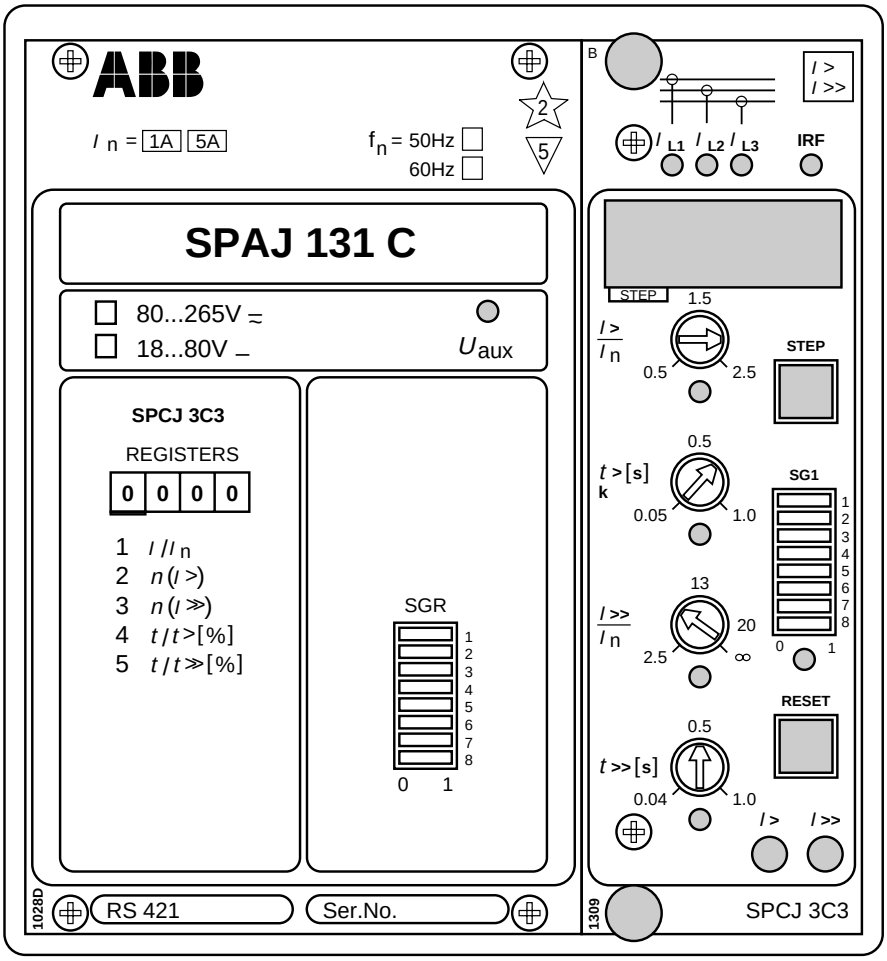
SPAJ 131 C
Overcurrent relay

User´s manual and Technical description



ABB

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Overcurrent relay

Contents

The complete manual for the three-phase overcurrent relay SPAJ 131 C includes the following partial manuals:

Overcurrent relay SPAJ 131 C, general description	1MRS 750660-MUM EN
Three-phase overcurrent relay module SPCJ 3C3	1MRS 750602-MUM EN
General characteristics of C-type relay modules	1MRS 750328-MUM EN

Features

Three-phase low-set phase overcurrent stage with definite time or inverse time characteristic

High-set phase overcurrent stage with definite time characteristic

Both overcurrent stages can be blocked by an external control signal

Output relay functions freely configurable for desired operation

Flexible adaptation of relay to specific applications

Local numerical display of setting values, measured values and recorded fault values

Serial interface for two-way data communication over fibre-optic bus between relay and substation and/or remote control systems

Continuous self-supervision of hardware and software, including auto-diagnostics

Application

The overcurrent relay SPAJ 131 C is designed to be used for two-stage phase overcurrent protection of distribution feeders, large low-voltage motors, high-voltage motors, medium-sized and large generators and power transformers. The relay can be used both as main protection relay and back-up protection relay.

The relay has two protection stages: a low-set overcurrent stage I> and a high-set overcurrent stage I>>. The low-set stage operates with definite-time characteristic or with inverse-time characteristic, while the high-set stage operates with definite time characteristic only.

The overcurrent relay is provided with five output relays, of which four are freely configurable for the desired function. Two of the output relays have heavy-duty contacts capable of directly controlling a circuit breaker.

Description of operation

The overcurrent relay SPAJ 131 C is a secondary relay that is connected to the current transformers of the protected object. The relay can be used for single-phase, two-phase or three-phase overcurrent protection. The overcurrent relay continuously measures the phase currents of the object to be protected. On the occurrence of a fault the overcurrent relay generates an alarm signal, trips the circuit breaker or starts external auto-reclose functions, in accordance with the current application.

When the phase current exceeds the set start value I> of the low-set stage, the overcurrent relay starts. When, at definite time operation, the set operate time t> or, at inverse definite minimum time (IDMT) operation, the calculated operate time t>, expires, the relay operates. In the same way the high-set stage starts once its set start value I>> is exceeded and, when the set operate time t>> expires, the relay operates.

The low-set stage of the overcurrent relay can be given either definite-time or inverse-time characteristic. At inverse time characteristic four inverse time curve sets with different slopes are available: Normal inverse, Very inverse, Extremely inverse and Long-time inverse. These curve sets comply with the BS 142 and IEC 60255 standards.

The start signals from the overcurrent relay are obtainable as contact functions. The start signal can be used, for instance, for blocking cooperating protection relays.

The relay contains one optically isolated logic input for incoming external control signals, generally blocking signals.

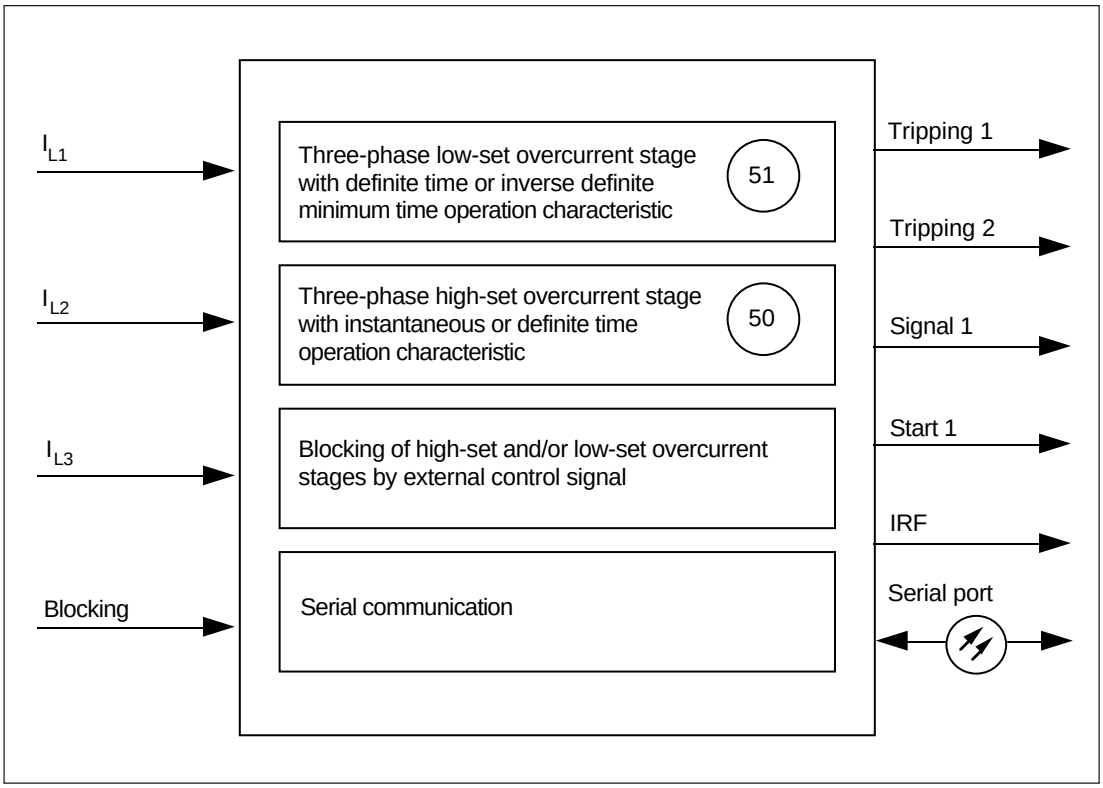


Fig. 1. Protection functions of the overcurrent relay SPAJ 131 C. The encircled numbers refer to the ANSI (=American National Standards Institute) number of the concerned protection function.

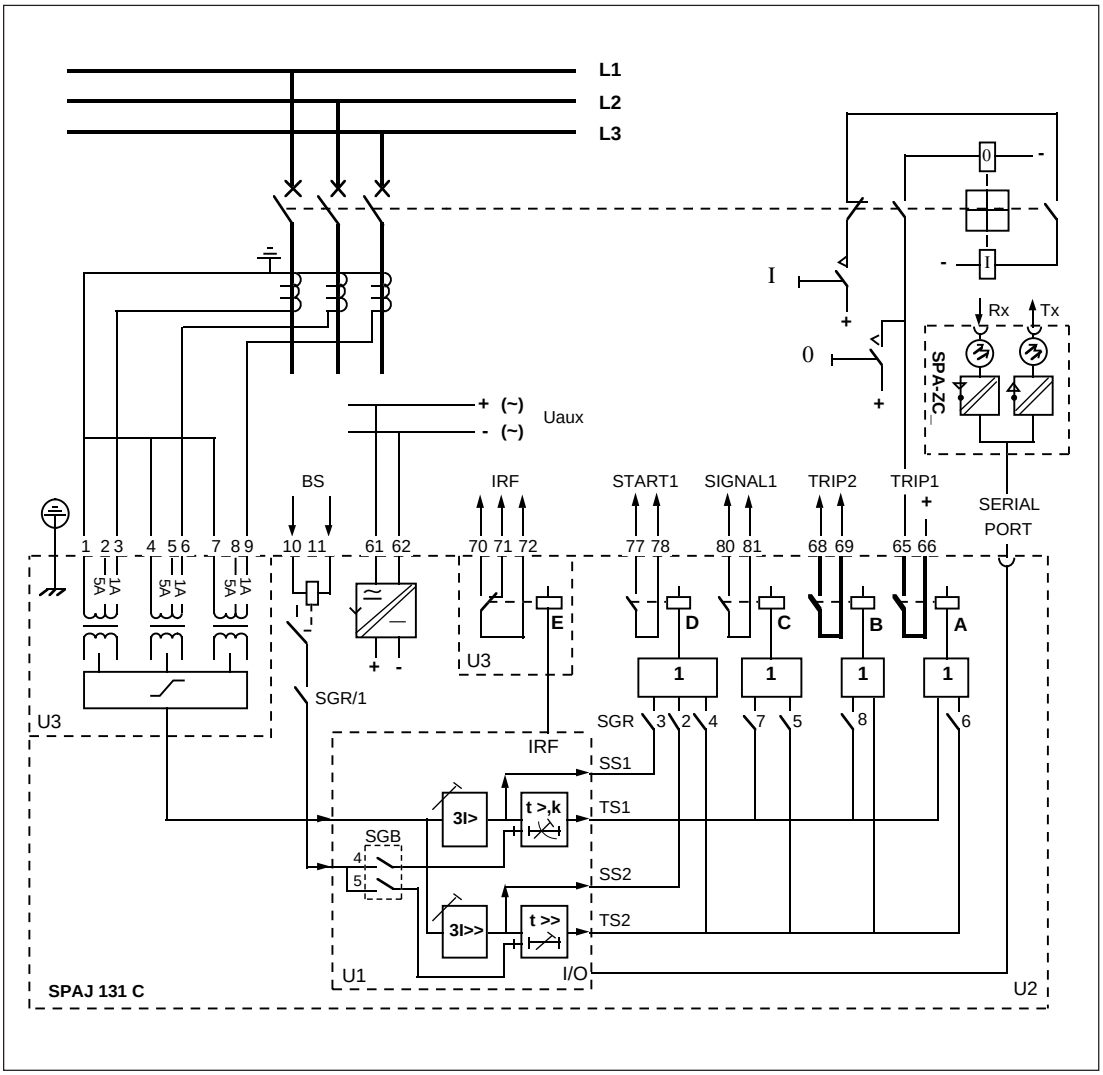


Fig. 2. Connection diagram for the three-phase overcurrent relay SPAJ 131 C.

U_{aux}	Auxiliary voltage
A,B,C,D,E	Output relays
IRF	Self-supervision function
BS	Blocking signal
SS	Start signal
TS	Trip signal
SGR	Switchgroup for configuring trip and alarm signals
SGB	Switchgroup for configuring blocking signals
TRIP_	Trip output
SIGNAL1	Signal on relay operation
START1	Start signal or signal on relay operation
U1	Three-phase overcurrent relay module SPCJ 3C3
U2	Power supply and I/O module SPTU 240S1 or SPTU 48S1
U3	I/O module SPTE 3E4
SERIAL PORT	Serial communication port
SPA-ZC_	Bus connection module
Rx/Tx	Optical-fibre receiver terminal (Rx) and transmitter terminal (Tx) of the bus connection module

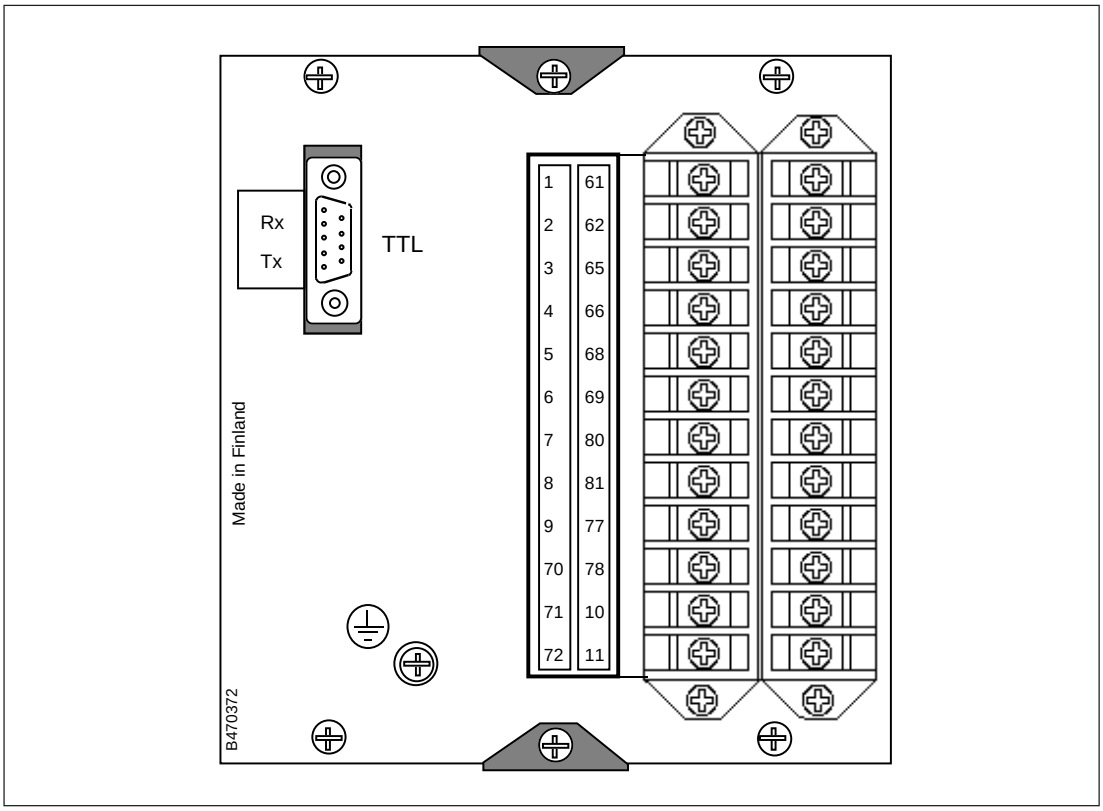


Fig.3. Rear view of the overcurrent relay SPAJ 131 C

Specification of input and output terminals

Contacts	Function
1-2	Phase current I_{L1} (I_n = 5 A)
1-3	Phase current I_{L1} (I_n = 1 A)
4-5	Phase current I_{L2} (I_n = 5 A)
4-6	Phase current I_{L2} (I_n = 1 A)
7-8	Phase current I_{L3} (I_n = 5 A)
7-9	Phase current I_{L3} (I_n = 1 A)
10-11	External blocking signal (BS)
61-62	Auxiliary power supply. When DC voltage is used the positive pole is connected to terminal 61.
65-66	Trip output 1 for the I> and I>> stages (TRIP 1)
68-69	Trip output 2 for the I> and I>> stages (TRIP 2)
80-81	Signal on tripping of the I> and I>> stages (SIGNAL 1)
77-78	Signal on tripping of stage I>>, starting of the I> and I>> stages (START1)
70-71-72	Self-supervision (IRF) alarm output. Under normal conditions the contact interval 70-72 is closed. When the auxiliary voltage disappears or an internal fault is detected, the contact interval 71-72 closes.
⏚	Protective earth terminal

In single-phase applications it is recommended that the energizing current is routed through two energizing inputs of the relay connected in series. This arrangement secures a faster operation time of the relay, in particular, at instantaneous operation.

