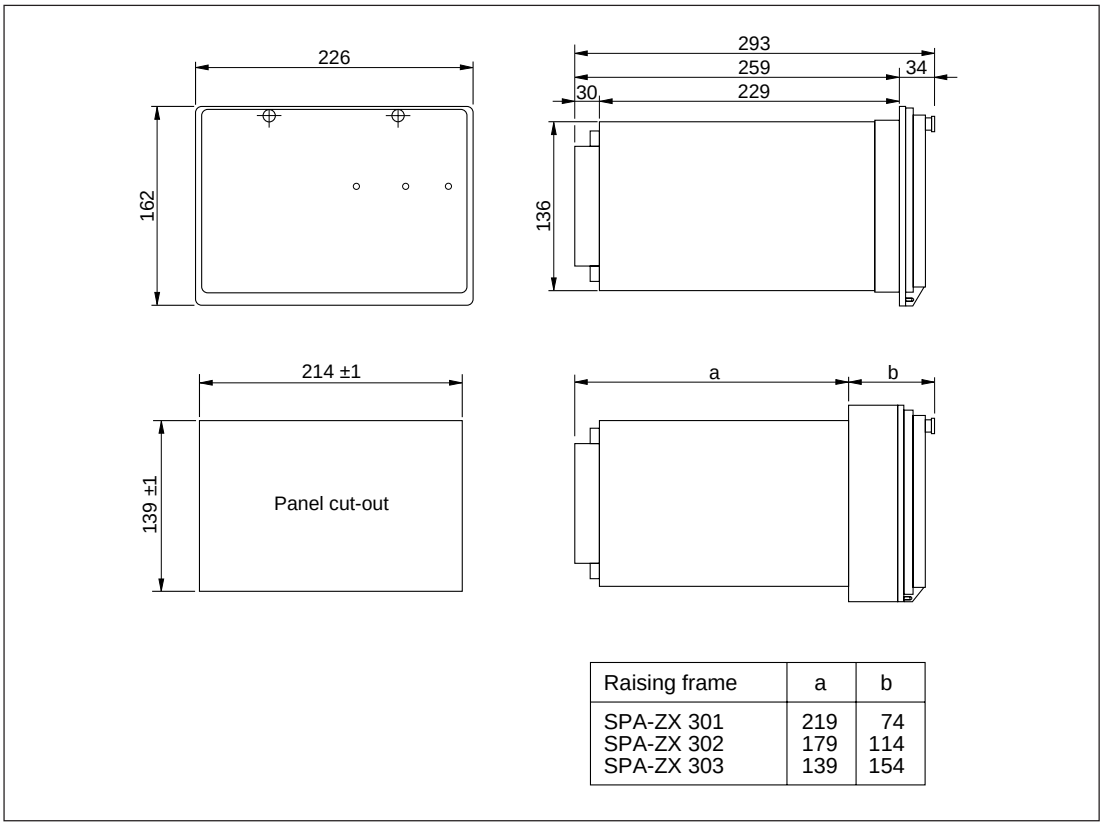
Residual overvoltage relay module	SPCU 1C6
Over- and undervoltage relay module	SPCU 1C1
Power supply modules	
- U_{aux} = 80...265 V ac/dc (operative range)	SPGU 240 A1
- U_{aux} = 18...80 V dc (operative range)	SPGU 48 B2
Output relay module	SPTR 6B3
Interface module	SPTE 4B9
Bus connection module	SPA-ZC 17_ or SPA-ZC 21_

Delivery alternatives

Type	Equipment	SPCU 1C6	SPCU 1C1	SPCU 1C1
SPAU 320 C	Basic version, all relay modules included	x	x	x
SPAU 320 C1	One residual overvoltage and one over- and undervoltage relay module included	x	x	
SPAU 320 C3	Only one residual overvoltage relay module included	x		
SPAU 320 C4	Two over- and undervoltage relay modules included		x	x
SPAU 320 C5	Only one over- and undervoltage relay module included		x	

Dimension drawings and mounting

The basic model of the protection relay case is designed for flush-mounting. When required, the mounting depth of the case can be reduced by using raising frames: type SPA-ZX 301 reduces the depth by 40 mm, type SPA-ZX 302 by 80 mm and type SPA-ZX 303 by 120 mm. When projecting mounting is preferred a relay case type SPA-ZX 306 is used. The relay case for projecting mounting is provided with front connectors.



Raising frame	a	b
SPA-ZX 301	219	74
SPA-ZX 302	179	114
SPA-ZX 303	139	154

Fig. 11. Dimension and mounting drawings for overvoltage, undervoltage and residual voltage relay SPAU 320 C.

The relay case is made of profile aluminium and finished in beige.

The rubber gasket fitted to the mounting collar provides an IP54 degree of protection by enclosure between the relay case and the mounting base.

The hinged cover of the case is made of transparent, UV-stabilized polycarbonate polymer and provided with two sealable locking screws. The rubber gasket of the cover provides an IP54 degree of protection between the case and the cover.

The required input and output connections are made to the multi-pole terminal blocks on the rear panel. Each screw terminal is dimensioned for one or two wires of maximum 2.5 mm^2. A connection diagram adjacent to the terminal blocks illustrates the connection of the terminals.

The 9-pole D-type connector is intended for serial communication of the relay. A 25-pole D-type connector is used for connecting the disturbance recorder module via the RS 232 C port on the front panel to an output device.

The bus connection modules (SPA-ZC 17_ or SPA-ZC 21_) and fibre-optic cables recommended by the manufacturer should always be used for the serial communication.

Ordering information

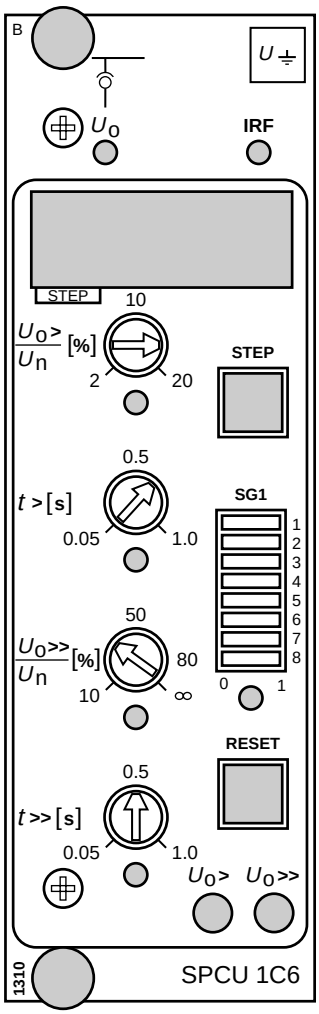
1. Number and type designation
2. Rated frequency
3. Auxiliary voltage
4. Accessories

5. Special requirements

Example
5 pcs SPAU 320 C
f_n = 50 Hz
U_{aux} = 110 V dc
5 raising frames SPA-ZX 301
5 bus connection modules SPA-ZC 17 MM2A
–

SPCU 1C6
Residual overvoltage relay module

User´s manual and Technical description



1MRS 750509-MUM EN

Issued 96-12-02
Version A (replaces 34 SPCU 2 EN1)
Checked L-W U
Approved TK

Data subject to change without notice

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.

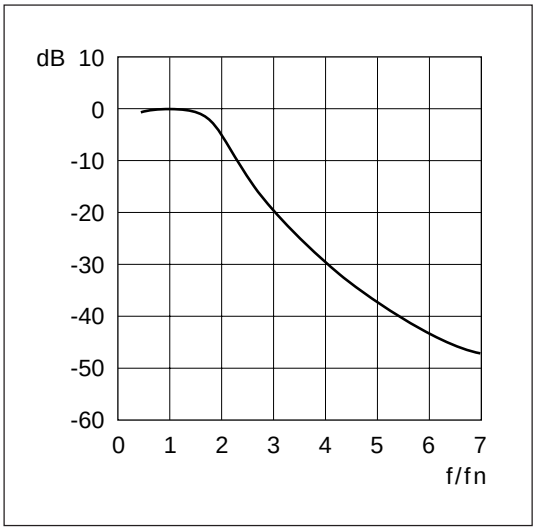


Fig. 1. Filter characteristics of the residual voltage input circuit.

Block diagram

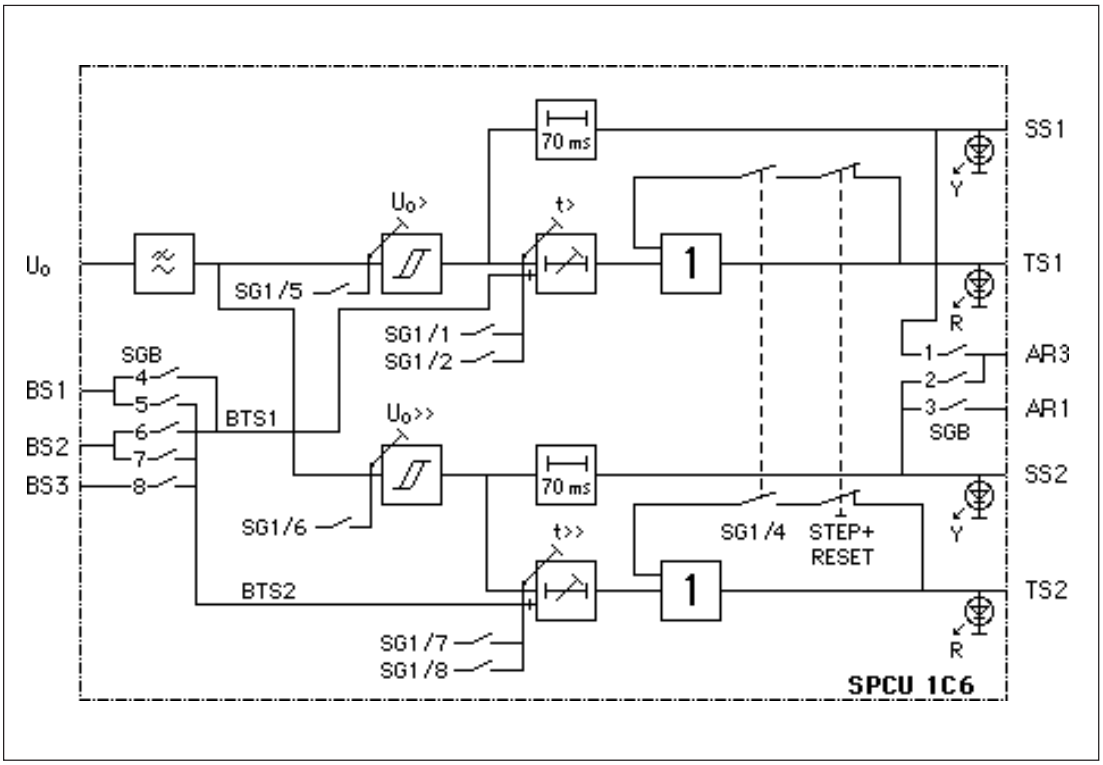


Fig. 2. Block schematic diagram of the residual overvoltage relay module SPCU 1C6.

