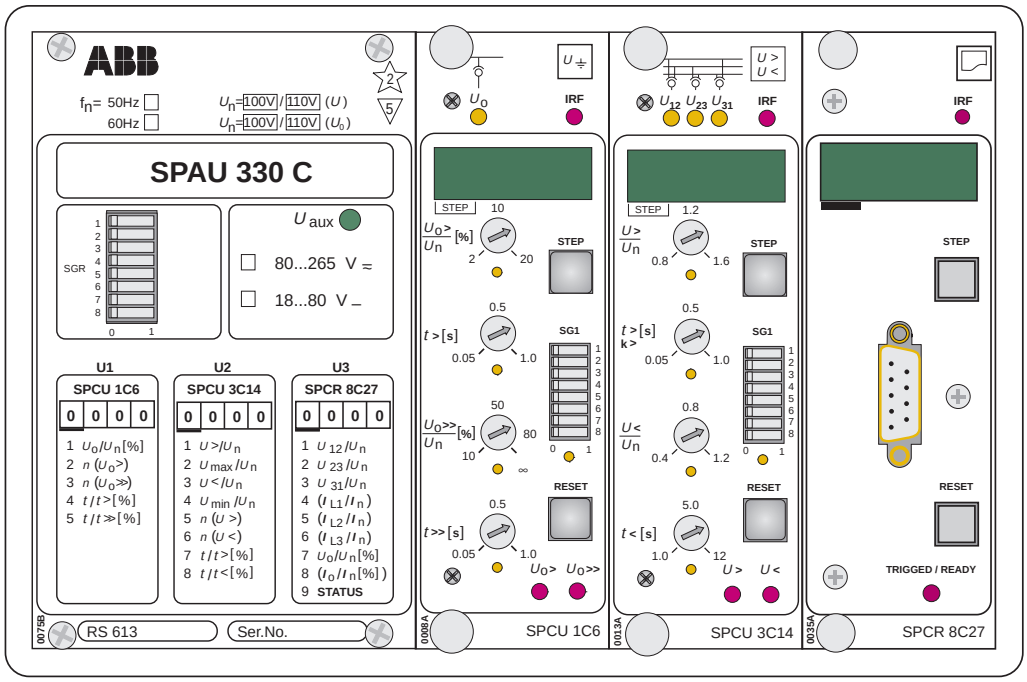
SPAU 330 C
Overvoltage, undervoltage and residual voltage relay

User´s manual and Technical description



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Contents

The complete manual for the voltage measuring relay SPAU 330 C includes the following submanuals:

Overvoltage, undervoltage and residual voltage relay manual, General part	1MRS 750508-MUM EN
Residual overvoltage relay module SPCU 1C6	1MRS 750509-MUM EN
Over- and undervoltage relay module SPCU 3C14	1MRS 750510-MUM EN
Disturbance recorder module SPCR 8C27	1MRS 750511-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

Optional disturbance recorder module used for verifying the correct operation of the protection relay and for analysing network operation quantities

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 enhansed 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 voltage measuring relay SPAU 330 C is intended for supervision and recording of phase-to-phase and residual voltages in substation busbar sytems. The relay forms an integrated protection scheme which includes two measuring modules and a disturbance recorder module. The residual voltage of the busbar system is measured by the two-stage residual overvoltage relay module SPCU 1C6. The phase-to-phase voltages are supervised by the overvoltage and undervoltage relay module SPCU 3C14. Furthermore, the protection relay package can be provided with a disturbance recorder module, type SPCR 8C27, which records the voltages measured by the relay and the starting conditions of the separate relay modules and stages. 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 low-set stage of the residual overvoltage relay module SPCU 1C6, the overvoltage stage starts and simultaneously starts the corresponding timing circuit. When the timing circuit has timed out, the relay module delivers a tripping signal to the output relays. The high-set stage of the residual overvoltage relay module operates in the same way. When the setting value of the stage is exceeded, it starts, simultaneously starting its timing circuit, and when the set operating time has elapsed, it performs tripping.

When one of the phase-to-phase voltages of the busbar system measured by the over- and undervoltage relay module SPCU 3C14 exceeds the setting value of the overvoltage stage, the overvoltage stage starts and performs tripping when the set operating time has elapsed. Correspondingly, if one the phase-to-phase voltages measured by the relay module falls below the setting value of the undervoltage stage, the timing circuit of the undervoltage stage starts. When the circuit has timed out, the undervoltage stage performs tripping.

To prevent unwanted operations during an autoreclose sequence, the starting and tripping of the undervoltage stage of the over- and undervoltage relay module SPCU 3C14 can be blocked by turning switch SG1/6 on the front panel of the relay module into the position 1. This prevents any operation of the undervoltage stage U< if the measured voltage falls to a value below 0.2 x U_n (see fig. 1).

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

NOTE!
To enable this blocking function, switch 5 of switchgroup SGB on the PC-board of the over- and undervoltage relay module SPCU 3C14 must be in the position 1.

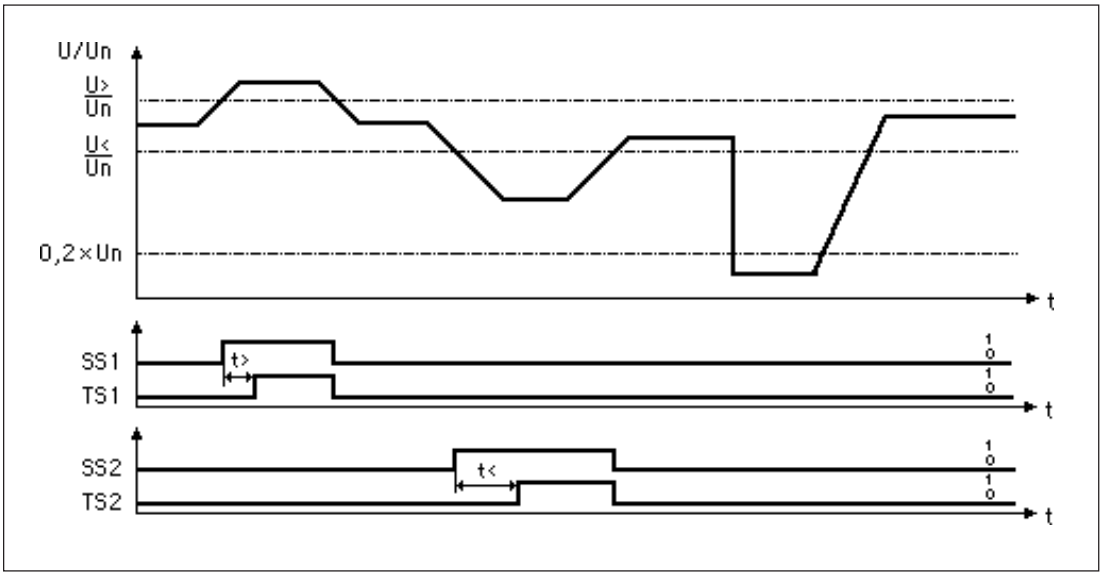


Fig. 1. Operation diagram for the over- and undervoltage relay module SPCU 3C14 when the starting of the undervoltage stage is blocked by switch SG1/6 = 1.

Explanations:

$U>/U_n$	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

In a fault situation the disturbance recorder module SPCR 8C27 records the curve forms of the residual voltage and the phase-to-phase voltage, and the startings of the protection stages of the relay modules. The recording operation of the module may be preset to start when certain triggering conditions are fulfilled. Recording may take place both prior to a fault situation and after the fault has occured. The fault data are made accessible either over the RS 232 C serial port on the front panel of the recorder module or over the SPA bus.

Connections

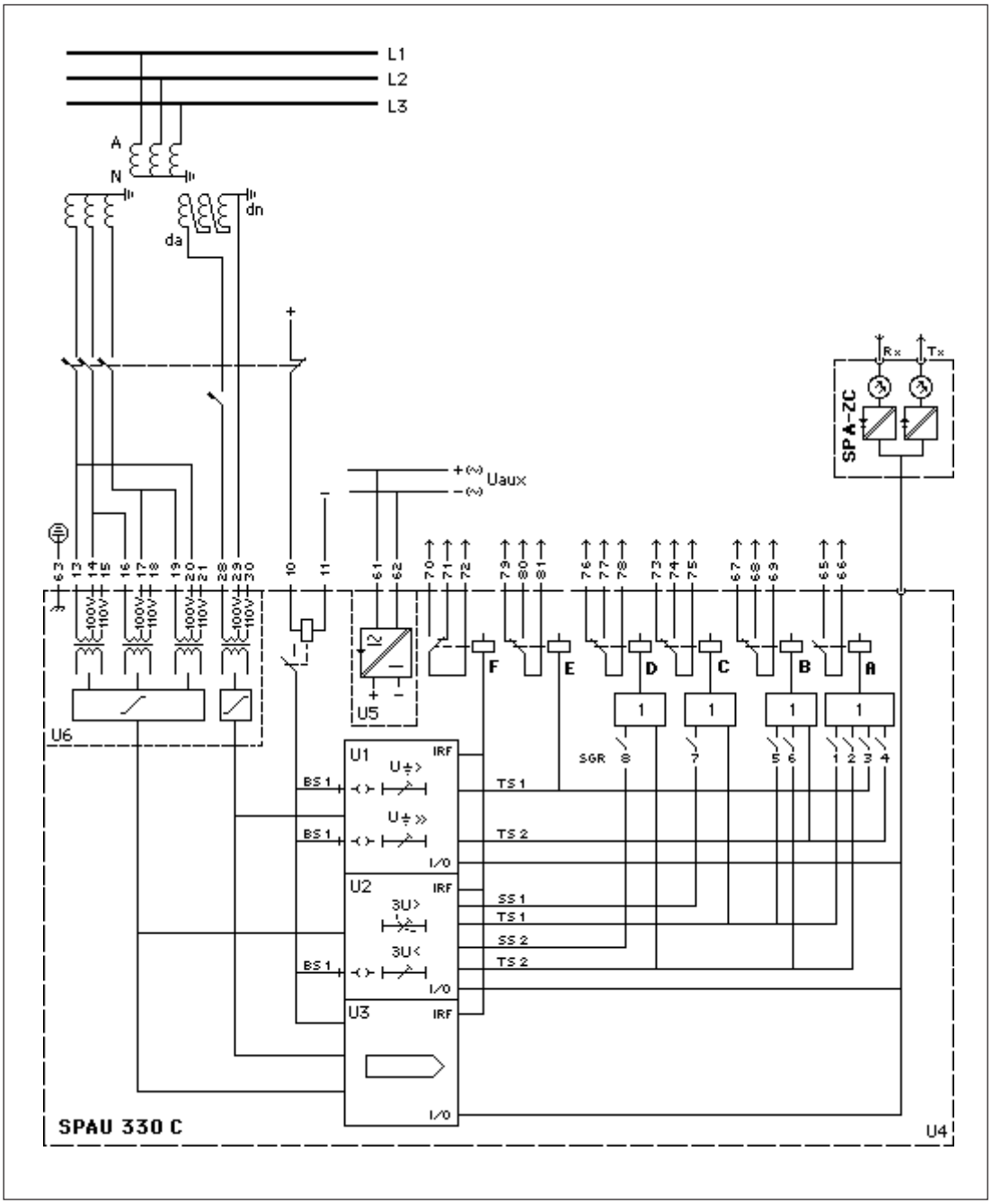


Fig. 2. Connection diagram for the overvoltage, undervoltage and residual voltage relay SPAU 330 C.

U_{aux}	Auxiliary supply voltage
A, B...F	Output relays
IRF	Self-supervision alarm
SS1, SS2	Output signals for starting
TS1, TS2	Output signals for tripping
BS1	Blocking input signal
SGR	Switchgroup for programming of starting and tripping signals
U1	Residual overvoltage relay module SPCU 1C6
U2	Over- and undervoltage relay module SPCU 3C14
U3	Disturbance recorder module SPCR 8C27
U4	Output relay module SPTR 6B3
U5	Power supply module
U6	Energizing input module SPTE 4B9
SPA-ZC_	Bus connection module
Rx/Tx	Optical fibre receiver (Rx) and transmitter (Tx) of the bus connection module

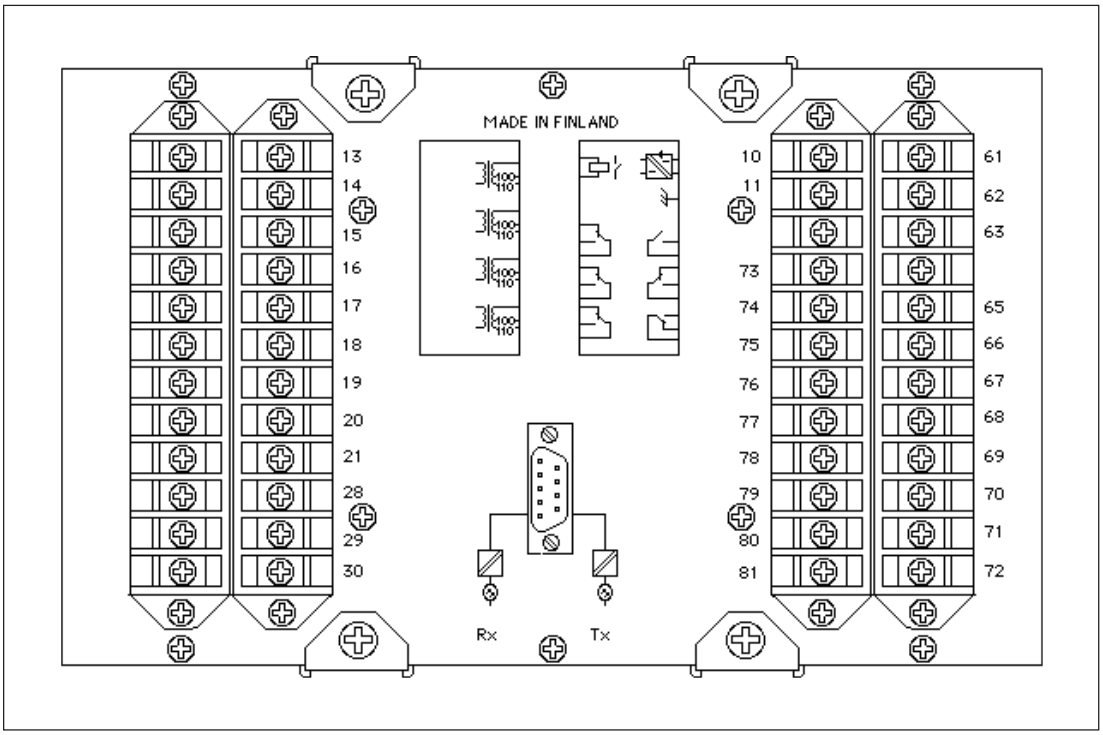


Fig. 3. Rear wiew of the overvoltage, undervoltage and residual voltage relay SPAU 330 C.

Specification of input and output terminals

Terminal number	Function
13-14 13-15	Phase-to-phase voltage U_{12} (100 V) Phase-to-phase voltage U_{12} (110 V) NOTE! If the over- and undervoltage relay module SPCU 3C14 is programmed for single-phase operation, the voltage to be measured has to be connected to terminals 13-14-15.
16-17 16-18	Phase-to-phase voltage U_{23} (100 V) Phase-to-phase voltage U_{23} (110 V)
19-20 19-21	Phase-to-phase voltage U_{31} (100 V) Phase-to-phase voltage U_{31} (110 V)
28-29 28-30	Residual voltage U_0 (100 V) Residual voltage U_0 (110 V)
10-11	External blocking signal BS1
61-62	Auxiliary supply voltage. The positive pole (+) of the DC supply is connected to terminal 61. The auxiliary supply voltage range is marked on the system front plate of the relay.
63	Protection earth (PE)
65-66	Tripping output relay A (heavy-duty) for all stages, U_0>, U_0>>, U> and U<
67-68-69 73-74-75 76-77-78 79-80-81 70-71-72	Alarm signal output relay B for stages U_0>>, U> and U< Alarm signal output relay C for stage U> Alarm signal output relay D for stage U< Alarm signal output relay E for stage U_0> Self-supervision output relay F. In normal service conditions the contact gap 70-72 is closed. In a fault situation the contact gap 71-72 closes. NOTE! Detailed information about the programming of starting and tripping signals in switchgroups SGB and SGR is given in the section "Intermodular control signal exchange".

The overvoltage, undervoltage and residual voltage relay SPAU 330 C is connected to the optical fibre communication bus by means of a 9-pole D-type connector located in the centre of the rear panel of the relay and a matching bus connection module SPA-ZC_. The opto-connectors of the optical fibres are plugged into the counter connectors Rx and Tx of the bus connection module and the optical fibres are linked from one protection relay to another and to the control data communicator.

Operation indicators and push-buttons

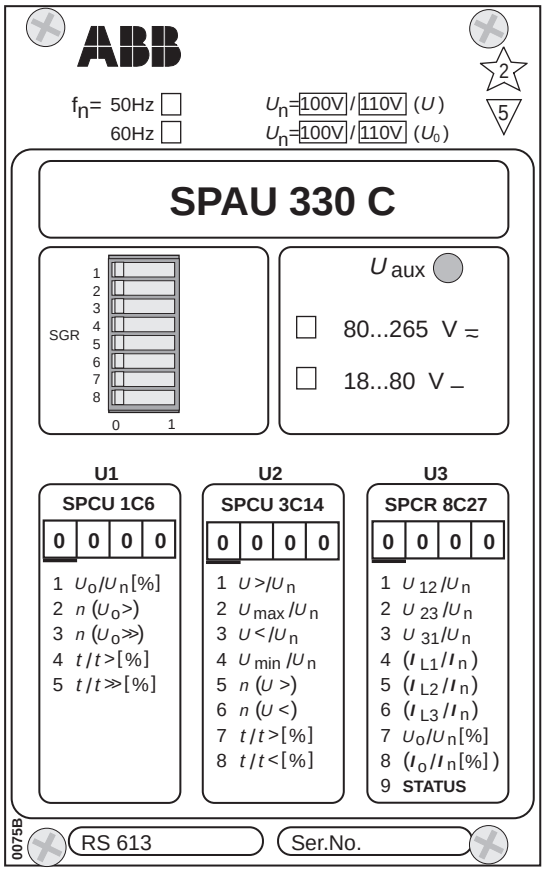


Fig. 4. System front panel of the overvoltage, undervoltage and residual voltage relay SPAU 330 C.

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 whitch 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 panel of the disturbance recorder module is provided with a numerical display, two push-buttons marked STEP and RESET, a 25-pole RS 232 C port connector and a LED operation indicator. The parameters measured by this module can be scanned and set by means of the STEP and RESET push-buttons, in the same way as with the other measuring relay modules. Normally the operation indicator of the disturbance recorder is dark. When the module is recording information, the operation indicator is lit with a green light and when the recording is completed and data is stored in the memory, the operation indicator turns red. The red operation indicator is lit as long as there is data stored in the recording memory of the module. The recorded data is made accessible either over the RS 232 C serial port on the front panel of the recorder module or over the SPA bus.

5. The front panels of the relay modules and the disturbance recorder module 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.

6. 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 330 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.

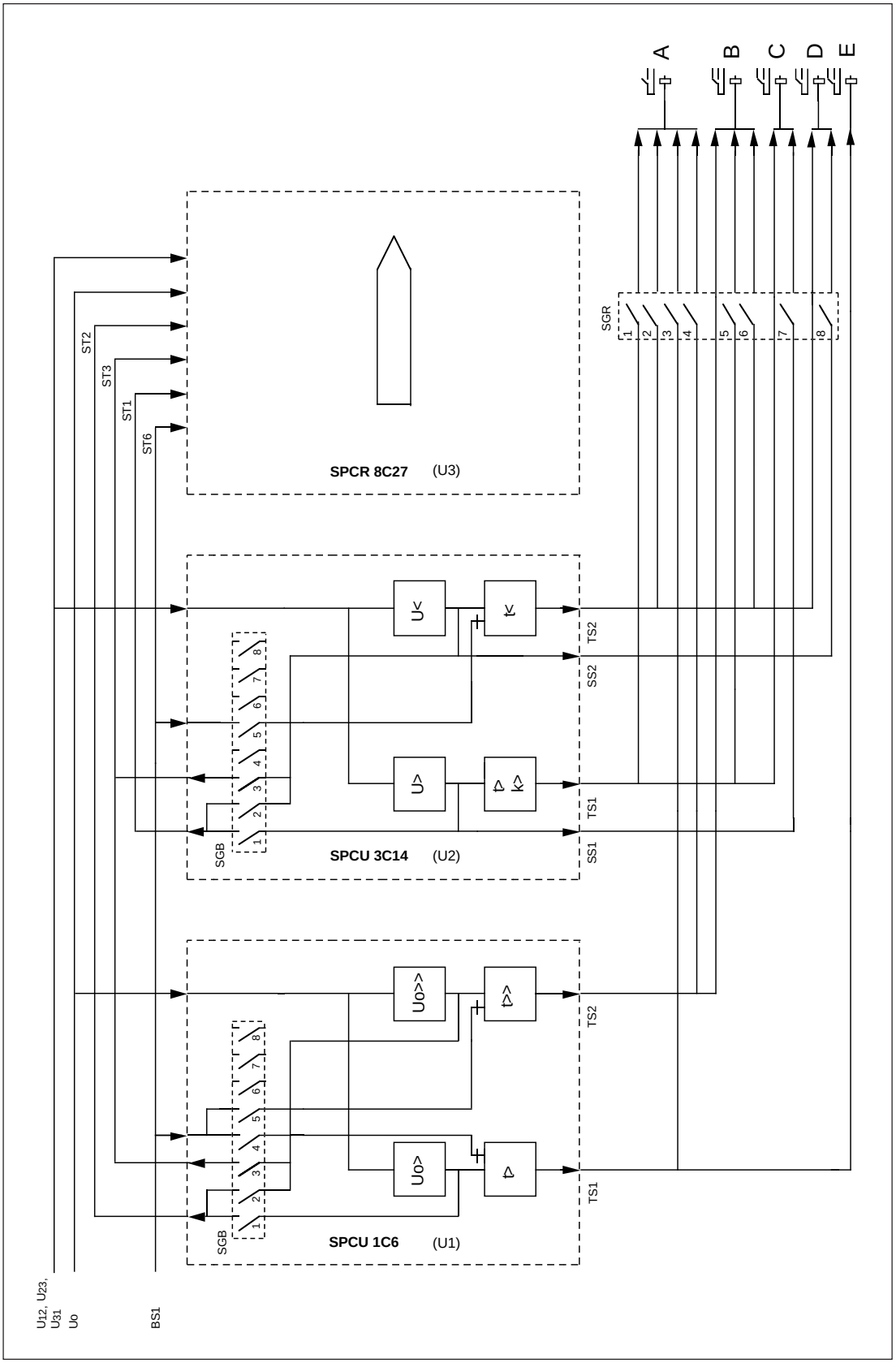


Fig. 5. Internal control signals between the relay modules of the overvoltage, undervoltage and residual voltage relay SPAU 330 C.