The overcurrent relay SPAJ 131 C connects to the fibre optic data communication bus by means of the bus connection module SPA-ZC 17 or SPA-ZC 21. The bus connection module is fitted to the D-type connector (SERIAL PORT) on the rear panel of the relay. The opto-connectors of the optical fibres are plugged into the counter connectors Rx and Tx on the bus connection module.

Configuration of output relays

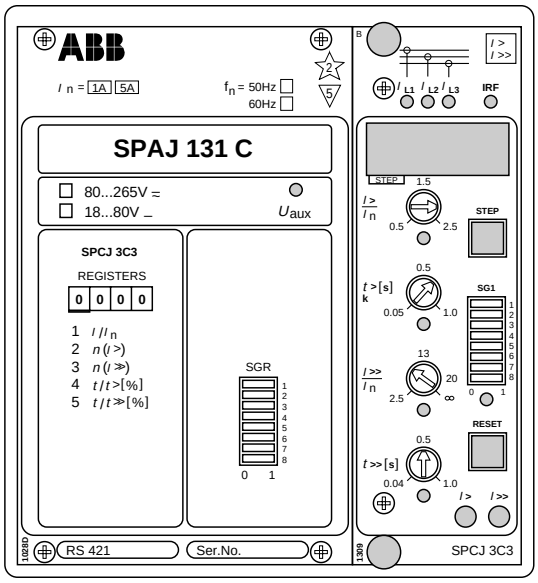
The trip signal of the I> stage is firmly wired to output relay A and the trip signal of the I>> stage is firmly wired to output relay B.

In addition, the following functions can be selected with the switches of the SGR switch-group on the front panel:

Switch	Function	Factory settings	User's settings
SGR/1	Routes the ext. blocking signal to the overcurrent module	1	
SGR/2	Routes the start signal of the I>> stage to output relay D	1	
SGR/3	Routes the start signal of the I> stage to output relay D	1	
SGR/4	Routes the trip signal of the I>> stage to output relay D	1	
SGR/5	Routes the trip signal of the I>> stage to output relay C	1	
SGR/6	Routes the trip signal of the I>> stage to output relay A	1	
SGR/7	Routes the trip signal of the I> stage to output relay C	1	
SGR/8	Routes the trip signal of the I> stage to output relay B	1	

The circuit breakers can be directly controlled with output relay A or output relay B. Thus either operation stage may have its own trip output relay and two separate circuit breakers can be controlled with the same overcurrent relay.

Start and operation indicators



1. Either overcurrent stage has its own operation indicator (I> and I>>), located in the right bottom corner of the front plate of the relay module. Yellow light indicates that the concerned stage has started and red light that the stage has operated (tripped).

   With the SG2 software switchgroup the start and trip indicators can be given a latching function, which means that the LEDs and the output relay remain lit, although the signal that caused operation returns to normal. The indicators are reset with the RESET push-button. An unreset indicator does not affect the operation of the relay.

2. The yellow LEDs (I_{L1}, I_{L2}, I_{L3}) on the upper black part of the front plate indicate, when lit, that the value of the concerned phase current is being displayed.

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

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

5. The LED indicator below a setting knob indicates, when lit, that the setting value is being displayed.

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

The start and operation indicators, the function of the SG2 software switchgroup and the functions of the LED indicators during setting are described more detailed in the relay module manual for the three-phase overcurrent relay module SPCJ 3C3.

Combined power supply and I/O module

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

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

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

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

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

Technical data
(modified 2002-05)

Energizing inputs

	1 A	5 A
Terminals	1-3, 4-6, 7-9	1-2, 4-5, 7-8
Rated current I_n	1 A	5 A
Thermal withstand capability		
Carry continuously	4 A	20 A
Make and carry for 10 s	25 A	100 A
Make and carry for 1 s	100 A	500 A
Dynamic current withstand capability, half-wave value	250 A	1250 A
Input impedance	<100 mΩ	<20 mΩ
Rated frequency f_n acc. to order	50 Hz or 60 Hz	

Output contact ratings

Terminals	65-66, 68-69
Rated voltage	250 V ac/dc
Carry continuously	5 A
Make and carry for 0.5 s	30 A
Make and carry for 3 s	15 A
Breaking capacity for dc, when the manoeuvre circuit time constant L/R ≤ 40 ms, at the control voltages	
- 220 V dc	1 A
- 110 V dc	3 A
- 48 V dc	5 A

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

External control input

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

Auxiliary supply voltage

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

Three-phase overcurrent relay module SPCJ 3C3

Low-set stage I>	
Start current I>, setting range	0.5...2.5 x I_n
Selectable modes of operation	
- definite time characteristic	
- operate time t>	0.05...100 s
- inverse definite minimum time (IDMT) characteristic	
- curve sets acc. to IEC 60255-3 and BS 142	Normal inverse Very inverse Extremely inverse Long-time inverse
- time multiplier k	0.05...1.00
High-set stage I>>	
Start current I>>, setting range	0.5...20 x I_n and ∞, infinite
Operate time t>>	0.04...100 s

Data communication

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

Insulation Tests *)

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

Electromagnetic Compatibility Tests *)

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

Environmental conditions

Specified ambient service temperature range	-10...+55°C
Long term damp heat withstand acc. to IEC 60068-2-3	<95%, +40°C, 56 d/a
Relative humidity acc. to IEC 60068-2-30	93...95%, +55°C, 6 cycles
Transport and storage temperature range	-40...+70°C
Degree of protection by enclosure for panel mounted relay	IP 54
Weight of relay including flush mounting case	3.0 kg

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

Examples of application

Fig. 4 shows how the phase overcurrent relay SPAJ 131 C can be applied for substation protection. For reasons of clarity the remote control equipment and possible other protection relays have been omitted.

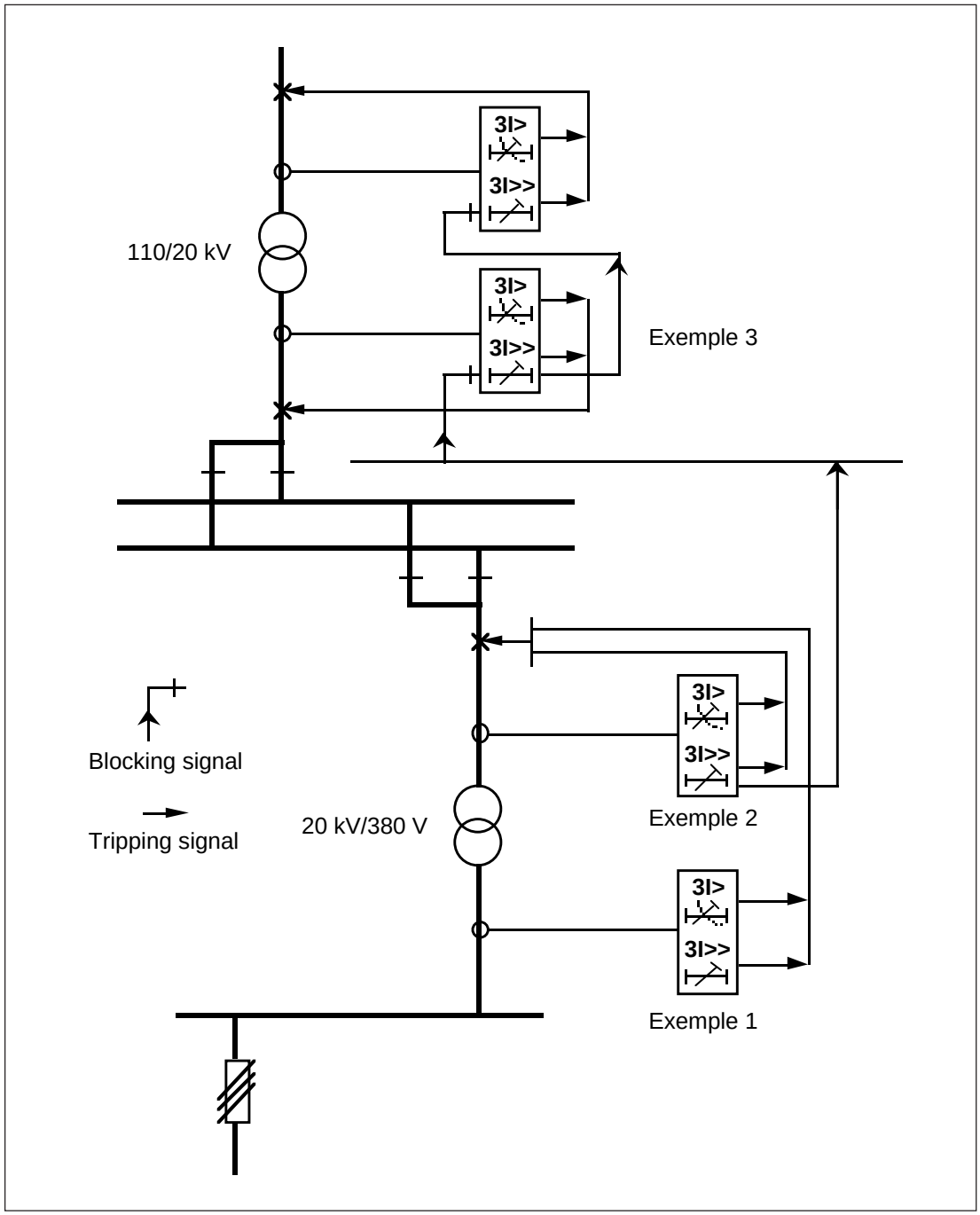


Fig. 4. Overcurrent relay SPAJ 131 C applied for the protection of a distribution substation.

In example 1 the low-voltage switchgear is protected by an overcurrent relay SPAJ 131 C. The trip signal is linked to the HV side circuit breaker of the distribution transformer.

In example 2 the overcurrent relay SPAJ 131 C is used for protecting the outgoing feeder of medium voltage distribution switchgear and in example 3 it is used for the busbar short circuit protection.

The short circuit protection is based on blockings between successive protection stages. In such an arrangement the relay located closer to the fault gives, when starting, a blocking signal backwards to the relay that is closer to the object supplying the short circuit current. If there is no blocking, the relay perceives the fault as being in its own protection area and trips the circuit breaker. As shown in Fig. 4 the busbar protection can be extended beyond the power transformer feeding the busbar system.

Example 1.
Protection of industrial low-voltage switchgear

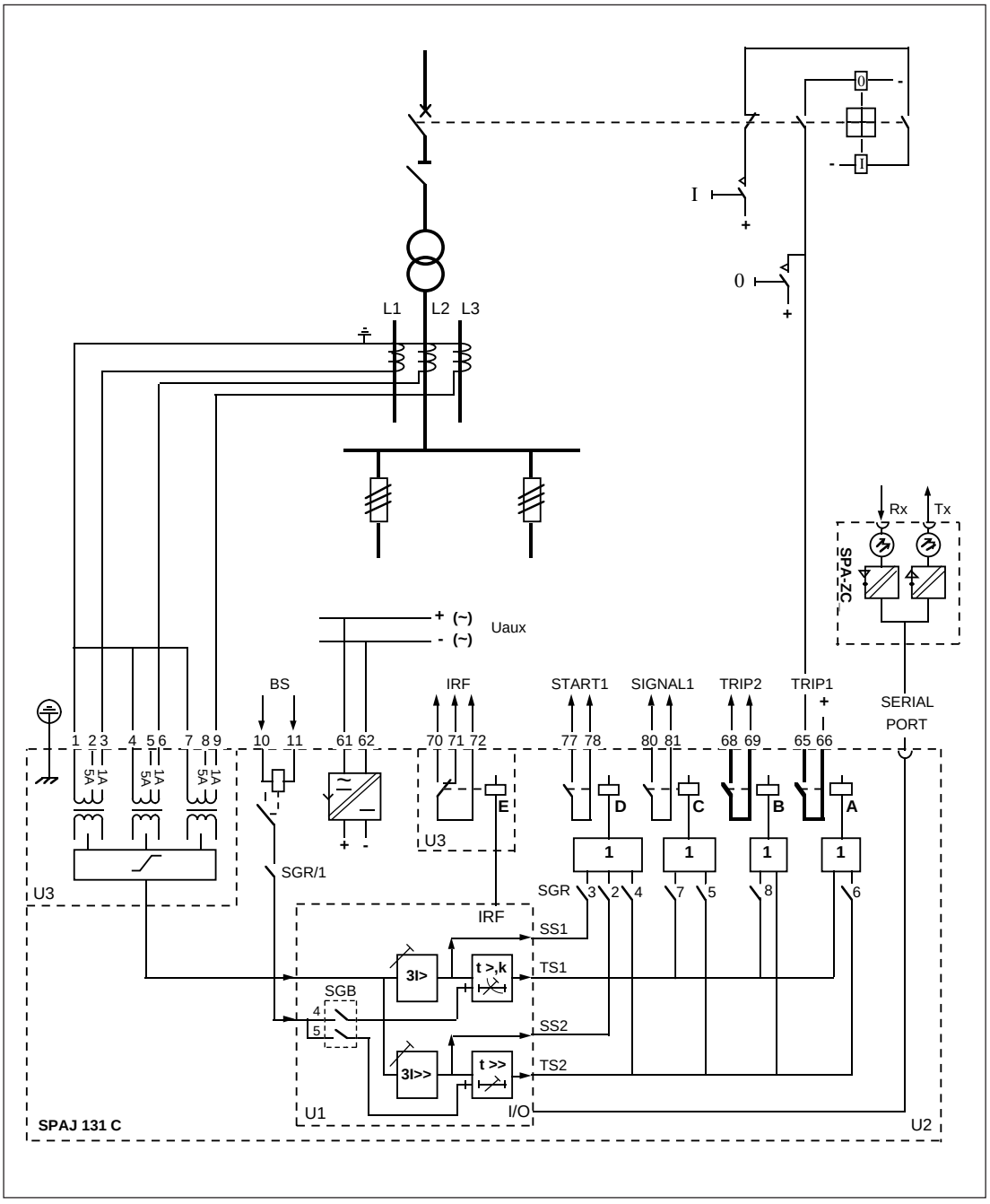


Fig. 5. Overcurrent relay SPAJ 131 C used to protect an outgoing feeder in industrial switchgear. The switch settings are shown in the table on the next page.

The low-set stage of the overcurrent module SPCJ 3C3 operates as overcurrent and short circuit protection for the low-voltage switchgear and as back-up protection for the outgoing feeder of the distribution switchgear. The low-set stage is set to extends to the next protection stage. The setting of the low-set stage should be selected so as to ensure that the protection operates selectively together with the fuses on the outgoing feeders. The high-set stage is set to operate at close-by short circuits.

Separate protection for the low-voltage switchgear is important if there are several distribution transformer along the same feeder. In particular faults in low-voltage switchgear fed by the smaller transformers of a system are not always capable of starting the overcurrent relay of the distribution switchgear feeder.

Current asymmetry, if it appears, does not have to be allowed for in the current settings, because due to the peak-to-peak measurement method employed by the overcurrent relay such asymmetry does not affect the operation of the relay.

The operation of the low-set stage of the overcurrent relay can be based on definite time characteristic or inverse time characteristic. When the definite time characteristic has been selected the operate time of the relay is independent of the magnitude of the fault current. At inverse time characteristic, on the contrary, the operate time is a function of the fault current level: the greater the fault current, the shorter the operate time. Therefore, the relay operate time is short at close-by faults.

Due to the inverse time characteristic short overloads, e.g. inrush currents, do not cause spurious operations. If fuses with a high rated current are used in the network, inverse time characteristic has advantages over definite time characteristic, when time selectivity is concerned.

The low-set stage of the overcurrent relay has four available inverse time characteristics. The desired characteristic is selected with the SG1 switches.

In order to obtain selectivity in a network protected by fuses the characteristic "Extremely inverse" is recommended. This characteristic is also recommended to be used when, in every switching configuration, the short circuit current is several times greater than the rated current of the feeder. When employing an extreme inverse characteristic, the relay allows a temporary overload in the feeder, for instance, during the run-up of a large motor.