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

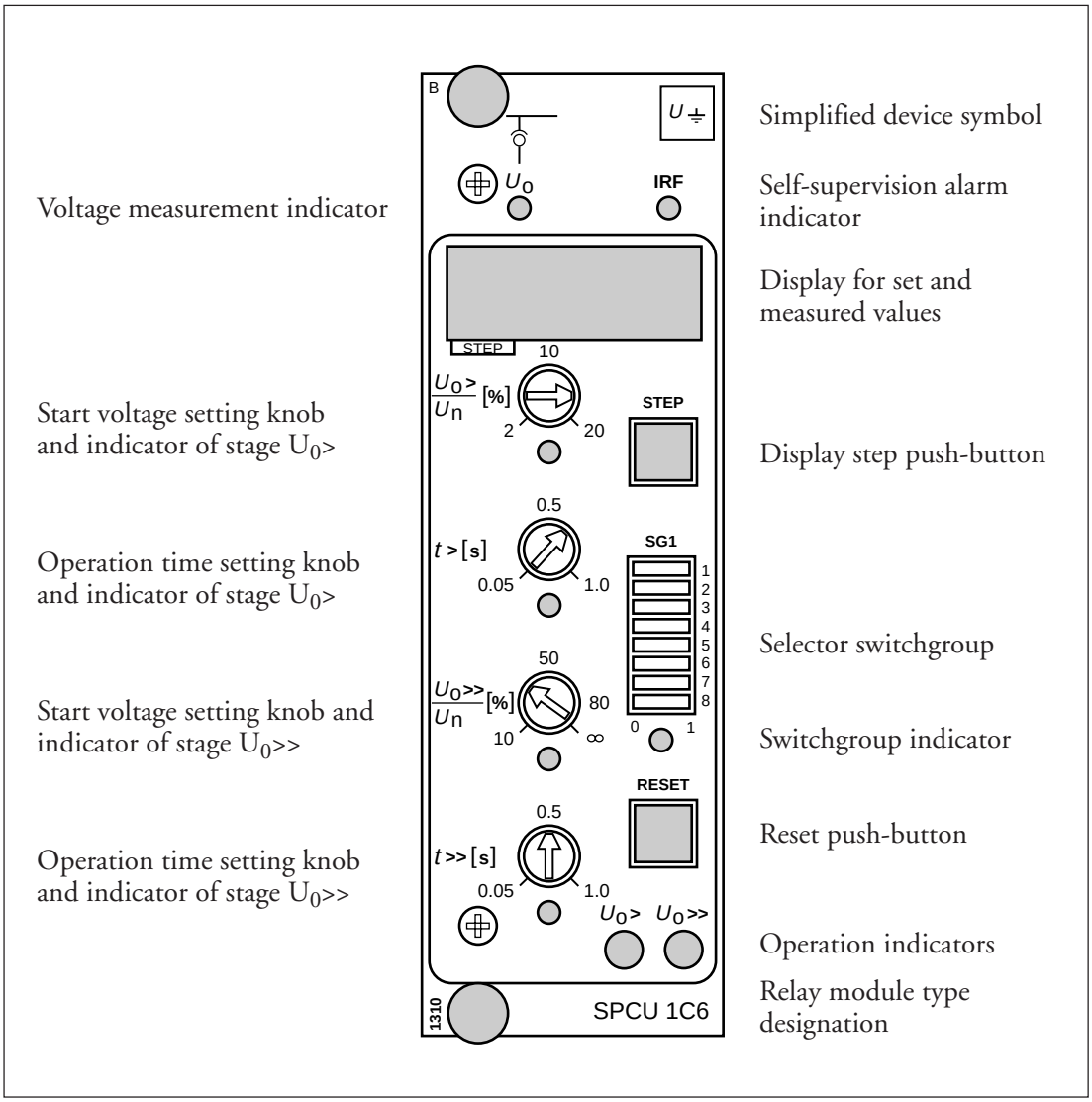


Fig. 3. Front panel of the residual overvoltage relay module SPCU 1C6.

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

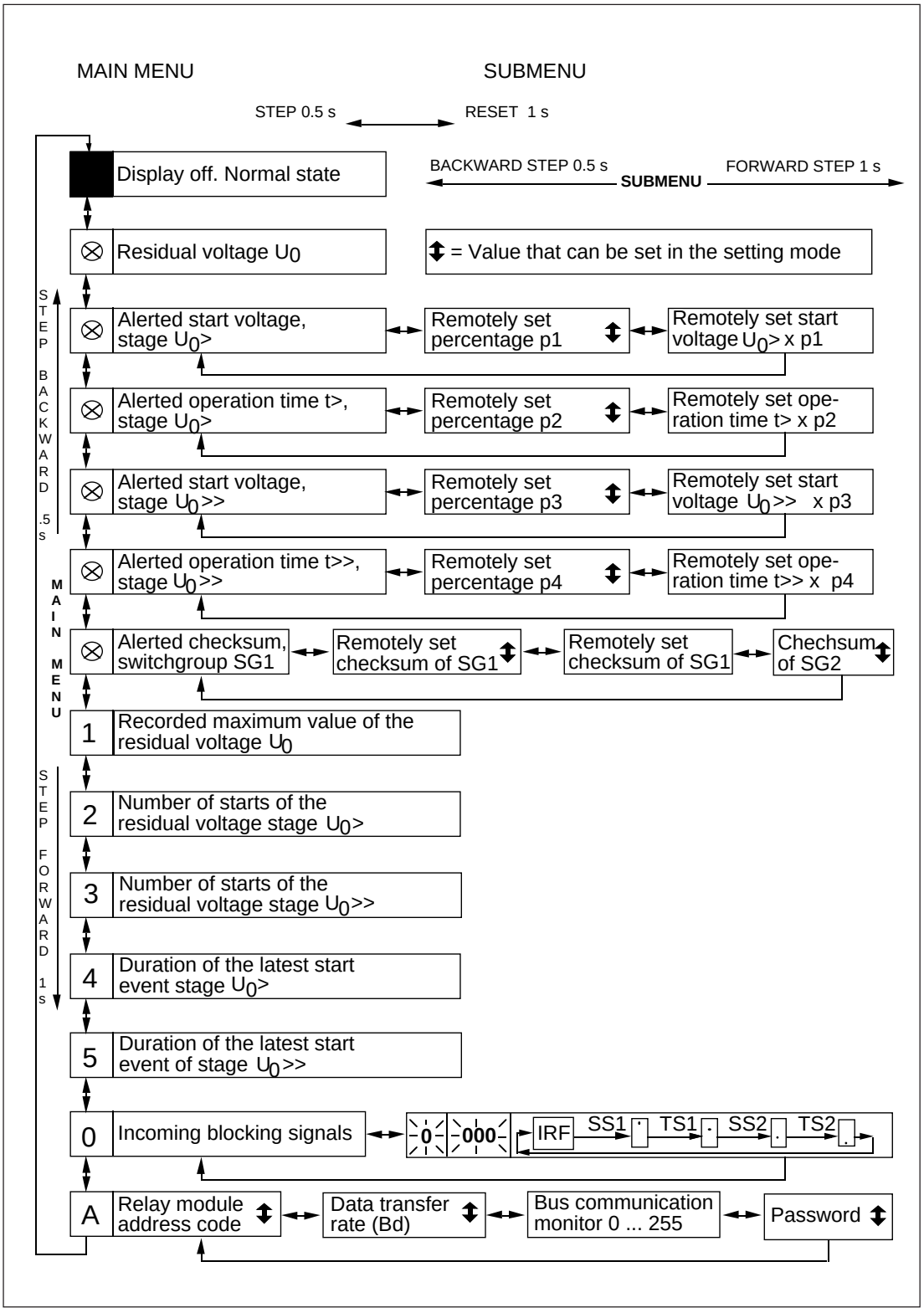


Fig. 4. Main menu and submenus of the residual overvoltage relay module SPCU 1C6.

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.

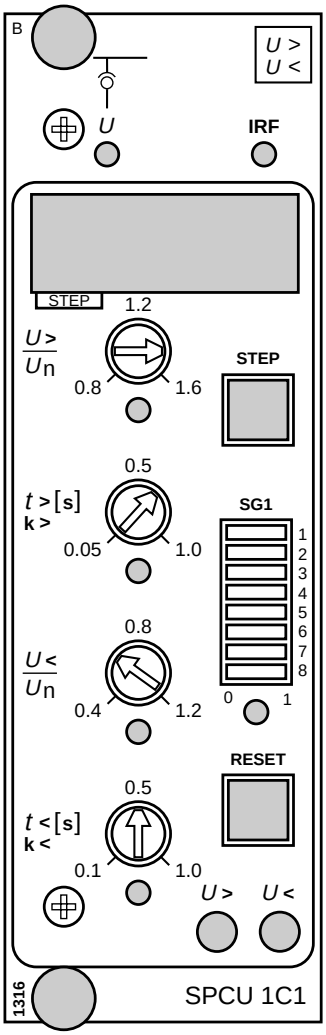
In most fault situations an auto-diagnostic fault code is shown on the relay display. The fault code cannot be reset. The fault code consists of a red digit one (1) and a green code number that indicates the fault type. The fault code should be recorded and stated when service is ordered.

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

SPCU 1C1
Combined overvoltage and undervoltage relay module

User´s manual and Technical description



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Data subject to change without notice

SPCU 1C1
Combined overvoltage and undervoltage relay module

Contents

Features

Single-phase voltage measuring protection relay module

Overvoltage stage with definite time or inverse definite minimum time operation characteristic

Undervoltage stage with definite time or inverse definite minimum time operation characteristic

Two sets of voltage/time curves available at inverse time operation characteristic of the undervoltage stage

External blocking of the operation of the undervoltage stage via a built-in control input

Automatic blocking of the undervoltage stage on loss of energizing voltage

Digital display of measured values, set values and recorded fault values

Serial communication capability for extensive exchange of data with substation level equipment

Continuous self-supervision of hardware and software for enhanced reliability and availability

Auto-diagnostic fault codes generated by the module on detection of a permanent internal fault

Description of function

The combined overvoltage and undervoltage relay module SPCU 1C1 contains an overvoltage stage and an undervoltage stage. The overvoltage stage and the undervoltage stage can be given either definite time or inverse time characteristic.