Configuration switches

Part of the starting and tripping signals from the relay modules are permanently connected to control the output relays, whereas part of the control signals are linked through the configuration switches of switchgroup SGR on the system panel of the relay. The programming is made through the opening in the system panel.

The switchgroups SGB on the PC-boards of the relay modules SPCU 1C6 and SPCU 3C14 are used for programming of the external blocking signals to the relay modules and the starting signals connected to the disturbance recorder module SPCR 8C27.

The functions of the switchgroups SGB and SGR are described in the tables as follows:

Switchgroup SGR on relay system panel

Switch	Function	Factory setting
SGR/1	Tripping signal from stage U> of SPCU 3C14 to output relay A	1
SGR/2	Tripping signal from stage U< of SPCU 3C14 to output relay A	1
SGR/3	Tripping signal from stage U_0> of SPCU 1C6 to output relay A	1
SGR/4	Tripping signal from stage U_0>> of SPCU 1C6 to output relay A	1
SGR/5	Tripping signal from stage U> of SPCU 3C14 to output relay B	1
SGR/6	Tripping signal from stage U< of SPCU 3C14 to output relay B	1
SGR/7	Starting signal from stage U> of SPCU 3C14 to output relay C	1
SGR/8	Starting signal from stage U< of SPCU 3C14 to output relay D	1

Switchgroup SGB on PC-board in residual overvoltage relay module SPCU 1C6

Switch	Function	Factory setting
SGB/1	Starting signal from stage U_0> to input ST2 of disturbance recorder module SPCR 8C27	1
SGB/2	Starting signal from stage U_0>> to input ST2 of disturbance recorder module SPCR 8C27	0
SGB/3	Starting signal from stage U_0>> to input ST3 of disturbance recorder module SPCR 8C27	0
SGB/4	Blocking signal BS1 for blocking of U_0>-tripping	0
SGB/5	Blocking signal BS1 for blocking of U_0>>-tripping	0
SGB/6	Not in use	0
SGB/7	Not in use	0
SGB/8	Not in use	0

Switchgroup SGB on PC-board in over- and undervoltage relay module SPCU 3C14

Switch	Function	Factory setting
SGB/1	Starting signal from stage U> to input ST1 of disturbance recorder module SPCR 8C27	1
SGB/2	Starting signal from stage U< to input ST1 of disturbance recorder module SPCR 8C27	0
SGB/3	Starting signal from stage U< to input ST3 of disturbance recorder module SPCR 8C27	1
SGB/4	Not in use	0
SGB/5	Blocking signal BS1 for blocking of U<-tripping	1
SGB/6	Not in use	0
SGB/7	Not in use	0
SGB/8	Not in use	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.

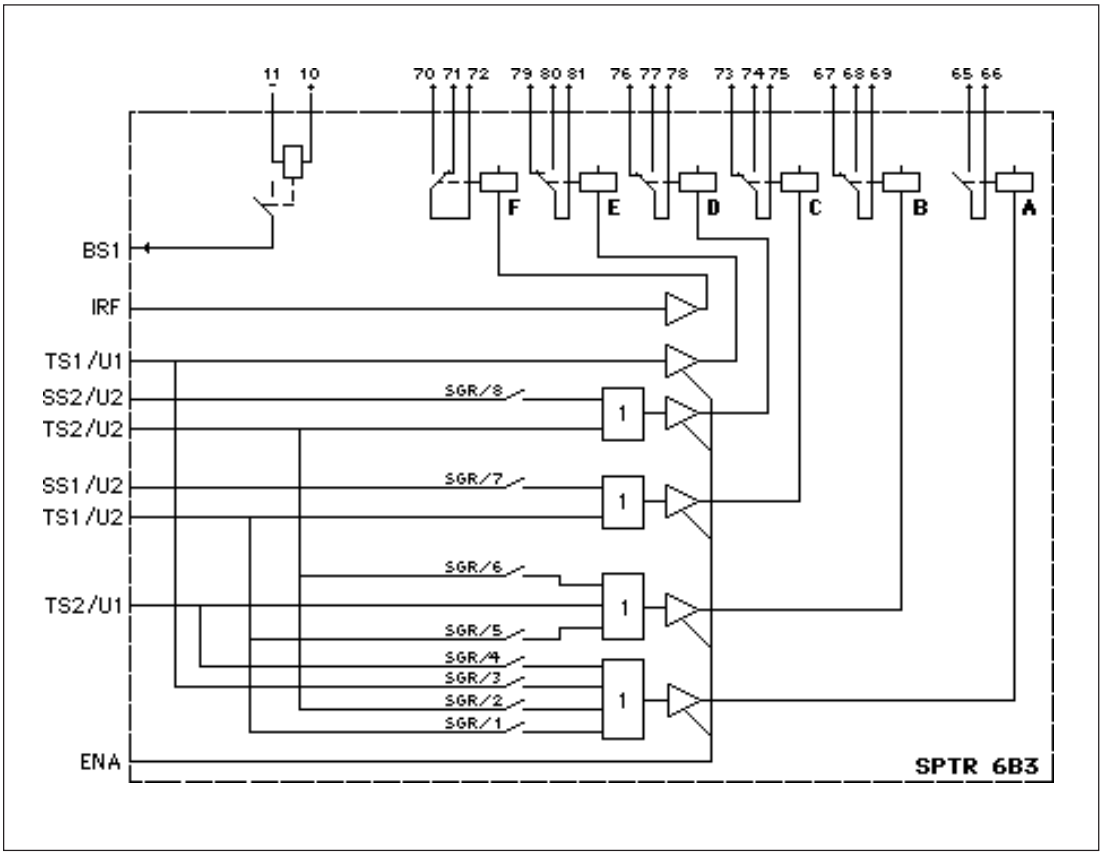


Fig. 6. Block diagram for the output relay module SPTR 6B3.

TS1/U1	Tripping signal of U_0>-stage
TS2/U1	Tripping signal of U_0>>-stage
SS1/U2	Starting signal of U>-stage
TS1/U2	Tripping signal of U>-stage
SS2/U2	Starting signal of U<-stage
TS2/U2	Tripping signal of U<-stage
BS1	External blocking input signal to U<-stage
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 V	110 V
Terminal numbers		
- phase-to-phase voltage U_{12}	13-14	13-15
- phase-to-phase voltage U_{23}	16-17	16-18
- phase-to phase voltage U_{31}	19-20	19-21
- residual voltage U_0	28-29	28-30
Continuous voltage withstand	2 x U_n	
Rated burden at rated voltage U_n	<0.5 VA	
Rated frequency f_n according to order	50 Hz or 60 Hz	

External control inputs

Terminal numbers	10-11
External control voltage	18...265 V dc or 80...265 V ac
Current drain, typically	2...15 mA

Contact outputs

Tripping outputs	
Terminal numbers	
- trip relay A	65-66
Rated voltage	250 V ac and dc
Continuous current carrying capacity	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
Signalling outputs	
Terminal numbers	
- alarm relay B	67-68-69
- alarm relay C	73-74-75
- alarm relay D	76-77-78
- alarm relay E	79-80-81
- self-supervision relay F	70-71-72
Rated voltage	250 V ac and dc
Continuous current carrying capacity	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

Auxiliary power supply

Voltage range of power supply modules:	
SPGU 240 A1	
- Nominal voltage U_n	110/120/230/240 V ac 110/125/220 V dc
- Operative range	80...265 V ac/dc
SPGU 48 B2	
- Nominal voltage U_n	24/48/60 V dc
- Operative range	18...80 V dc
Power consumption under quiescent/ operation conditions	10 W / 15 W

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 3C14

See "Technical data" in the document 1MRS 750510-MUM EN for the relay module.

Disturbance recorder module SPCR 8C27

See "Technical data" in the document 1MRS 750511-MUM EN for the recorder 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

Emission tests

Radiated and conducted emission according to EN 55011	Class A

EMC tests

CE approved and tested according to
EN 50081-2 and EN 50082-2

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.

Maintenance and repair

When the overvoltage, undervoltage and residual voltage relay SPAU 330 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 3C14
Disturbance recorder module	SPCR 8C27
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
Case (including connection module)	SPTK 4B9
Bus connection module	SPA-ZC 17_ or SPA-ZC 21_

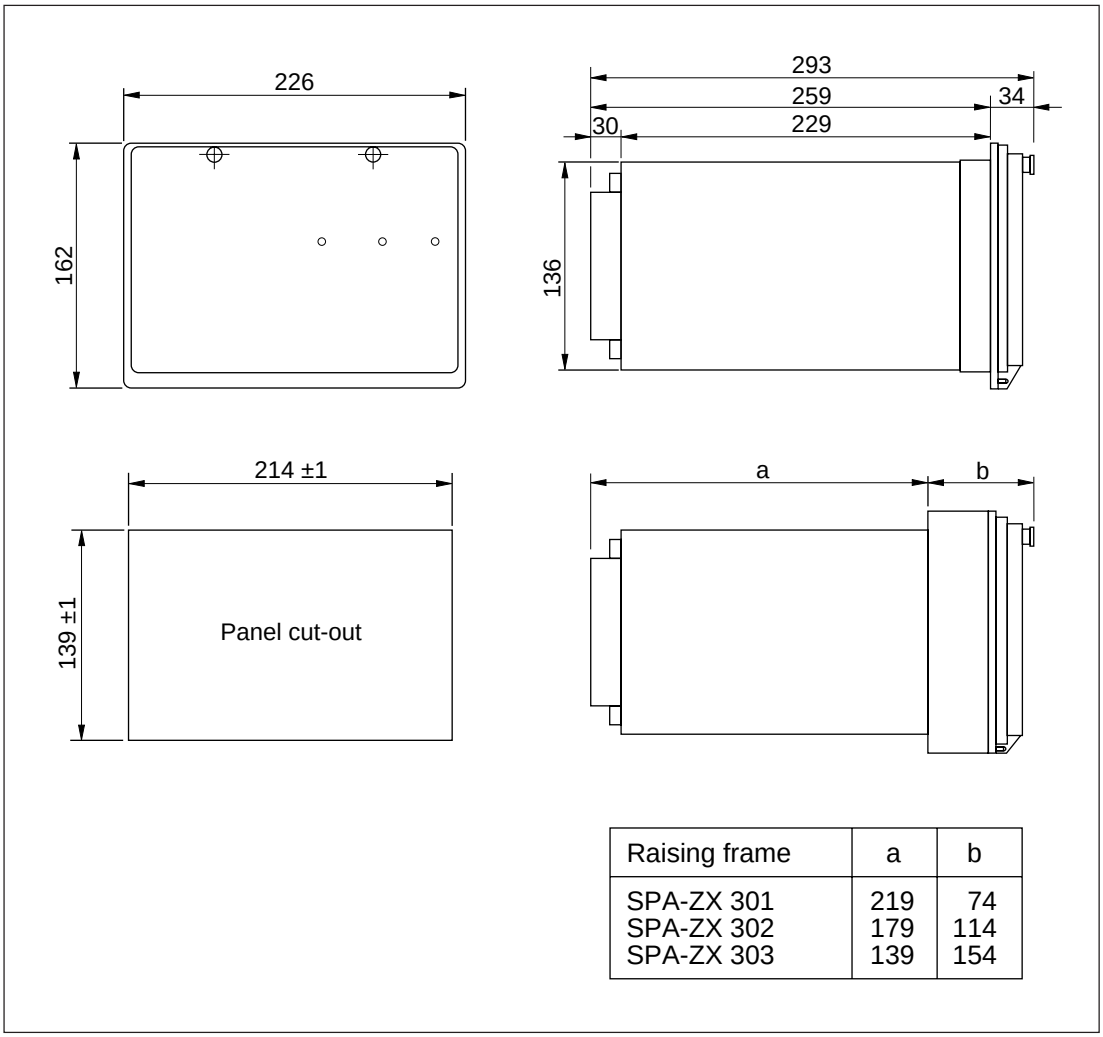
Delivery alternatives

Type	Equipment	SPCU 1C6	SPCU 3C14	SPCR 8C27
SPAU 330 C	Basic version, all relay modules included	x	x	x
SPAU 330 C1	Basic version, disturbance recorder module excluded	x	x	
SPAU 330 C2	Basic version, over- and undervoltage relay module excluded	x		x
SPAU 330 C3	Basic version, over-and undervoltage relay module and disturbance recorder module excluded	x		
SPAU 330 C4	Basic version, residual overvoltage relay module excluded		x	x
SPAU 330 C5	Basic version, residual overvoltage relay module and disturbance recorder module excluded		x	
SPAU 330 C6	Basic version, residual overvoltage relay module and over- and undervoltage relay module excluded			x

Delivery alternatives of overvoltage, undervoltage and residual voltage relay SPAU 330 C.

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. 7. Dimension and mounting drawings for overvoltage, undervoltage and residual voltage relay SPAU 330 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.

Order numbers and ordering information

Overvoltage, undervoltage and residual voltage relay

SPAU 330 C	RS 613 020 - AA, CA, DA, FA
SPAU 330 C1	RS 613 021 - AA, CA, DA, FA
SPAU 330 C2	RS 613 022 - AA, CA, DA, FA
SPAU 330 C3	RS 613 023 - AA, CA, DA, FA
SPAU 330 C4	RS 613 024 - AA, CA, DA, FA
SPAU 330 C5	RS 613 025 - AA, CA, DA, FA

The letter combinations of the order number denote the rated frequency f_n and the operative range of the auxiliary supply voltage:

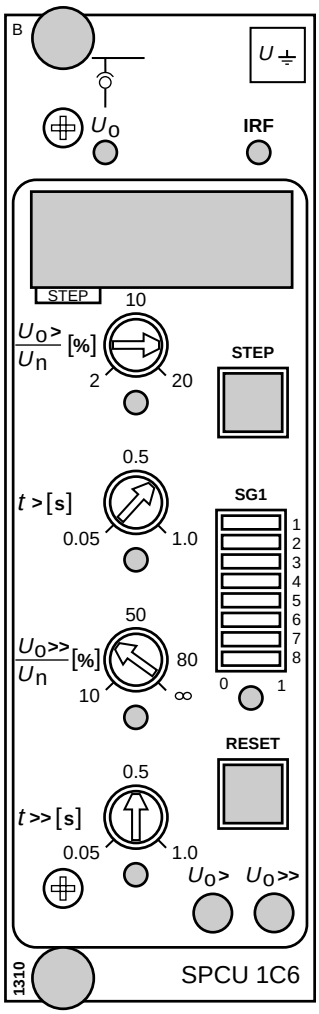
AA: f_n = 50 Hz, U_{aux} = 80...265 V ac/dc
CA: f_n = 50 Hz, U_{aux} = 18...80 V dc
DA: f_n = 60 Hz, U_{aux} = 80...265 V ac/dc
FA: f_n = 60 Hz, U_{aux} = 18...80 V dc

Ordering example:

1. Number and type designation	5 pcs SPAU 330 C
2. Order number	RS 613 020 - AA
3. Rated frequency	f_n = 50 Hz
4. Auxiliary voltage	U_{aux} = 110 V dc
5. Accessories	5 raising frames SPA-ZX 301 5 bus connection modules SPA-ZC 17 MM2A
6. Special requirements	–

SPCU 1C6
Residual overvoltage relay module

User´s manual and Technical description



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SPCU 1C6
Residual overvoltage relay module

Contents

Features

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

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

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

Effective suppression of harmonics of the input energizing voltages

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

Flexible selection of special operational features for particular applications

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

Description of operation

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

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

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

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

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

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

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

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

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

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

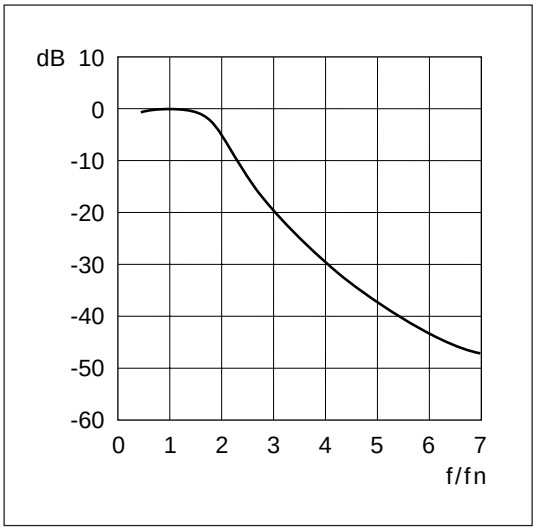


Fig. 1. Filter characteristics of the residual voltage input circuit.

Block diagram

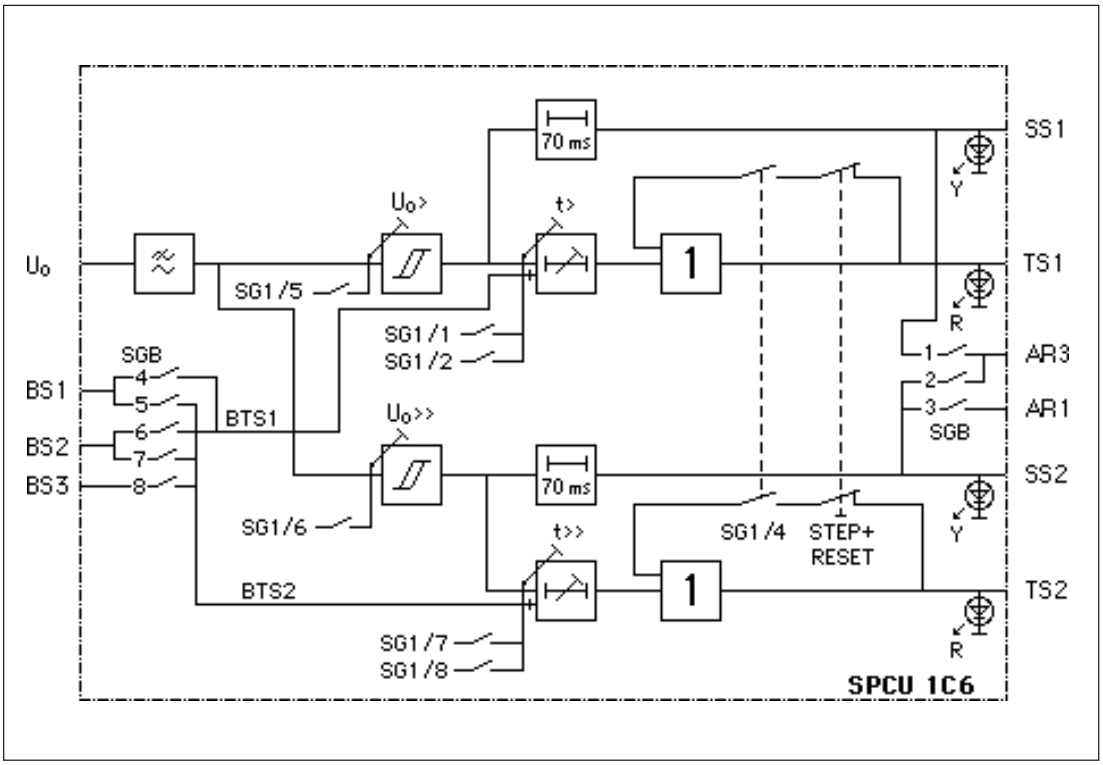


Fig. 2. Block schematic diagram of the residual overvoltage relay module SPCU 1C6.