In networks with large fault current variations a normal inverse characteristic is recommended. In such a case the protection relay trips the circuit breaker relatively quickly, even though the short circuit current exceeds the rated current of the feeder only slightly. A normal inverse characteristic does not permit very heavy overloads.

The very inverse characteristic is an intermediate form between normal inverse and extremely inverse. In a short circuit situation the operate time is rather short, even though the short circuit current varies according to the switching configuration. On the other hand, the "very inverse" characteristic, too, allows temporary overloading of the feeder.

The accuracy limit factor should be considered when current transformers are selected, because the use of instantaneous tripping, in particular, requires current transformers with good capabilities of reproducing high fault currents.

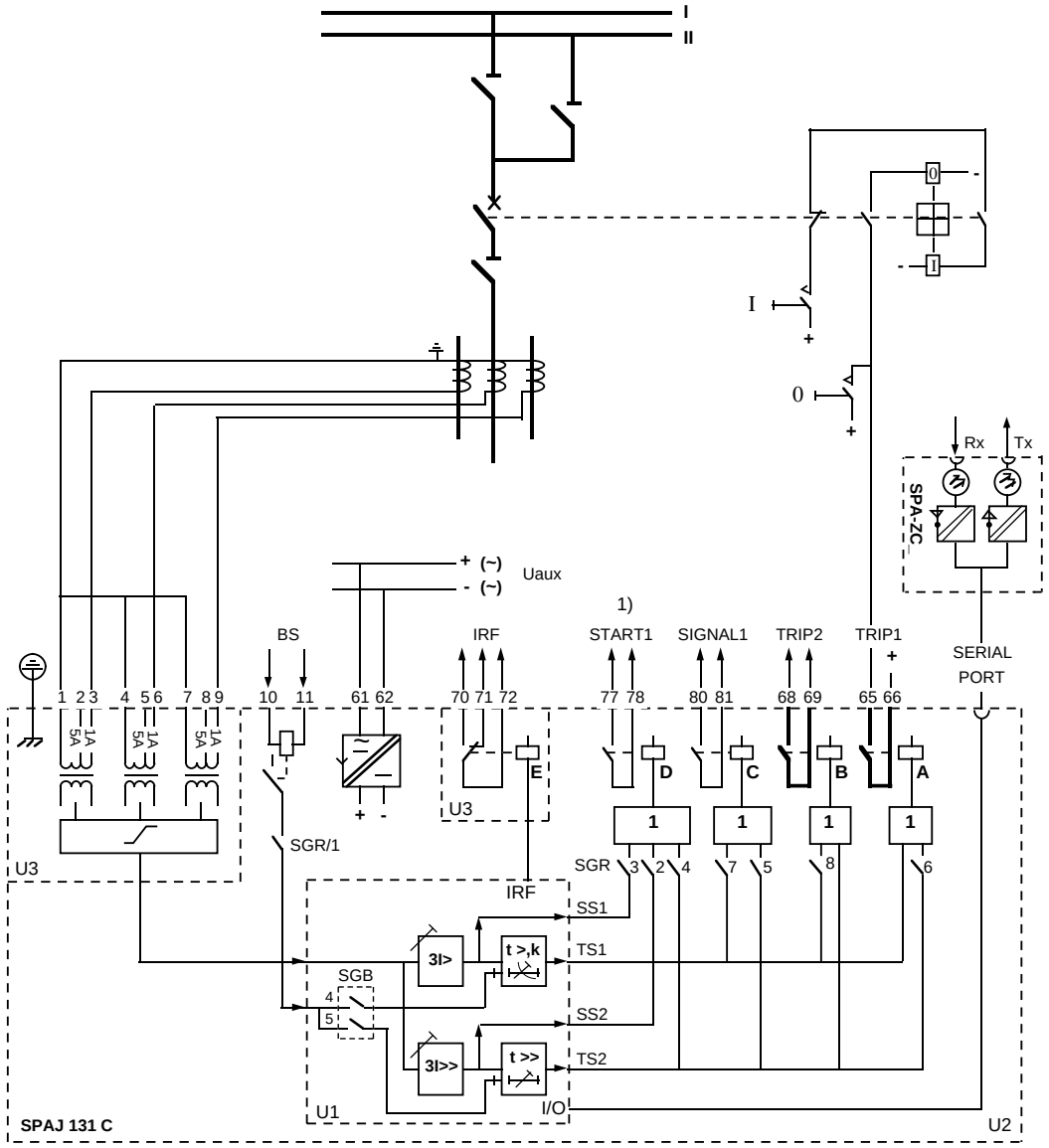
The selector switches of the phase overcurrent relay SPAJ 131 C can be set as follows:

Switch	SG1/SPCJ 3C3	SGB/SPCJ 3C3	SGR
1	0 } extremely inverse	0 not in use	0 no blocking signal
2	0 }	0 not in use	0 no I>> start to output relay D
3	1 IDMT characteristic	0 not in use	1 I> start to output relay D
4	0 no self-holding	0 no blocking to t>	0 no I> start to output relay D
5	0 no I>> doubling	0 no blocking to t>>	0 no I>> trip to output relay D
6	0 I>> = 2.5...20 x I_n	0 not in use	1 I>> trip to output relay A
7	0 } t>> = 0.04...1 s	0 not in use	1 I> trip to output relay C
8	0 }	0 not in use	0 no I> trip to output relay B
Σ	4		

With above switch settings the output relays of SPAJ 131 C have the following functions:

Output relay (contact)	Function
A (65-66)	CB open (I>, I>>)
B (68-69)	Signal on final trip (I>>)
C (80-81)	Signal on final trip (I>)
D (77-78)	Start of I> stage
E (70-71-72)	Self-supervision alarm

Example 2.
Overvoltage protection of an outgoing feeder in a distribution substation.



1) Blocking signal to the overcurrent module of the busbar system

Fig. 6. Overcurrent relay SPAJ 131 C protecting an outgoing feeder in a distribution substation. The selector switch settings are shown in the table on the next page.

The high-set stage operates rapidly on short circuits on the feeder and the low-set stage operates as back-up protection for faults occurring behind the distribution transformer.

Definite time characteristic has been employed, but it is also possible to use inverse time operation characteristic of operation. The difference between the inverse time characteristics has been explained in example 1.

On starting the I>> stage blocks the high-set stage of the overcurrent relay.

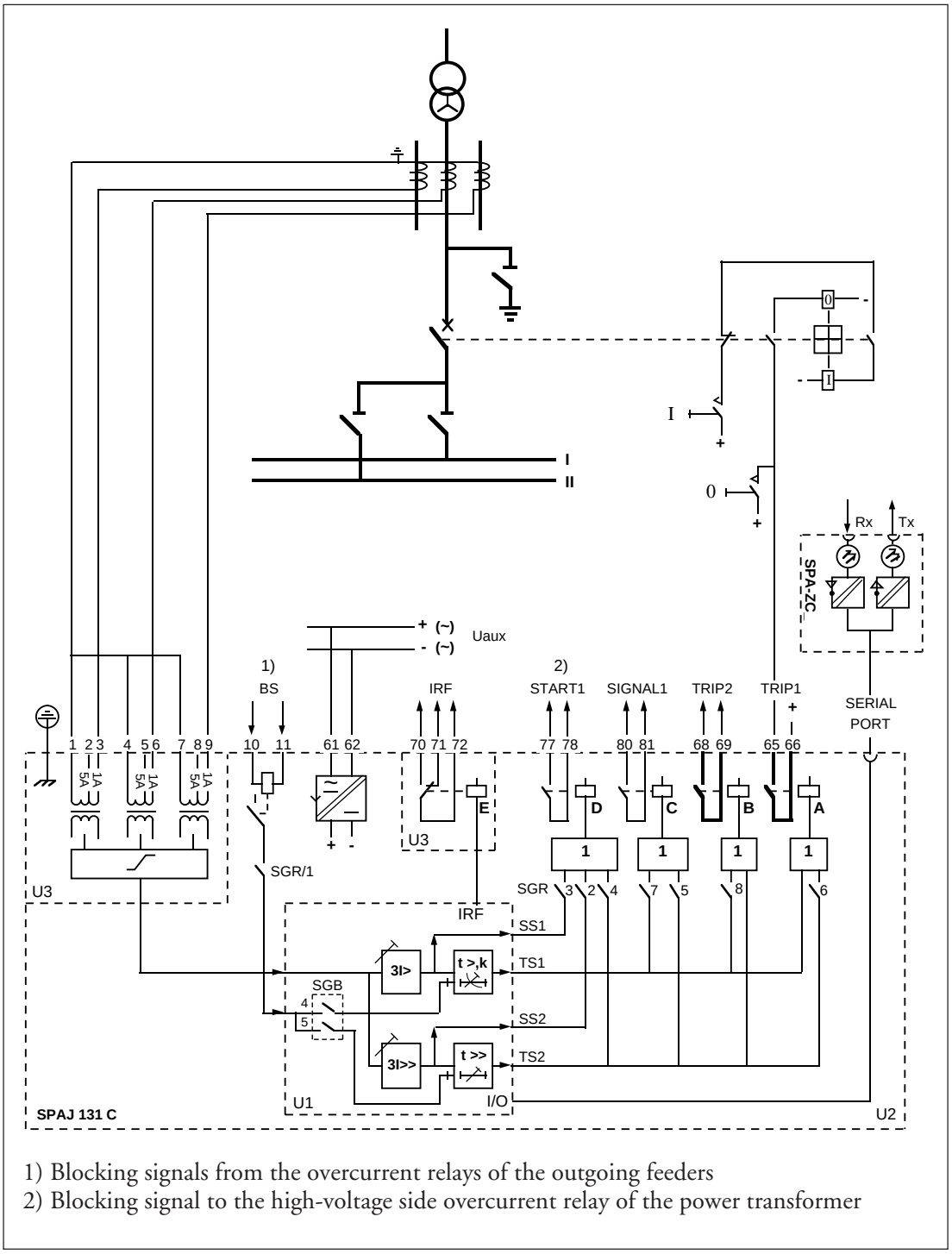
The selector switches of the overcurrent relay SPAJ 131 C can be set as follows:

Switch	SG1/SPCJ 3C3	SGB/SPCJ 3C3	SGR
1	0 } t> = 0.05...1.00 s	0 not in use	0 no blocking from feeders
2	0 }	0 not in use	1 I>> start to output relay D
3	0 Def. time charact.	0 not in use	0 no I> start to output relay D
4	0 no self-holding	0 no blocking to t>	0 no I>> trip to output relay D
5	0 no I>> doubling	0 no blocking to t>>	0 no I>> trip to output relay C
6	0 I>> = 2.5...20 x I_n	0 not in use	1 I>> trip to output relay A
7	0 } t>> = 0.04...1 s	0 not in use	1 I> trip to output relay C
8	0 }	0 not in use	0 no I> trip to output relay B
Σ	0		

With above switch settings the output relays of SPAJ 131 C have the following functions:

Output relay (contact)	Function
A (65-66)	CB open (I>, I>>)
B (68-69)	Signal on final trip (I>>)
C (80-81)	Signal on final trip (I>)
D (77-78)	Start of I>> stage, blocking signal to the overcurrent relay module of the busbar system
E (70-71-72)	Self-supervision alarm

Example 3.
Overcurrent protection of the busbar system in a substation



1) Blocking signals from the overcurrent relays of the outgoing feeders
2) Blocking signal to the high-voltage side overcurrent relay of the power transformer

Fig. 7. Overcurrent relay SPAJ 131 C used for protecting the infeeder cubicle and the busbar system. The switch settings are shown on the next page

In the example in Fig. 7 the low-set stage backs up the protection of the outgoing feeders, whereas the high-set stage is used for protecting the busbar system.

The operation of the busbar protection is based on blocking signals received from the relay modules of the outgoing feeders. If a fault occurs on an outgoing feeder, the overcurrent relay module of the feeder sends a blocking signal to the overcurrent module of the infeeder cubicle. Should, however, the fault be on the busbar there will be no blocking and the overcurrent module of the infeeder cubicle provides a trip signal to the infeeder circuit breaker. In this way relay times of about 100 ms can be obtained at a busbar short circuit. If required the blocking succession can be extended to the overcurrent module on the HV side of the power transformer (see Fig. 4). The trip signal, too, can be linked from the busbar system to the HV side circuit breaker of the power transformer. The wide setting range of the high-set stage makes it well suited for starting the busbar protection.

Busbar system protection based on blockings can also be used in the case of reverse supply on the feeder, provided the reverse current does not exceed the setting value of the high-set stage on the feeder. In such a case the blocking signal is generated by the high-set stage of the overcurrent relay of the feeder.

The blocking signals to terminals 10-11 are linked to the high-set stage of the overcurrent relay by means of the SGR/1 switch on the front panel and the SGB/5 switch on the PC board of the overcurrent module. These switches have to be in position 1.

The blocking circuit is easily tested through the Trip test function of the relay modules and the display. The blocking stage of the module to generate the blocking signal is started via the Trip test function (see manual "General characteristics of C-type SPC relay modules"). Via register 0 of the module to receive the blocking signal it is checked that the blocking signal arrives. For example in this application the high-set stage of the overcurrent module on the outgoing feeder is started, signal SS2. Then the left-most digit of register 0 of the overcurrent module is 2, which means that the tripping of the high-set stage is blocked.

In this example the operation of the low-set stage of the overcurrent relay is based on definite time characteristic, but inverse time characteristic is possible as well.

The selector switches of the phase overcurrent relay SPAJ 131 C can be set as follows:

Switch	SG1/SPCJ 3C3	SGB/SPCJ 3C3	SGR
1	0 } t> = 0.05...1.00 s	0 not in use	1 blocking from outgoing feeders
2	0 }	0 not in use	1 I>> start to output relay D
3	0 def. time charact.	0 not in use	0 no I> start to output relay D
4	1 self-holding	0 no blocking to t>	0 no I>> trip to output relay D
5	0 no I>> doubling	1 blocking to t>>	0 no I>> trip to output relay C
6	0 I>> = 2.5...20 x I_n	0 not in use	1 I>> trip to output relay A
7	0 } t>> = 0.04...1 s	0 not in use	1 I> trip to output relay C
8	0 }	0 not in use	0 no I> trip to output relay B
Σ	8		

With above switch settings the output relays of SPAJ 131 C have the following functions:

Output relay (contact)	Function
A (65-66)	CB open (I>, I>>)
B (68-69)	Signal for final trip (I>>)
C (80-81)	Signal for final trip (I>)
D (77-78)	Start of I>> stage, blocking signal to the HV side overcurrent module of the power transformer
E (70-71-72)	Self-supervision alarm

Recorded data and fault analysis

The information stored in the registers of the protection relay can be used for analysing fault situations and situations during normal operation.

Register 1 stores the highest current value measured on one of the phases L1, L2 or L3, as a multiple of the rated value of the relay. If the module performs tripping, the current value at moment of tripping is memorized. Any new trip resets the old recorded value and updates the register. The same thing happens if the measured current exceeds the previous recorded value.

The data stored in register 1 show the agreement between the setting values and, on the one hand, the actual current values that occur in a fault situation and, on the other hand, the operation values in normal situations.

If a short circuit occurs on the feeder, the overcurrent module records the current value at the moment of tripping and stores the value in register 1. The level of the current indicates how close the fault location is and also whether it is a two-phase or three-phase fault. In addition, the indicators on the front plate of the overcurrent module show in which phases the current has exceeded the setting value of the tripping stage.

Auxiliary submenu 1 of register 1 indicates the current measured at the last tripping. A recorded value is reset only by a new trip that simultaneously enters the new value into the register.

A connection inrush current has a very short duration, but the current level may be high enough to start the relay and the value consequently stored in register 1. In this case the current value recorded at the previous tripping is also stored in submenu 1 of register 1 and available for the analysis of the fault situation.

The level of the fault current is directly indicated by the register values. If, for instance, the value is 5.0 after tripping, the highest value for a separate phase at the moment of tripping was five times the rated primary current of the current transformers.

The number of starts of the various operation stages, registers 2 and 3, illustrates the occurrence of the the overcurrents. Frequent starts on a feeder may, for instance, be due to too low setting values of the relay, connection inrush currents or a concealed fault, e.g. a defective insulator.

Registers 4 and 5 show the duration of the latest start situation of the operation stages, as a percentage of the preset operate time or, when inverse time characteristic has been selected, of the calculated operate time. A new start always resets the counter that starts counting from zero again. When the stage trips, the register value is 100.