If the voltage measured by the module exceeds the set start value of the U> stage, the module delivers a start signal SS1 after the set start time has expired. The start time of the U> stage is selected by means of switches SG1/1 and SG1/2, and four alternative values are available. After the preset operate time t>, or at inverse time characteristic, after a time depending on the level of the overvoltage, the overvoltage stage operates delivering a trip signal TS1.

The operation characteristic of the U> stage, i.e. definite time or inverse time characteristic, is selected with switch SG1/3. At definite time characteristic the setting range of the operate time is selected with switches SG1/4. At inverse time characteristic two different sets of voltage/time curves, called A and B, can be selected with switch SG1/4.

If the voltage measured by the module falls below the set start value of the U< stage, the module delivers a start signal SS2 after the set operate time has expired. The start time of the U< stage is selected by means of switch SG1/8, and two alternative values are available. After the preset operate time t<,or at inverse time characteristic, after a time depending on the level of the undervoltage, the undervoltage stage operates delivering a trip signal TS2.

The operation characteristic of the U< stage, i.e. definite time or inverse time characteristic, is selected with switch SG1/7. At definite time characteristic the setting range of the operating time is selected with switch SG1/6. At inverse time characteristic one set of voltage/time curve, called C, is available.

To avoid unwanted operations, for instance during an auto-reclose sequence, starting and tripping of the undervoltage stage can be blocked by turning switch SG1/5 into the position 1. The blocking function is activated if the measured signal falls below 0.2 x U_n. This function is illustrated in Fig. 1.

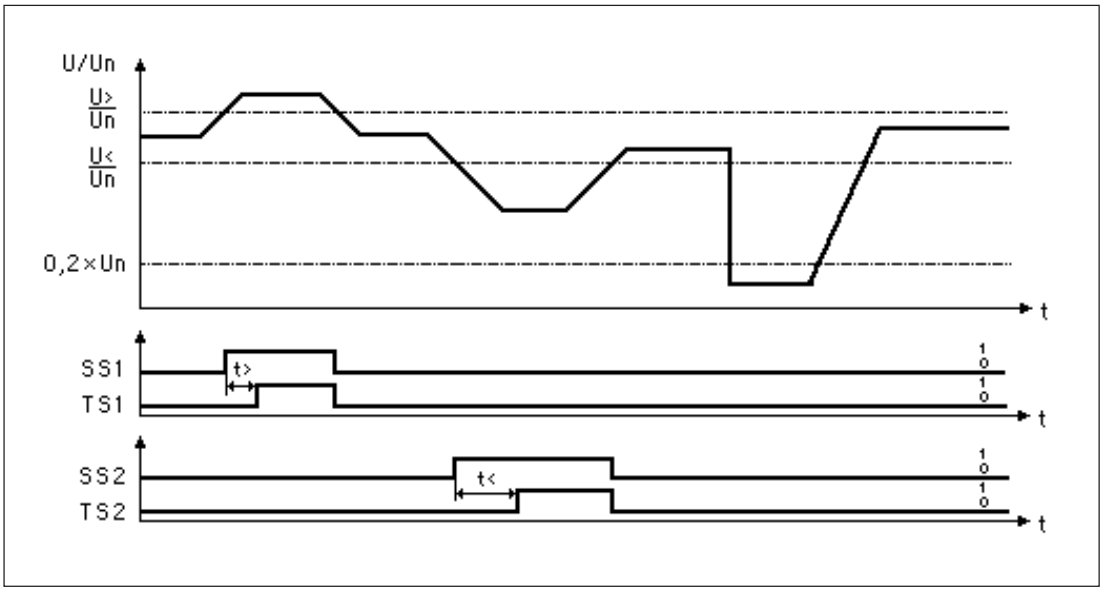


Fig. 1. Operation of the combined overvoltage and undervoltage relay module SPCU 1C1 when the function of the undervoltage stage is internally blocked (SG1/5 = 1).

Tripping (TS2) of the U< stage alone, may be blocked by routing a blocking signal BTS2 to the undervoltage stage. The blockings are configured individually for the different protection relays by means of the switchgroup SGB on the PC board of the relay module. Instructions for setting the SGB switchgroup are given in the user's manual of the concerned protection relay. Also see the signal diagram of the concerned protection relay.

Block diagram

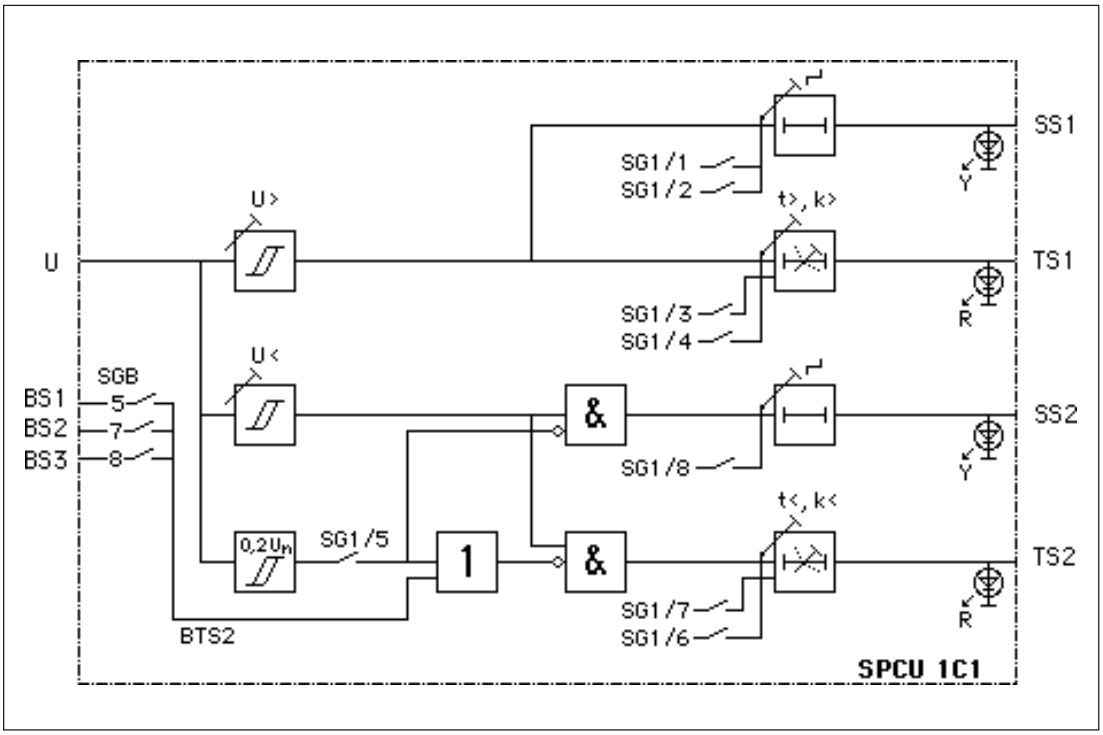


Fig. 2. Block diagram for the overvoltage and undervoltage relay module SPCU 1C1

U	Measured voltage
BS1, BS2, BS3	Blocking signals
BTS2	Blocking of the tripping of the U< stage
SG1	Front panel selector switchgroup
SG2	Software selector switchgroup for defining the mode of function of the start and operation indicators
SGB	Selector switchgroup for configuration of blockings (on the PC-board)
SS1	Start signal of the U> stage
TS1	Trip signal of the U> stage
SS2	Start signal of the U< stage
TS2	Trip signal of the U< stage
Y	Yellow indicator
R	Red indicator

NOTE!
All input and output signals of the relay module are not necessarily wired to the terminals of each protection relay including the overvoltage and undervoltage relay module. The signals wired to the terminals are shown in the signal diagram of the concerned protection relay, see user's manual for the concerned protection relay.