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

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

Front panel

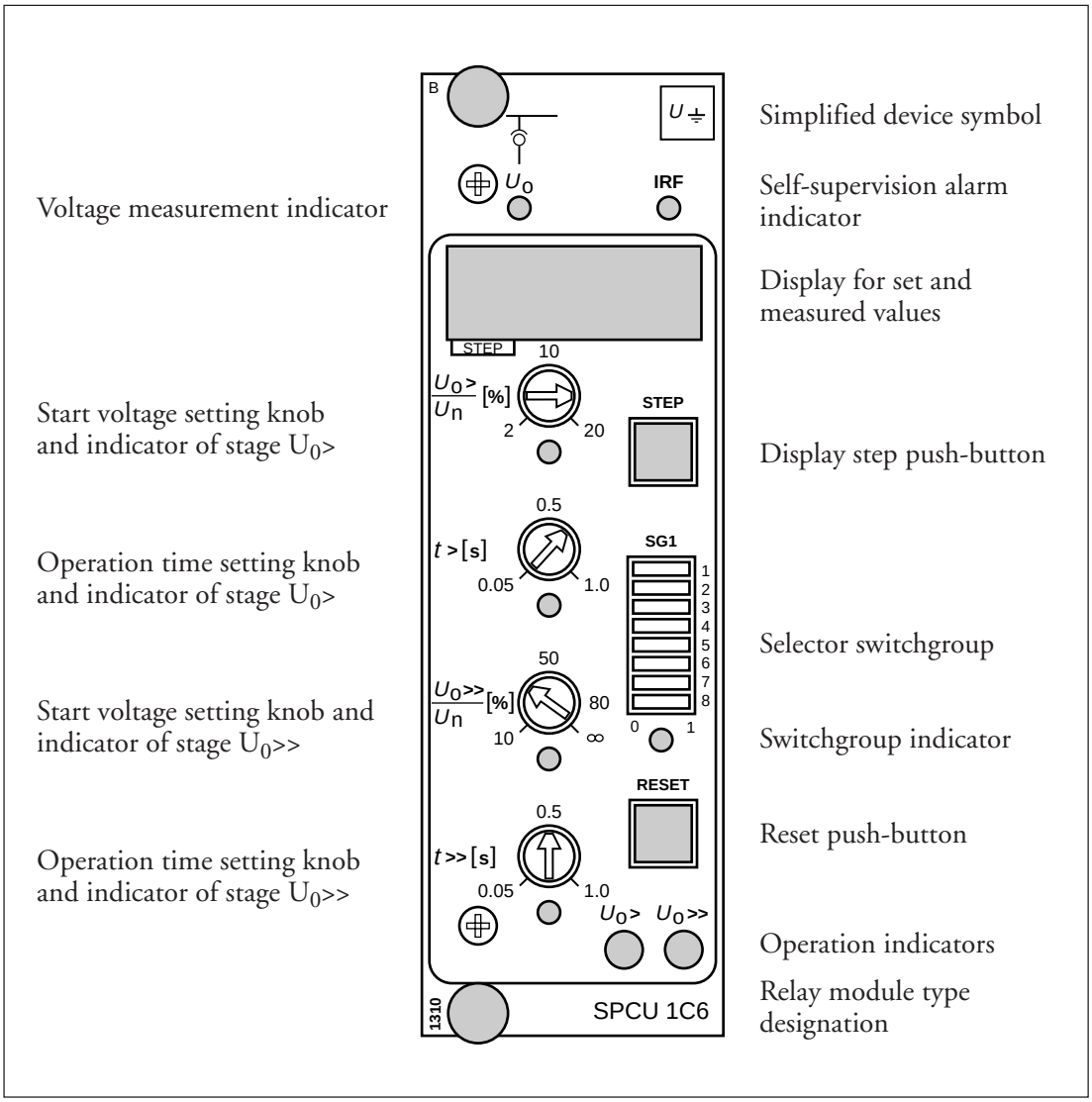


Fig. 3. Front panel of the residual overvoltage relay module SPCU 1C6.

Operation indicators

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

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

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

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

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

Settings

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

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

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

Selector switches

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

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

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

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

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

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

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

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

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

Measured data

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

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

Recorded information

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

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

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

Menu chart

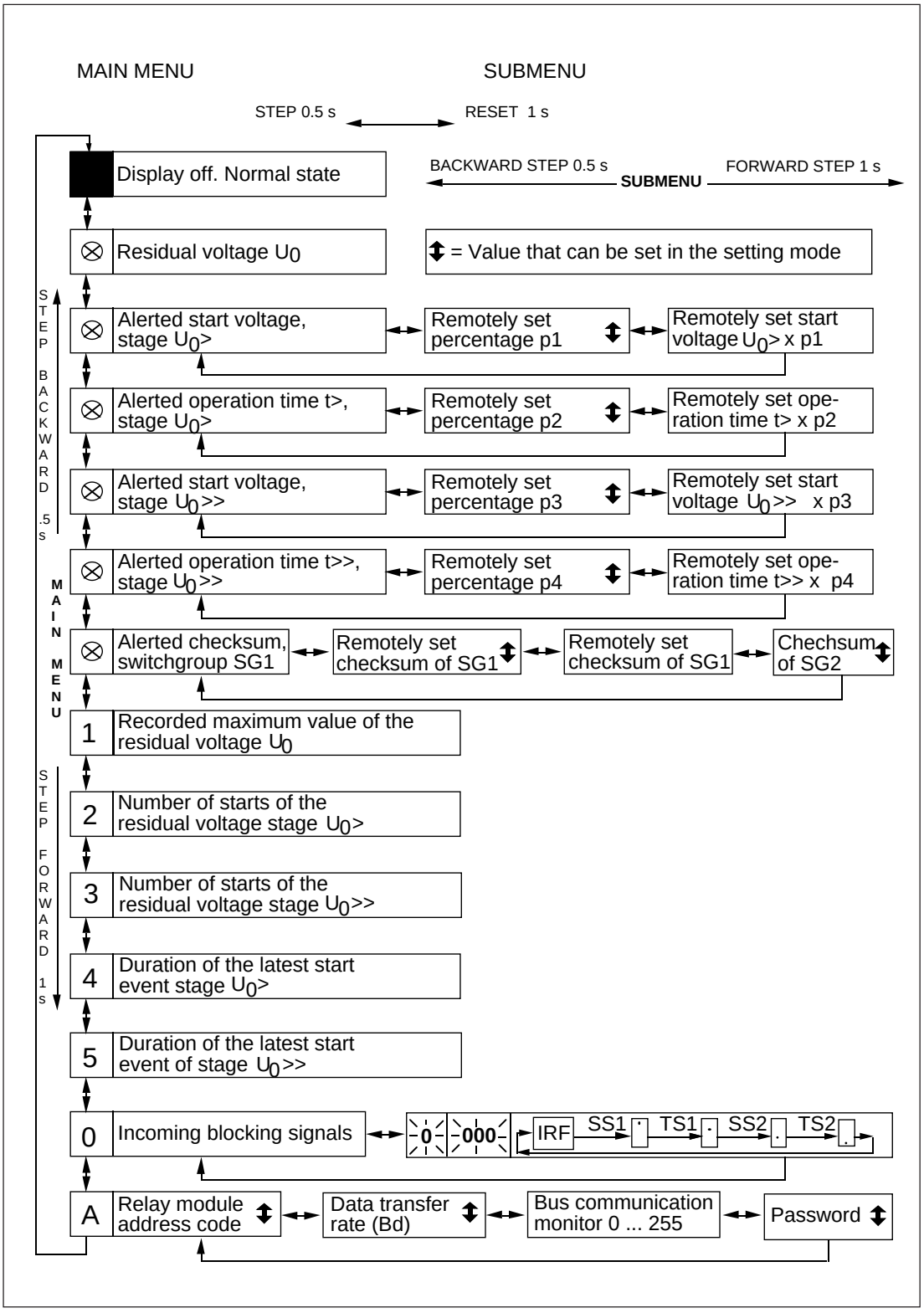


Fig. 4. Main menu and submenus of the residual overvoltage relay module SPCU 1C6.

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

Low-set overvoltage stage U_0>

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

High-set overvoltage stage U_0>>

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

Serial communication parameters

Event codes

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

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

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

Event codes of residual voltage relay module SPCU 1C6:

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

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

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

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

Data to be transferred over the serial bus

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

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

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

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

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

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

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

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

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

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

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

Fault codes

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

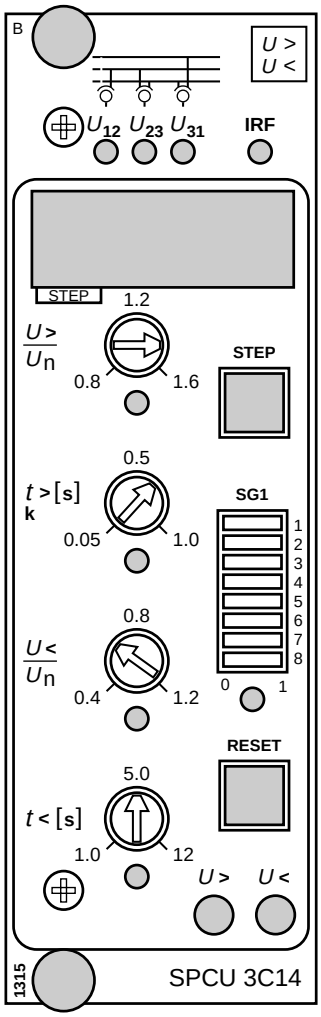
In most fault situations an auto-diagnostic fault code is shown on the relay display. The fault code cannot be reset. The fault code consists of a red digit one (1) and a green code number that indicates the fault type. The fault code should be recorded and stated when service is ordered.

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

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

SPCU 3C14
Combined overvoltage and undervoltage relay module

User´s manual and Technical description



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SPCU 3C14
Combined overvoltage and undervoltage relay module

Contents

Features

Three-phase voltage measuring relay module which also can be programmed for use in single-phase applications

Overvoltage stage with definite time or inverse definite minimum time characteristic

Two sets of voltage/time curves selectable at inverse time operation

Undervoltage stage with definite time characteristic

External blocking of the undervoltage stage via 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 operation

The combined overvoltage and undervoltage module SPCU 3C14 is a three-phase relay module, which can be programmed for single-phase operation by means of switch SG1/1 on the front panel. The module contains an overvoltage stage and an undervoltage stage. The overvoltage stage can be given either definite time or inverse time characteristic, whereas the operation of the undervoltage stage is based on definite time characteristic only.

If one of the voltages 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 switch SG1/2, 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 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 operating time is programmed with switches SG1/4 and 5. At inverse time characteristic two different sets of voltage/time curves, called A and B, can be selected by means of switch SG1/4. At inverse time characteristic switch SG1/5 has no function.

If one of the voltages 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 SG1/7, and two alternative values are available.

After the preset operate time t<, a trip signal TS2 is delivered by the undervoltage stage. The setting range of the operate time is selected with switch SG1/8.

To avoid unwanted operations, for instance during an auto-reclose sequence, starting and tripping of the undervoltage stage can be blocked by turning switch SG1/6 into the position 1. The blocking function is activated if the measured signal falls to a value below $0.2 \times U_n$. This function is illustrated in Fig. 1.

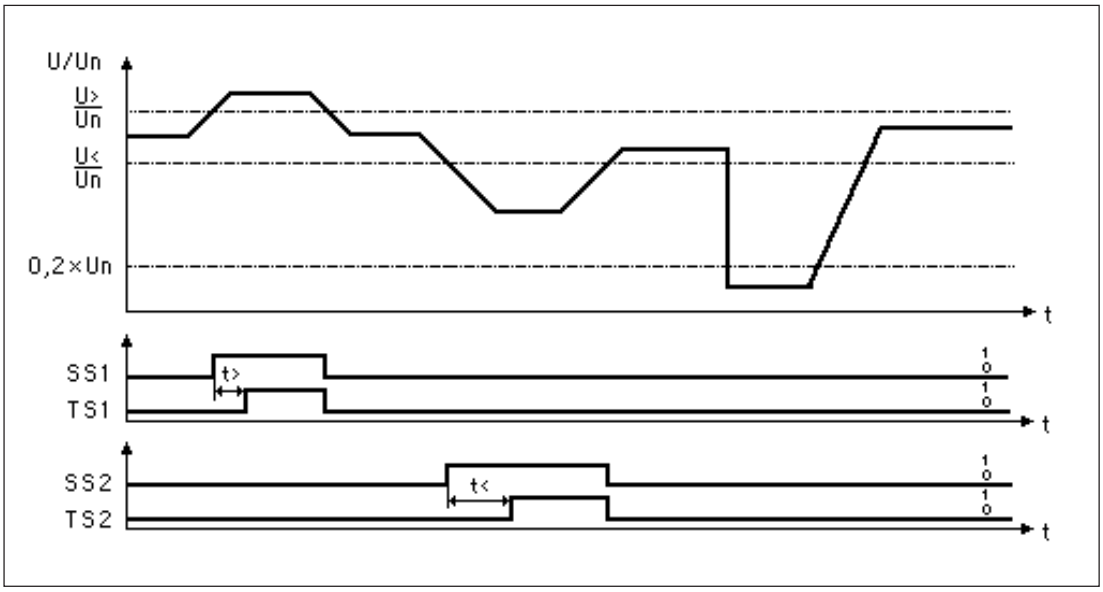


Fig. 1. Operation of the combined overvoltage and undervoltage relay module SPCU 3C14 when the function of the undervoltage stage is internally blocked (SG1/6 = 1).

Tripping (TS2) of the U< stage alone, may be blocked by applying a blocking signal BTS2 on the stage. The blockings are programmed individually for the various relay assemblies by means of the switchgroup SGB on the relay module. Programming instructions for the SGB switchgroup are given in the user's manual of the concerned protection relay unit. Also see the signal diagram of the concerned protection relay unit.

Block diagram

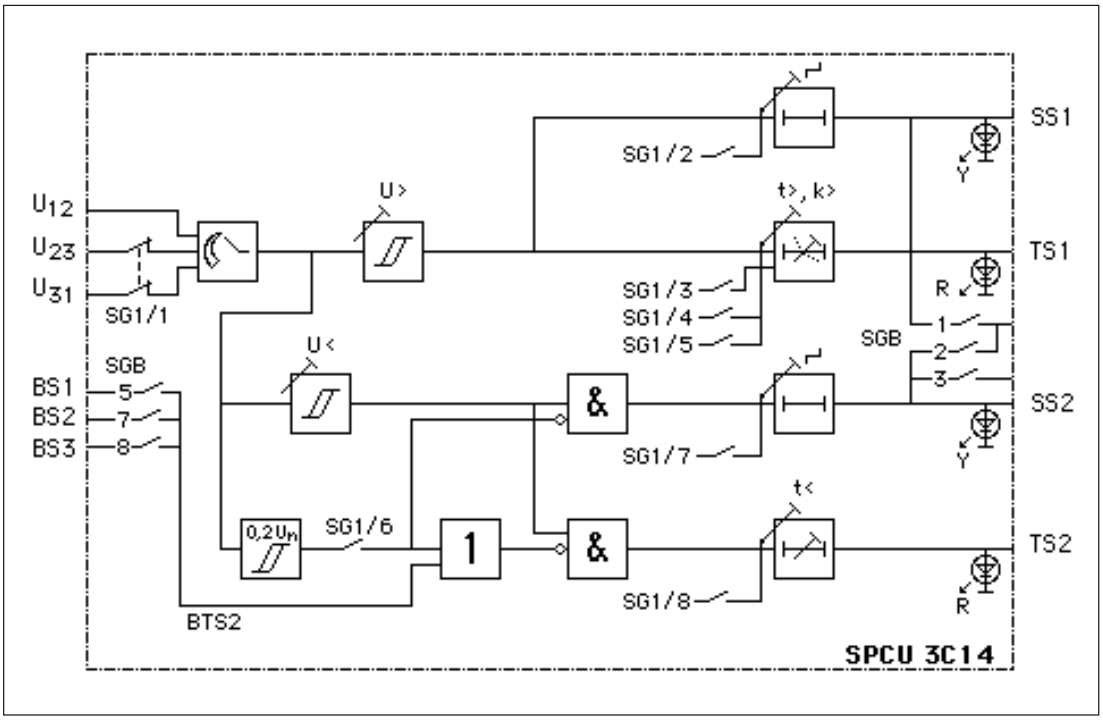


Fig. 2. Block diagram for combined overvoltage and undervoltage relay module SPCU 3C14.

U_{12}, U_{23}, U_{31}	Measured phase-to-phase voltages
BS1, BS2, BS3	Blocking signals
BTS2	Blocking of the tripping of the U< stage
SG1	Front panel programming 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 every protection relay unit including the overvoltage and undervoltage relay module.

The signals wired to the terminals are shown in the signal diagram of the concerned protection relay unit, see user's manual.

Front panel

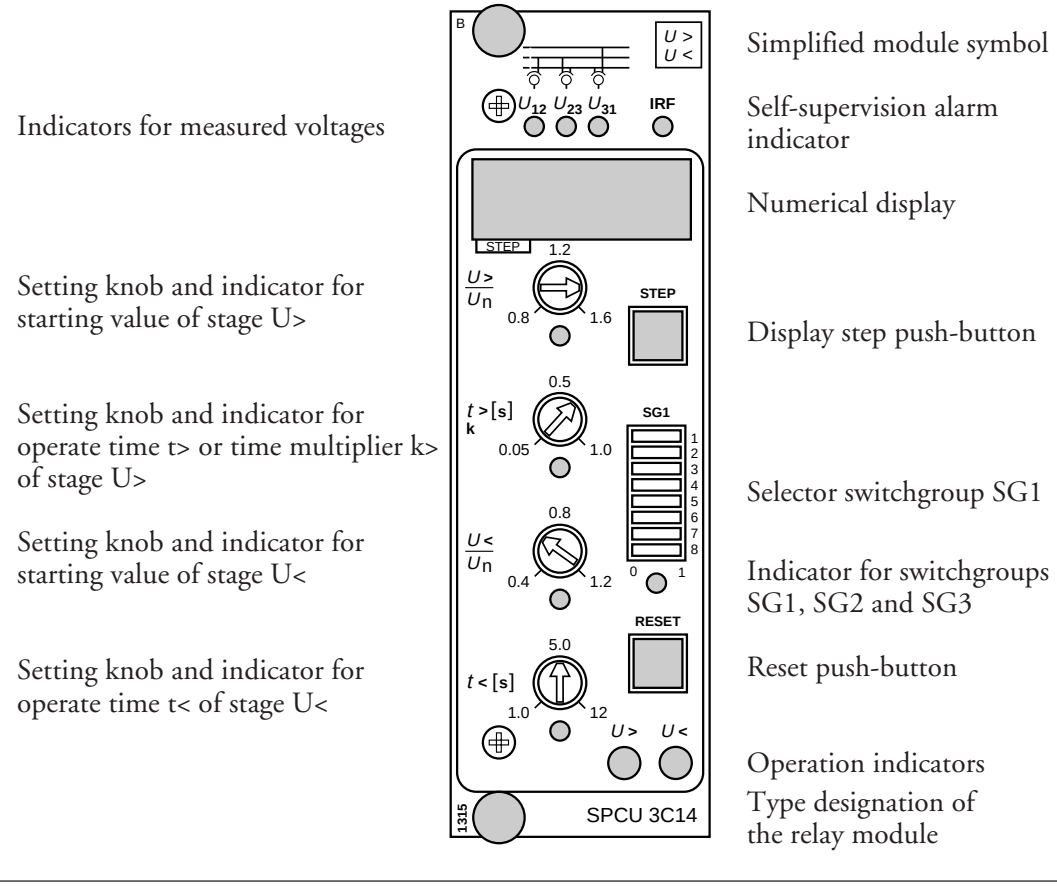


Fig. 3. Front panel of the combined overvoltage and undervoltage relay module SPCU 3C14.

Start and operation indicators

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

The four LED indicators can, independently of one another, be given self-reset or manual reset mode of operation with switches in 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 it turns red if the stage operates. When the stage resets after operation the red indication remains lit. If the stage starts but does not operate the yellow indicator is lit during the 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 protective functions of the relay module. The relay module is constantly operative, regardless of the indicators have 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 serve 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. Setting range 0.8...1.6 x U_n.
t> [s]	Operate time of the U> stage, expressed in seconds, at definite time mode of k> operation. The required setting range, 0.05...1.00 s, 0.5...10.0 s or 5...100 s, is selected with switches SG1/4 and 5. 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. Setting range 0.4...1.2 x U_n.
t< [s]	Operate time of the U< stage expressed in seconds. The setting range is selected with switch SG1/8, alternatives 1...12 s and 10...120 s.

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

Selector switches

(Modified 99-12)

When the module has been given single-phase operation, only U_{12} is measured. Additional relay functions required in various applications are selected by means of the selector switches of switchgroup SG1 located on the front panel of the relay module. The numbering of the switches, 1...8, and the switch positions, 0 and 1, are marked on the front panel.