Registers 4 and 5 contain information about the duration of, for instance, the connection inrush current or the safety margin of the grading times of the selective protection. If register 4 of the busbar overcurrent relay operating as back-up protection for an outgoing feeder has the value 75 when the overcurrent module of the feeder has performed tripping, the selective protection has a safety margin of 25% of the operate time of the low-set stage of the busbar overcurrent protection.

Secondary injection testing

Testing, both primary and secondary, should always be performed in accordance with national regulations and instructions.

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

The secondary testing described in this manual is based on the relay's setting values in the concerned application. If necessary, the secondary testing can be extended by testing the protection stages throughout their setting ranges.

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

To enable secondary injection testing the relay has to be disconnected, either through disconnectable terminal blocks or a test plug fitted on the relay.

DANGER!
Do not open the secondary circuit of a current transformer during testing, if the primary circuit is live. The high voltage produced by an open CT secondary circuit could be lethal and may damage measuring instruments and insulation.

When the auxiliary voltage is connected to the protection relay, the relay performs a self-testing program. The self-testing does not include the matching transformers and the contacts of the output relays. The operational condition of the relay is tested by means of ordinary relay test equipment and such a test also includes the matching transformers, the output relays and the accuracy of the operate values.

Equipment required for testing:
- adjustable voltage transformer 0...260 V, 1 A
- current transformer
- ammeter, accuracy ±0.5%
- stop watch or counter for time measurement
- dc voltage source for auxiliary supply
- switches and indicator lamps
- supply and pilot wires
- calibrated multimeter

The secondary current of the current transformer is to be selected on the basis of the rated current, 1 A or 5 A, of the relay energizing input to be tested. The energizing inputs are specified under the heading "Technical data, Energizing inputs".

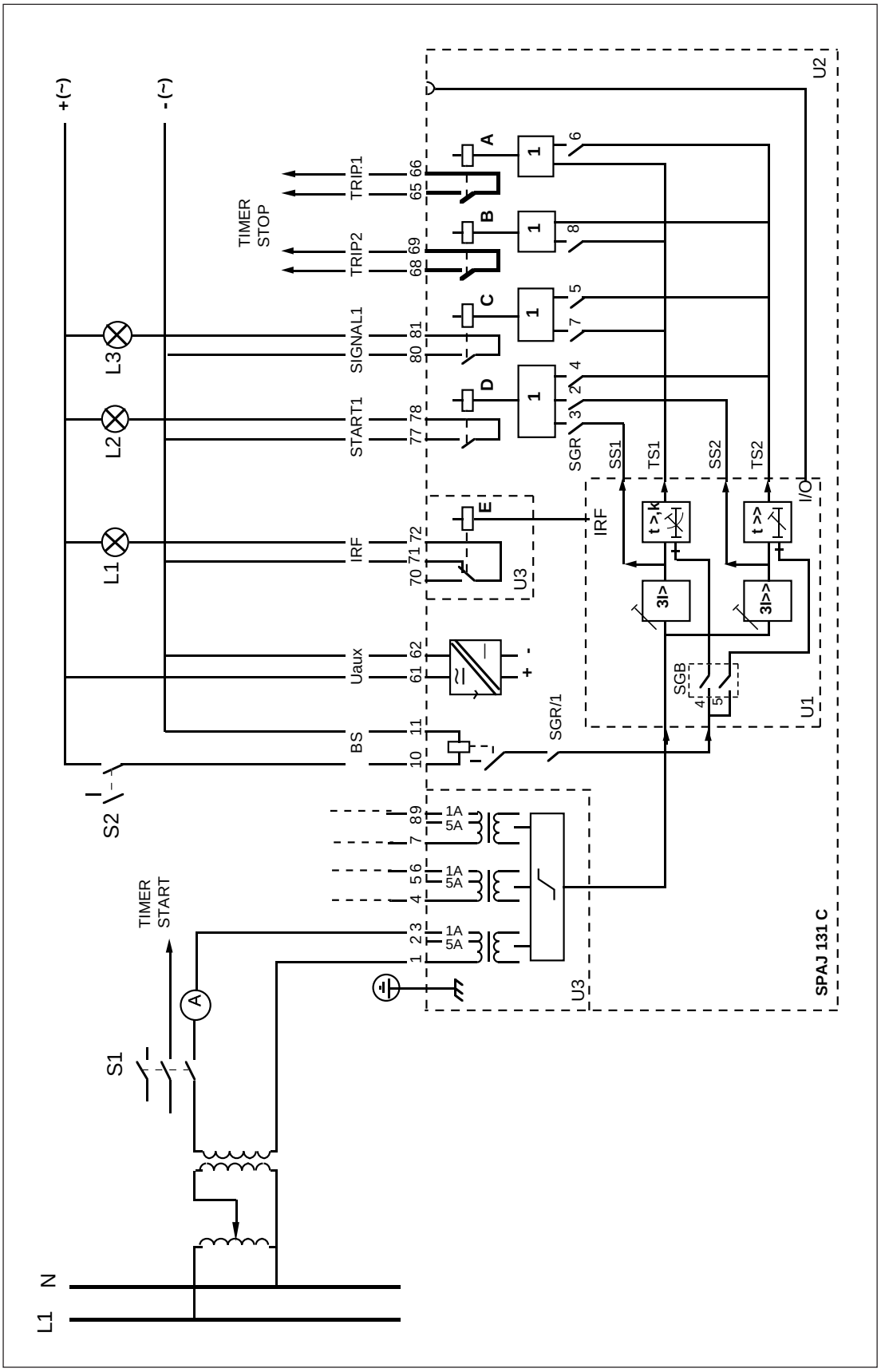


Fig. 8. Secondary injection test connection for the overcurrent relay SPAJ 131 C.

When the test connection has been finished and the selector switches properly set, the auxiliary voltage can be connected to the relay.

The correctness of the test connection can be verified by using a multimeter.

Checking of matching transformers

The matching transformers of the protection relay are tested separately for each phase. A pure sinusoidal current is fed to the relay. The current value indicated in the display of the relay should be equal to that indicated by the ammeter. The measurements can be made at the rated current of the relay. It should be noticed that the relay shows the measured current as a multiple of the rated current I_n of the energizing input occupied.

Testing of low-set current stage I>

The switches of switchgroup SGR should be set as follows:

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

Then the following signals are linked to the output relays:

Output (terminals)	Function
A (65-66)	Tripping of stage I>
B (68-69)	(Tripping of stage I>>)
C (80-81)	Signal on tripping of stage I> (LED L3)
D (77-78)	Start of stage I> (LED L2)
E (71-72)	Signal on internal relay fault (LED L1)

Starting

The start function for one phase is tested in accordance with Fig. 8. When required, the test can be repeated separately for each phase. The test current is slowly increased until the relay starts (LED L2 is lit) and the value of the current at starting is read on the ammeter.

Operate time

Definite time characteristic

The operate time of the overcurrent relay is measured at a test current equal to 2 x the setting value of stage I>. The timer is started by closing switch S1 and stopped by contact 65-66 on operation of output relay A.

The operation of output relay C is indicated by lighting of LED L3.

When the relay starts, the yellow indicator I> in the right bottom corner of the front panel of the relay module is lit, and when the relay trips it turns red.

Inverse time characteristic

At inverse time characteristic the operate time of the relay is measured at two current values (2 x I> and 10 x I>). The operate times thus received are compared with the operate times shown in the current/time curves for the corresponding inverse time characteristic.

Blocking

Switches 4 and 5 of switchgroup SGB on the PC board of the relay module are to be set in position 1 (ON). Switch SGR/1 on the system panel, too, has to be in position 1.

The blocking function is tested by applying a control voltage of the auxiliary voltage level to input 10-11 via switch S2. At first switch S2 is closed and then the test current is encreased well above the set start current level.The relay will start, i.e. L2 is lit, but it must not operate, i.e. L3 remains dark.

Testing of high-set stage

The switches of switchgroup SGR should be set as follows:

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

Then the following signals are linked to the output relays:

Output (terminals)	Function
A (65-66)	Tripping of stage I>
B (68-69)	(Tripping of stage I>>)
C (80-81)	Signal on tripping of stage I> (LED L3)
D (77-78)	Start of stage I>> (LED L2)
E (71-72)	Signal on internal relay fault (LED L1)

The high-set stage is tested in the same way as the low-set stage. The clock measuring the operate time is stopped by contact 68-69 when output relay B operates.

N.B. High test currents are permitted for short durations only, because the wires, terminals and the matching transformers of the relay have a limited current-carrying capability. The test leads should have an area of 4 mm^2. Then a current of 100 A can be connected to a 1 A energizing input for 1 s and to a 5 A energizing input for 10 s.

Testing of the self-supervision system (IRF)

The self-supervision system and its operation indicator IRF and output relay E can be tested in the Trip-Test mode described in section "General characteristics of C-type relay modules" of this manual. The operation of output relay E is indicated by the LED indicator L1.

Maintenance and repair

When used under the conditions specified in the section "Technical data", the relay requires practically no maintenance. The relay includes no parts or components that are liable to abnormal physical or electrical wear under normal operating conditions.

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

- Signs of mechanical damage on relay case and terminals
- Dust accumulated inside the relay cover or case; remove carefully with compressed air or a soft brush
- Signs of corrosion on terminals, case or components inside the relay

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

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

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

Spare parts

Three-phase overcurrent relay module	SPCJ 3C3
Combined power supply and I/O module	
- U_{aux} = 80...265 V ac/dc	SPTU 240S1
- U_{aux} = 18...80 V dc	SPTU 48S1
Case (including I/O module)	SPTK 3E4
I/O module	SPTE 3E4
Bus connection module	SPA-ZC 17_ or SPA-ZC 21_

Ordering numbers

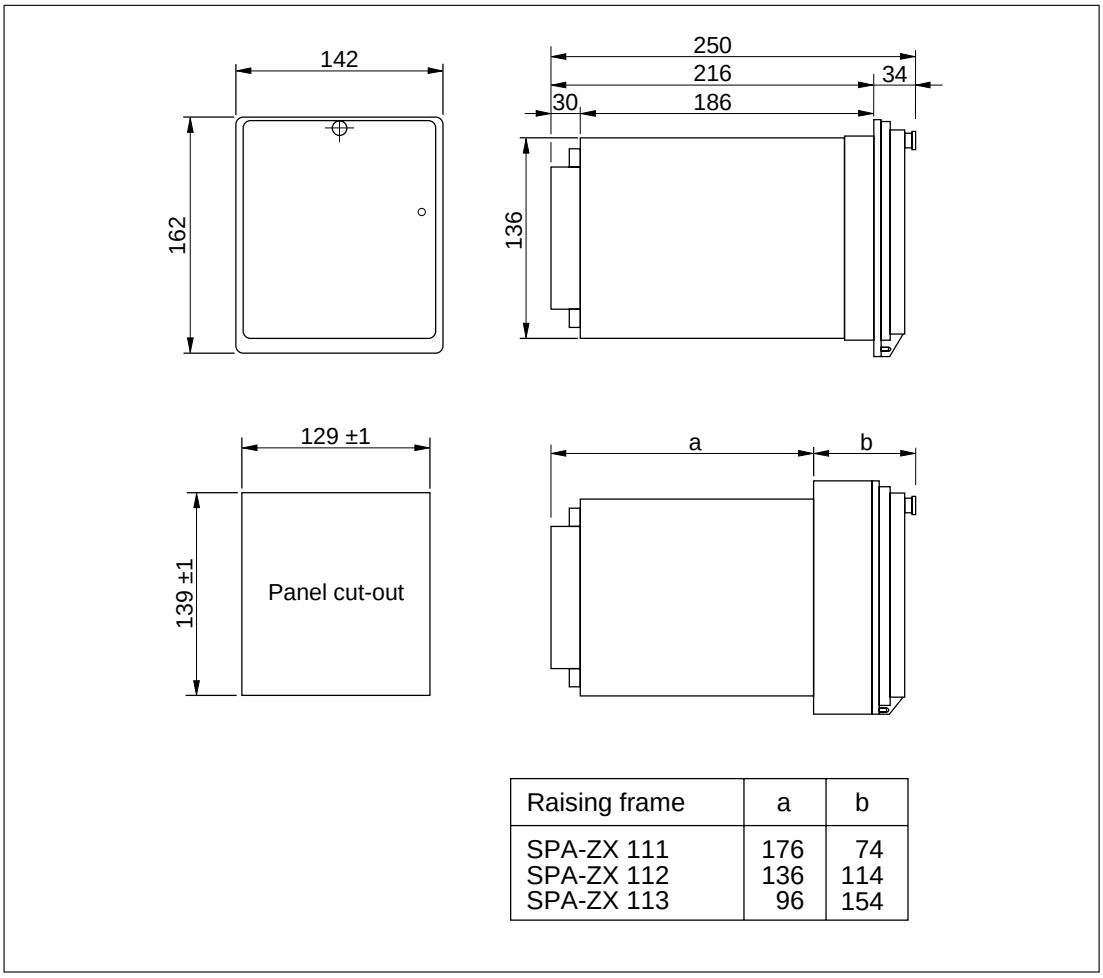
Overcurrent relay without test adapter	
SPAJ 131 C	RS 421 013 -AA, CA, DA, FA
Overcurrent relay with test adapter RTXP 18	
SPAJ 131 C	RS 421 213 -AA, CA, DA, FA

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

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

Dimensions and instructions for mounting

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



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

Fig. 9. Dimensions of the overcurrent relay SPAJ 131 C

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

A rubber gasket fitted on the mounting collar provides an IP54 degree of protection between relay case and mounting panel, when the relay is flush mounted.

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

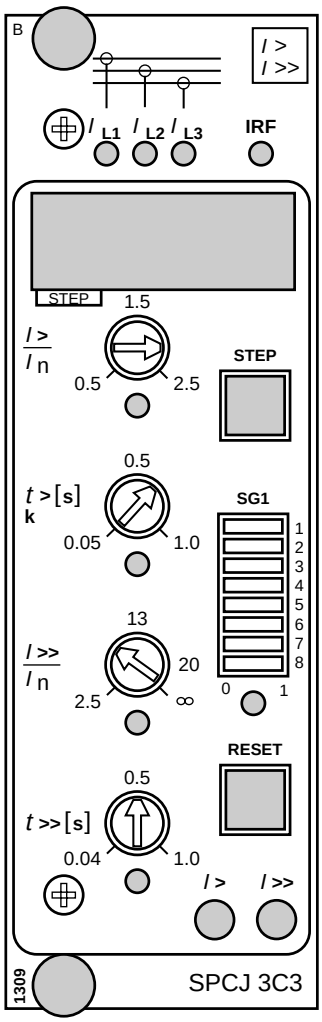
All input and output wires are connected to the screw terminal blocks on the rear panel. Each terminal is dimensioned for one max. 6 mm^2 wire or two max. 2.5 mm^2 wires. The D-type connector connects to the serial communication bus.

Order information

Example	
1. Quantity and type designation	15 pces relay SPAJ 131 C
2. Order number	RS 421 013-AA
3. Rated frequency	f_n = 50 Hz
4. Auxiliary voltage	U_{aux} = 110 V dc
5. Accessories	15 bus connection modules SPA-ZC 21 MM
	2 fibre optic cables SPA-ZF MM 100
	14 fibre optic cables SPA-ZF MM 5
6. Special requirements	-

SPCJ 3C3
Overcurrent relay module

User´s manual and Technical description



1MRS 750602-MUM EN

Issued 1996-12-30
Modified 2002-05-15
Version D (replaces 34 SPCJ 2 EN1)
Checked MK
Approved OL

SPCJ 3C3
Overcurrent relay module

Contents

Features

Low-set overcurrent stage I> with selectable definite time or inverse definite minimum time (IDMT) operation characteristic

High-set current stage I>> with instantaneous operation or definite time operation characteristic

Both overcurrent stages can be blocked by means of an external control signals from cooperating protection relays

Digital display of measured and set values, recorded fault values, operation indications and fault messages

Comprehensive serial communication capability

Continuous self-supervision of the electronics and the software including autodiagnostics

Description of operation

The overcurrent relay module SPCJ 3C3 can be used in single-phase, two-phase or three-phase protection relays and it contains two overcurrent stages, i.e. a low-set overcurrent stage I> and a high-set overcurrent stage I>>.

The low-set or high-set overcurrent stage starts if the current on one of the protected phases exceeds the set start value of the concerned stage. On starting, the concerned stage provides a starting signal SS1 or SS2 and simultaneously the operation indicator of the stage is lit with yellow light. If the overcurrent situation lasts long enough to exceed the set operation delay, the stage that started provides a tripping signal, TS1 or TS2. At the same time the operation indicator of the concerned stage is lit with red light. The red operation indicator remains lit although the protection stage resets. The yellow start indications and the red operation indications can be given self-reset or latching mode of operation. When the latching mode is selected the indicators are restet with the RESET push-button on the module's front panel or by the command V101 or V102 over the serial interface.