Front panel

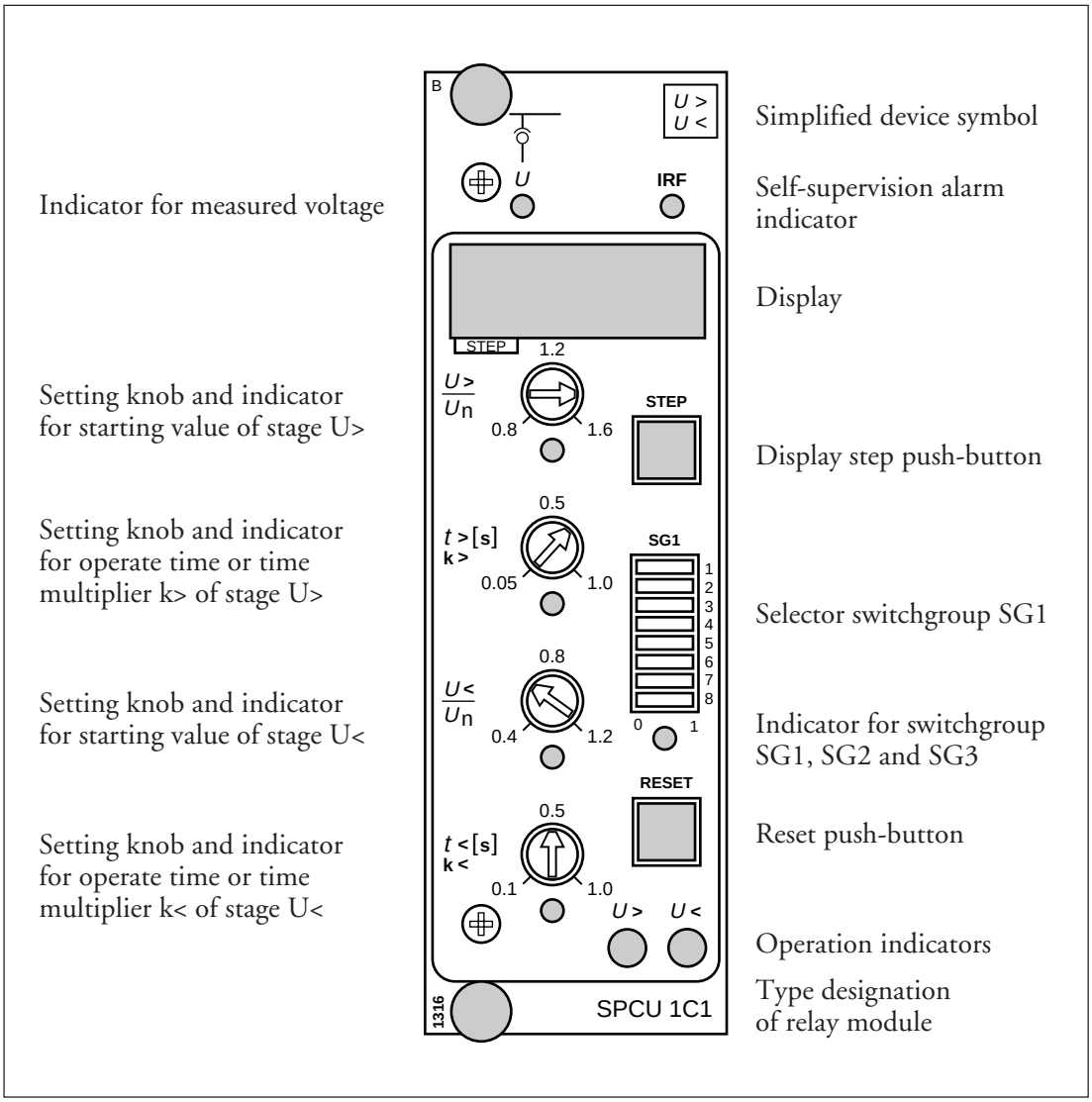


Fig. 3. Front panel of the combined overvoltage and undervoltage relay module SPCU 1C1.

Start and operation indicators

Each stage has its own yellow/red operation indicator. Yellow light indicates starting of the operating stage and red light indicates that the stage has delivered a trip signal.

The four LED indicators can, independently of one another, be given a self-reset or manual reset mode of operation by using switchgroup SG2. The manual reset mode means that the indicator remains lit after being switched on, although the stage, which controls the indicator, resets. If, for instance, the yellow start indicator has been given self-reset mode of operation and the red operation indicator manual-reset mode of operation, the yellow indicator is lit, when the stage starts and turns red if the stage operates. When the stage resets after operation the red indication remains lit. If the stage starts but resets before operation the yellow indicator is lit during starting and reset automatically when the stage resets. The indicators, which have been given the manual reset mode, are reset locally by pushing the RESET push-button on the front panel or by remote control over the SPA bus using the command V101 or V102. See also table (for switchgroup SG3) on page 7 in chapter "Selector switches".

An unreset operation indicator does not affect the protection functions of the relay module. The relay module is constantly operative, regardless of the indicators having been reset or not.

The self-supervision alarm indicator IRF indicates that the self-supervision system has detected a permanent fault. The indicator is lit with red light shortly after a permanent internal fault has been detected. At the same time a control signal is put forward to the output relay of the self-supervision system. Additionally, in most fault cases, a fault code indicating type of fault appears on the display of the relay module. The fault code is to be recorded to facilitate the subsequent fault location and repair actions.

Settings

The setting values are shown by the three rightmost green digits of the display. The LED indicator below the setting knob shows, when lit, the setting value currently being shown on the display.

$U>/U_n$	Start value of the U> stage as a multiple of the rated voltage of the relay energizing input being used. Setting range 0.8...1.6 x U_n
t> [s] k>	Operate time of the U> stage, expressed in seconds, at definite time mode of operation. The required setting range, 0.05...1.00 s, 0.5...10.0 s, is selected with switch SG1/4. At IDMT mode of operation the setting range of the multiplier k> is 0.05...1.00
$U</U_n$	Start value of the U< stage as a multiple of the rated voltage of the relay energizing input being used. Setting range 0.4...1.2 x U_n
t< [s] k>	Operate time of the U< stage, expressed in seconds, at definite time mode of operation. The required setting range, 1...10 s, 10...100 s, is selected with switch SG1/6. At IDMT mode of operation the setting range of the multiplier k< is 0.1...1.00

The checksum of the programming switchgroup SG1 is indicated on the display when the indicator under the switchgroup is lit. In this way a check can be made to prove that the switches have been set and that they work properly. An example of hoe the checksum is calculated is given in the description "General characteristics of C-type relay modules".

Selector switches

Additional relay functions required in various applications are selected with the selector switches of switchgroup SG1 located on the front panel of the module. The numbering of the switches, 1...8, and the switch positions, 0 and 1, are marked on the front panel.

<table>
<tr><th>Switch</th><th>Functions to be selected</th></tr>
<tr><td>SG1/1
SG1/2</td><td>Start time for the overvoltage stage U>.
<table>
<tr><th>SG1/1</th><th>SG1/2</th><th>Start time</th></tr>
<tr><td>0</td><td>0</td><td>0.1 s</td></tr>
<tr><td>1</td><td>0</td><td>1 s</td></tr>
<tr><td>0</td><td>1</td><td>10 s</td></tr>
<tr><td>1</td><td>1</td><td>60 s</td></tr>
</table></td></tr>
<tr><td>SG1/3
SG1/4</td><td>Definite time or inverse time operation characteristic for the U> stage. At definite time characteristic switch SG1/4 is used for selecting the setting range of the operate time t>. At inverse time operation switch SG1/4 is used for selecting the characteristic curve set.
<table>
<tr><th>SG1/3</th><th>SG1/4</th><th>Mode of operation</th><th>Operate time t> or
characteristic curve set</th></tr>
<tr><td>0</td><td>0</td><td>Definite time</td><td>0.05...1.00 s</td></tr>
<tr><td>0</td><td>1</td><td>Definite time</td><td>0.5...10.0 s</td></tr>
<tr><td>1</td><td>0</td><td>Inverse time</td><td>Curve set A</td></tr>
<tr><td>1</td><td>1</td><td>Inverse time</td><td>Curve set B</td></tr>
</table></td></tr>
<tr><td>SG1/5</td><td>Automatic blocking of starting and tripping of the undervoltage stage U<.

When SG1/5 = 0, the undervoltage stage operates once a measured voltage falls below the setting value.
When SG1/5 = 1, starting and tripping of the undervoltage stage are blocked if the measured voltage falls below 0.2 x U_n.

This feature can be used for preventing unnecessary starts and trips during autoreclose sequences.</td></tr>
</table>

<table>
<tr><td>Switch</td><td>Functions to be selected</td></tr>
<tr><td>SG1/6
SG1/7</td><td>Definite time or inverse time operation characteristic for the U< stage. At definite time characteristic switch SG1/6 is used for selecting the setting range of the operate time t<. At inverse time operation switch SG1/6 is used for selecting the characteristic curve set.
<table>
<tr><th>SG1/6</th><th>SG1/7</th><th>Mode of operation</th><th>Operate time t>
or characteristic curve</th></tr>
<tr><td>0
1
0
1</td><td>0
0
1
1</td><td>Definite time
Definite time
Inverse time
Inverse time</td><td>1...10 s
10...100 s
Curve set C
Curve set C</td></tr>
</table></td></tr>
<tr><td>SG1/8</td><td>Start time selection for the undervoltage stage U<.

When SG1/8 = 0, the start time is 0.1 s.
When SG1/8 = 1, the start time is 30 s.</td></tr>
</table>

Switchgroup SG2 is a so called software switchgoup, which is located in the third submenu of checksum register of switchgroup SG1. The mode of operation, i.e. self-reset or manually reset, of the LED indicators U> and U< 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	Manual reset mode	Factory set default value	User's settings
Start indicator U>	1	0	
Operation indicator U>	2	2	
Start indicator U<	4	0	
Operation indicator U<	8	8	
Checksum Σ	15	10	

Switchgroup SG3 is a so called software switchgroup, which is located in the fourth submenu of switchgroup SG1. The front panel push-buttons STEP and RESET can be programmed with switch SG3/1. Switches SG3/2…8 are not in use. The default value for SG3 is 0.

SG3/1	Push-button	Clear start/trip LED's	Erase memorized values
0	STEP		
	RESET	x	
	STEP & RESET	x	x
1	STEP	x	
	RESET	x	
	STEP & RESET	x	x

The PC board of the relay module contains a switchgroup SGB with eight switches. The switches 1...3 are used for configuring the start signals going from the module, whereas the switches 5, 7 and 8 are used for configuring the blocking signals to be routed to the undervoltage stage in different protection relays. Switches 4 and 6 have no function in the relay module SPCU 1C1. Instructions for configuring switchgroup SGB are given in the user's manual of the different protection relays and in the signal diagram of the user's manual.

Measured data

The measured value is shown by the three rightmost green digits on the display. The data currently being presented on the display are indicated by LED indicators on the front panel.

Indicator	Measured quantity
U	The voltage measured by the module, expressed as a multiple of the rated voltage of the relay energizing input.

Recorded information

The leftmost red digit displays the register address and the other three digits the recorded information.

Register/ STEP	Recorded information
1	The highest voltage value measured during the start sequence as a multiple of the rated voltage of the relay energizing input. Any overvoltage stage start erases the old value and starts a new recording sequence. The recording sequence is stopped on operation of the overvoltage stage and the highest value during the start sequence is found in the register.
2	The highest voltage value measured as a multiple of the rated voltage of the relay energizing input. The register value is updated as soon as the measured value exceeds the value alredy in the register. Register 2 is erased with a command via the serial port or by pushing the STEP and RESET push-buttons simultaneously. The registered value is also erased on loss of auxiliary supply.
3	The lowest voltage value measured during the start sequence as a multiple of the rated voltage of the relay energizing input. Any undervoltage stage start erases the old value and starts a new recording sequence. The recording sequence is stopped on operation of the undervoltage stage and the lowest value during the start sequence is found in the register.
4	The lowest voltage value measured as a multiple of the rated voltage of the relay energizing input. The register value is updated as soon as the measured value falls below the value already in the register. Register 4 is erased with a command via the serial port or by pushing the STEP and RESET push-buttons simultaneously. The registered value is also erased on loss of auxiliary supply.
5	Number of starts of the overvoltage stage, n (U>) = 0...255.
6	Number of starts of the undervoltage stage, n (U<) = 0...255.
7	Duration of the latest start event of the overvoltage stage, expressed as percentage of the set operate time t>, or, at IDMT mode of operation, of the calculated operate time. A new start resets the counter which starts recounting from zero. If the stage has tripped, the counter reading is 100.
8	Duration of the latest start event of the undervoltage stage, expressed as percentage of the set operate time t<, or, at IDMT mode of operation, of the calculated operate time. A new start resets the counter which starts recounting from zero. If the stage has tripped, the counter reading is 100.