Switch	Function
SG1/1	Selection of three-phase or single-phase operation. Three-phase operation when SG1/1 = 0. Single-phase operation when SG1/1 = 1.
SG1/2	Start time selection for the overvoltage stage U>. When SG1/2 = 0, the start time is 0.1 s. When SG1/2 = 1, the start time is 30 s.
SG1/3 SG1/4 SG1/5	Selection of definite time or IDMT mode of operation for the U> stage. At definite time mode of operation switches 4 and 5 are used for selecting the setting range of the operate time t>. At IDMT mode of operation switch 4 is used for selecting the inverse time curve, switch 5 has no function.

SG1/3	SG1/4	SG1/5	Mode of operation	Operate time t> or characteristic curve
0	0	0	Definite time	0.05...1.00 s
0	0	1	Definite time	0.5...10.0 s
0	1	0	Definite time	0.5...10.0 s
0	1	1	Definite time	5...100 s
1	0	0	Inverse time	Curve A
1	0	1	Inverse time	Curve A
1	1	0	Inverse time	Curve B
1	1	1	Inverse time	Curve B

Switch	Function
SG1/6	Selection of automatic blocking of starting and tripping of the undervoltage stage U<. When SG1/6 = 0, the undervoltage stage always operates when a measured voltage falls below the setting value. When SG1/6 = 1, starting and tripping of the undervoltage stage are blocked if one of the measured voltages, falls to a value below 0.2 x U_n. This feature can be used for preventing unnecessary startings and trippings during auto-reclose sequences.
SG1/7	Start time selection for the undervoltage stage U<. When SG1/7 = 0, the start time is 0.1 s. When SG1/7 = 1, the start time is 30 s.
SG1/8	Selection of the setting range for the operate time t< of the undervoltage stage U<. When SG1/8 = 0, the setting range of the operate time is 1.0...12.0 s. When SG1/8 = 1, the setting range of the operate time is 10...120 s.

Switchgroup SG2 is a so called software switchgroup, which is located in the third submenu of the 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	Manually reset	Factory default
Start indicator U> Operation indicator U> Start indicator U< Operation indicator U<	1 2 4 8	0 2 0 8
Checksum	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 applied on the undervoltage stage in various protection relay units. Switches 4 and 6 have no function in the relay module SPCU 3C14. Instructions for setting the switchgroup SGB are given in the user's manual of the protection relay unit and in the signal diagram of the relay.

Measured data

The measured values are presented with the rightmost three green digits on the display. The data being presented are indicated by LED indicators on the front panel.

Indicator	Measured data
U_{12}	The U_{12} voltage measured by the module expressed as a multiple of the rated voltage of the relay energizing input.
U_{23}	The U_{23} voltage measured by the module expressed as a multiple of the rated voltage of the relay energizing input.
U_{31}	The U_{31} voltage measured by the module expressed as a multiple of the rated voltage of the relay energizing input.

Recorded information

The leftmost red digit on the display indicates the register address and the three rightmost 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 a 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 a percentage of the set operate time t<. 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 on to the TEST mode, where the starting and tripping signals of the module can be activated one by one. For further details see the description "General characteristics of C-type relay modules".
A	The address code of the measuring relay module, required by the serial communication system. Submenu 1: Selection of the data transfer rate. Submenu 2: Bus traffic monitor. If the relay module is connected to a data communication system and the communication is operating, the counter reading of the bus traffic monitor will be 0. Otherwise the numbers 0...255 are continuously rolling in the counter. Submenu 3: Password required for remote setting. The password given in the setting mode of a submenu must always be entered via the serial communication before the settings can be altered remotely.

When the display is dark, the register can be re-entered by pressing the STEP push-button.

The registers 1...8 are cleared 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 data transfer rate of the serial communication system and the password of the module are not affected by voltage failures. The instructions for setting the address and the data transfer rate are given in the 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 "– – –"

Menu chart

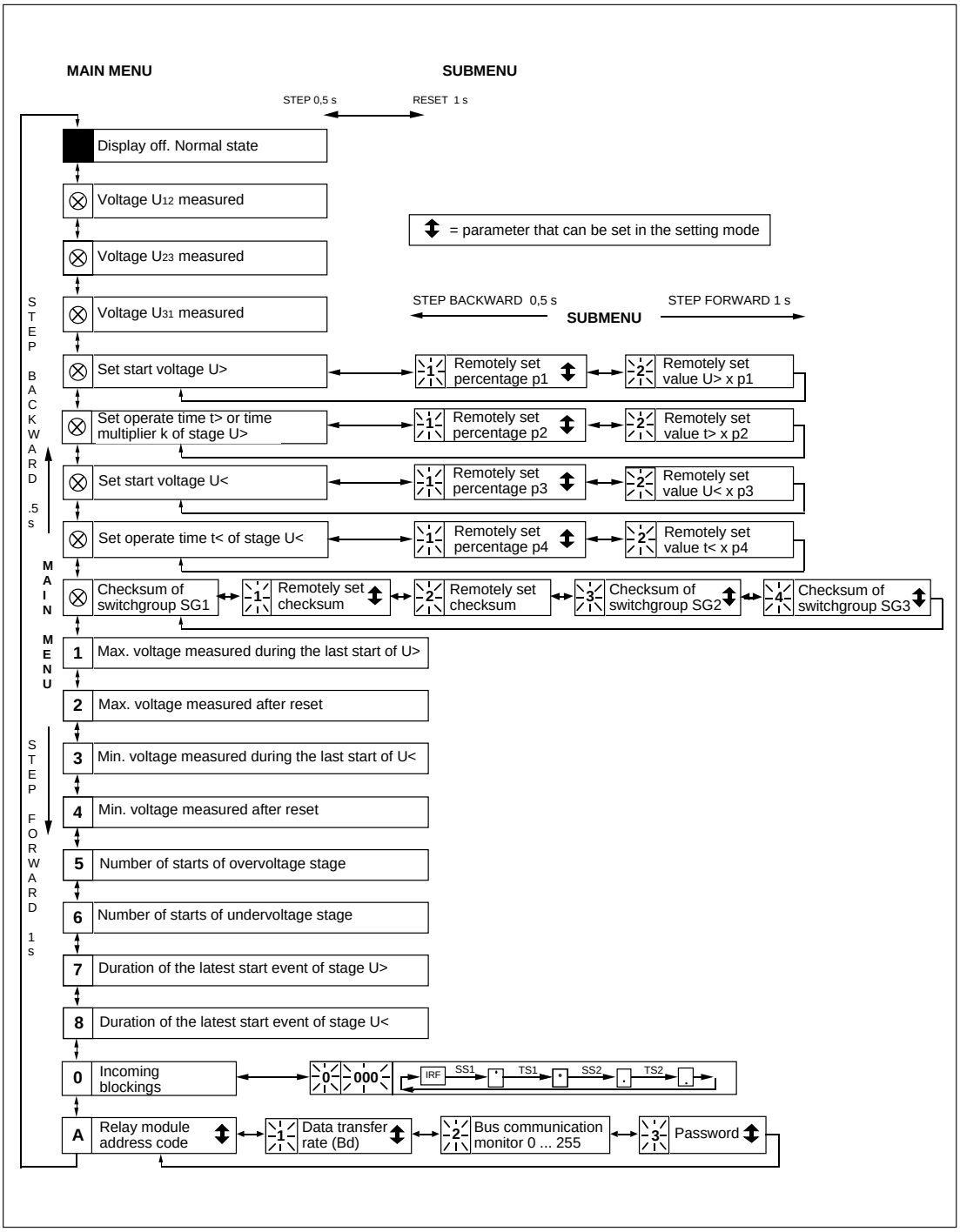


Fig. 4. Main menus and submenus of the combined overvoltage and undervoltage relay module SPCU 3C14.

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".

Voltage/time characteristic
(Modified 99-10)

At inverse time characteristic the operate time of the overvoltage stage 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. The relationship between time and voltage at inverse time characteristic can be expressed as follows:

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

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 tripping time of the overvoltage stage does not start until the voltage exceeds the setting value by 6%. The operating time accuracy stated in the technical data applies when the voltage exceeds the setting value by 10%. The overvoltage stage includes two characteristics with different inversities. The characteristic is selected with the programming switch SG1/4. The degree of inversity is determined by the factor p as follows:

Characteristic	p (constant)
A	2
B	3

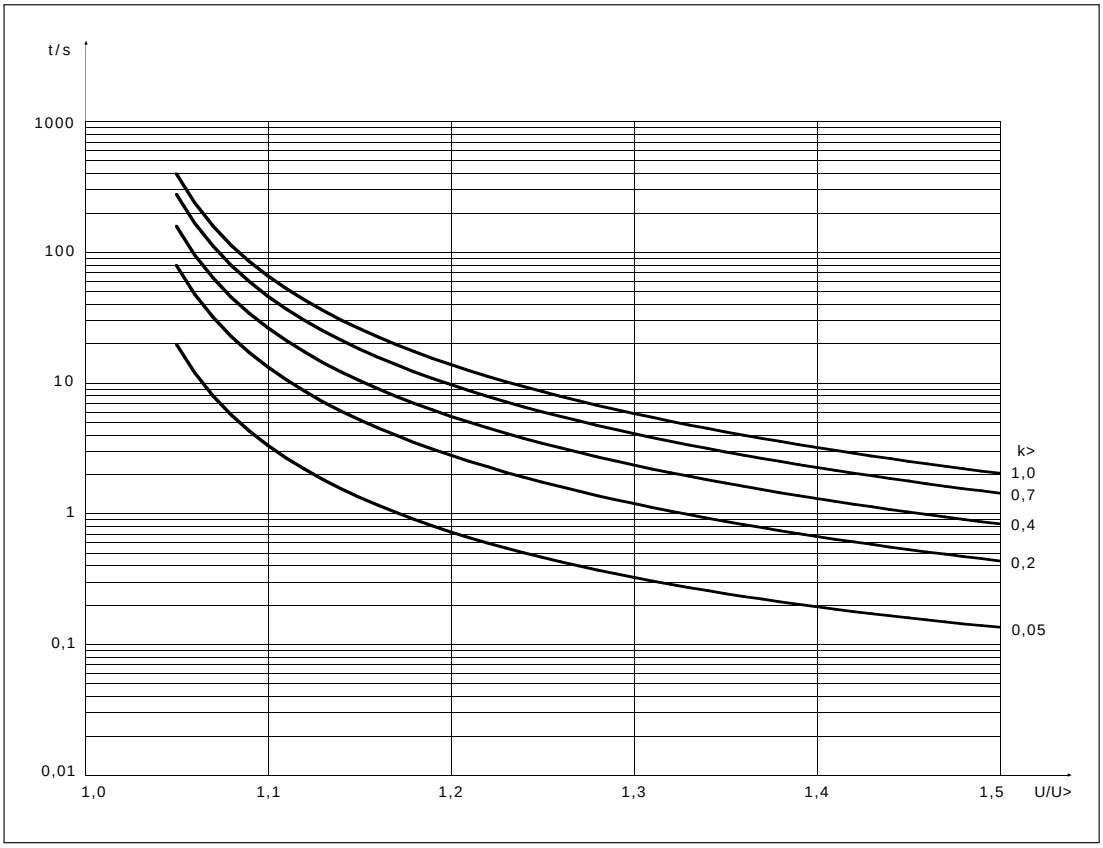


Fig. 5. Characteristic curve set A of overvoltage stage U>.

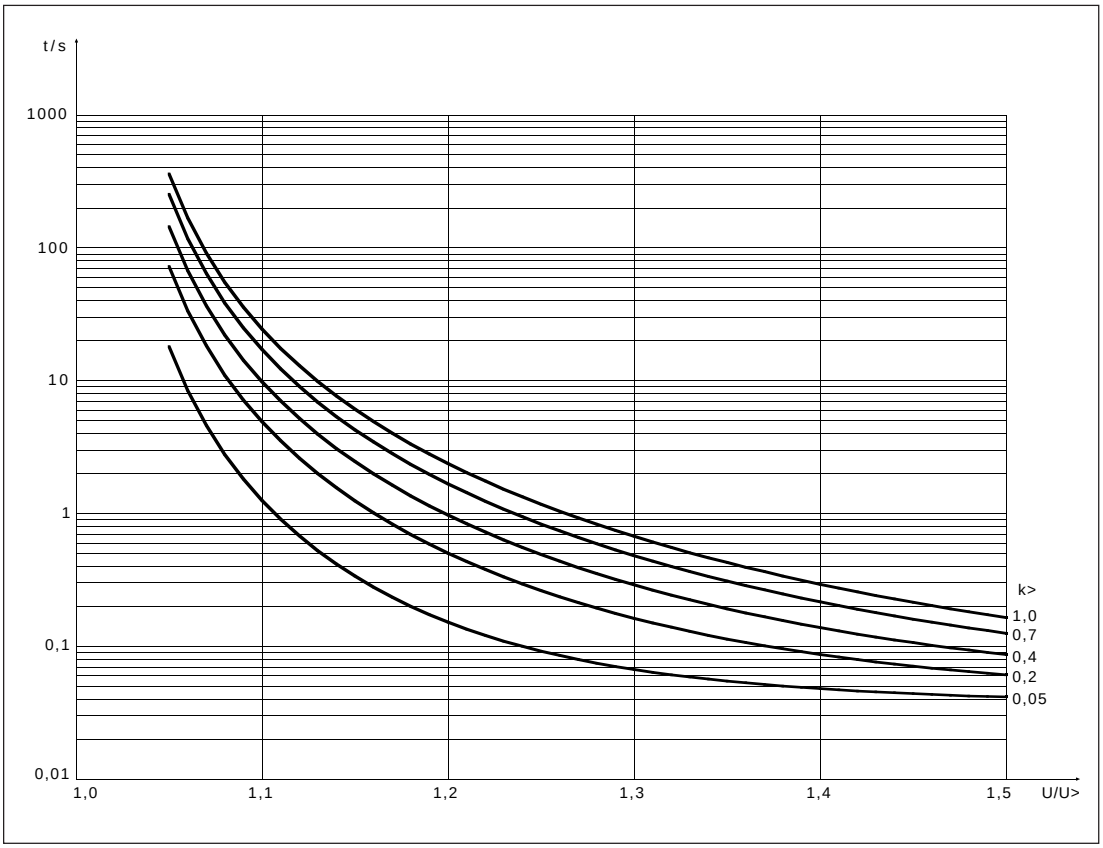


Fig. 6. Characteristic curve set B of overvoltage stage U>.

Technical data

Overvoltage stage U>

Start voltage U>	0.8...1.6 x U_n
Start time	0.1 s or 30 s
Operate time at definite time mode of operation	0.05...1.00 s, 0.5...10.0 s or 5...100 s
Time multiplier k> at inverse time characteristic	0.05...1.00
Reset time, typically	60 ms
Drop-off/pick-up ratio, typically	0.97
Operate time accuracy at definite time mode of operation 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	0.1 s or 30 s
Operate time at definite time characteristic	1...12 s or 10...120 s
Reset time, typically	60 ms
Drop-off/pick-up ratio, typically	1.03
Operate time accuracy and start time accuracy	± 2% of set value or ± 25 ms
Operation accuracy	± 3% 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 data of the module, e.g. starting and tripping, from the over-/undervoltage relay module SPCU 3C14. Event information called for are printed out in the format: time (ss.sss) and event code. The event codes of the module are E1...E8, E50 and E51. Furthermore, the substation level control data communicator is able to form event codes relating to e.g. the data communication.

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 over-/undervoltage relay module SPCU 3C14 is 85, which means that all startings and trippings are included in the reporting, but not the resetting. The codes E50...E54 and the events represented by these cannot be excluded from the reporting.

Event codes for over-/undervoltage relay module SPCU 3C14:

Code	Event	Weighting coefficient	Default setting
E1	Starting of overvoltage stage U>	1	1
E2	Starting of overvoltage stage U> reset	2	0
E3	Tripping of overvoltage stage U>	4	1
E4	Tripping 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	Tripping of undervoltage stage U<	64	1
E8	Tripping of undervoltage stage U< reset	128	0
	Default value of event mask V155		85

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

0 not included in event reporting
1 included in 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 *(Modified 99-12)*

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
Measured voltage U_{12}	I1	R	0...9.99 x U_n
Measured voltage U_{23}	I2	R	0...9.99 x U_n
Measured voltage U_{31}	I3	R	0...9.99 x U_n
Blocking of tripping of undervoltage stage	I4	R	0 = no blocking 1 = tripping of stage U< blocked
Starting of overvoltage stage U>	O1	R	0 = U> stage not started 1 = U> stage started
Tripping of overvoltage stage U>	O2	R	0 = U> stage not tripped 1 = U> stage tripped
Starting of undervoltage stage U<	O3	R	0 = U< stage not started 1 = U< stage started
Tripping of undervoltage stage U<	O4	R	0 = U< stage not tripped 1 = U< stage tripped
Activated start value for stage U>	S1	R	0.8...1.6 x U_n
Activated operate time t> or time multiplier k for stage U>	S2	R	0.05...100 s or 0.05...1.00
Activated start value for stage U<	S3	R	0.4...1.2 x U_n
Activated operate time for stage U<	S4	R	1...120 s
Activated checksum of switchgroup SG1	S5	R	0...255
Start value for stage U>, set with the setting knob	S11	R	0.8...1.6 x U_n
Operate time or time multiplier for stage U>, set with the setting knob	S12	R	0.05...100 s or 0.05...1.00
Start value for stage U<, set with the setting knob	S13	R	0.4...1.2 x U_n
Operate time for stage U<, set with the setting knob	S14	R	1...120 s
Checksum of switchgroup SG1 (set with the switches)	S15	R	0...255
Remote setting percentage of the start value for stage U>	S21	R, W	0...999%
Remote setting percentage of operate time or time multiplier for stage U>	S22	R, W	0...999%
Remote setting percentage of start value for stage U<	S23	R, W	0...999%
Remote setting percentage of operate time for stage U<	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 for stage U>	S31	R	0.8...1.6 x U_n
Remotely set operate time or time multiplier for stage U>	S32	R	0.05...100 s or 0.05...1.00
Remotely set start value for stage U<	S33	R	0.4...1.2 x U_n
Remotely set operate time for stage U<	S34	R	1...120 s
Remotely set checksum of switchgroup SG1	S35	R	0...255
Max. voltage measured when stage U> started	V1	R	0...9.99 x U_n
Max. voltage measured after resetting	V2	R	0...9.99 x U_n
Min. voltage measured when stage U< started	V3	R	0...9.99 x U_n
Min. voltage measured after resetting	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
Resetting of output relays, operation indicators and erasing of recorded data simultaneously	V102	W	1 = output relays, operation indicators reset and registers (codes V1…V8) 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 (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 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 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	W	1...254
Program version	V205	R	072_

Data	Code	Data direct.	Values
Type designation of the relay module	F	R	SPCU 3C14
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.

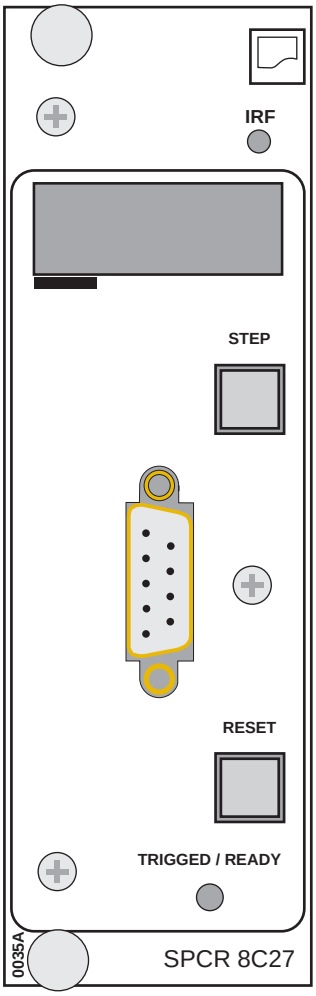
In most fault situations an auto-diagnostic fault code is shown on the relay display. The fault code cannot be reset. The fault code consists of a red digit one (1) and a green code number that indicates the fault type. The fault code should be recorded and stated when service is ordered.

The fault codes of the over-/undervoltage relay module SPCU 3C14 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

SPCR 8C27
Disturbance recorder

User´s manual and Technical description



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SPCR 8C27
Disturbance recorder

Contents

Features

Recording capability; three phase-to-phase voltages, three phase currents, one residual voltage, one neutral current and eight on/off signals

Total recording time 12 seconds, of which 0… 100% may proceed the triggering. Several recordings available within the 12 s total recording time

Adjustable undervoltage, overvoltage, overcurrent, residual overvoltage and neutral overcurrent triggering levels

Recordings can be started manually, by analogue or binary channels or with a command given via the serial bus

Serial communication capability. The recordings can be transmitted via the RS 232 C bus on the front panel of the module or via the SPA bus of the host relay

Records the minimum and maximum values of the phase-to-phase voltages, the phase currents, the residual voltage and the neutral current

Recordings, maximum values and minimum values are provided with date and time stamps

Timer synchronization to substation data communication equipment and system clock

Optional menu-driven easy-to-use PC program for performing settings, for downloading recordings to a PC and for plotting curves on a screen or writing to a matrix printer

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Application

The disturbance recorder SPCR 8C27 is intended to be used for verifying the proper operation of protection relays and circuit breakers and for analysing protection problems in electrical power systems.

The disturbance recorder captures the curve forms of the monitored quantities of the supervised object, both under normal service conditions and when the protection relay operates. Thus the relay settings can be based on the recorded information.