The operation of the low-set overcurrent stage I> can be blocked by routing a blocking signal BTS1 to the stage. Similarly, the operation of the high-set overcurrent stage I>> can be blocked by a blocking signal BTS2. The blockings are selected by means of switchgroup SGB on the PC board of the relay module.

If the protection relay incorporates an auto-reclose relay module, switchgroup SGB is additionally used for the purpose of selecting the start signals for the auto-reclose module. The instructions for selector switchgroup SGB are given in the general description of the protection relay unit, in association with the diagram illustrating the signals between the relay modules.

The operation of the low-set overcurrent stage I> can be based on definite time or inverse definite minimum time (IDMT) characteristic. The required operation characteristic is selected with switch SG1/3. At definite time characteristic the operation time t> can be selected within one of the three available setting ranges of the stage. The operation time setting range is selected with switches SG1/1 and SG1/2. When inverse time characteristic (IDMT) is used four time/current curve groups with different slopes of inversity are available. The required characteristic is selected with switches SG1/1 and SG1/2.

The operation time t>> of the high-set overcurrent stage is set separately. The setting range, one of three available, is selected by means of switches SG1/7 and SG1/8.

Normally both overcurrent stages are self-reset. With the selector switch SG1/4 both stages can be given a so called latching function, which means that the tripping output is kept energized after an operation though the fault has disappeared, until separately reset. The outputs are reset by pressing the push-buttons STEP and RESET simultaneously or by the commands V101 or V102 over the serial interface. See also table (switchgroup SG3) on page 9 in chapter "Selector switches".

The set start value of the high-set overcurrent stage I>> may be automatically doubled when the protected object is energized, i.e. during a current inrush situation. Thus the set start value of the high-set overcurrent stage can be lower than the connection inrush current. The automatic doubling feature is selected with switch SG1/5. A starting situation is defined as a situation where the phase currents increase from a value below 0.12 x I> to a value exceeding 3.0 x I> in less than 60 ms. The starting situation ceases when the phase currents fall below 2.0 x I>.

The setting range of the high-set overcurrent stage is selected with switch SG1/6. Two alternatives setting ranges are available, 2.5...20 x I_n and 0.5...4.0 x I_n. When the lower range is chosen the relay module will contain two almost identical operation stages. In this case the overcurrent module SPCJ 3C3 may be used e.g. as a two-stage load shedding module. The operation of the high-set overcurrent stage may be blocked by choosing the setting value ∞, infinite.

Block diagram

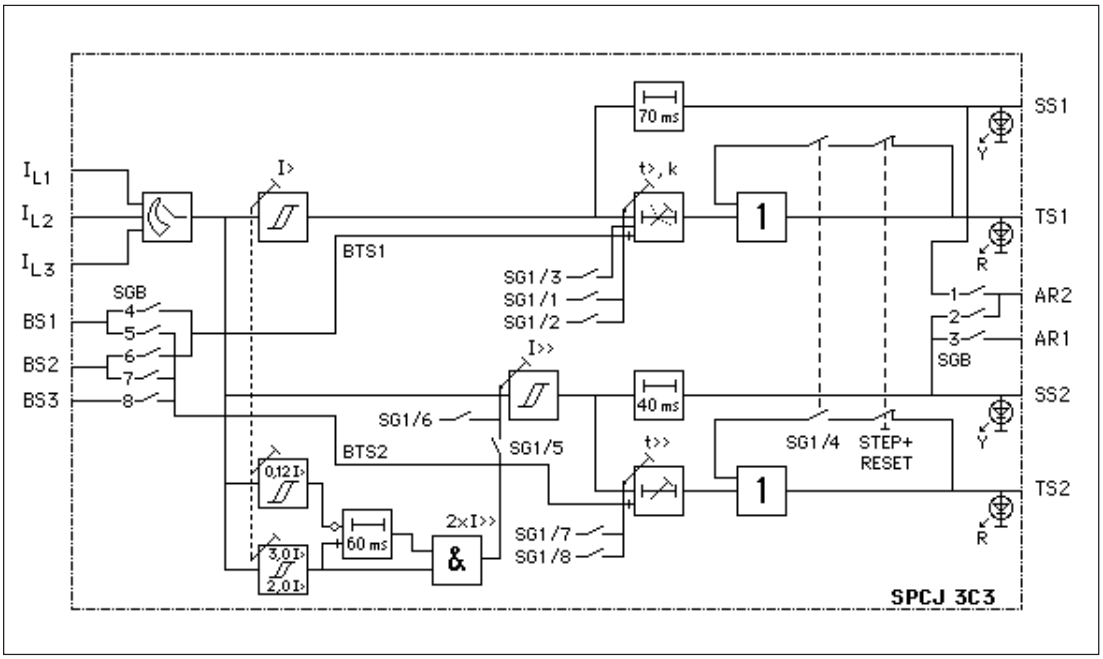


Fig. 1. Block diagram for the overcurrent relay module SPCJ 3C3.

I_{L1}, I_{L2}, I_{L3}	Measured phase currents
BS1, BS2, BS3	External blocking signals
BTS1	Blocking signal for the tripping of stage I>
BTS2	Blocking signal for the tripping of stage I>>
SG1	Selector switchgroup on the front panel
SG2	Function selector switchgroup for the operation indicators
SGB	Blocking signal selector switchgroup on the PC board and starting signal selector switchgroup for the auto-reclose functions
SS1	Start signal of stage I>
TS1	Trip signal of stage I>
SS2	Start signal of stage I>>
TS2	Trip signal of stage I>>
AR1, AR2	Start signals for auto-reclose functions
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 any protection relay incorporating this module. The signals wired to the terminals are shown in the diagram illustrating the interchange of signals between the various modules of the protection relay.

Front panel

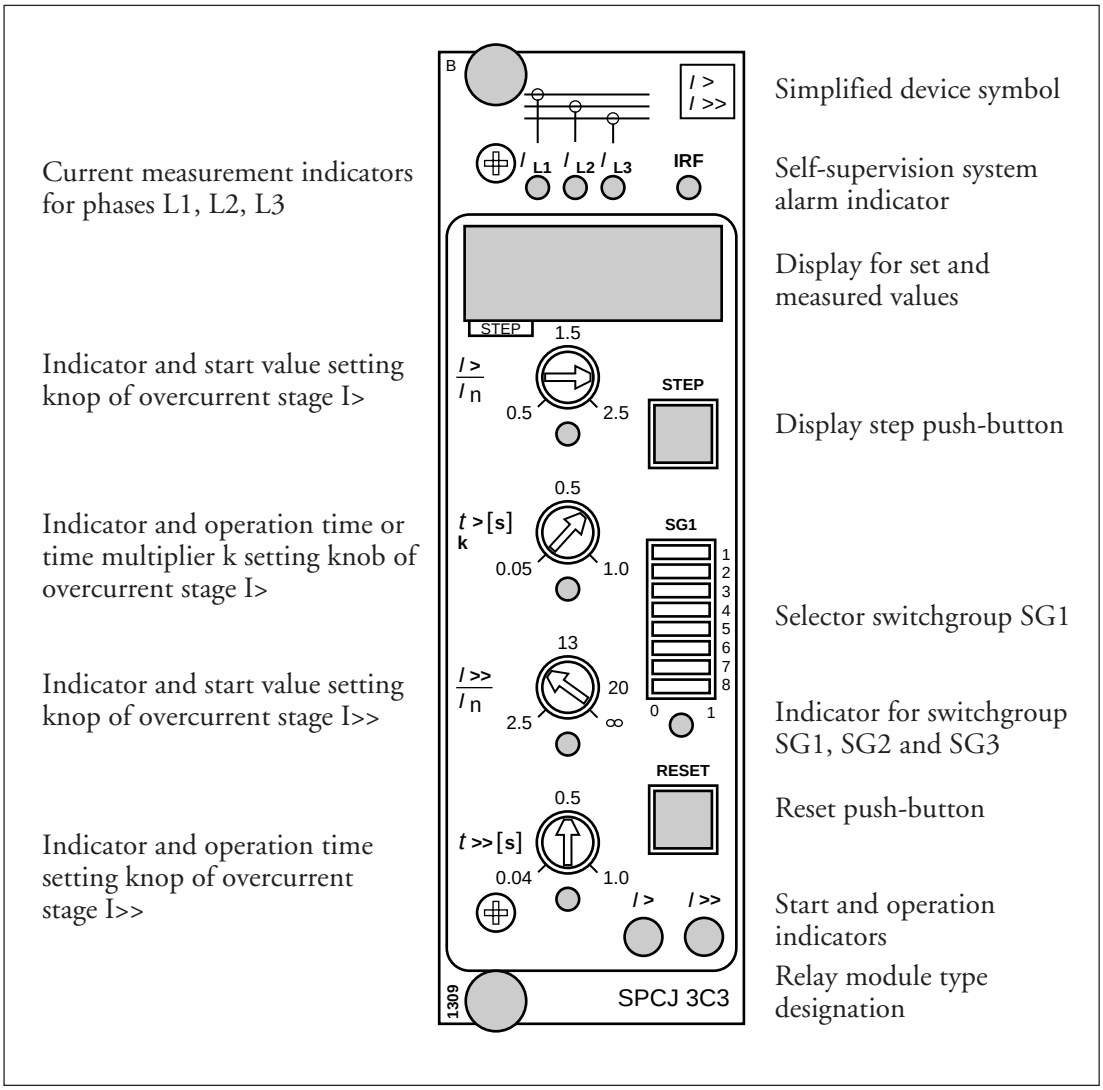


Fig. 2. Front panel of the overcurrent relay module SPCJ 3C3.

Operation indicators

Both overcurrent stages are provided with a yellow/red indicator. Yellow light indicates starting of the concerned overcurrent stage and red light indicates that the overcurrent stage has operated (tripped).

The four indications, two starts and two trippings, can be given a self-reset mode of opersation or manual reset mode. If, for instance, the yellow start indicator of the low-set overcurrent stage I> has been given the manual reset mode, the indicator is lit with yellow colour when the overcurrent stage starts and turning red when the stage operates. When the protection stage returns to normal the yellow indication remains lit. The indicators that have been given the manual reset mode are reset by pushing the RESET push-button or by the command V101 or V102 via the serial interface. The function of the relay module is not affected by an unreset operation indicator.

When the display of the relay module is dark and one of the protection stages operates, the indicators for the measured values of the module indicate the faulty phase, i.e. in which phase(s) the current has exceeded the setting value of the stage (so called phase fault indication). If, for instance, the operation indicator of stage I> is lit with red light and the indicators I_{L1} and I_{L2} also are lit, the relay operation was caused by overcurrent on phases L1 and L2. The phase fault indications are reset by pushing the STEP push-button or the RESET push-button. See also table (switchgroup SG3) on page 9 in chapter "Selector switches".

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.

The setting values are shown by the three rightmost digits of the display. When lit, the indicator below a setting knob shows that the concerned setting value is being displayed.

$I>/I_n$	Set start current of stage I> as a multiple of the rated current I_n of the energizing input used. Setting range 0.5...2.5 x I_n.
t> [s] k	The set start time of stage I>, expressed in seconds, when the definite time characteristic is used (SG1/3 = 0). The setting range is determined by the position of switches SG1/1 and SG1/2. Selectable setting ranges 0.05...1.00 s, 0.5...10.0 s and 5...100 s. At inverse definite minimum time characteristic (SG1/3 = 1) the setting range of time multiplier k is 0.05...1.00.
$I>>/I_n$	Set starting current of stage I>> as a multiple of the rated current I_n of the energizing input used. Setting range 2.5...20.0 x I_n, when SG1/6 = 0, and 0.5...4.0 x I_n, when SG1/6 = 1. Additionally, the setting infinite (displayed as - - -) can be selected, rendering the high-set stage I>> inoperative.
t>> [s]	The set operation time of stage I>>, expressed in seconds. The setting ranges, 0.04...1.00 s, 0.4...10.0 s and 4...100 s, are determined by the position of switches SG1/7 and SG1/8, see below.

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

Selector switches

Additional functions required by individual applications are selected by means of the 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 front panel.

<table>
<tr><th>Switch</th><th>Function</th></tr>
<tr><td>SG1/1
SG1/2
SG1/3</td><td>Switch SG1/3 is used for choosing the operation characteristic of the low-set current stage I>, i.e. definite time or inverse definite minimum time (IDMT) characteristic. At definite time mode characteristic the setting range of the operation time t> is selected by means of switches SG1/1 and SG1/2, whereas, at inverse definite minimum time characteristic the switches are used for choosing the current/time characteristic of the overcurrent stage.
<table>
<tr><th>SG1/1</th><th>SG1/2</th><th>SG1/3</th><th>Characteristic</th><th>Operation time t> or type of characteristic</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>Definite time</td><td>0.05...1.00 s</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>"</td><td>0.5...10.0 s</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>"</td><td>0.5...10.0 s</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>"</td><td>5...100 s</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>IDMT</td><td>Extremely inverse</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>"</td><td>Very inverse</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>"</td><td>Normal inverse</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>"</td><td>Long-time inverse</td></tr>
</table></td></tr>
<tr><td>SG1/4</td><td>Selection of the latching function for the tripping signals TS1 and TS2.

When SG1/4 = 0, the tripping signals return to normal (= the output relay resets, when the energizing input signal causing the operation falls below the start level.
When SG1/4 = 1, the tripping signals remain on (= output relay energized), although the energizing input signal falls below the starting level. The latched tripping signals are reset by pressing the push-buttons STEP and RESET simultaneously or with the command V101. When the STEP and RESET push-buttons are pushed the recorded values are erased as well. *)</td></tr>
<tr><td>SG1/5</td><td>Selection of automatic doubling of the setting value of the high-set overcurrent stage when the protected object is connected to the network.

When SG1/5 = 0, no doubling of the set start value of stage I>> is obtained.
When SG1/5 = 1, the set start value of stage I>> doubles automatically. The doubling feature makes it possible to give the high-set current stage a setting value, which is lower than the connection inrush current of the protected object.</td></tr>
<tr><td>SG1/6</td><td>Selection of the start current setting range of the high-set overcurrent stage I>>.

When SG1/6 = 0, the setting range is 2.5...20 x I_n and ∞, infinite.
When SG1/6 = 1, the setting range is 0.5...4 x I_n and ∞, infinite.
When SG1/6 =1, the module comprises two almost identical overcurrent stages and may in this case be used for load shedding purposes. The setting ∞, infinite, is indicated by - - - on the display.</td></tr>
</table>

*) From the program version 052 C and later an additional switchgroup (SG3) has been incorprated into the relay module. When the latching function is used the latched output can be reset by pushing the RESET button alone, if SG3/3=1, or by pushing the STEP button alone, if SG3/2=1, in which case the stored information of the module is not erased.

<table>
<tr><th>Switch</th><th>Function</th></tr>
<tr><td>SG1/7
SG1/8</td><td>Selection of the setting range of the operation time t>> of the high-set overcurrent stage I>>.
<table>
<tr><th>SG1/7</th><th>SG1/8</th><th>Operation time t>></th></tr>
<tr><td>0
1
0
1</td><td>0
0
1
1</td><td>0.04...1.00 s
0.4...10.0 s
0.4...10.0 s
4...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. In switchgroup SG2 the mode of operation of the LED indicators is selected. The start and operation indicators of the low-set and the high-set overcurrent stage can be given self-reset mode of operation or latching mode of operation. The selection is made by means of a checksum which is calculated from the table below. Normally the start indications are self-reset and the operation indications latching.

If the checksum of switchgroup SG2 = 0 no LED indications are obtained after a fault, i.e. no start or operation indications I> or I>> nor phase indications I_{L1}, I_{L2} or I_{L3}.

Indication	Latching	Default
Starting, stage I>, yellow	1	0
Tripping, stage I>, red	2	2
Starting, stage I>>, yellow	4	0
Tripping, stage I>>, red	8	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 switches SG3/1…3. Switches SG3/4…8 are not in use. The default value for SG3 is 0.

SG3/1	SG3/2	SG3/3	Push-button	Clear start/trip LED's	Reset latched relays	Erase memorized values
0	0	0	STEP			
			RESET	x		
			STEP & RESET	x	x	x
1	0	0	STEP	x		
			RESET	x		
			STEP & RESET	x	x	x
0	1	0	STEP	x	x	
			RESET	x		
			STEP & RESET	x	x	x
0	0	1	STEP			
			RESET	x	x	
			STEP & RESET	x	x	x
1	0	1	STEP	x		
			RESET	x	x	
			STEP & RESET	x	x	x

The PC board of the relay module holds a switchgroup SGB including switches 1...8. Switches 1...3 are used for selecting the starting signals for a possible auto-reclose module, whereas switches 4...8 are used for routing blocking signals to the overcurrent module in various protection relays. The functions of the selector switchgroup SGB is described in the general part of the manual of the concerned protection relay.