Register/ STEP	Recorded information
0	Display of blocking signals and other external control signals. The digit at the extreme right indicates the state of the blocking of the undervoltage stage. The following states are indicated: 0 = no blockings 2 = tripping of the undervoltage stage blocked The middle digit of the register is always a zero. The leftmost green digit indicates the state of the remote reset input, if any. The following states are indicated: 0 = remote reset control input not energized 1 = remote reset control input energized From this register it is possible to move to the TEST mode, where the start and trip signals of the module can be activated one by one. For further details see the description "General characteristics of C type relay modules".
A	Address code of the protection relay module, required by the serial communication system. Register A has three subregisters with the following contents: 1) Selection of data transfer rate for the serial communication. Selectable values 300, 1200, 2400, 4800 or 9600 Bd. Default value 9600 Bd. 2) Communication interruption counter. If the relay module is connected to a communication system, which is in operation, the value of the communication interruption counter is 0 (zero). When disturbance occurs on the communication system, the numbers 0…255 are scrolling in the communication interruption counter. 3) Password required for remote setting of relay module parameters.

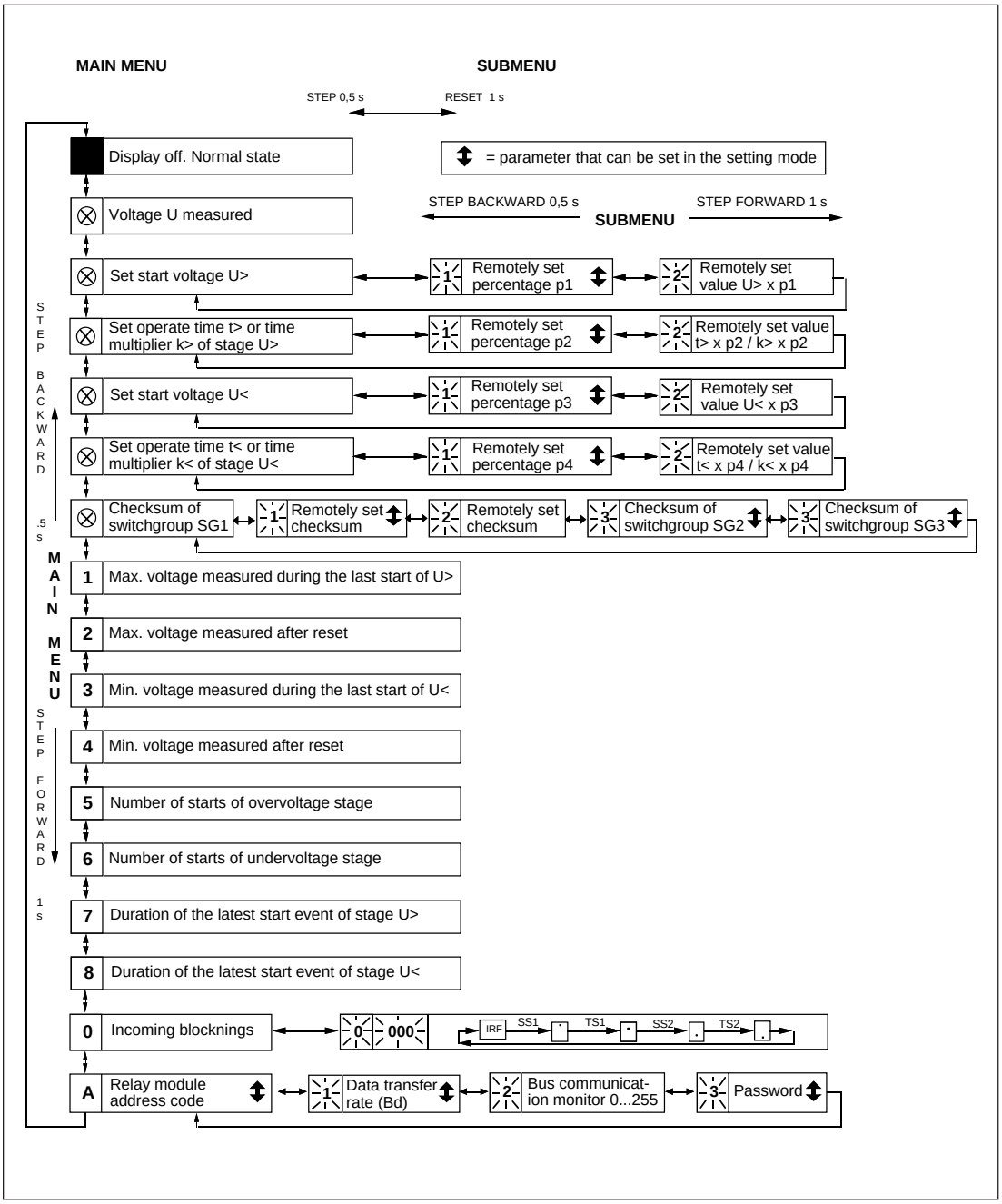
When the display is dark the starting point of the display menu can be reached by pushing the STEP push-button once.

The registers 1...8 are set to zero by pressing the push-buttons STEP and RESET simultaneously or via the SPA bus with the command V102. The registers are also cleared if the auxiliary power supply to the module is interrupted. The address code of the relay module, the baud rate of the serial communication and the password are not erased by a voltage failure. Instructions for setting the address and the baud rate are given in user's manual "General characteristics of C type relay modules".

At the initial state when none of the stages has started, the reading of register 1 is "000" and that of register 3 is "– – –"

Register menu chart

The figure below shows the menus and submenus of the combined overvoltage and undervoltage relay module SPCU 1C1.



The manual "General characteristics of C type relay modules", describes how submenus and setting modes are entered and escaped from and how setting is carried out. Further the manual describes the TRIP-TEST mode of the relay module.

Voltage/time characteristic

At inverse time characteristic the operate time will be shorter the greater the deviation from the setting value.

The operation of the U> stage is based on inverse time characteristic, when the selector switch SG1/3 on the front panel is in position 1. At inverse time characteristic the relationship between time and voltage can be expressed as follows:

$$t = \frac{k> \ a}{(b \frac{U - U>}{U>} - 0.5)^{p}} + c$$

where t = operate time [s]
k> = time multiplier
U = measured voltage [V]
U> = set start voltage [V]
a = constant 480
b = constant 32
c = constant 0.035
p = constant

At an IDMT mode of operation the recording of the operate time of the overvoltage stage does not start until the voltage exceeds the set start value by 6%. The operate time accuracy stated in the technical data applies when the voltage exceeds the set start value by 10%. The overvoltage stage includes two characteristic curve set. The characteristic curve set is selected with the selector switch SG1/4.

The degree of inversity is determined by the factor p as follows:

Characteristic	p (constant)
A	2
B	3

The operation of the U< stage is based on inverse time characteristic, when the selector switch SG1/7 on the front panel is in position 1. At inverse time characteristic the relationship between time and voltage can be expressed as follows:

$$t = \frac{k< \ a}{(b \frac{U< - U}{U<} - 0.5)^{p}} + c$$

where t = operate time [s]
k< = time multiplier
U = measured voltage [V]
U< = set start voltage [V]
a = constant 480
b = constant 32
c = constant 0.055
p = constant 2

At an IDMT mode of operation the recording of the operate time of the undervoltage stage does not start until the voltage falls below the set start value by 6%. The operate time accuracy stated in the technical data applies when the voltage falls below the set start value by 10%. The undervoltage stage is provided with one characteristic curve set.

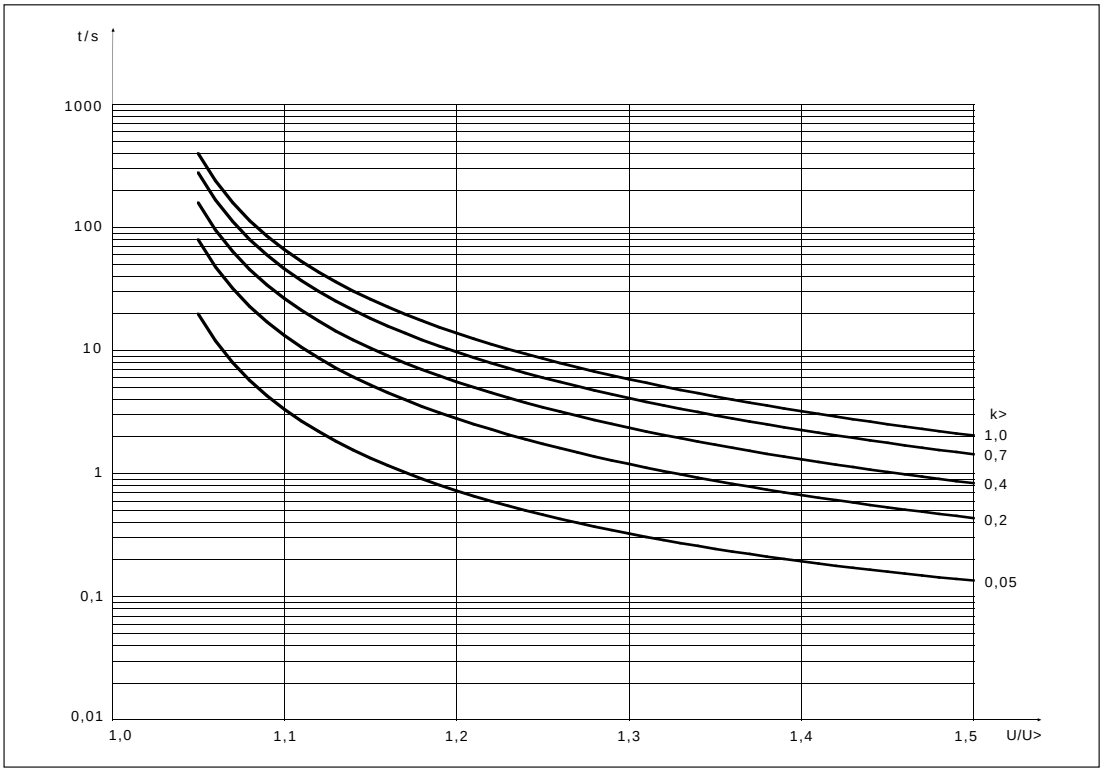


Fig. 4. Characteristic curve set A of overvoltage stage.