Monitoring of the maximum and minimum values also makes the disturbance recorder suitable for analyzing network operation quantities, for instance, under certain unnormal loading or voltage conditions. The disturbance recorder thus offers a way to collect basic information about a certain network object. This information facilitates network planning and operation.

Description of operation

The disturbance recorder SPCR 8C27 is designed to be inserted into any unoccupied relay module location of a SPACOM relay case. Thus the recorder module measures the same signals as the protection relay modules. The number and type of signals to be recorded depend on the protection relay into which the disturbance recorder module has been inserted.

Triggering

The recorder module may be triggered by phase overcurrent, undervoltage, overvoltage, residual overvoltage or neutral overcurrent. Further it can be triggered by on/off input signals, manual control, automatically and periodically or by a command via the serial bus.

The length of the recording can be selected separately for each of the triggering conditions. When the recorder module triggers, a recording is made and an event message is generated according to the settings made. The recording of the parameters and the generation of an event can be enabled or disabled separately for each triggering condition.

When at least two successive measurements exceed the preset start value, the triggering condition is fulfilled. The undervoltage condition is fulfilled if the value of the two last half cycles falls below the preset undervoltage start value and the undervoltage is not due to a high-speed auto-reclosure going on in the network or any other circuit-breaker operation. If, during two half cycles, the measured voltage falls below 20% of the rated voltage of the relay, the situation is considered to be a circuit-breaker operation and the undervoltage condition is not fulfilled.

The on/off triggering signals are obtained from the internal bus of the host relay. The triggering signals are formed by start and operate signals of the relay modules or by certain external control signals. A change of the status of a monitored signal triggers the recorder according to the set configuration.

The recorder may also be triggered periodically which means that the recorder automatically makes a recording at certain time intervals.

The recorder may also be triggered manually with the push-buttons on the front panel.

The parameters defining the triggering conditions are set via the SPA port of the host relay or via the RS 232 C port on the front panel of the recorder module.

Recording

When the triggering conditions are fulfilled, a recording is made the length of which is max. 12 seconds when all channels are used. 0…100% of the recording may precede the triggering. The recording memory is divided into 0.5 seconds blocks. When the shortest possible recording time, i.e. 0.5 seconds, is used, there is enough memory for 24 consecutive recordings.

The recording memory is used as a buffer storage. When the available recording capacity has been exceeded no further recordings are made, unless the recorder module has been otherwise configured.

The clock and the recording memory of the disturbance recorder module have been provided with a ten years battery back-up to maintain information over an auxiliary voltage outage.

The sampling rate for each recording channel is 500 Hz.

Recording of maximum and minimum values

The module records the maximum and minimum values of the measured phase-to-phase voltages and the associated time stamps. In the same way the module records the max. values of the phase currents and the associated time stamps. Further, the module records the maximum value of the residual voltage and the maximum value of the neutral current, and their associated time stamps. For status signals the time of the last status change is recorded. For analog signals the recorded value and time change once a new maximum or minimum value is detected.

The recording of the maximum value is based on instantaneous values and therefore possible spikes and the dc component of the measured signal appear in the recording. The recorded maximum and minimum values can be read via the RS 232 C port or the SPA bus.

Event register

The event register is a log-book containing a list of the events generated. The events, which are to be recorded are selected separately in an event log mask. Any start-up of the recorder module and any event register overflow situation are also recorded as events. The register also holds date and time stamps of the recorded events.

Unloading of recordings

The recordings can be unloaded via the serial buses. The recordings can be erased, even before they have been unloaded, with a command via the serial buses or manually by means of the push-buttons on the front panel.

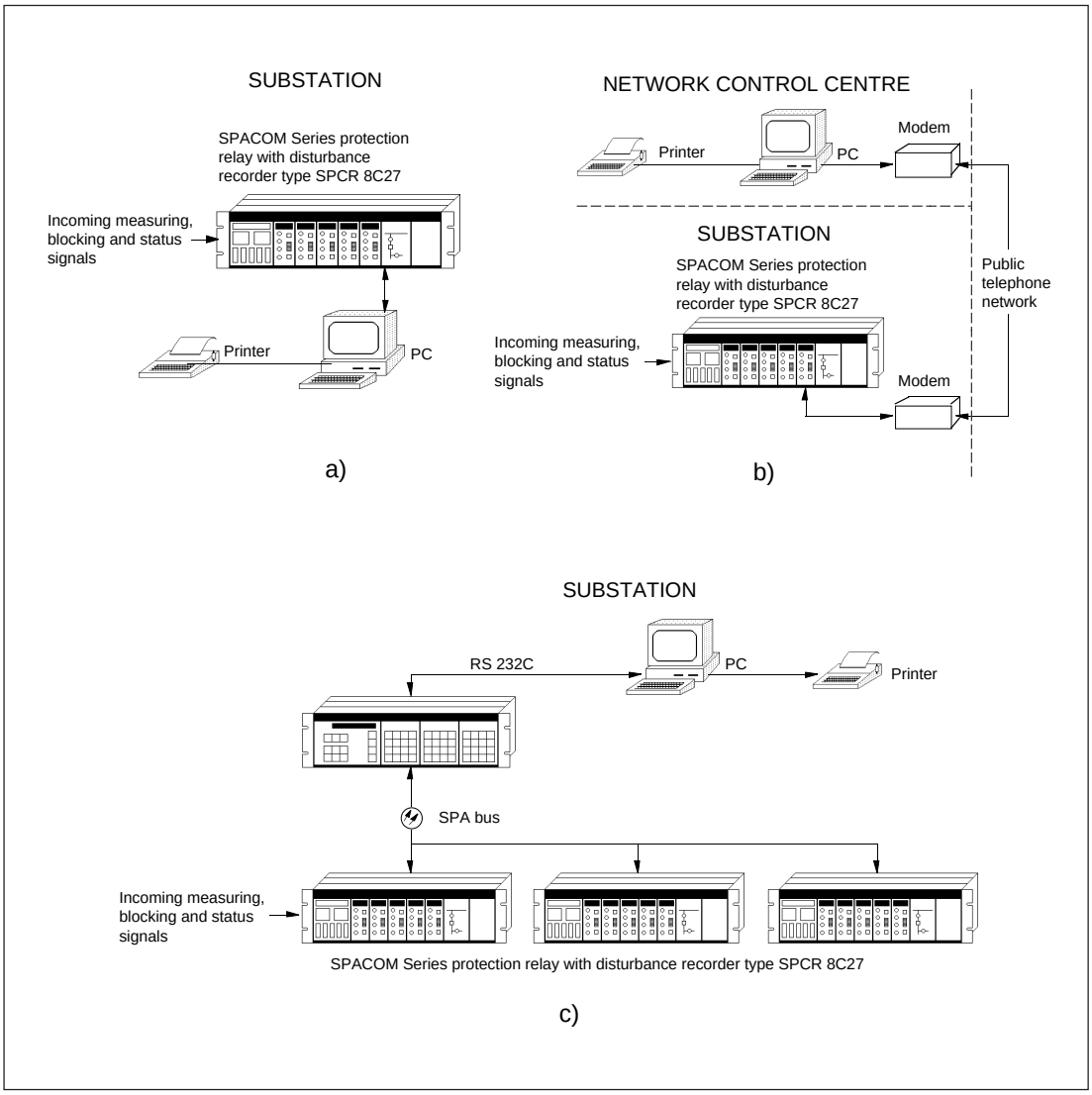


Fig. 1. Connection of the disturbance recorder SPCR 8C27 to its environment.
a) Direct connection to a PC via the RS 232 C port on the front panel.
b) Connection to a PC in the control room via the RS 232 C port on the front panel and a modem.
c) Connection to a local substation PC via the SPA bus.

Serial port

The RS 232 C port on the front panel of the module and the SPA-bus is used for unloading recordings, for setting module parameters and for an extended use of the module.

The serial port on the front panel is intended to be used for the connection of a data communication modem, or if the distance is short, for the connection of an IBM compatible PC.

When the module recordings are unloaded into a PC the data can be processed later. A modem connection allows the recordings to be unloaded via a telephone line to the control room or any other place.

An available optional menu-driven PC program facilitates setting of the module and downloading and plotting of the records. The program features versatile possibilities for plotting the recorded signals. An ordinary matrix writer can be used as a hard copy output device.

The PC support program incorporates features facilitating the use of the program and making it easy to change and update recorder parameters. The recorder parameters and the plot parameters can be recorded in a file, a feature that facilitates work that may occur repeatedly.

Operating modes

Start-up

When the auxiliary supply has been connected the recorder module can be started in two ways, that is by performing a warm start-up or a cold start-up.

Normally the event recorder performs a warm start-up. But if the module memory contents have been lost because of a supply failure, the module perfoms a cold start-up, which means that the the memory will be initialized with default values. At a cold start-up the module loses any earlier set values and any recorded information, if any.

At a cold start-up the leftmost red display element initially indicates "-" and the rightmost green display element shows a number within the range 01…15 as long as the module is starting up.

Following both a warm start-up and a cold start-up the recorder performs a display test by switching on the digits from zero to nine in each element of the display. The numbers are displayed five times.

The module always performs a cold start-up when the STEP and RESET push-buttons are pressed during start-up.

After the start-up the recorder enters the measuring mode and the display turns dark. In this mode the measuring signals and the communication parameters of the module can be scanned and set by means of the STEP and RESET push-buttons, in the same way as the SPC type relay modules are set.

Setting mode

In the setting mode e.g. the triggering conditions are specified for the module. The settings are made via the SPA bus or via the RS 232 C port. The setting mode is entered with the command V17:1 via the serial bus. A flashing indication "- - - -" on the display indicates that the recorder module is in the setting mode. Exit from the setting mode is obtained with command V17:0.

The module performs no measurements as long as it is in the setting mode. Therefore, it is important to leave the setting mode when the setting procedure has been finished. The display cannot be scanned in the setting mode.

When the settings have been made, the PC connected to the RS 232 C port can be moved to another place. If no modem or PC is connected to the RS 232 C port on the front panel, the recorder responds to commands coming via the SPA bus.

If a device providing a DSR handshaking signal has been connected to the RS port of the recorder module, the recorder automatically changes for communication via RS-bus. The recorder module cannot receive messages from both buses at the same time.

An optional menu-driven PC program considerably facilitates the setting procedure. The settings can also be saved on a floppy disk for later use.

The push-buttons on the front panel of the module can only be used for setting the data communication parameters. In the setting mode the recorder module performs no measurements.

Measuring mode

The recorder module is normally in the measuring mode. It enters the measuring mode after start-up. The module also automatically enters the measuring mode, when an output device connected to the RS 232 C port is disconnected.

In the measuring mode the recorder measures the input signals, monitors the triggering conditions and records data. Data, that is the curve forms of the supervised signals are constantly recorded into the history memory of the recorder. As the module triggers, a specified part of the history recording preceding the triggering is moved into the recording memory and the post-triggering recording starts.

When the measuring mode is left the history memory is erased. After the module has been switched over into the measuring mode a new history is collected. Should the module triggers until the history has been completely collected, the history part of the recording would be inaccurate.

Normally the operation indicator of the recorder is dark. When the module makes a recording, the operation indicator turns green. When the recording has been finished, the operation indicator turns red. Then the module is still in the measuring mode. If there is an old recording in the memory and the module is triggered again, the indicator is lit with both red and green colour.

The contents of the recording memory, the recorded maximum and minimum values, the date and time information of the recordings remain in the memory. However, all information is lost at a cold start-up.

Unload mode

In the unload mode the curve forms of the signals stored in the recording memory are transmitted from the recorder via the SPA bus or the RS 232 C port. This mode is indicated by a flashing "U" in the rightmost element of the display.

The recordings are always unloaded starting from the oldest one. Access to the younger recordings is admitted only after removing the older ones.

The recordings are unloaded and erased in the setting mode using the commands V15, "unloading of the oldest recording" or V16, "erasing of the oldest recording", which are transmitted over the RS bus. In this state the recorder performs no measurement or recording functions.

When data is unloaded via the RS 232 C port the information is transmitted in the form of messages of max. 80 characters each, according to the SPA protocol. The entire recording is transmitted after command V15, i.e. "unloading of the oldest recording". Proceeding the measured data a few lines of information about the recording is transmitted, such as an output information heading, a code of the event causing triggering, input headings, rated values etc. The sample values are related to the peak value of the sinusoidal signal, that is the peak value of the nominal sinusoidal signal equals 1. RMS values can be calculated from individual sample values by multiplying the values by the factor $\sqrt{2}$.

Each line of measured data (= one measured value per signal) forms a separate message. The unloading of a recording ends with an empty message. The unloading can be interrupted by transmitting any message to the recorder.

At a 1200 baud data transfer rate via the RS 232 C port, unloading of a one second recording takes about 5 minutes. The same data transfer takes about 40 s at a data transfer rate of 9600 baud.

The unloading via the SPA bus is made in the so called SPA unloading mode (V20). Then the records are unloaded piece by piece by reading one line of measured data at a time. Thus the SPA bus is occupied for unloading recordings only for short periods at a time.

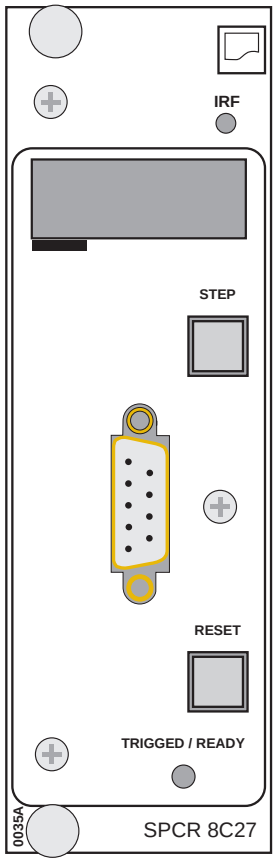
In the SPA-unloading mode the recorder measures the input signals but performs no recordings.

The same command as with the RS 232 C port is used for removing the oldest recording.

The optional PC program makes it possible to read the recordings, display them grafically on a monitor or to produce hard copy outputs. With the PC program signals can be expanded and shifted in time and value to show all information in detail. It is also possible to save the records on a floppy disk.

Front panel

From the front panel it is possible to check the measured values and to do certain settings required for the data communication. Information associated with the operation states of the module is also displayed on the front panel.



Simplified device symbol

Self-supervision alarm indicator

Digital display for measured values

Display STEP push-button

9-pin female D-type connector of the RS 232 C port

RESET push-button

Operation indicator

Module type designation

Fig. 2. Front panel of the disturbance recorder SPCR 8C27.

Indicators

The state of the recorder is shown by the LED indicator in the right-hand bottom corner of the front panel. The operation indicator shows that the module has triggered (Trig) and is making or has already made a recording. Under normal service conditions the indicator is dark indicating that the recorder is prepared for recording (Ready) and that there are no recordings in the memory.

The red light will remain on until all the recordings have been read and/or erased. The red light does not prevent the recording function.

The self-supervision alarm indicator IRF in the upper right-hand corner of the front panel is lit when the self-supervision system has detected a permanent hardware or software fault in the recorder module. In most fault situations an auto-diagnostic fault code appears on the display. The fault code consists of a red number "1" and a green code number.

When the self-supervision system detects an internal fault an automatic self-recovery attempt is made. If the self-recovery attempt proves unsuccessful a renewed start-up or a cold start-up should be performed.

The following fault codes may appear on the display on detection of an internal fault:

Fault code	Explanation
1	Random Access Memory (RAM) fault
2	Program memory (EPROM) fault
3	Stack overflow
4	Parameter memory (EEPROM) fault

Menu chart

The measured voltages and currents, the state signals and communication parameters can be read from the display. The STEP push-button is used to select the value to be displayed.

The left-most red digit indicates the data type (i.e. display address). The actual value is shown by the three right-hand green digits.

The main menu and the submenus are presented in Fig. 3. The display returns to the basic state from position A. From a dark display it is possible to step in the forward direction only (in Fig. 3 downwards). Should the panel push-buttons not be used for 5 minutes, the display returns to normal, i.e. dark state.

When the display is dark two special functions can be performed. Pressing the RESET push-button for 10 seconds erases all the recordings and switches off the indicator, when it is lit with red colour. Pressing the STEP and RESET push-buttons simultaneously causes a manual triggering, if the manual triggering has been enabled.

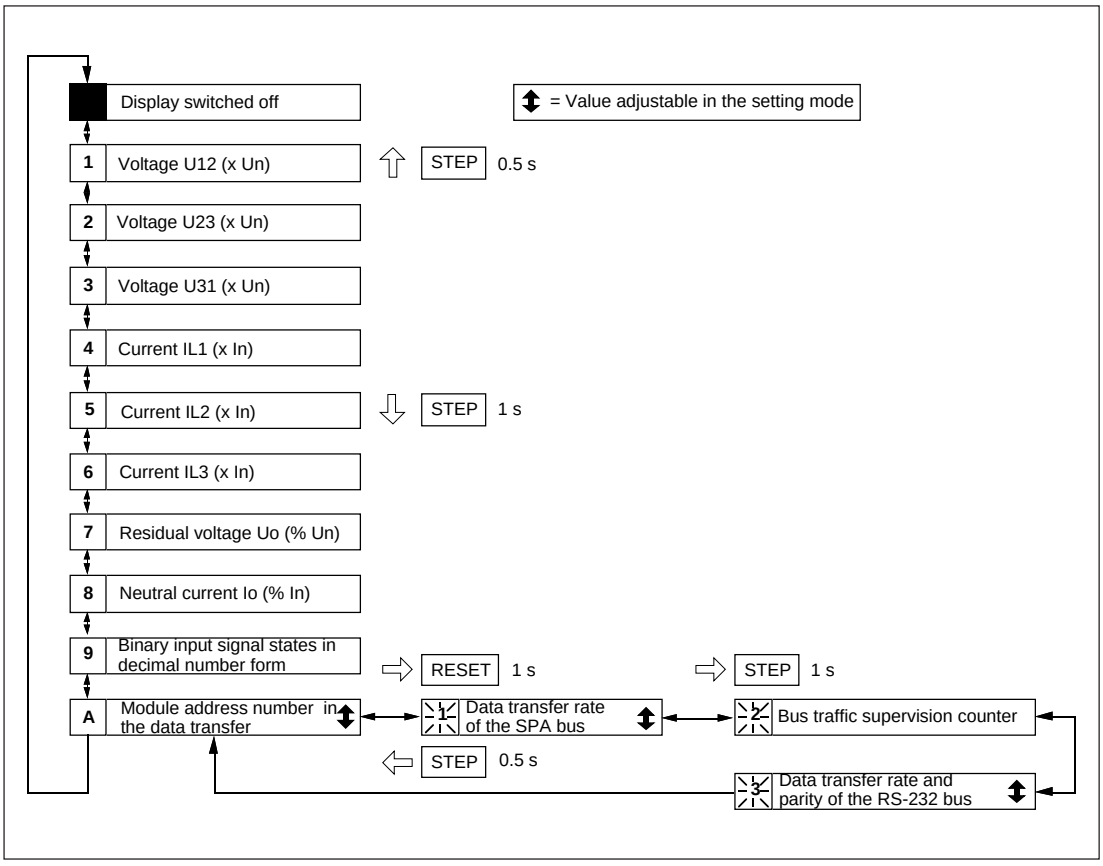


Fig. 3. Main menu and submenus of the display. The measures required for entering the submenus are described in the data sheet "General characteristics of C type relay modules".

Displayed data

Measured data

There are eight analog input signals: for three phase-to-phase voltages, three main currents, one residual voltage and one neutral current. The data are displayed in the display address locations 1…8, see Fig. 3.

When the recorder module is plugged into a three-phase differential relay for power transformers all the six phase currents, that is three on the high-voltage side and three on the low-voltage side of the transformer can be measured. This can be done after the phase-to-phase voltage inputs have been changed from voltage inputs to current inputs by means of jumpers on the PC board of the recorder module. (See W 3, 4, 5 in Fig. 5, 6 and 7).

The measured data are not updated at the same rate as the measurements would allow. An average value function forms the measured value to be displayed. This method yields a more stable display but, consequently, the display does not fully respond to rapid changes.

The measured data are presented as relative values of the set rated values interpreted from the maximum value that has occurred during a half cycle. For sinusoidal input signals the display ratio factor also corresponds to the relative RMS value of the input signal.

The phase-to-phase voltages and the phase currents are presented as multiples of the rated voltage (x U_n) or the rated current (x I_n). The measured values of the residual voltage channel and the neutral current channel are presented as percentages of the rated voltage U_n and the rated current I_n.

Status signals

The eight status signals are coded to decimal numbers within the range 0…255 and presented on the display in the address location 9. The number is formed by adding the values, representing the different states, in the same way as the checksum of switchgroup SG1 of the relay modules is calculated. The same coding is used for the status data read over the serial communication.

By splitting the displayed number into the elements which form the number, the relevant status data are retrieved. The coding method is based on the principle of presenting positive integers in binary form. This method makes it possible to use a calculator capable of decimal-binary conversions for retrieving the states.

The numbers representing the different status data are shown in the table below.