Measured data

The measured values are displayed by the rightmost three digits on the display. The relevant measured data are indicated by a lit indicator on the front panel.

Indicator	Measured data
I_{L1}	Line current on phase L1 as a multiple of the rated current I_n.
I_{L2}	Line current on phase L2 as a multiple of the rated current I_n.
I_{L3}	Line current on phase L3 as a multiple of the rated current I_n.

NOTE! The rated current I_n is the rated current of the energizing input taken in use in the concerned protection relay.

Recorded information

The leftmost digit of the display shows the address of the register and the three rightmost digits the recorded information. The address digit is recognized by its red colour.

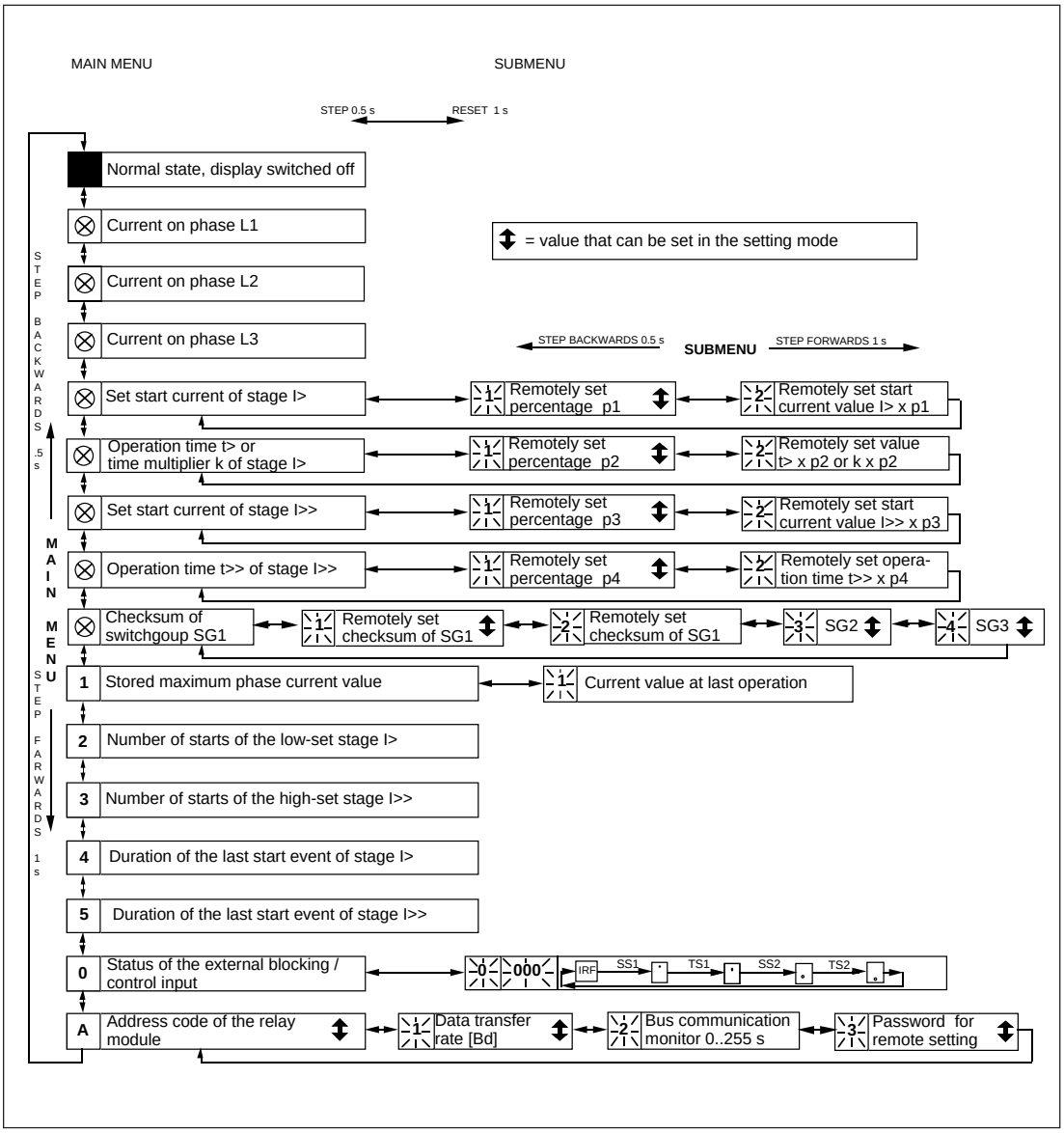
Register/ STEP	Recorded information
1	Maximum phase current measured as a multiple of the rated current of the protection relay. If the module operates, the current value at the moment of operation is stored in the memory. A new tripping erases the old value and updates the register with the new value. The same thing happens if the current exceeds a previously registered maximum value. In the 1.st submenu the current value measured at the last operation is recorded.
2	Number of startings of the low-set overcurrent stage I>, n (I>) = 0...255.
3	Number of startings of the high-set overcurrent stage I>>, n (I>>) = 0...255.
4	Duration of the latest starting situation of stage I> as a percentage of the set operation time t> or at IDMT mode of operation the calculated operation time. A new starting resets the counter which thus always contains the value from the latest starting. When the stage has operated, the counter reading is 100.
5	Duration of the latest starting situation of stage I>> as a percentage of the set operating time t>>. A new starting resets the counter which thus always contains the value from the latest starting. When the stage has operated, the counter reading is 100.
0	Display of blocking signals and other external control signals. The leftmost digit indicates the state of the blocking inputs of the module. The following states may be indicated: 0 = no incoming blockings 1 = operation of stage I> blocked 2 = operation of stage I>> blocked 3 = operation of both stages blocked In this register the middle green digit of the display is always zero. The leftmost green digit indicates the state of the remote reset input, if any. 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 the description "General characteristics of C-type relay modules".

Register/ STEP	Recorded information
A	The address code of the protection relay module, required by the serial communication system. If the address code is set at zero the serial communication is out of use. The submenus in this register are: 1) Selection of data transfer rate for the serial communication. Selectable values: 300, 1200, 2400, 4800 or 9600 Bd. Default value 9600 Bd. 2) Bus communication counter. If the module is connected to a data communication device and the communication system is working, the communication counter shows 0. If the communication is interrupted the numbers 0…255 is scrolling in the display. 3) Password required for the remote control of relay settings
-	Display dark. By pressing the STEP push-button the starting point of the display menu obtained.

The values of the registers 1...5 are erased by pressing the push-buttons STEP and RESET simultaneously or with 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 value of the data transfer rate of the serial communication and the password are not erased by an auxiliary voltage interruption. The instructions for setting the address and the data transfer rate are given in the description "General characteristics of C-type relay modules".

Main menus and submenus of settings and registers

The diagram below shows the available main menus and submenus of the overcurrent relay module SPCJ 3C3.



Instructions for entering a submenu or the setting mode, procedures for doing the settings and for handling the TEST mode are given in the manual "General characteristics of C-type relay modules".

Time/current characteristics

(modified 2002-05)

The operation of the low-set current stage I> of the overcurrent module is based on either definite time or inverse time characteristic. The operation characteristic is selected with switch 3 of switchgroup SG1, see page 7.

When an I.D.M.T. characteristic is chosen, the operation time of the low-set overcurrent stage I> will be a function of the current; the higher the current, the shorter the operation time. The relationship between current and time comply with the standards BS 142 of 1966 and IEC 60255-3 and may generally be expressed as:

$$t = \frac{k \times \beta}{\left(\frac{I}{I>}\right)^{\alpha} - 1} \quad [s]$$

where t = operation time in seconds
k = time multiplier
I = measuring current
I> = set start current

The module includes four characteristics with different slopes. The characteristic to be used is chosen with switches 1 and 2 of switchgroup SG1, see page 7.

The slope of the time/current curves is determined by the values of the constants α and β:

Characteristic of the time/current curves	α	β
Normal inverse	0.02	0.14
Very inverse	1.0	13.5
Extremely inverse	2.0	80.0
Long-time inverse	1.0	120.0

According to the standard BS 142 of 1966 a normal current range is defined as 2...20 times the setting. Additionally the relay must start at the latest when the measured current exceeds 1.3 times the set start current, when the time/current characteristic is normal inverse, very inverse or extremely inverse. At long-time inverse characteristic, the normal range according to the standard is 2...7 times the set start current and the relay is to start when the current exceeds 1.1 times the set start current.

The following requirements with regard to operation time tolerances are specified in the standard, where E denotes accuracy in per cent, - = not specified:

I/I>	Normal inverse	Very inverse	Extremely inverse	Long-time inverse
2	2.22 E	2.34 E	2.44 E	2.34 E
5	1.13 E	1.26 E	1.48 E	1.26 E
7	-	-	-	1.00 E
10	1.01 E	1.01 E	1.02 E	-
20	1.00 E	1.00 E	1.00 E	-

Over the normal current ranges, the inverse-time stage of the overcurrent module SPCJ 3C3 complies with the tolerances of class 5 for all four characteristics.

The time/current characteristics specified in the standards are illustrated in Fig. 3, 4, 5, and 6.

Note.
The actual operate time of the relay, presented in the graphs in Fig. 3…6, includes an additional filter and detection time plus the operate time of the trip output relay. When the operate time of the relay is calculated using the mathematical expression above, these additional times of about 30 ms in total have to be added to the time received.

Inverse-time characteristics of overcurrent relay module SPCJ 3C3.

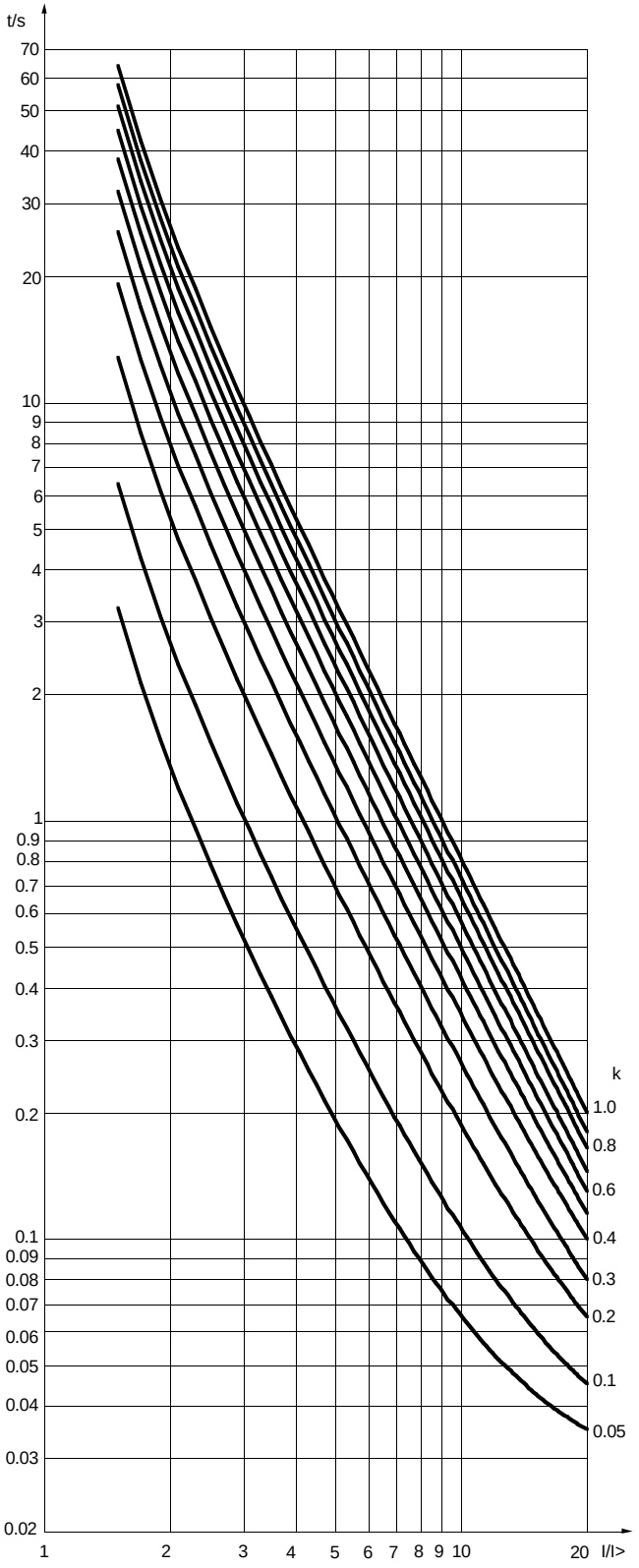


Fig. 3. Extremely inverse characteristic.

I = measured current
I> = set start current
t = operation time
k = time multiplier

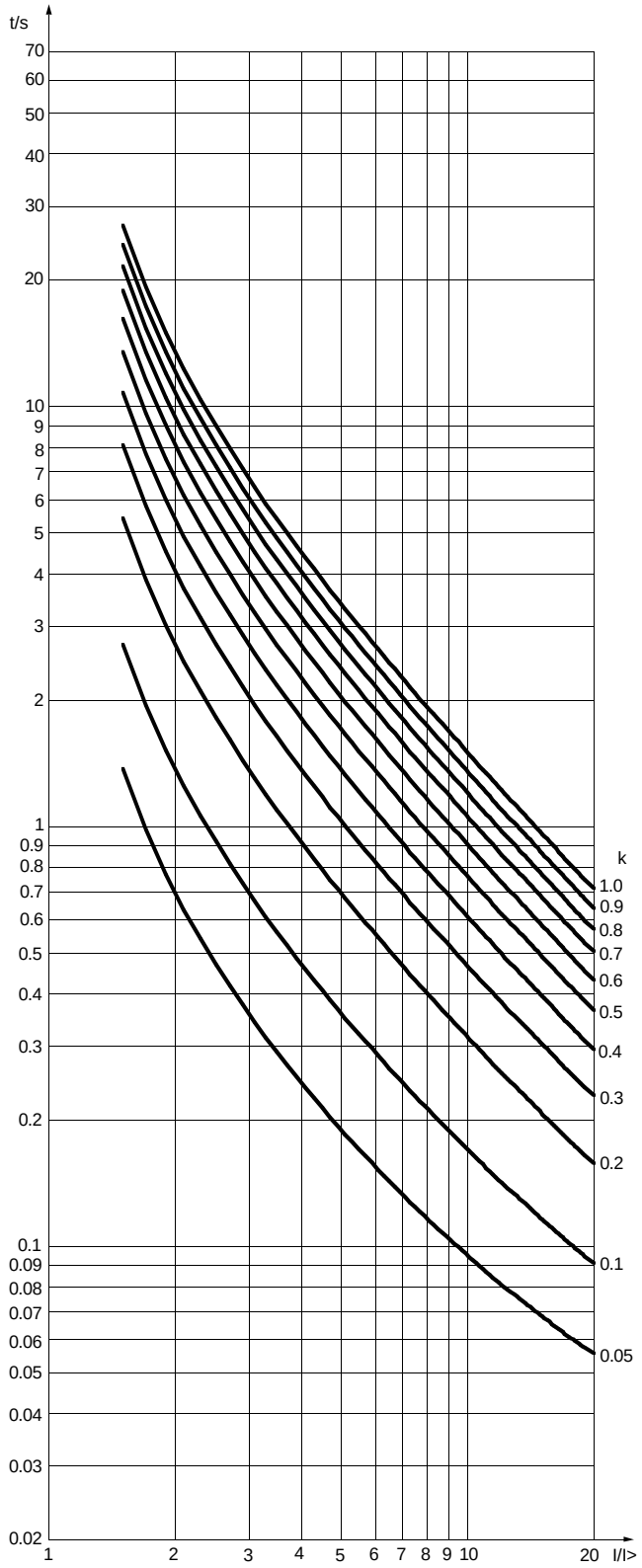


Fig. 4. Very inverse characteristic.