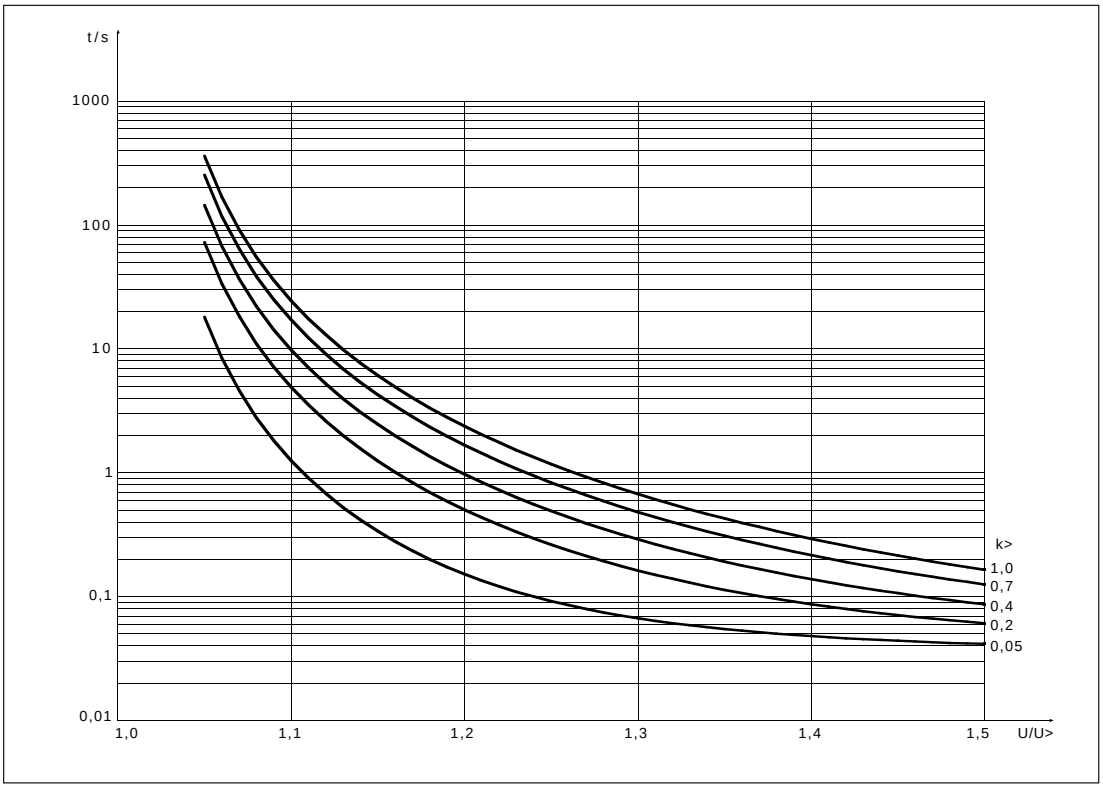


Fig. 5. Characteristic curve set B of the overvoltage stage U>

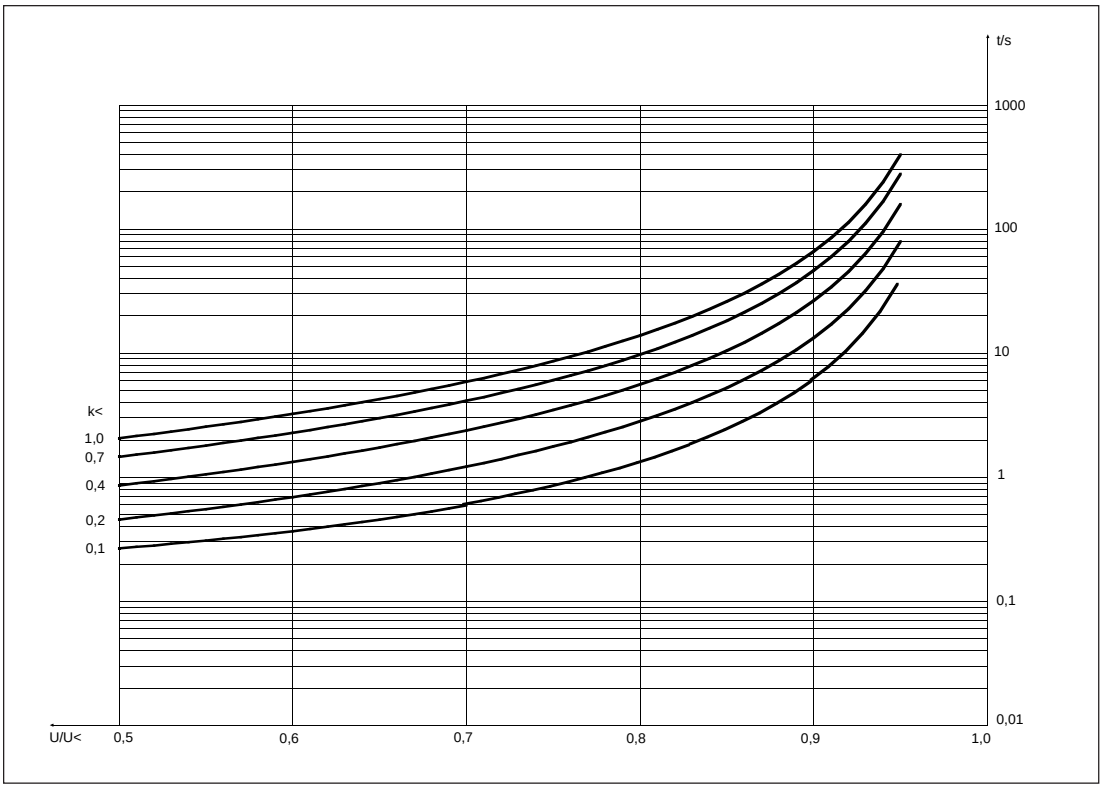


Fig. 6. Characteristic curve set C of the undervoltage stage U<

Overvoltage stage U>

Start voltage U>	0.8...1.6 x U_n
Start time, preset values	0.1, 1 s, 10 s or 60 s
Operate time at definite time operation characteristic	0.05...1.00 s and 0.5...10.0 s
Time multiplier k> at inverse time operation characteristic	0.05...1.0
Reset time, typically	50 ms
Drop-off/pick-up ratio, typically	0.97
Operate time accuracy at definite time characteristic and start time accuracy	±2 % of set value or ±25 ms
Operate time accuracy at inverse time characteristic	±25 ms or the inaccuracy appearing when the measured voltage varies ±3%
Operation accuracy	±3% of set value

Undervoltage stage U<

Start voltage U<	0.4...1.2 x U_n
Start time, preset values	0.1 s or 30 s
Operate time at definite time operation characteristic	1...10 s and 10...100 s
Time multiplier k< at inverse time operation characteristic	0.1...1.0
Reset time, typically	60 ms
Drop-off/pick-up ratio, typically	1.03
Operate time accuracy at definite time characteristic and start time accuracy	±2% of set value or ±25 ms
Operate time accuracy at inverse time characteristic	±25 ms or the inaccuracy appearing when the measured voltage varies ±3%
Operation accuracy	±3% of set value

Event codes

The substation level control data communicator reads, over the SPA serial bus, the event data of the relay module, e.g. start and trip events, from the overvoltage and undervoltage relay module SPCU 1C1. The events are printed out in the format: time (ss.sss) and event code. The event codes of the module are E1...E8 and E50 and E51. Further, the substation level control data communicator generates communicator-releted event codes.

The codes E1...E8 and the events represented by these can be included in or excluded from the event reporting by writing, over the SPA bus, a so called event mask (V155) to the 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 above numbers either by 0 (event not included in reporting) or 1 (event included in reporting) and adding up the numbers received (compare calculation of checksum).

The event mask may have a value in the range 0...255. The default value of the overvoltage and undervoltage relay module SPCU 1C1 is 85, which means that all start and trip events are included in the reporting, but no resets. The events E50...E54 cannot be excluded from the reporting.

Event codes of the combined overvoltage and undervoltage relay module SPCU 1C1:

Event code	Event specification	Weighting factor of event	Factory set default value
E1	Starting of overvoltage stage U>	1	1
E2	Starting of overvoltage stage U> reset	2	0
E3	Operation of overvoltage stage U>	4	1
E4	Operation of overvoltage stage U> reset	8	0
E5	Starting of undervoltage stage U<	16	1
E6	Starting of undervoltage stage U< reset	32	0
E7	Operation of undervoltage stage U<	64	1
E8	Operation of undervoltage stage U< reset	128	0
E50	Restarting	*	-
E51	Overflow of event register	*	-
E52	Temporary disturbance in data communication	*	-
E53	No response from the relay module via the SPA bus	*	-
E54	The relay module responds again over the SPA bus	*	-

0 not included in event reporting
1 included in event reporting
* no code number
- cannot be programmed

NOTE!
In the SPACOM system the station level control data communicator forms the event codes E52...E54.

Remote transfer data

Apart from the event codes the substation level communication equipment reads, over the SPA bus, all input data (I data) and output data (O data), setting values (S values), information recorded in the memory (V data), and some other data of the module. Further, part of the data can be altered by commands given over the SPA bus. Any data are available on channel 0.