Status data	Number representing the status data
Status data 1	1
Status data 2	2
Status data 3	4
Status data 4	8
Status data 5	16
Status data 6	32
Status data 7	64
Status data 8	128

Data communication parameters

The modules' address code, which is the same on the SPA bus and the RS 232 bus, is shown in address A. The address code may have a value within the range 001…899. The default code after a cold start-up is 001. The address code of the recorder module is set in the setting mode, one number at a time, starting from the rightmost digit.

The data transfer rate for the SPA bus, the bus traffic monitor value and the data transfer rate and the parity of the RS 232 C bus are to be found in the submenues of address location A.

The data transfer rate of the SPA bus, which is connected to the D-type connector on the rear plate, is expressed in thousand bits/second (kBd). Alternative values are 0.3 kBd, 1.2 kBd, 2.4 kBd, 4.8 kBd and 9.6 kBd. Even parity is always used and shown as a number 2 in front of the data transfer rate value.

The bus traffic monitor shows whether the recorder module receives messages via the communication buses or not. The counter runs from 0 to 255, one step a second. Any message received resets the counter. If the counter value remains 0, it indicates that messages are arriving at a rate higher than once a second.

The parity of the RS 232 C bus is presented as a number in front of its data transfer rate value. The number may be 0 (parity none) or 2 (parity even). The number of data bits is 8. The recorder does not approve of odd parity.

After a cold start-up the RS 232 C bus has no parity and the data transfer rate is 1.2 kBd. The other available baud rates are the same as those of the SPA bus. The data transfer rate is set in the same way as for the SPA bus.

PC programs

Two PC programs for MS-DOS or PC-DOS based microcomputers have been developed for the use together with the disturbance recorder. The programs facilitate parametrization of the module and unloading of recordings either via the RS 232 C port on the front panel or via the SPA bus. The PC programs are not part of the recorder delivery but they are available on request as optional products. The SPCR EVAL type designation includes the English language versions of both programs and a 3 m cable which connects the recorder module to a PC.

The first program is a easy-to-use communication program for operating the recorder module. The program runs using SPA protocol commands recognised by the recorder module. The program also transmits and receives messages based on the SPA protocol.

The second menu-driven program facilitates parameter setting and downloading of recordings. In addition, this program allows the curve forms unloaded from the recorder module to be presented on the PC screen, written down on paper or recorded on a disk.

The current versions of the two programs require a microcomputer with the following features:

- microcomputer IBM/PC, IBM/XT, IBM/AT or compatible
- at least 384 kB conventional RAM
- at least 1 MB XMS or free hard disk space
- display drivers:
  - EGA, VGA or SVGA colour display
  - Hercules single-colour display
  - Toshiba T2100/T3100 plasma display
  - AT & T single-colour display (Olivetti single-colour display)
  - MikroMikko 3 single-colour display
  - Wyse GDA single-colour display
- operating system MS-DOS 2.11 or later version.

Should a printer be used, it has to be a 9-pin IBM compatible or a 24-pin Epson LQ-2500 compatible version. Most of the 24-pin printers on the market are compatible with the Epson LQ-2500 printer.

MS-DOS is a registered trade mark of Microsoft Corp. IBM is a registered trade mark of International Business Machines Corp. PC-DOS, IBM/PC, IBM/XT, IBM/AT are registered trade marks of International Business Machines Corp.

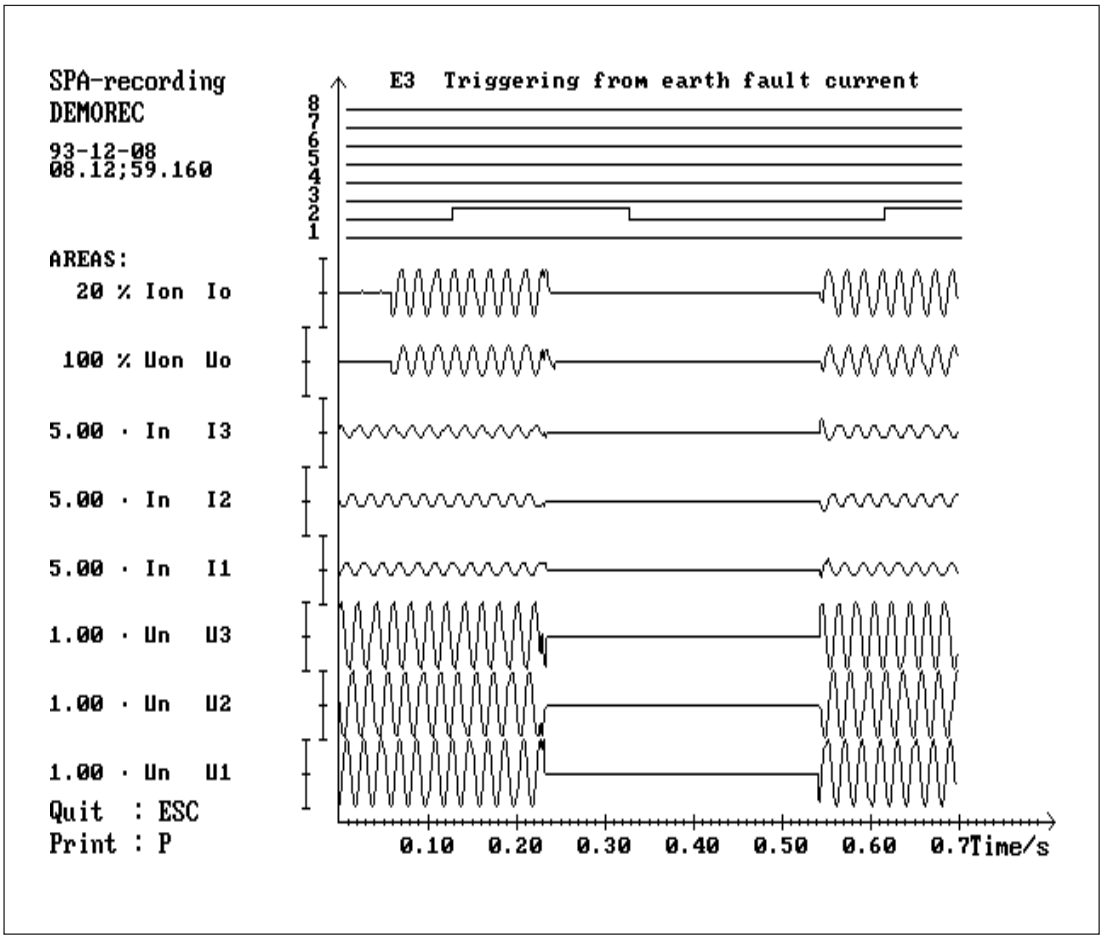


Fig. 4. Example of the curve display made by SPCR EVAL software.

Technical data

Number of input channels	8 analogue inputs 8 on/off inputs
Sampling frequency/channel	500 Hz (default)
A/D converter	11 bit
Time difference between sampling of adjacent input channels	250 µs (default)
Recording capacity	
- 1 MB SRAM	Max. 24 recordings Max. 224 blocks
- 4 MB SRAM (option)	Max. 26 recordings Max. 992 blocks (1 block = 1 recorded channel x 0.5 s)
Analogue channels	
Measuring ranges	
- Phase-to-phase voltages; analogue inputs 1…3	0.0…2.5 x U_n or 0.0…21 x U_n
- Phase currents; analogue inputs 4…6	0.0…2 x I_n or 0.0…20 x I_n
- Residual voltage; analogue input 7	0.0…102% U_n
- Neutral current, analogue input 8	0.0…20% I_n or 0.0…102% I_n
Measuring accuracy of individual samples (value >0.2 x range, f = 0…60 Hz)	±2%
Triggering limits:	
- Undervoltage condition; for analogue inputs 1…3	0.2…overvoltage condition x U_n
- Overvoltage condition; for analogue inputs 1…3	Undervoltage condition… …21 x U_n
- Overcurrent condition; for analogue inputs 4…6	0.0…20.4 x I_n
- Residual voltage condition; for analogue input 7	0.0…102% U_n
- Neutral current condition; for analogue input 8	0.0…102% I_n
- Status signal inputs	Triggering on rising or falling edge
Clock resolution	5 ms
Clock accuracy	<1 min/month
Optional PC program	SPCR EVAL (3 1/2" disk)
Ambient temperature	-10…+55°C
Storage temperature	-40…+70°C
EMC-Tests	
Fast transients IEC 255-22-4	2 kV, 5/50 ns
Electrostatic discharge IEC 255-22-2, class III	
- air discharge	8 kV
- contact discharge	6 kV

Connection of measuring signals

The pins of the PCB connector of the SPCR 8C27 module have been designated according to the table below. The signal names are the same as those used in the instruction manuals for the SPACOM relays.

Input	Terminal number	Name of signal in the SPACOM system
Analogue input 1	4a(8a)	Phase-to-phase voltage U_{12} (or IL1')
Analogue input 2	5a(8c)	Phase-to-phase voltage U_{23} (or IL2')
Analogue input 3	6a(9a)	Phase-to-phase voltage U_{31} (or IL3')
Analogue input 4	4c	Phase current I_{L1}
Analogue input 5	5c	Phase current I_{L2}
Analogue input 6	6c	Phase current I_{L3}
Analogue input 7	7a	Residual voltage U_0
Analogue input 8	7c	Neutral current I_0
Status signal inputs		
Status data 1	9c	Autoreclose initiation via AR2
Status data 2	10a	Autoreclose initiation via AR3
Status data 3	10c	Autoreclose initiation via AR1
Status data 4	11a	Autoreclose blocking and interruption via ARINH
Status data 5	11c *)	Circuit-breaker position via CBPOS
Status data 6	12a	
Status data 7	12c *)	Blocking of circuit-breaker closing via CBINH
Status data 8	13a	Selection of basic angle for E/F relays via BACTRL
Status data 5x	13c	
Status data 6x	14a *)	Blocking signal BS1
Status data 7x	14c	
Status data 8x	15a *)	Blocking signal BS2

5x…8x alternatives to status datas 5…8. Programming is made with resistors R49 (a, b, c, d) and R50 (a, b, c, d), see fig. 6 and 7. *) Factory programming.

Programming with W_ jumpers or PC poard

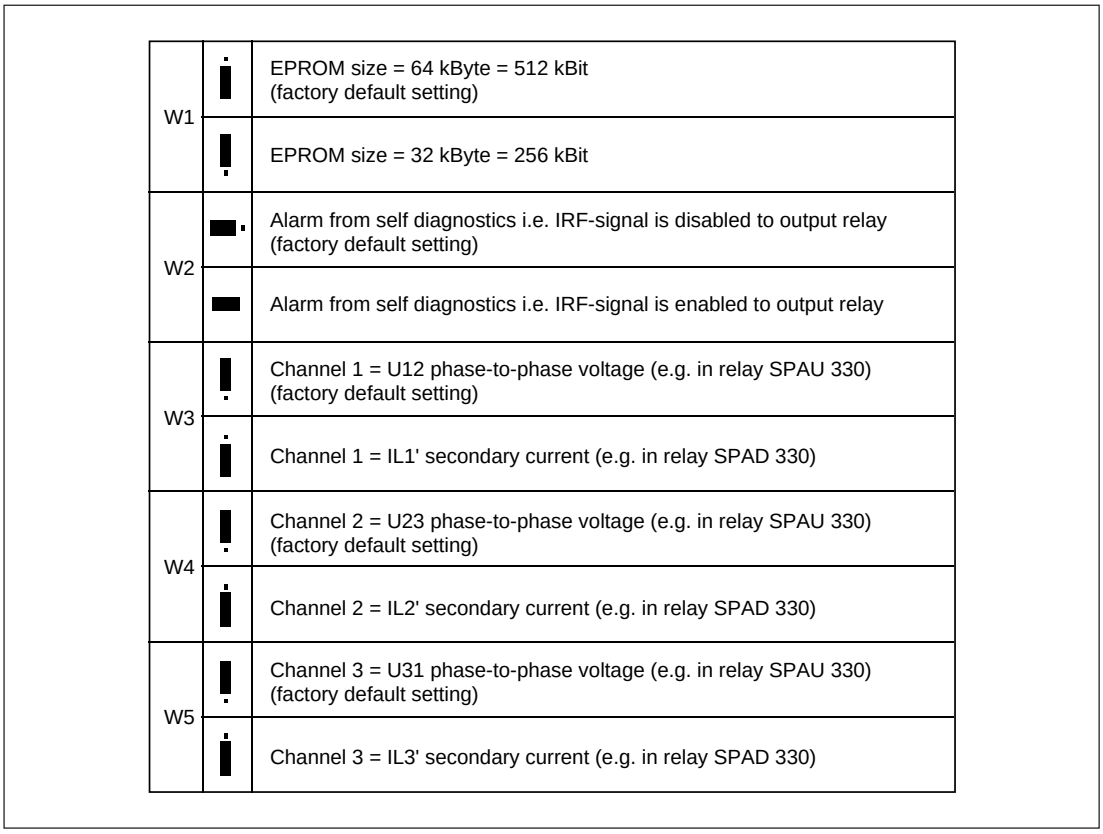


Fig. 5. Programming using the W_ jumpers.

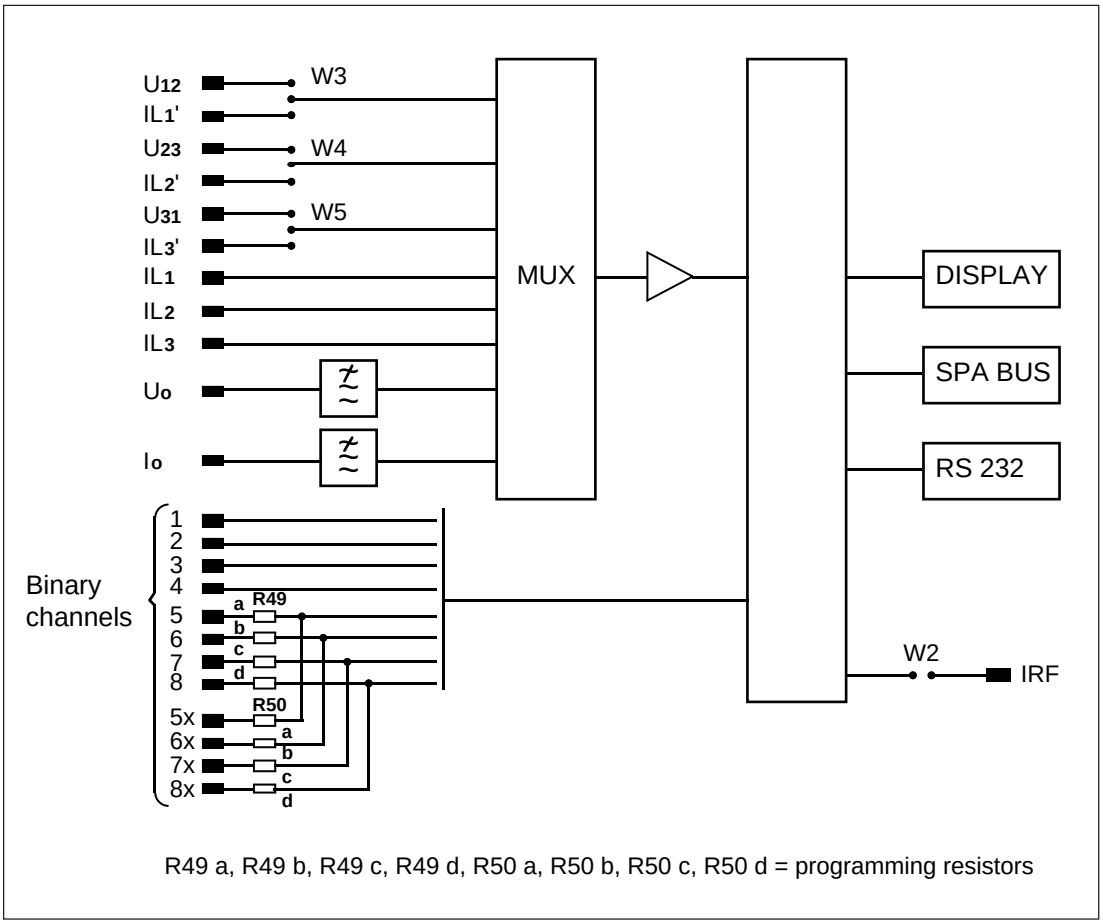


Fig. 6. Signal block diagram of the SPCR 8C27 recorder module.

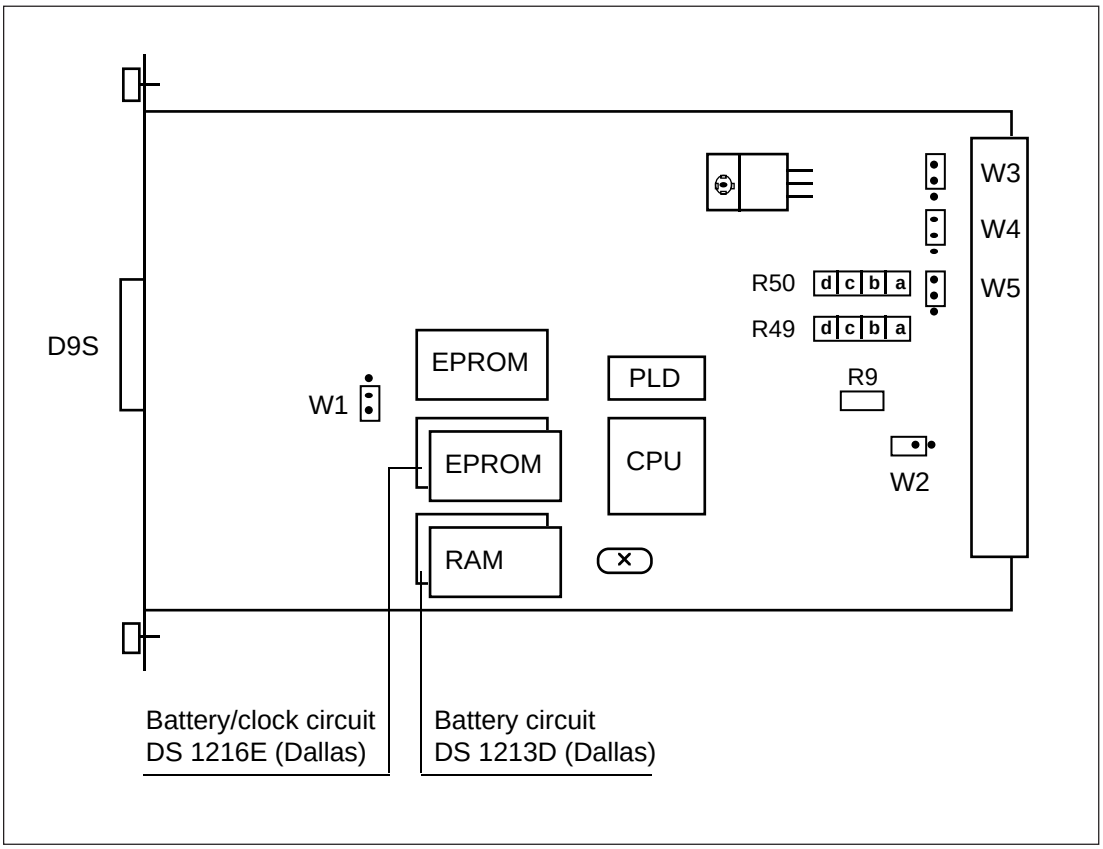


Fig. 7. PC board lay-out showing the location of jumpers and resistors.

Connection cables

Cables suited for connecting the disturbance recorder SPCR 8C27 to the output device, via the RS 232 C port of the front panel, are listed in the table below. The left column refers to the connection of the cable connector on the disturbance recorder side and the other columns to the connection of the output device or modem side connector. The pins not mentioned in the table are left unconnected.

SPCR 8C27	
9-pin connector	Signal and direction
1	DCD<---
2	RxD <---
3	TxD --->
4	DTR/+11 V--->
5	GND
6	DSR <---
7	RTS --->
8	CTS <---
9	No connection

IBM PC-AT or corresp.		IBM PC or correspond.		Modem	
9-pin connector	Signal and direction	25-pin connector	Signal and direction	25-pin connector	Signal and direction
-		-		-	
2	- - -> RxD	3	- - -> RxD	2	- - -> TxD
3	<- - - TxD	2	<- - - TxD	3	<- - - RxD
8	- - -> CTS	5	- - -> CTS	4	- - -> RTS
7	<- - - RTS	4	<- - - RTS	5	<- - - CTS
1, 4	<- - - DCD, DTR	8, 20	<- - - DCD, DTR	6	<- - - DSR
5	GND	7	GND	7	GND
6	<- - - DSR	6	<- - - DSR	8	<- - - DCD
6	- - -> DSR	6	- - -> DSR	20	- - -> DTR

A 9-pin male D-type connector is always used on the disturbance recorder side. When the disturbance recorder is connected to an IBM PC-AT or a compatible device, a 9-pin female D-type connector is normally used on the PC side. Correspondingly, a 25-pin femaleconnector is used for an IBM PC or a compatible device, and a 25-pin male connector for connecting the cable to a modem.

Examples of cables to be used between a modem and a PC are given in the table below. The left column refers to the connection of the cable in the cable on the modem side and the other columns to the connection of the cable on the output device side. The pins not mentioned are to be left unconnected.