I = measured current
I> = set start current
t = operation time
k = time multiplier

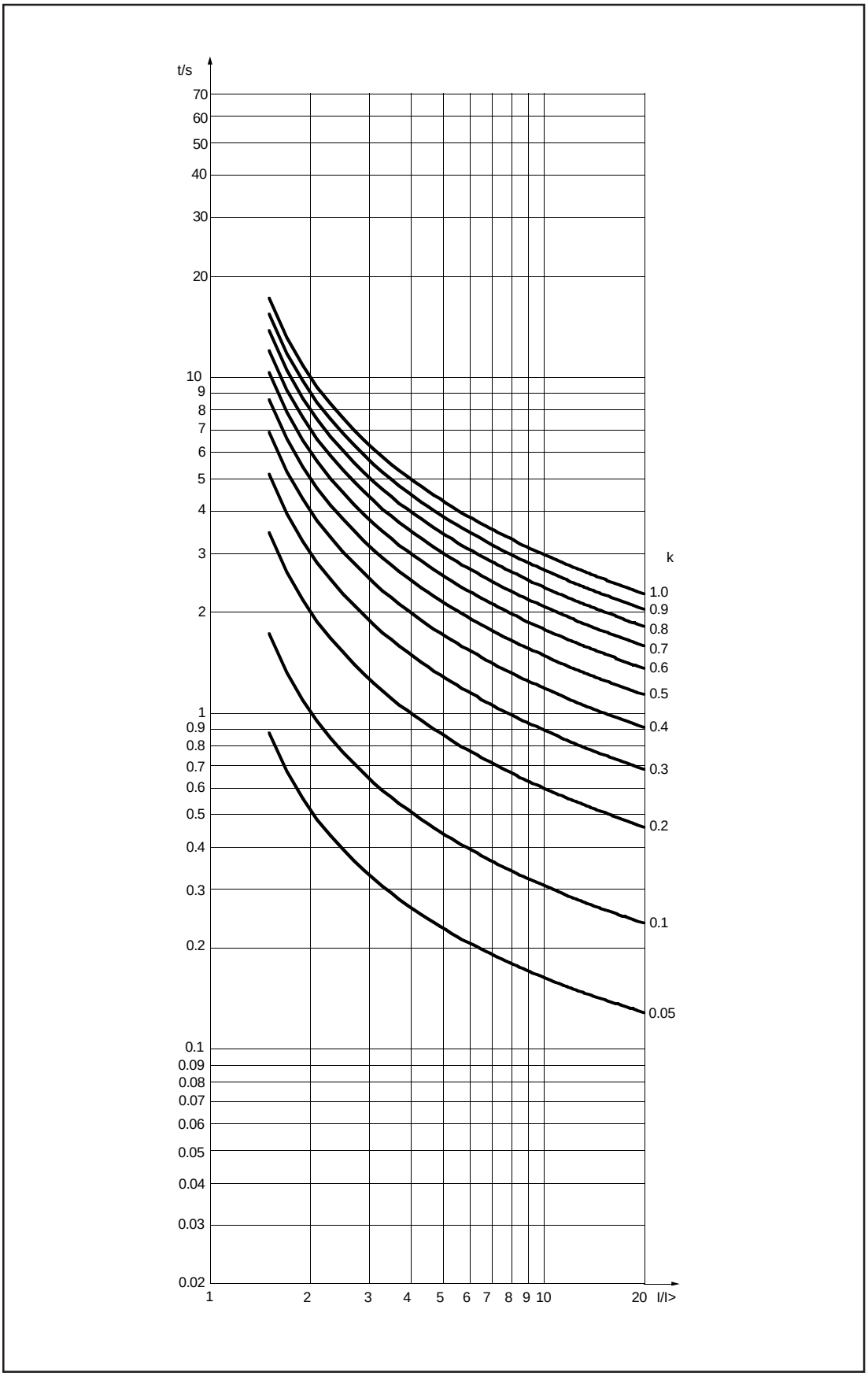


Fig. 5. Normal inverse characteristic.

I = measured current
I> = set current
t = operation time
k = time multiplier

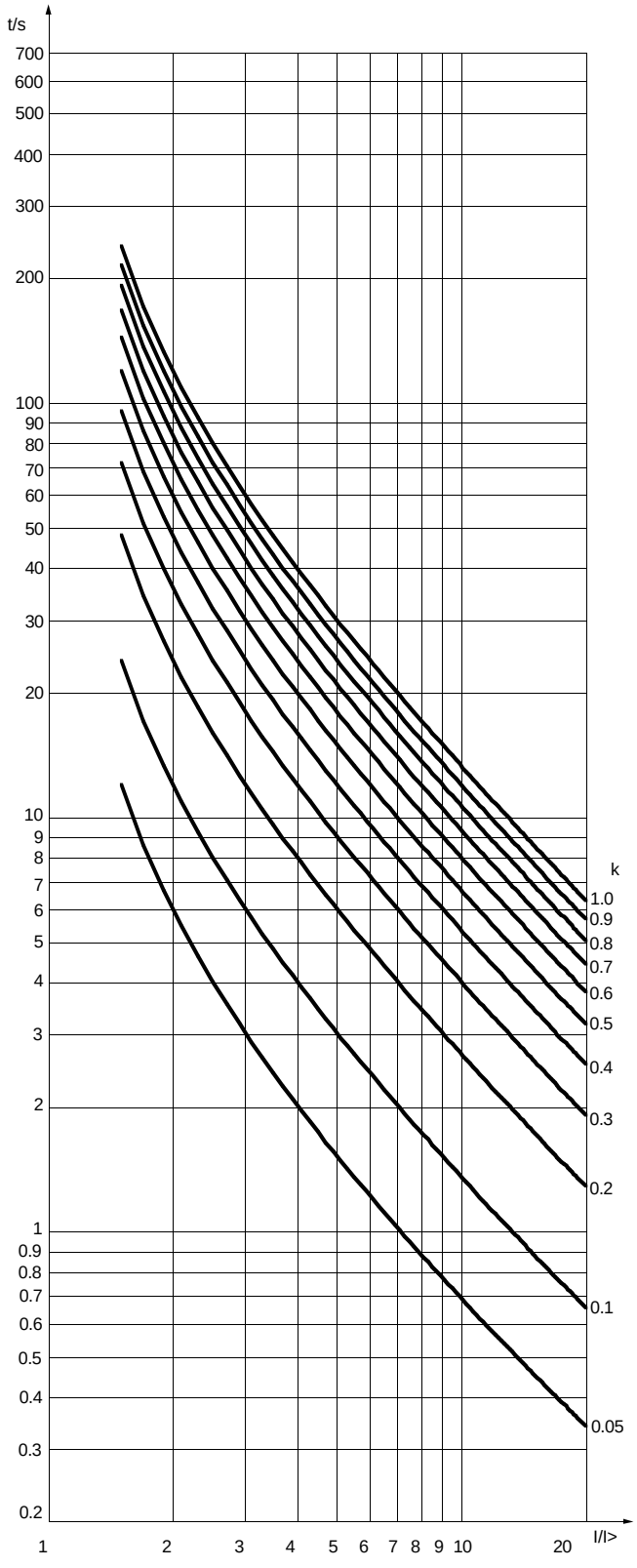


Fig. 6. Long-time inverse characteristic.

I = measured current
I> = set start current
t = operation time
k = time multiplier

Low-set overcurrent stage I>

Start current I>	0.5...2.5 x I_n
Start time, typically	55 ms
Operate time t> at definite time characteristic	0.05...1.00 s, 0.5...10.0 s or 5...100 s
Time/current curves at inverse time characteristic (IDMT)	Extremely inverse Very inverse Normal inverse Long-time inverse
Time multiplier k	0.05...1.00
Reset time, typically	60 ms
Retardation time	<30 ms
Drop-off/pick-up ratio, typically	0.96
Operation time accuracy at definite time operation characteristic	±2% of set value or ±25 ms
Operation time accuracy class E at inverse time mode of operation	5
Operation accuracy	±3% of set value

High-set overcurrent stage I>>

Start current I>>	2.5...20.0 x I_n & ∞, infinite or 0.5...4.0 x I_n & ∞, infinite
Start time, typically	40 ms
Operation time t>>	0.04...1.00 s, 0.4...10.0 s or 4...100 s
Reset time, typically	60 ms
Retardation time	<30 ms
Drop-off/pick-up ratio, typically	0.96
Operation time accuracy	±2% of set value or ±25 ms
Operation accuracy	±3% of set value

Event codes

The substation level control data communicator is able to read, over the SPA serial bus, the event data of the protection module of the relay, e.g. start and trip information. Event information that have been read are printed out in the format: time (ss.sss) and event code. The event codes of the relay module SPCJ 3C3 are denoted E1...E8, E50 and E51. Additional event codes, i.e. E52…E54, are generated by the control data communicator. These event codes are, for instance, related to the data communication.

The event 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, 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, one by one, the above numbers either with 0 (event not included in the reporting) or 1 (event included in the reporting) and adding the products, check for the procedure for calculating the checksum.

The event mask may take a value within the range 0...255. The default value of the relay module SPCJ 3C3 is 85, which means that all start and trip signals are included in the reporting, but not the resetting. The event codes E50...E54 and the events represented by these cannot be excluded from the reporting.

Event codes for the overcurrent relay module SPCJ 3C3:

Code	Event	Number representing the event	Factory set default value
E1	Starting of stage I>	1	1
E2	Reset of starting of stage I>	2	0
E3	Tripping of stage I>	4	1
E4	Reset of tripping of stage I>	8	0
E5	Starting of stage I>>	16	1
E6	Reset of starting of stage I>>	32	0
E7	Tripping of stage I>>	64	1
E8	Reset of tripping of stage I>>	128	0
E50	Restarting	*	-
E51	Overflow of event register	*	-
E52	Temporary disturbance of the data communication	*	-
E53	No response from the relaymodule over the data communication	*	-
E54	The relay module responds again over the data communication	*	-

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

Remote transfer data

Apart from the event codes the control data communicator is able to read, over the SPA bus, all input data (I data) of the relay module, set values (S values), output status data (O data) information recorded in the memory (V data), and some other data. Further, part of the data can be altered by commands given over the SPA bus. Any information is located on channel 0, which needs not to be written in the data communication instructions.

Data	Code	Data direct.	Values
Current on phase L1 as a multiple of the rated current	I1	R	0...63 x I_n
Current on phase L2 as a multiple of the rated current	I2	R	0...63 x I_n
Current on phase L3 as a multiple of the rated current	I3	R	0...63 x I_n
Blocking of tripping of stage I>	I4	R	0 = no blocking 1 = tripping of stage I> blocked
Blocking of tripping of stage I>>	I5	R	0 = no blocking 1 = tripping of stage I>> blocked
Starting of stage I>	O1	R	0 = stage I> has not started 1 = stage I> started
Tripping of stage I>	O2	R	0 = stage I> not tripped 1 = stage I> tripped
Starting of stage I>>	O3	R	0 = stage I>> not started 1 = stage I>> started
Tripping of stage I>>	O4	R	0 = stage I>> not tripped 1 = stage I>> tripped
Alerted start value for stage I>	S1	R	0.5...2.5 x I_n
Alerted operation time for stage I> or time multiplier k	S2	R	0.05...100 s 0.05...1.00
Alerted start value for stage I>>	S3	R	0.5...20 x I_n 999 = ∞, infinite
Alerted operation time for stage I>>	S4	R	0.04...100 s
Alerted checksum of switchgroup SG1	S5	R	0...255
Start value of stage I>, set with the setting knob	S11	R	0.5...2.5 x I_n
Operation time or time multiplier of stage I>, set with the setting knob	S12	R	0.05...100 s 0.05...1.00
Start value of stage I>>, set with the setting knob	S13	R	0.5...20 x I_n 999 = ∞, infinite
Operation time of stage I>>, set with the setting knob	S14	R	0.04...100 s
Checksum of switchgroup SG1, set with the switches	S15	R	0...255
Remote setting percentage of the start value of stage I>	S21	R, W	0...999%
Remote setting percentage of the operation time or time multiplier of stage I>	S22	R, W	0...999%
Remote setting percentage of the start value of stage I>>	S23	R, W	0...999%
Remote setting percentage of the operation time of stage I>>	S24	R, W	0...999%
Remotely set checksum for the switchgroup SG1	S25	R, W	0...255

Data	Code	Data direct.	Values
Remotely set start value of stage I>	S31	R	0.5...2.5 x I_n
Remotely set operation time value or time multiplier of stage I>	S32	R	0.05...100 s 0.05...1.00
Remotely set start value of stage I>>	S33	R	0.5...20 x I_n 999 = ∞, infinite
Remotely set operation time value of stage I>>	S34	R	0.04...100 s
Remotely set checksum of switch-group SG1	S35	R	0...255
Max. measured current or current value at relay operation	V1	R	0...63 x I_n
Number of starts of stage I>	V2	R	0...255
Number of starts of stage I>>	V3	R	0...255
Duration of the latest start situation of stage I>	V4	R	0...100%
Duration of the latest start situation of stage I>>	V5	R	0...100%
Phase data recorded at the latest triping occasion	V6	R	1 = I_{L3}>, 2 = I_{L2}>, 4 = I_{L1}>, 16 = I_{L3}>>, 32 = I_{L2}>>, 64 = I_{L1}>> + combinations
Current value at relay operation	V7	R	0…63 x I_n
Resetting of output relays and operation indicators	V101	W	1 = output relays and operation indicators are reset
Resetting of output relays and operation indicators and erasing of recorded data	V102	W	1 = output relays and operation indicators are reset and registers (codes V1...V7) are erased
Remote control of settings	V150	R, W	0 = setting with knobs S11...S15 alerted 1 = remote settings S31...S35 alerted
Event mask word	V155	R, W	0...255, see paragraph "Event codes"
Manual or automatic resetting of LED indicators (SG2)	V156	R, W	0…15, see paragraph "Selector switches"
Programming push-buttons (SG3)	V157	R, W	0…7, see paragraph "Selector switches"
Opening of password for remote setting of module parameters	V160	W	1...999
Renaming or closing of password for remote setting of parameters	V161	W	0...999
Activation of the self-supervision system output	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.
Fault code number	V169	R	0…255

Data	Code	Data direct.	Values
Data communication address of the relay module	V200	R, W	1...254
Program version number	V205	R	e.g. 052 B
Relay module type designation	F	R	SPCJ 3C3
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 relay module state 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 state data	C	W	0 = resetting
Time reading and setting	T	R, W	00.000...59.999 s

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

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

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

The set values S1...S5 are the alerted set values currently used by the relay. These values can be set either by means of the setting knobs and selector switches or by remote control. The values S11...S15 are set with the setting knobs and the switches of the relay module. The values S21...S25 are percentage factors to be multiplied by the set values given with the setting knobs. The set values S21...S25 can be both read and written. A condition for writing is that the password, V160, for remote setting has been opened and the potentiometer settings must be valid, V150=0. The variables S31...S35 contain the actual remotely set values.

The remote setting percentage of variables S21...S24 can be given a percentage value within the range 0...999. This means that set values outside the limits of the specified setting range can be given to a certain parameter. However, the proper operation of the relay is guaranteed only for set values within the setting range limits specified in the technical data.

Activation of the self-supervision input (V165) prevents the relay from operating as long as the self-supervision input is active and the IRF indicator is lit.

After an operation the relay module indicates by means of variable V6 the phases (phase indication) which have exceeded the setting value of the low-set stage or the high-set stage at the moment of operation. The same data are indicated by the LED indicators of the module, see section "Operation indicators". The data are binary numbers coded to decimal numbers, so that, for the low-set overcurrent stage as well as for the high-set overcurrent stage, each phase is represented by a specific number. The final code is obtained by adding the separate phase code numbers.

Coding of phase fault data:

Fault	Code number
Low-set stage I> set value exceeded on phase L3	1
Low-set stage I> set value exceeded on phase L2	2
Low-set stage I> set value exceeded on phase L1	4
High-set stage I>> set value exceeded on phase L3	16
High-set stage I>> set value exceeded on phase L2	32
High-set stage I>> set value exceeded on phase L1	64

For instance when V6 = 7 (1 + 2 + 4), the low-set current stage has operated (tripped) and the current on each phase has exceeded the set start value of the low-set stage I>.

Register data V6 includes two separate parts, one for the low-set overcurrent stage and one for the high-set overcurrent stage. If the low-set overcurrent stage operates, the value of register V6 is updated with regard to the codes 1, 2 and 4 only. If the high-set overcurrent stage operates, only the codes 16, 32 and 64 are updated. A new value always erases the old recorded value.

Register V6 can be set to zero either by pushing the buttons STEP and RESET simultaneously or by giving the variable V102 the value 1 via the SPA bus.