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

Data	Code	Data direct.	Values
Measured voltage U	I1	R	0...9.99 [x U_n]
Blocking of operation of undervoltage stage U<	I2	R	0 = no blocking 1 = tripping of stage U< blocked
Starting of overvoltage stage U>	O1	R	0 = U> stage has not started 1 = U> stage has started
Operation of overvoltage stage U>	O2	R	0 = U> stage has not operated 1 = U> stage has operated
Starting of undervoltage stage U<	O3	R	0 = U< stage has not started 1 = U< stage has started
Operation of undervoltage stage U<	O4	R	0 = U< stage has not operated 1 = U< stage has operated
Alerted start voltage of stage U>	S1	R	0.8...1.6 [x U_n]
Alerted operate time t> or time multiplier k> of stage U>	S2	R	0.05...10 [s] or 0.05...1.00
Alerted start voltage of stage U<	S3	R	0.4...1.2 [x U_n]
Alerted operate time t< or time multiplier k< of stage U<	S4	R	1...100 [s] or 0.1…1.0
Alerted checksum of switchgroup SG1	S5	R	0...255
Start voltage of stage U>, set with the setting knob	S11	R	0.8...1.6 [x U_n]
Operate time t> or time multiplier k> of stage U>, set with the setting knob	S12	R	0.05...10 [s] 0.05...1.00
Start voltage of stage U<, set with the setting knob	S13	R	0.4...1.2 [x U_n]
Operate time t< or time multiplier k< of stage U<, set with the setting knob	S14	R	1...100 [s] or 0.1…1.0
Checksum of switchgroup SG1 (set with the switches)	S15	R	0...255
Remote setting percentage of the start voltage of stage U>	S21	R, W	0...999%
Remote setting percentage of operate time t> or time multiplier k> of stage U>	S22	R, W	0...999%
Remote setting percentage of the start voltage of stage U<	S23	R, W	0...999%
Remote setting percentage of operate time t< or time multiplier k< of stage U<	S24	R, W	0...999%
Remotely set checksum of switchgroup SG1	S25	R, W	0...255
Remotely set start voltage of stage U>	S31	R	0.8...1.6 [x U_n]
Remotely set operate time t> or time multiplier k> of stage U>	S32	R	0.05...10 [s] or 0.05...1.00
Remotely set start voltage of stage U<	S33	R	0.4...1.2 [x U_n]
Remotely set operate time t< or time multiplier k< of stage U<	S34	R R	1...100 [s] or 0.1…1.0
Remotely set checksum of switchgroup SG1	S35	R	0...255

Data	Code	Data direct.	Values
Max. voltage measured at starting of stage U>	V1	R	0...9.99 [x U_n]
Max. voltage measured after last reset	V2	R	0...9.99 [x U_n]
Min. voltage measured at starting of stage U<	V3	R	0...9.99 [x U_n]
Min. voltage measured after last reset	V4	R	0...9.99 [x U_n]
Number of starts of overvoltage stage	V5	R	0...255
Number of starts of undervoltage stage	V6	R	0...255
Duration of the latest start event of stage U>	V7	R	0...100%
Duration of the latest start event of stage U<	V8	R	0...100%
Resetting of output relays and operation indicators	V101	W	1 = output relays and operation indicators reset
Simultaneous resetting of output relays and operation indicators and erasing of recorded data	V102	W	1 = output relays and operation indicators reset and registers erased (codes V1…V8)
Remote control of settings	V150	R, W	0 = setting with knobs S11...S15 alerted 1 = remote settings S31...S35 alerted
Event mask word	V155	R, W	0...255, see section "Event codes"
Self-reset or manual reset mode of operation for LED indicators (SG2)	V156	R, W	0…15, see section "Selector switches"
Programming push-buttons (SG3)	V157	R, W	0…1, see section "Selector switches"
Opening of password required for remote setting	V160	W	1...999
Changing or closing of password for remote setting	V161	W	0...999
Activation of self-supervision system	V165	W	1 = self-supervision output is activated and IRF indicator lit in about 5 seconds, whereafter the self-supervision system resets and the IRF indicator is switched off
Fault code generated by the self-supervision system	V169	R	0…255
Data communication address of the module	V200	W	1...254
Program version of the relay module	V205	R	e.g. 066A

Data	Code	Data direct.	Values
Type designation of the relay module	F	R	SPCU 1C1
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 state data	C	R	0 = normal status 1 = module has been subject to automatic resetting 2 = overflow of event register 3 = events 1 and 2 together
Resetting of relay module status data	C	W	0 = resetting
Reading and setting of clock time	T	R, W	00.000...59.999 [s]

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

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

The setting values S1...S5 are the setting values used by the protection programs. These values are set either remotely or by means of the setting knobs. The values S11...S15 are settings set with setting knobs or switches. S21...S25 are knob setting percentage factors to be set remotely. The settings S21...S25 allow reading or writing.

A condition for writing is that the password, V160, for remote setting has been opened and the potentiometer settings must be valid, V150=0. The variables S31...S35 contain the remote setting values.

When changing the remote setting percentages S21...S24, these variables can be given a percentage factor within the range 0...999. Then it is also possible to alter the setting value beyond the setting ranges specified in the technical data of the module. However, the validity of the setting values is guaranteed only within the setting ranges specified in the technical data.

Activation of the self-supervision input (V165) prevents the protection from operating as long as the self-supervision input is activated and the IRF indicator is on.

Fault codes

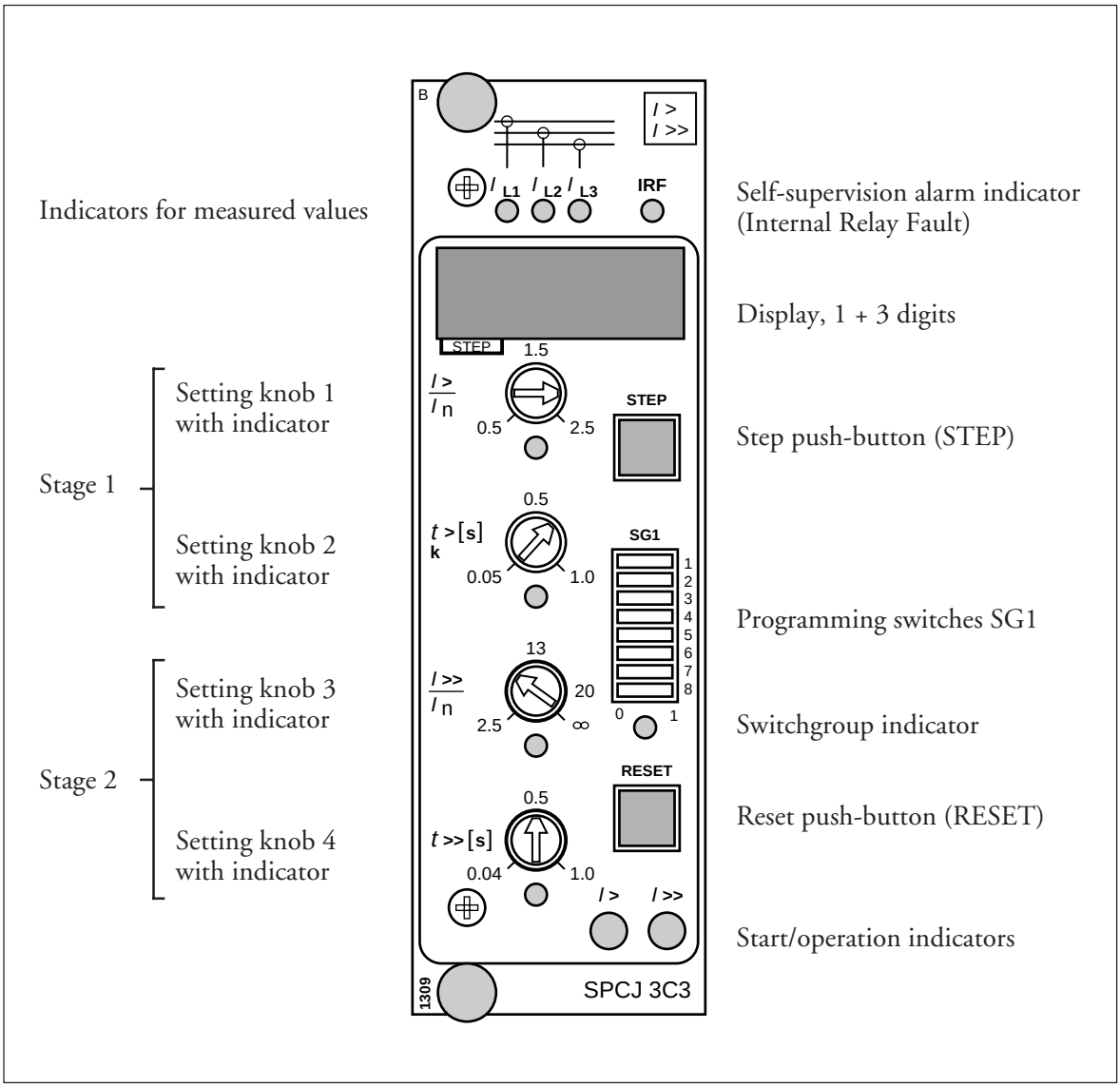
Shortly after the self-supervision system has detected a permanent internal fault the red IRF indicator is lit. Simultaneously the relay module puts forward a control signal to the output relay of the self-supervision system. In most fault situations an autodiagnostic fault code appears on the display of the module. The fault code consists of a red figure 1 (one), and a green, one, two or three digit code number. When a fault is detected the fault code should be recorded and stated when the relay module is to be repaired.

Some of the fault codes that may appear on the display of the combined overvoltage and undervoltage relay module SPCU 1C1 are shown in the following list:

Fault code	Type of fault
4	Output relay control circuit interrupted or output relay module missing
30	Faulty Read Only Memory (ROM)
50	Faulty Random Access Memory (RAM)
195	Too low a value on reference channel with multiplier 1
131	Too low a value on reference channel with multiplier 5
67	Too low a value on reference channel with multiplier 25
203	Too high a value on reference channel with multiplier 1
139	Too high a value on reference channel with multiplier 5
75	Too high a value on 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.

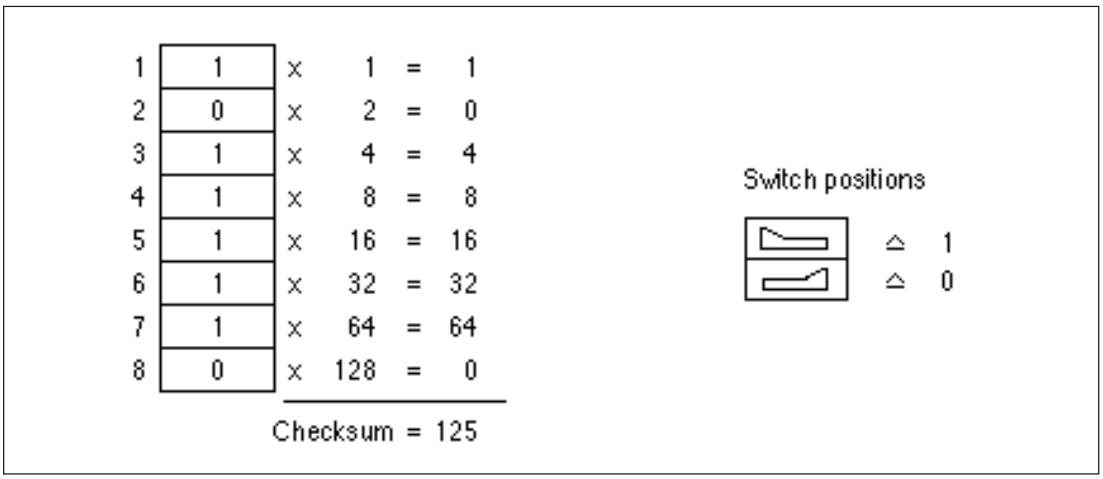


Fig. 2. Example of calculating the checksum of programming switchgroup SG1.