Modem	
25-pin connector	Signal and direction
1	
2	TxD <- - -
3	RxD - - ->
4	RTS <- - -
5	CTS - - ->
6	DSR - - ->
7	GND
8	DCD - - ->
20	DTR <- - -

IBM PC-AT or corresp.		IBM PC or corresp.	
9-pin connector	Signal and direction	25-pin connector	Signal and direction
-		-	
3	<- - - TxD	2	<- - - TxD
2	- - -> RxD	3	- - -> RxD
7	<- - - RTS	4	<- - - RTS
8	- - -> CTS	5	- - -> CTS
6	- - -> DSR	6	- - -> DSR
5	GND	7	GND
1	- - -> DCD	8	- - -> DCD
6	<- - - DSR	20	<- - - DTR

A 25-pin male D-type connector is always used in the cable end towards the modem, whereas a 9-pin female D-type connector is normally used for the cable end connecting an IBM PC-AT or a compatible device. A 25-pin female D-type connector is used for the cable end connecting an IBM PC or a compatible device.

A cable type SPA-ZP17A_ is available for connection of the recorder module to a PC provided with a 9-pin D-type connector.

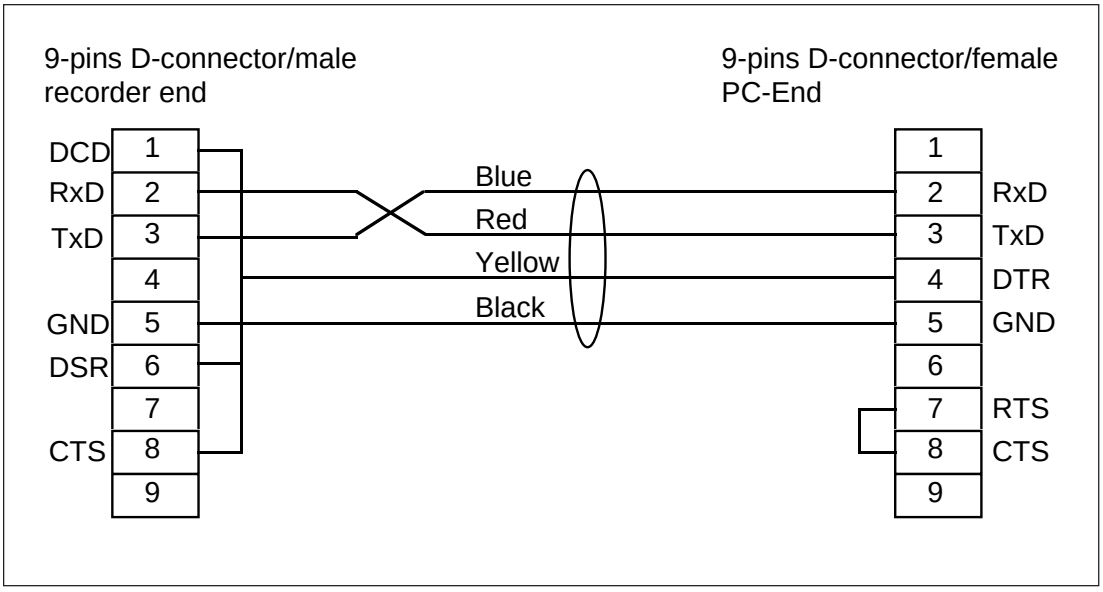


Fig. 8. Connection cable type SPA-ZP17A_.

Event codes

The event monitoring functions of the disturbance recorder memorize the code of each event and the time at which the event occurred. The triggerings of the recorder are regarded as events. On request the module prints out the event data over the SPA bus in the format: time (ss.sss, a so called short clock time) and event code. The event data transmitted over an RS 232 C bus includes the event code and a long-clock time (yy-mm-dd hh.mm; ss.sss).

The event codes of the module are E1…E16 and E50 and E51. The codes E1…E16 and the events represented by these can be included in or excluded from the event reporting by writing an event mask (V155) to the module. The event mask is a binary number coded to a decimal number. The event codes E1…E16 are represented by the numbers 1, 2, 4…32768. The event mask is formed by multiplying the above numbers either by 0 (event not included in the reporting) or 1 (event included) and adding up the numbers received (cf. the calculation of the checksum).

The event mask may take a value in the range 0…65535. The default value of the disturbance recorder is 65535, which means that all the events that have caused triggering are included in the event reporting. The events E52…E54 are included only in the data communication over the SPA bus. These codes are formed by the substation control data communicator and cannot be excluded from the event reporting.

The event codes of the disturbance recorder SPCR 8C27 are as follows:

Code	Event	Weighting coefficient	Default setting
E1	Triggering on overcurrent (I_{L1}, I_{L2} or I_{L3})	1	1
E2	Triggering on residual voltage (U_0)	2	1
E3	Triggering on neutral current (I_0)	4	1
E4	Triggering on overvoltage (U_{12}, U_{23} or U_{31})	8	1
E5	Triggering on undervoltage (U_{12}, U_{23} or U_{31})	16	1
E6	Triggering on change of signal 1 status	32	1
E7	Triggering on change of signal 2 status	64	1
E8	Triggering on change of signal 3 status	128	1
E9	Triggering on change of signal 4 status	256	1
E10	Triggering on change of signal 5 status	512	1
E11	Triggering on change of signal 6 status	1024	1
E12	Triggering on change of signal 7 status	2048	1
E13	Triggering on change of signal 8 status	4096	1
E14	Manual triggering or triggering on external control signal	8192	1
E15	Triggering on remote command (V21)	16384	1
E16	Automatic periodical triggering (V22, V23)	32768	1
	Defalt value of event mask V155		65535

E50	Unacknowledged reset (status word = 1)	*	-
E51	Overflow of event register (status word = 2)	*	-
E52	Temporary interruption in 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 event reporting
1 included in 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 substation data communicator.

Short parameter specification

The parameters readable and settable via serial communication can be grouped in the following way:

Programming mode

The parameters can be read while the recorder is in the measuring mode, but the parameters are chiefly set in the setting mode. The settting mode is entered and exit using parameter V17, see chapter "Setting mode" in the manual, (page 5).

Instantaneous values

The signals measured by the recorder module, i.e. the currents, voltages and status signals, are read using parameters I1…I8 and I10. The values obtained from the recorder module are values dating to the moment of measurement and scaled to the rated values I_n and U_n. The scaling factors can be altered using parameters M36 and M37, see passage "Rated values".

Maximum and minimum values supervision

The recorder module continuously searches for and records the max. and min. values of the monitored signals. The limit values can be read using parameters V2…V14. The values are scaled to the corresponding rated values.

A value or a value and a time tag are obtained on reading. The three phase-to-phase voltages and the three phase currents refer to the same measuring moment, i.e. for voltages when one of the voltages reaches its maximum or minimum value or for currents when one of the currents reaches its peak value. Only one value can be written for the different phase-to-phase voltages and the phase currents. When a new value is written, all the old values are reset. Writing always resets the time. If the search for a maximum and minimum value is to be started all over, the desired start level must be written to the variable.

The status channel contains only the time record of the last change. According to parameters S1 and S10, writing of any permitted character to variables V7…V14 will erase the time record.

Triggering conditions

For the recorder module to make a recording, the following conditions must be fulfilled:

- the recorder module is in the measuring mode
- enough unused recording memory is available
- a triggering condition is fulfilled
- a recording from the particular triggering condition is permitted, see variable V24
- the length of the recording from the particular triggering condition has been set greater than 0 blocks using parameter M27.

The triggering conditions are set with parameters S1…S6 and S10.

The triggering conditions for the analog signals are defined directly as current and voltage values.

The triggering conditions for the status signals are given as binary coded values, all eight signals with one parameter as described in chapter "Displayed data/Status signals" of the manual, (page 9).

Triggering from a status signal can be obtained from the rising edge or the falling edge of a status signal as defined with parameter S10. Parameter value 0 = triggering on falling edge and parameter value 1 = triggering on rising edge. The triggering conditions for all the eight channels 1, 2, 3,…8 are given in the same parameter one by one after each other. The setting 00001111, for instance, means that the channels 1…4 are triggered on a falling edge and the channels 5…8 on a rising edge.

Periodical triggering

The recorder module can be set to automatically execute triggerings at certain time intervals, i.e. a so called periodical triggering. The required time interval in seconds is written to variable V22. When a new value is written to parameter V22, the timer starts counting seconds from the set value backwards. When the counter reaches zero, a triggering occures, the counter setting is re-established and the backwards counting starts again. The counter value can be read from parameter V23. The counter value can be altered by writing a new value to parameter V23.

If the value of parameter V22 is 0, no periodical triggering is obtained.

Remote triggering

The recorder module can be triggered via the serial bus using parameter V21. The parameter is first given the value 0 which then is changed to 1.

Recording from triggering

The triggerings from which a recording is permitted are selected with parameter V24. The parameter is set in the same way as parameterV155, the setting of which is described in chapter "Event codes" (page 17).

The length of the recording is defined with parameter M27, separately for each triggering. Note! The history part of each recording has the same length for all triggerings. If attempts are made to set history parts of different lengths, the recorder module, however, equalizes the history parts for the different triggerings. The length of the history part is determined by the last setting value. When parameter M27 is read the lengths of all triggerings are obtained at the same time, but when new values are written the values must be given separately for each triggering. The message to be written shall have the form: A B Ex, where A denotes the history length in blocks, B denotes the length of the recording in blocks, counted from the triggering moment and Ex is the code of the concerned triggering. For instance, by writing 1 5 E1 the recorder module is programmed to make a six block recording including one history block on triggering on overcurrent (E1). Further it must be noted that the values A and B together must not exceed the maximum recording capacity of the recorder module.

If a recording has been made from one of the triggerings E1…E5 of the analog channels, a new triggering of the same channel is prevented for a time interval defined by parameter M35. However, any other triggering than the one which started the last recording, starts an immediate recording.

Event reporting

The triggerings which are to be included in the event reporting are defined with parameter V155, i.e. the event mask parameter. This parameter does not affect the recording procedure. The event register can be read once with the L command. If, for instance, a fault arises in the communication system, the contents of the event register once read with the L command can be re-read by using the B command. If required, the B command can be repeated.

Range selections

Each analogue quantity, except for the residual voltage, have two selectable measuring ranges, which are selected with parameter M34. If the signal to be measured exceeds the measuring range, the measured signal will be cut. The form of the parameter is Ix Io Ux, where Ix denotes the ranges of the phase current channels, Io the range of the residual current channel and Ux the ranges of the voltage channels. The different phases of the voltage channels and the current channels cannot be given different measuring ranges. If the recorder module is going to be plugged into a differential relay the voltage channels are transformed into current channels by means of jumpers, in which case Ux determines the measuring range for the low-voltage side phase currents.

M34	Phase currents (Ix)	I_0 current (I_0)	Phase-to-phase voltages (Ux)
0 0 0	0…20 x I_n	0…20% I_n	0…2.5 x U_n
0 0 1	0…20 x I_n	0…20% I_n	0…21 x U_n
0 1 0	0…20 x I_n	0…102% I_n	0…2.5 x U_n
0 1 1	0…20 x I_n	0…102% I_n	0…21 x U_n
1 0 0	0…2 x I_n	0…20% I_n	0…2.5 x U_n
1 0 1	0…2 x I_n	0…20% I_n	0…21 x U_n
1 1 0	0…2 x I_n	0…102% I_n	0…2.5 x U_n
1 1 1	0…2 x I_n	0…102% I_n	0…21 x U_n

Rated values

The rated values used for scaling the recorder module can be altered with parameters M36 and M37. The values of parameter M36 function on the normal ranges (the corresponding range of M34 = 0) and M37 on the alternative ranges (the corresponding range of M34 = 1). The values correspond to the value of the A/D converter at a 100% input signal level. By changing these values only the scaling of the measuring range is affected and changes are not to be recommended.

Management of recording resources

The default setting of the recorder module permits no further recordings, when the capacity of the recording memory has been fully used. With parameter M38 the recorder module can, however, be given a mode of function, where the recorder module automatically creates the necessary amount of free recording capacity by erasing the oldest recordings from the memory.

The currently available amount of free recording memory of the recorder module can be read with parameter M32.

Both parameters have the form: REC CHA BLO, where REC is the number of free recording headers. Each recording needs one recording header. CHA denotes the number of free channel headers. Each recording requires as many channel headers as the number of monitored channels (all channels = 9 pcs). BLO denotes the number of recording blocks. The number of recording blocks needed per channel is defined with parameter M27.

Note! The recording resources needed for collecting history parts are not seen in parameter M32, unless the recorder module is in the setting mode. Therefore the recorder module may be able to perform a recording, although the recording resource seems to be zero.

Recorder mode

Parameter C can be used for determining, if the recorder module has performed an unreset start or if the event register is full (overflow). Both states are also seen in the reading of the event buffer. The states are reset by writing 0 to the parameter.

The number of recordings made by the recorder module (cumulative counter) and the number of recordings currently in the memory can be read with parameter V1. Any value written to the parameter makes the cumulative counter show the number of recordings still in the memory.

With parameter V25 the state of the recorder module can be read. The V25 parameter shows whether the recorder module is in the measuring mode, whether the recorder module has succeeded in collecting the necessary number of history parts and whether the recorder module currently is making a recording. The collection of history recordings is explained in chapter "Measuring mode" (page 6).

Unloading of recordings

The recordings are unloaded via the bus interface on the front panel using parameters V20 and V15. The recordings are unloaded via the SPA bus using parameters V20, M28…M31.

The recordings are maintained in the memory of the recorder module after they have been unloaded. The recordings are erased with parameter V16.

Data included into recordings

The monitored quantities of the recorder module which are to be included in the recording are determined with parameter M33. The default setting is that all the measured quantities (channels) are included in the recording. Those channels which are not used (no measurement) can be excluded from the recording with parameter M33. Any excluded channel will obtain a fixed value of zero, which will increase the recording capacity of the module. If, for instance, only half of the channels are included in the recording the recording capacity is doubled. The parameter value is written in binary form as follows:

Channel	Weighting coefficient
1 (U12)	1
2 (U23)	2
3 (U31)	4
4 (I1)	8
5 (I2)	16
6 (I3)	32
7 (U_0)	64
8 (I_0)	128
9 (8 status channels)	256

Further, among other things the following settable data are part of the recording:

- Main heading of the recording (M21)
- headings of the measuring channels (M22)
- primary values of the measured quantities (M23…M25)

These values are not utilized by the recorder module and they do not affect the function of the recorder module in any other way than that they are included in the recordings. Parameters M21 and M22 define the heading of the recording and the headings of the various channels (quantities). When parameter M22 is read all the channel headings are obtained at once, but when the headings are written the headings of the channels are preferrably written one by one. The write message should be composed of the channel number and the channel heading. Example: 4 L1, which means that channel 4 will obtain the heading L1. The characters < > : / nor & must not be included in the headings written by parameters M21 and M22. The primary values of the corresponding quantities are written with parameters M23…M25.

Communication settings

The communication address of the recorder module is given with V200 and the data transfer rate with parameter V201. The same parameters are used for both communication ports (the front panel port and the SPA port). Parameter V201 affects only the settings of the communication port used for setting, while the other port remains unchanged.

Other parameters

Parameter V102 can be used for restarting the recorder module.

Parameter V165 can be used for testing the self-supervision function (IRF) of the recorder module.

Parameter F can be used for reading the type designation and parameter V205 for reading the program version indicator of the recorder module.

Parameters T and D are used for setting the date and time of the recorder module.

Setting example

The recorder module has been inserted into the feeder terminal type SPAC 531 C.

Parameter	Parameter specification	
S1	7	Status signals 1…3 are used for triggering
V24	224	Recording permitted from triggering of status signals 1…3 (32 + 64 + 128 = 224)
M21	K5 plant	Main heading of recording (cubicle name)
M22	4 I1	Channel heading of recording
M22	5 I2	Channel heading of recording
M22	6 I3	Channel heading of recording
M22	7 U_0	Channel heading of recording
M22	8 I_0	Channel heading of recording
M23	20	Primary value of voltage (kV)
M24	1000	Primary value of current (A)
M25	70	Primary value of earth-fault current (A)
M27	1 4 E6	Length of recording
M27	1 4 E7	Length of recording
M27	1 1 E8	Length of recording
M33	504	Selection of channels (the voltage channels are excluded)
M34	0 1 0	For channel I_0 the bigger range is selected
M35	10	Dead time between triggerings
M38	2 12 60	Old recordings are deleated so that capacity is always available for two new recordings

In the above example the recorder module has been inserted into a feeder terminal type SPAC 531 C. On operation the protection relay modules initiate autoreclose functions via the starting signals AR1…AR3. By programming the recorder module to be triggered via these signals (status signals 1…3) a recording is obtained any time the relay operates.

The lengths of the recordings triggered with the AR2 and AR3 signals are set to be 2.5 s of which 0.5 s is history. This time normally reaches over one high-speed autoreclosure. The length of the recording triggered with the AR1 signal is shorter (0.5 s + 0.5 s) because the AR1 signal is (normally) obtained from the high-set stage of the overcurrent protection module.

The phase-to-phase voltages are not measured, which increased the available recording capacity with approx. 30%. Thus the total recording capacity will be 37 blocks, that is max. 7 recordings. Further only the last five recordings are kept in the recording memory, as selected with parameter M38. The recorder module always provides recording capacity for two recordings, i.e. 2 x 6 channels x 5 blocks = 60 blocks.

Remote transfer data

In addition to the event codes it is possible to read over the SPA or RS 232 C bus all the input data (I data), setting values (S data), recorded data (V data) and some other data of the disturbance recorder. Further, part of the information can be altered with commands given over the SPA bus.

All information cannot be read or written over both buses. The table shows the bus over which reading or writing is permitted.

All data are available on the SPA protocol based channel 0, except for the unloading of recordings over the SPA bus.

Data	Code	Data direct.	Bus	Values
Measured value of the U_{12} voltage	I1	R	SPA/RS	0…2.558 x U_n or 0…21.3 x U_n
Measured value of the U_{23} voltage	I2	R	SPA/RS	0…2.558 x U_n or 0…21.3 x U_n
Measured value of the U_{31} voltage	I3	R	SPA/RS	0…2.558 x U_n or 0…21.3 x U_n
Measured value of the I_{L1} current	I4	R	SPA/RS	0…20.46 x I_n or 0…2.046 x I_n
Measured value of the I_{L2} current	I5	R	SPA/RS	0…20.46 x I_n or 0…2.046 x I_n
Measured value of the I_{L3} current	I6	R	SPA/RS	0…20.46 x I_n or 0…2.046 x I_n
Measured value of the U_0 voltage	I7	R	SPA/RS	0…102.3% x U_n
Measured value of the I_0 current	I8	R	SPA/RS	0…20.46% x I_n or 0…102.3% I_n
States of the binary inputs, binary coded decimals	I10	R	SPA/RS	0…255
Binary input condition mask, binary coded decimals	S1	R, W	SPA/RS	0…255. Determines the channels which are to be used for triggering. Default value: 255
Overvoltage condition	S2	R, W	SPA/RS	[S3]…999.999 x U_n Default value: 1.20 x U_n S2 and S3 cannot be cross-set
Undervoltage condition	S3	R, W	SPA/RS	0.201…[S2] x U_n Default value: 0.80 x U_n
Overcurrent condition	S4	R, W	SPA/RS	0…999.9 x In Default value 2.00 x I_n
Residual overvoltage condition	S5	R, W	SPA/RS	0…999.9% x U_n Default value: 20.0 % x U_n
Neutral overcurrent condition	S6	R, W	SPA/RS	0…999.9% x I_n Default value: 5.0% x I_n
Triggering of the binary input channels	S10	R, W	SPA/RS	XXXXXXXX, where the X letters stand for the binary input channels 1…8. X = 1 trig. on rising edge X = 0 trig. on falling edge Default value: 11111111
Total number of recordings	V1	R, X	SPA/RS	AB, where A = total number of recordings made B = number of recordings currently in memory Writing any value makes A = B in the device

Data	Code	Data direct.	Bus	Values
Supervision of the maximum value of the phase-to-phase voltage	V2	R, X	SPA/RS	U_{12}, U_{23}, U_{31} date time Voltage notation x U_n Date: yy-mm-dd Time: hh.mm;ss.sss
Supervision of the minimum value of the phase-to-phase voltage	V3	R, X	SPA/RS	U_{12}, U_{23}, U_{31} date time Also see command V2
Supervision of the maximum value of the phase current	V4	R, X	SPA/RS	I_{L1}, I_{L2}, I_{L3} date time Current notation x I_n Also see command V2
Supervision of the maximum value of the residual voltage	V5	R, X	SPA/RS	U_0 date time Voltage notation % U_n Also see command V2
Supervision of the maximum value of the neutral current	V6	R, X	SPA/RS	I_0 date time Current notation x I_n Also see command V2
Time of activation of binary input channels 1…8	V7… V14	R, X	SPA/RS	Date time Writing clears date and time
Unloading of oldest recording	V15	R	RS	Writes the oldest recording to the RS 232 C port
Erasing of oldest recording	V16	W	SPA/RS	When V16 changes from 0 to 1, the oldest recording is deleted
Selection of setting mode	V17	X	SPA/RS	0 = exit setting mode 1 = enter setting mode
Selection of unloading mode	V20	R, X	SPA	0 = no unloading via the SPA bus 1 = unloading via the SPA bus using commands M28…M31. After initiation of unloading the variables M29 and M30 are reset
Remote triggering	V21	R, X	SPA/RS	Change from 0 to 1 causes triggering via event E15
Setting of time interval for periodical recording	V22	R, X	SPA/RS	0…40 000 000 seconds 0 = triggering disabled
Timer for the periodical triggering	V23	R, X	SPA/RS	1…40 000 000 seconds The timer counts down-wards.
Selection of events that are to trigger recordings	V24	R, X	SPA/RS	0…65535, see chapter "Event codes"
Measurement status	V25	R	SPA/RS	0…65535 0 = inoperative (not in measuring mode) 1 = measuring mode, history collecting not ready 3 = measuring mode, history collected 5 = currently recording, uncollected history 7 = currently recording