Fault codes

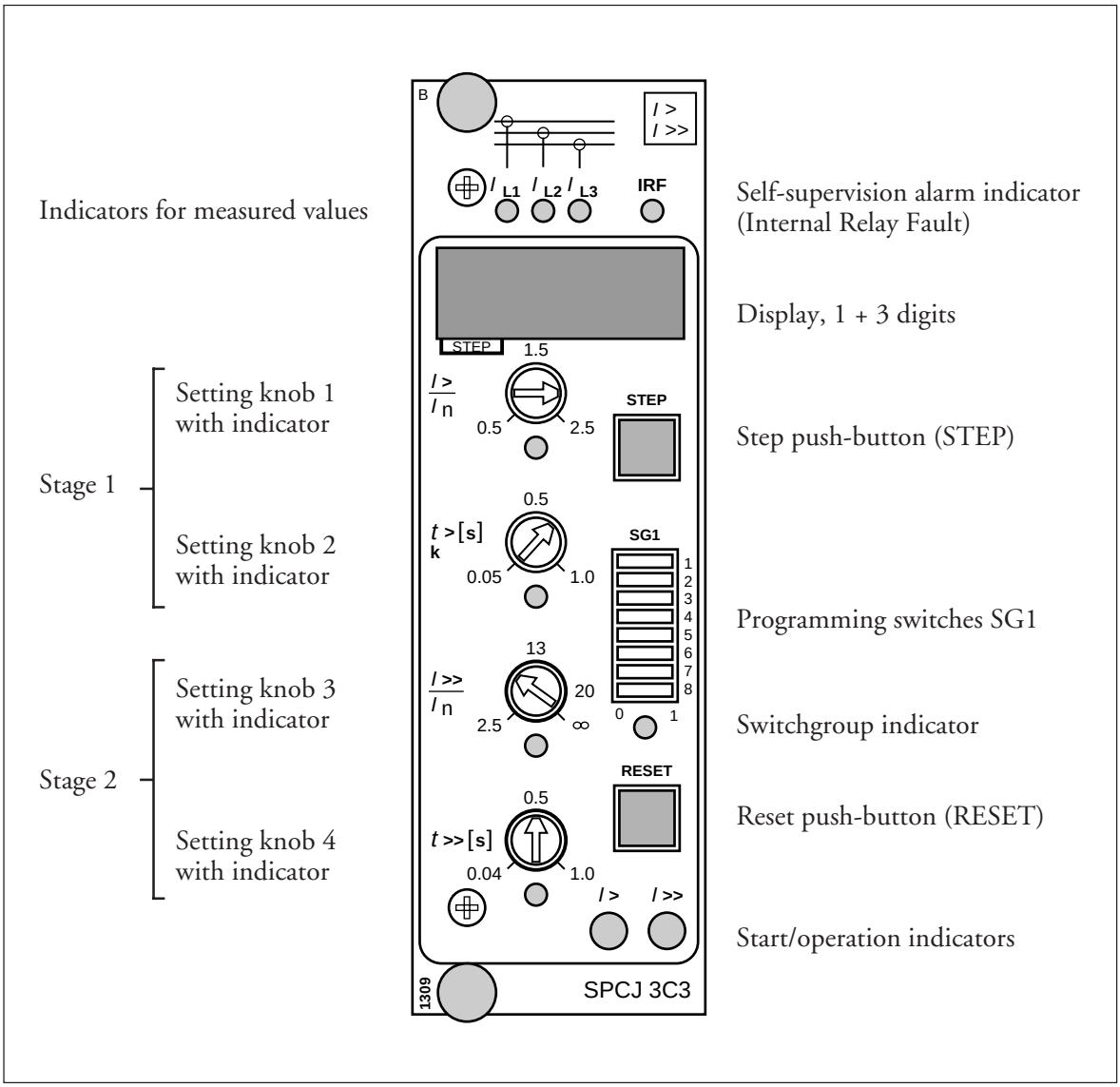
Shortly after the self-supervision system has detected a permanent internal fault the red fault indicator IRF on the relay module front panel is lit. At the same time the self-supervision system puts forward a control signal to the output relay of the self-supervision system. Further, in most fault situations a self-diagnostic fault code is shown on the display of the relay module. The fault code is composed of a red number one (1) and a green, one or two digit code number. It is recommended that the fault code number is noted down and passed forward to the service shop when overhaul and repair of the faulty relay module is ordered.

The three-phase overcurrent relay module SPCJ 3C3 may display the following fault codes:

Fault code	Type of fault
4	Trip signal path broken or output relay module missing
30	Faulty program memory (ROM)
50	Faulty random access memory (RAM)
195	Too low a value on the reference channel with multiplier 1
131	Too low a value on the reference channel with multiplier 5
67	Too low a value on the reference channel with multiplier 25
203	Too high a value on the reference channel with multiplier 1
139	Too high a value on the reference channel with multiplier 5
75	Too high a value on the reference channel with multiplier 25
253	No interruptions from the D/A converter

General characteristics of C-type relay modules

User´s manual and Technical description



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General characteristics of C-type relay modules

Contents

Push-buttons

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

Programming switches SG1

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

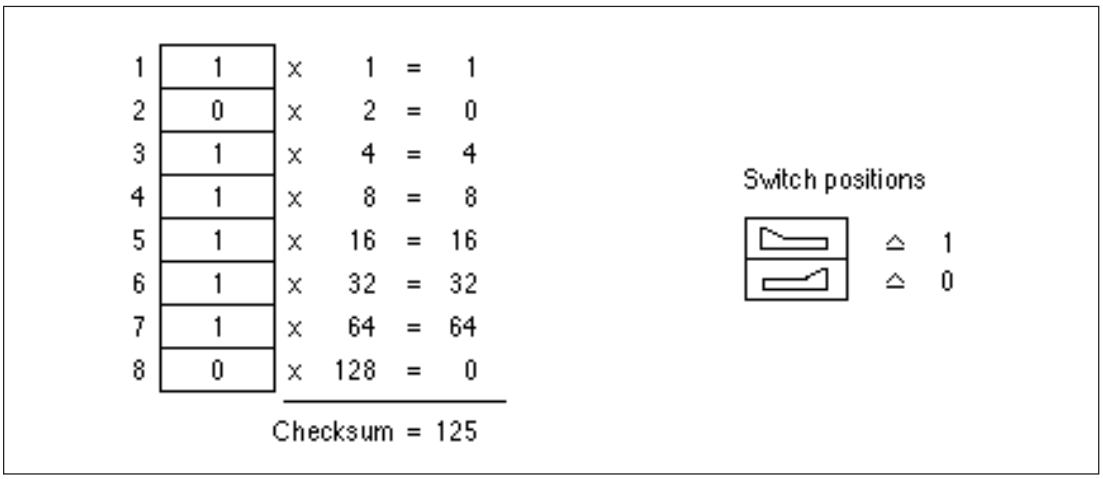


Fig. 2. Example of calculating the checksum of programming switchgroup SG1.

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

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

Setting knobs

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

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

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

Display

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

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

Display main menu

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

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

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

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

Display submenu

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

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

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

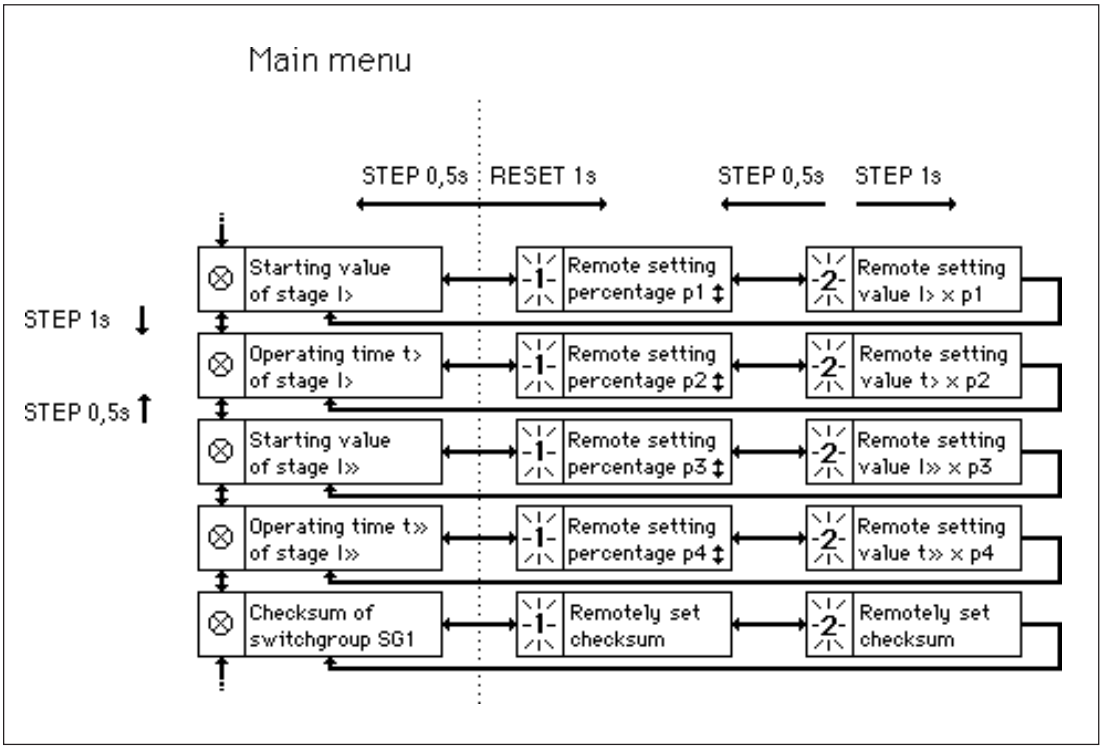


Fig. 3. Example of the main and submenus for the settings of the overcurrent relay module SPCJ 3C3. The settings made with the setting knobs are in the main menu and they are displayed by pressing the STEP button. In addition to the setting knob settings the main menu contains the measured current values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

Setting mode

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

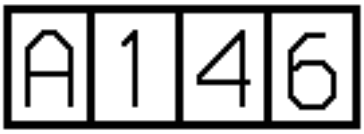
A set value is stored in the memory by pressing the push-buttons STEP and RESET simultaneously. In practice the RESET button must be pressed slightly in excess of the STEP button. Return from the setting mode to the main menu or submenu is possible by pressing (for about 10 s) the RESET button until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

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

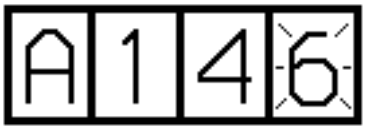
Example 1:

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

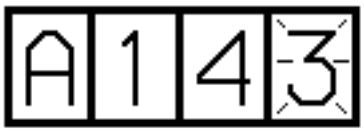
a)
Press push-button STEP until register address A appears on the display.



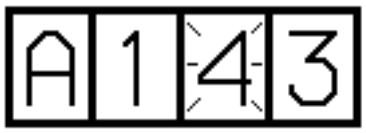
b)
Press the RESET button for about 10 s until the right most digit starts flashing.



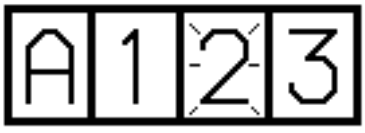
c)
Press the STEP button repeatedly to set the digit to the value desired.



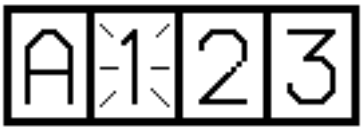
d)
Press the RESET button to make the middle of the green digits flash.



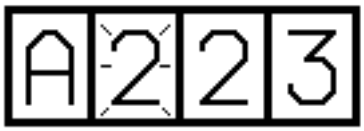
e)
Set the middle address digit by means of the STEP button.



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

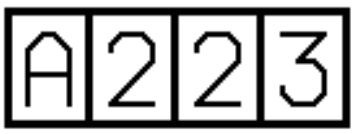


g)
Set the digit by means of the STEP button.



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

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



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

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

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

Stored information

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

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

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

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

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

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

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

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

Trip-test mode

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

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

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

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

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

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

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

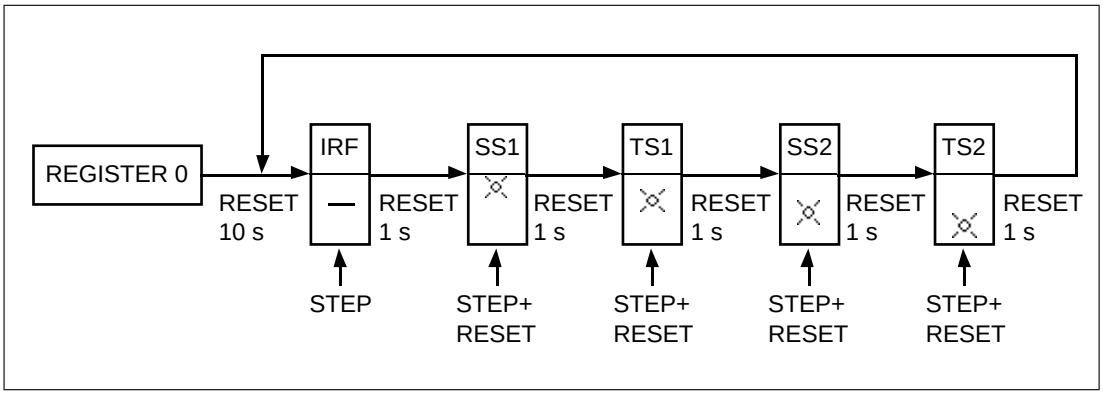


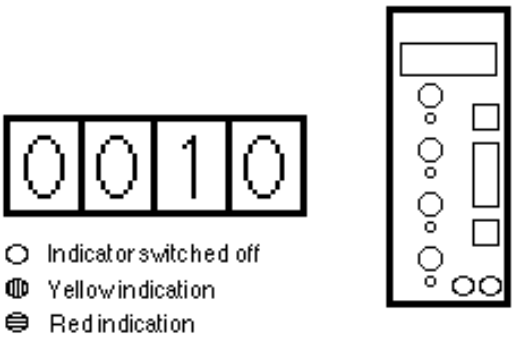
Fig. 4. Sequence order for selecting the output signals in the Trip-test mode.

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

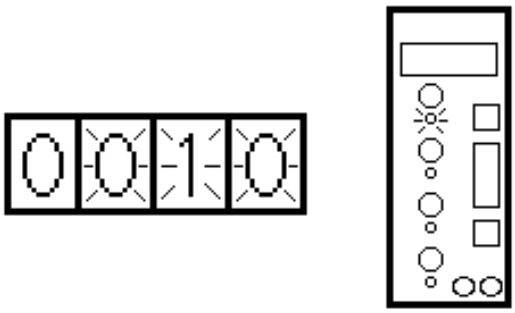
Example 2:

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

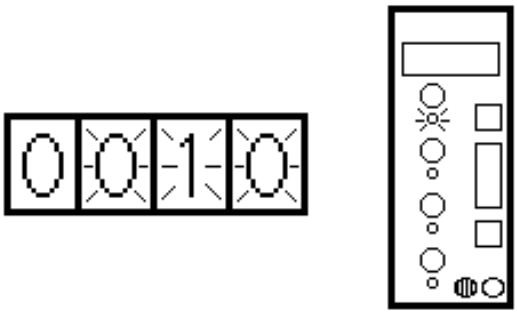
a)
Step forward on the display to register 0.



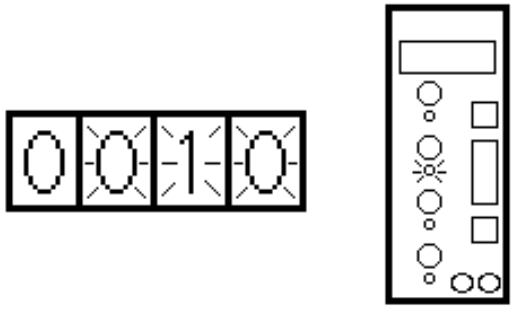
b)
Press the RESET button for about 10 seconds until the three green digits to the right and the LED indicator of the uppermost setting knob start flashing.



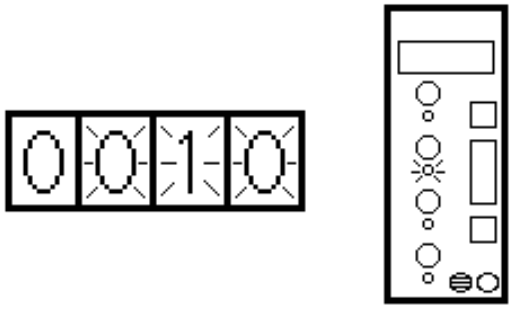
c)
Press the push-buttons RESET and STEP simultaneously. Then the starting of stage 1 (e.g. the I>-stage of the overcurrent module SPCJ 3C3) is activated and, simultaneously, the indicator of the stage starts glowing yellow.



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



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



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

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

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

Operation indicators

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

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

Fault codes

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

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

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

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