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.

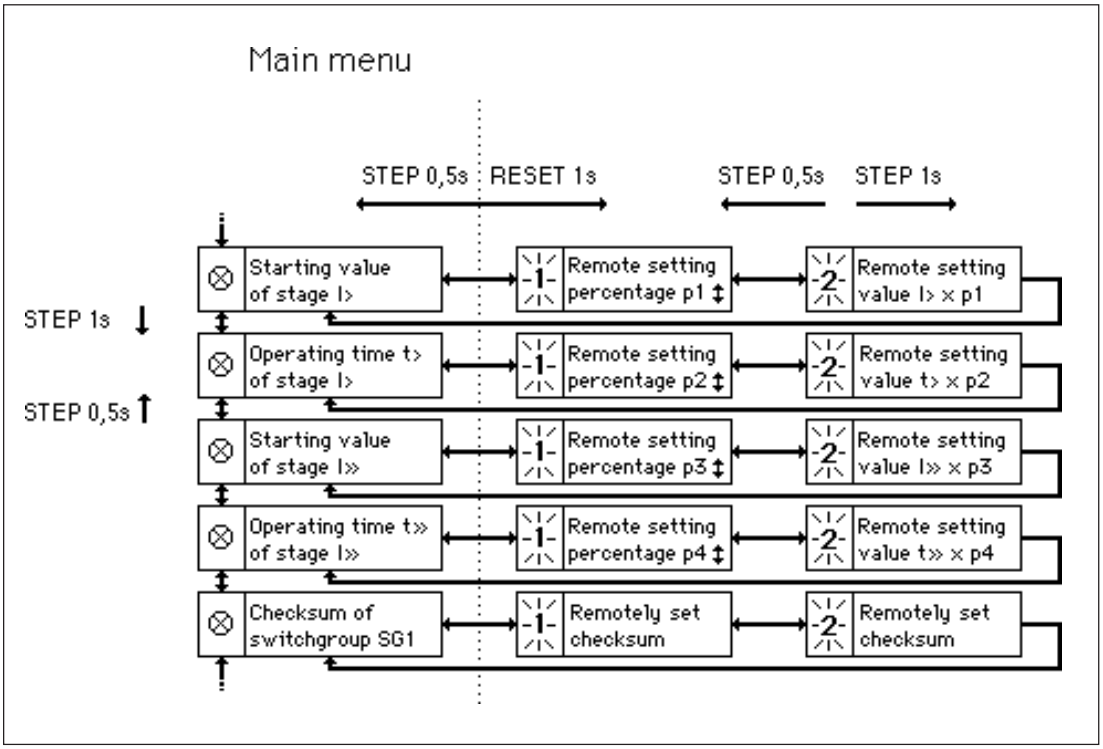


Fig. 3. Example of the main and submenus for the settings of the overcurrent relay module SPCJ 3C3. The settings made with the setting knobs are in the main menu and they are displayed by pressing the STEP button. In addition to the setting knob settings the main menu contains the measured current values 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.

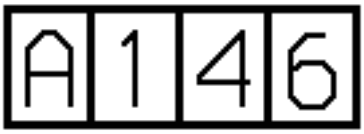
A set value is stored in the memory by pressing the push-buttons STEP and RESET simultaneously. In practice the RESET button must be pressed slightly in excess of the STEP button. Return from the setting mode to the main menu or submenu is possible by pressing (for about 10 s) the RESET button until 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.

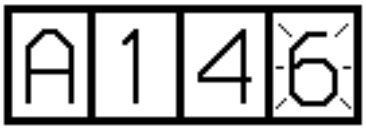
Example 1:

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.

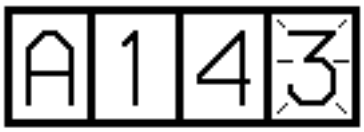
a)
Press push-button STEP until register address A appears on the display.



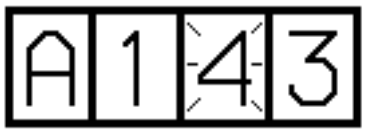
b)
Press the RESET button for about 10 s until the right most digit starts flashing.



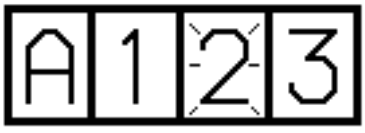
c)
Press the STEP button repeatedly to set the digit to the value desired.



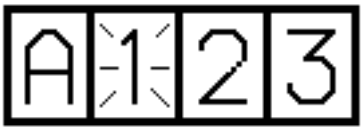
d)
Press the RESET button to make the middle of the green digits flash.



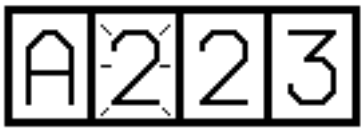
e)
Set the middle address digit by means of the STEP button.



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

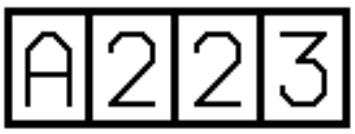


g)
Set the digit by means of the STEP button.



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.

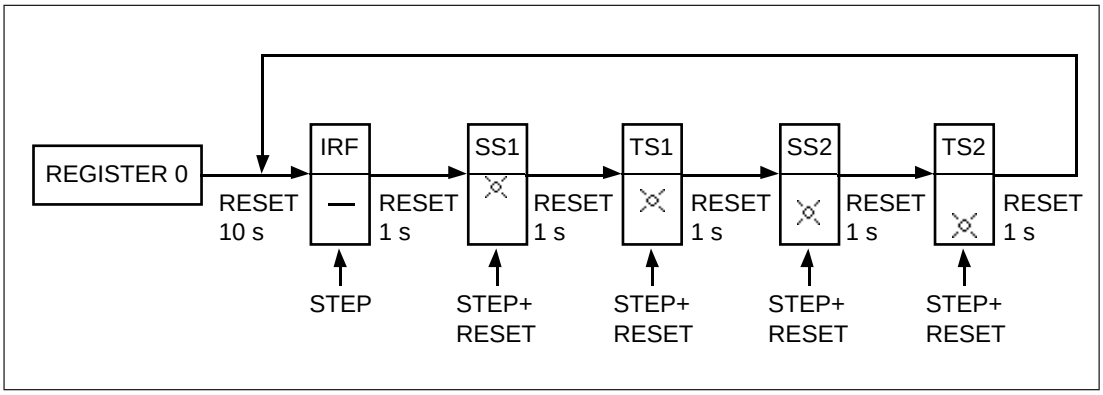


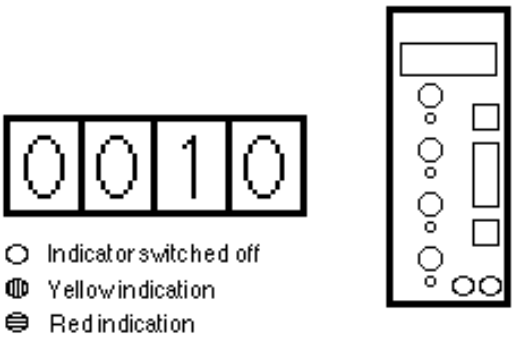
Fig. 4. Sequence order for selecting the output signals in the Trip-test mode.

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.

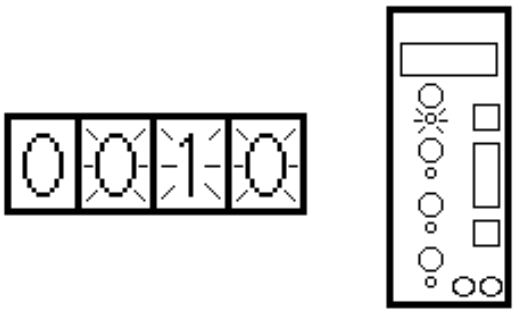
Example 2:

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

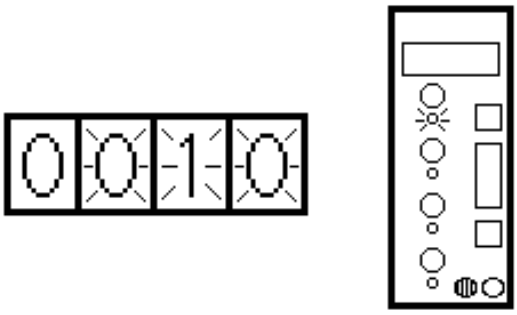
a)
Step forward on the display to register 0.



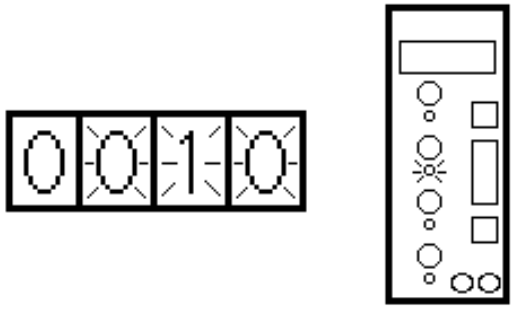
b)
Press the RESET button for about 10 seconds until the three green digits to the right and the LED indicator of the uppermost setting knob start flashing.



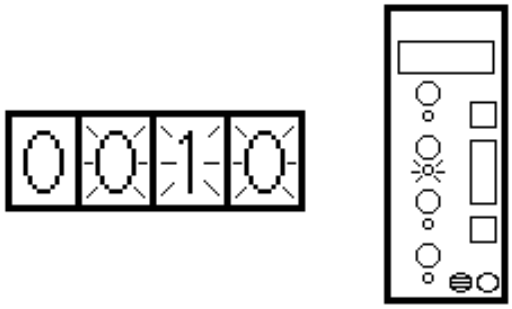
c)
Press the push-buttons RESET and STEP simultaneously. Then the starting of stage 1 (e.g. the I>-stage of the overcurrent module SPCJ 3C3) is activated and, simultaneously, the indicator of the stage starts glowing yellow.



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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