Data	Code	Data direct.	Bus	Values
Resetting of recorder	V102	X	SPA/RS	1 = warm start-up 2 = cold start-up
Event mask word for event logging	V155	R, W	SPA/RS	0…65535, see chapter "Event codes"
Activation of self-supervision output (IRF)	V165	X	SPA/RS	0 = reset of output 1 = activation of output
Recorder module address	V200	W	SPA/RS	001…899
Data transfer rate	V201	W	SPA	20.3, 21.2, 22.4, 24.8 or 29.6 kBd using 7 data bits, even parity and one stop bit. The first figure means even parity.
		W	RS	0.3, 1.2, 2.4, 4.8, 9.6 or 19.2 kBd using 8 data bits, no parity and one stop bit.
		W	RS	20.3, 21.2, 22.4, 24.8, 29.6 or 219.2 kBd using 8 data bits, even parity and one stop bit. The first figure means even parity.
Program version code	V205	R	SPA/RS	E.g. NDR110
Main heading of recording	M21	R, X	SPA/RS	Character string; max. 64 characters. *Warning!* *Do not use characters reserved by the SPA protocol.*
Channel headings	M22	R, X	SPA/RS	When read, the channel titles are sent in a row separated by slashes. Max. title length is 6 characters. When written, the data field contains channel number and title separated by a blank. One title can be set for each message.
Rated voltage (kV), peak value	M23	R, X	SPA/RS	0…9999.999
Rated current (A), peak value	M24	R, X	SPA/RS	0…9999.999
Rated neutral current (A), peak value	M25	R, X	SPA/RS	0…9999.999 Also see M23
Length of the recordings	M27	R, W	SPA/RS	A B Ex, where A = history length in blocks B = recording length after triggering in blocks. Event codes E1…E16

Data	Code	Data direct.	Bus	Values
Reading of the recording headline of the oldest recording	M28	R	SPA	Ex B C date time, where Ex = letter E and event number B = history length [blocks] C = rec. length [blocks] date = yy-mm-dd time = hh.min;ss.sss Also see command V20.
Block index for unloading of recording via the SPA bus	M29	R, X	SPA	1…blocks in recording
Line index for unloading of recording via the SPA bus	M30	R, X	SPA	1…250 data sample lines
Reading of recording line	M31	R	SPA	Example: >1 R1/10 M31:xx 1/10 = channels 1 to 10 Channels 1…8 = analogue signals Channel 9 = empty Channel 10 = 8 pcs binary signals
Available free recording memory	M32	R	SPA/RS	REC CHA BLO
Selection of channels to be monitored	M33	R, W	SPA/RS	0…511, used as bitmask
Gain setting for the analogue channels	M34	R, W	SPA/RS	Ixgain Iogain Uxgain Three blank separated boolean numbers (0/1). Default value 0 0 0
Dead time between triggerings of the same triggering source	M35	R,X	SPA/RS	0…1000 seconds Default setting: 120 s
Rated value factor for the analogue channels	M36	R,W	SPA/RS	8 blank separated numbers at range 1…65535. Channel order in the vector is U12, U23, U31, IL1, IL2, IL3, U0 and I0
Alternative rated value factor for the analogue channels	M37	R,W	SPA/RS	See M36 command
Recording resource reserver	M38	R,W	SPA/RS	REC CHA BLO This command is used to set the minimum amount of recording memory that the recorder tries to maintain available.
Sampling rate of recording	M40	R	SPA/RS	Rate of each channel command See M31 command
Type designation of the recorder module	F	R	SPA/RS	SPCR 8C27
Short time setting	T	X	SPA/RS	00.000…59.999 s Only to transmission address 900

Data	Code	Data direct.	Bus	Values
Long time reading or setting	T	R, X	SPA/RS	date = yy-mm-dd time = hh.min;ss.sss To the recorder's own address
Long time setting	D	X	SPA/RS	Equal to variable T To transmission address 900 of all modules
Reading of event register	L	R	SPA/RS	Time (short/long), channel number and event code Example: 34.630 0E7/10.780 0E1 This is in long format when reading via the RS bus (date included)
Re-reading of event register	B	R	SPA/RS	See previous code (L)
Reading of module status data	C	R	SPA/RS	0 = normal state 1 = module has restarted 2 = overflow of event register 3 = events 1and 2 together
Resetting of module status data	C	X	SPA/RS	0 = resetting

Explanation of the direction codes:
R = data to be read from the module
W = data to be written in the setting mode (V17 = 1)
X = data to be written (does not require setting mode)

Maintenance

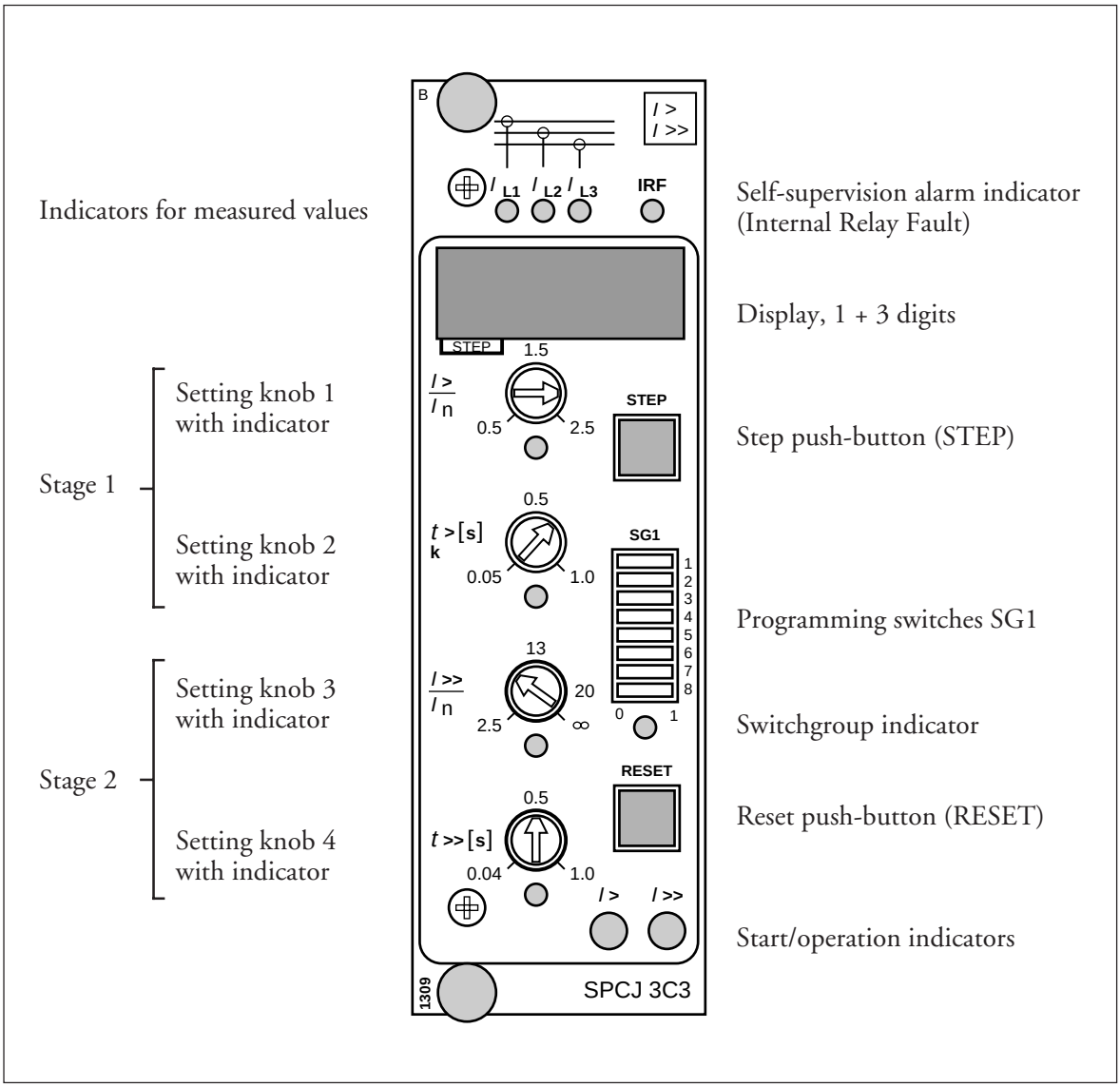
The recorder module is provided with battery support for the clock circuit and the data memory. The calculated life time for the batteries is 10 years but proper operation of the recorder module is guaranteed if the batteries are replaced every fifth year.

The batteries are mounted on IC sockets.

Clock back-up battery type	Dallas DS 1216 E
Data memory battery type	Dallas DS 1213 D

General characteristics of C-type relay modules

User´s manual and Technical description



1MRS 750328-MUM EN

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Data subject to change without notice

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.

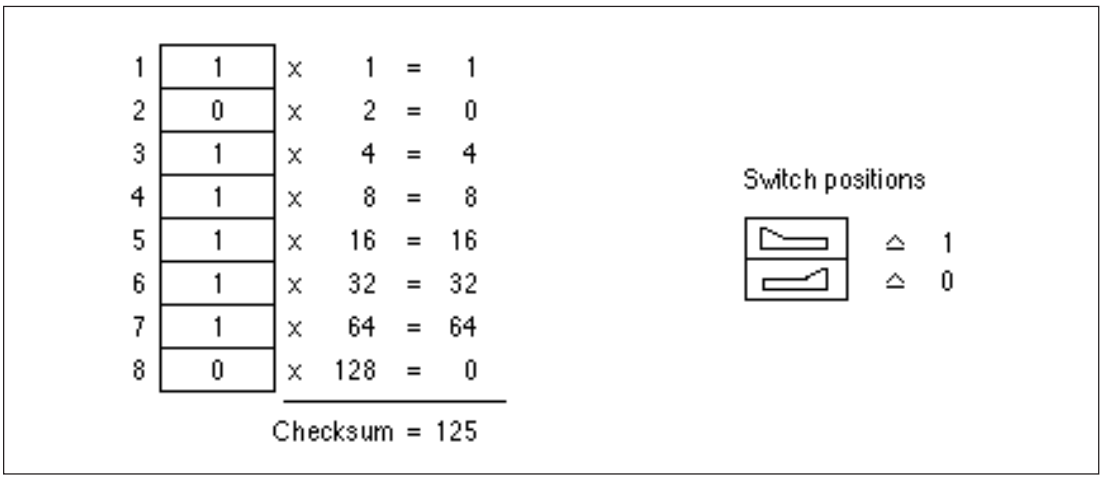


Fig. 2. Example of calculating the checksum of programming switchgroup SG1.

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.

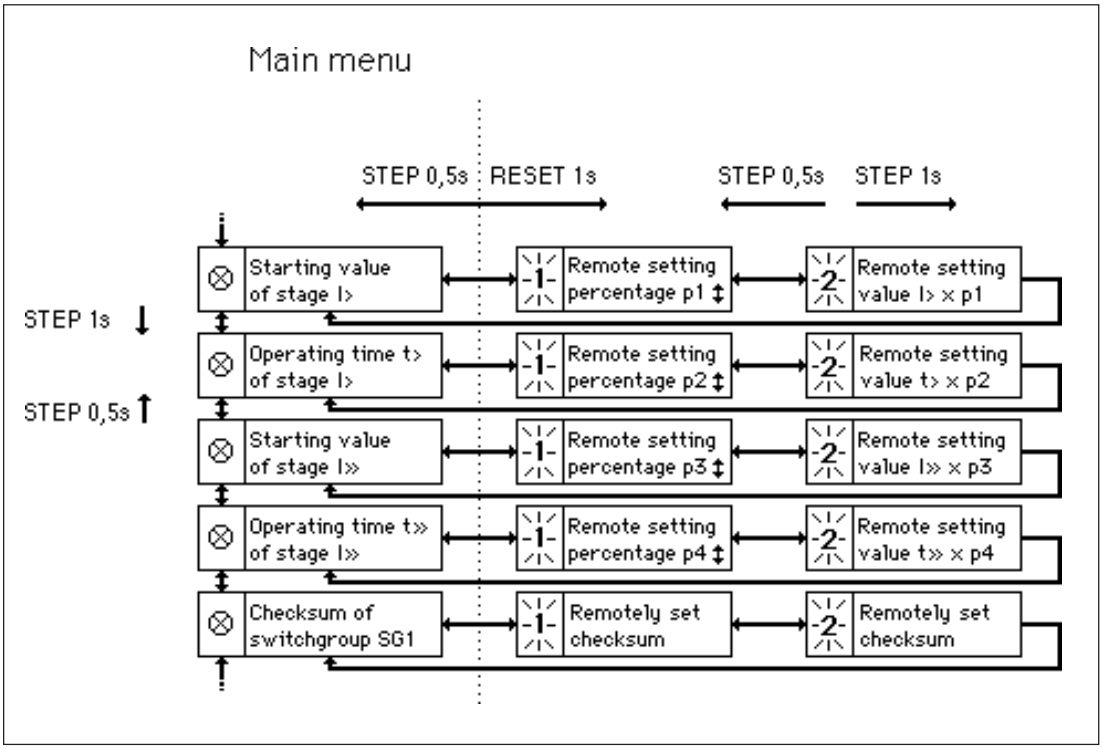


Fig. 3. Example of the main and submenus for the settings of the overcurrent relay module SPCJ 3C3. The settings made with the setting knobs are in the main menu and they are displayed by pressing the STEP button. In addition to the setting knob settings the main menu contains the measured current values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

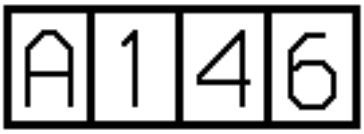
A set value is stored in the memory by pressing the push-buttons STEP and RESET simultaneously. In practice the RESET button must be pressed slightly in excess of the STEP button. Return from the setting mode to the main menu or submenu is possible by pressing (for about 10 s) the RESET button until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

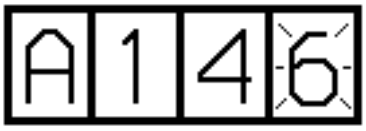
Example 1:

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.

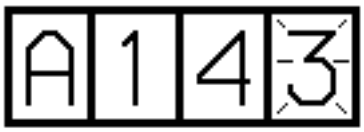
a)
Press push-button STEP until register address A appears on the display.



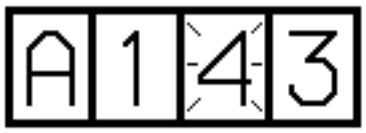
b)
Press the RESET button for about 10 s until the right most digit starts flashing.



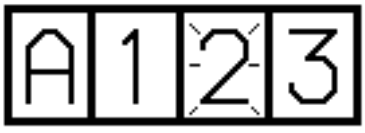
c)
Press the STEP button repeatedly to set the digit to the value desired.



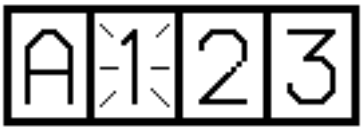
d)
Press the RESET button to make the middle of the green digits flash.



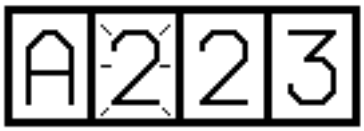
e)
Set the middle address digit by means of the STEP button.



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

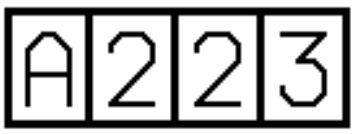


g)
Set the digit by means of the STEP button.



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.

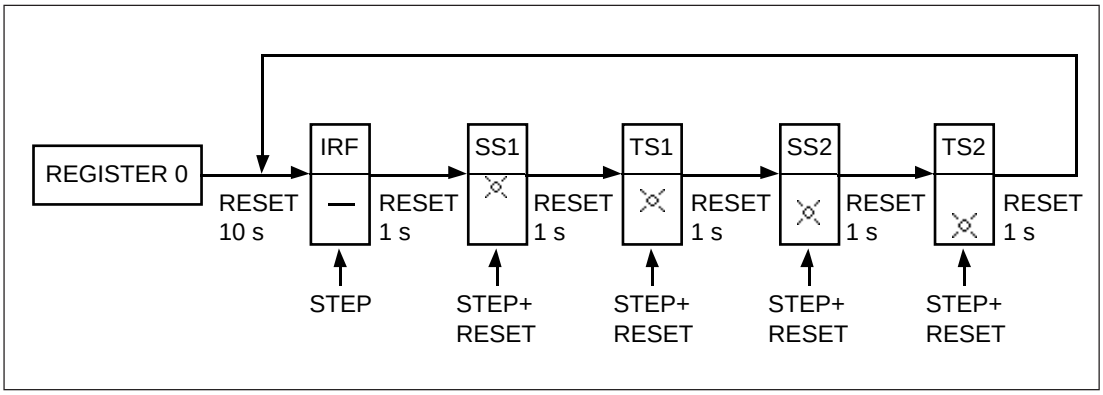


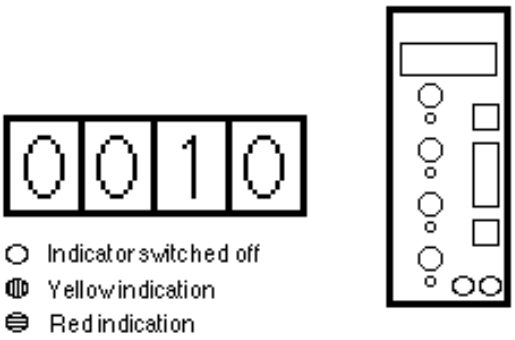
Fig. 4. Sequence order for selecting the output signals in the Trip-test mode.

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.

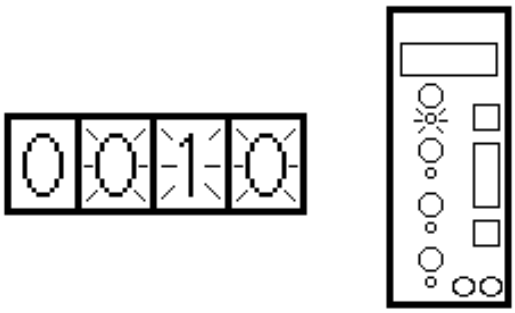
Example 2:

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

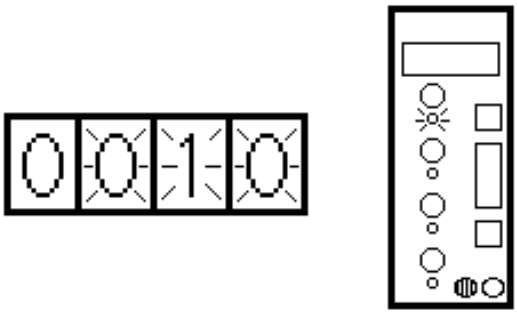
a)
Step forward on the display to register 0.



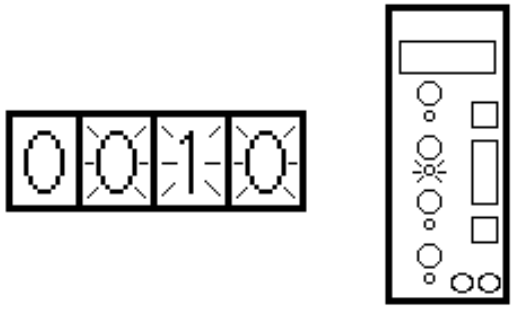
b)
Press the RESET button for about 10 seconds until the three green digits to the right and the LED indicator of the uppermost setting knob start flashing.



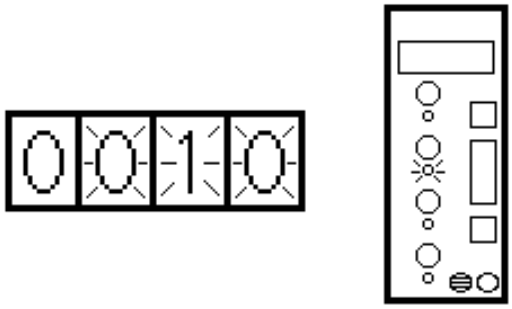
c)
Press the push-buttons RESET and STEP simultaneously. Then the starting of stage 1 (e.g. the I>-stage of the overcurrent module SPCJ 3C3) is activated and, simultaneously, the indicator of the stage starts glowing yellow.



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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