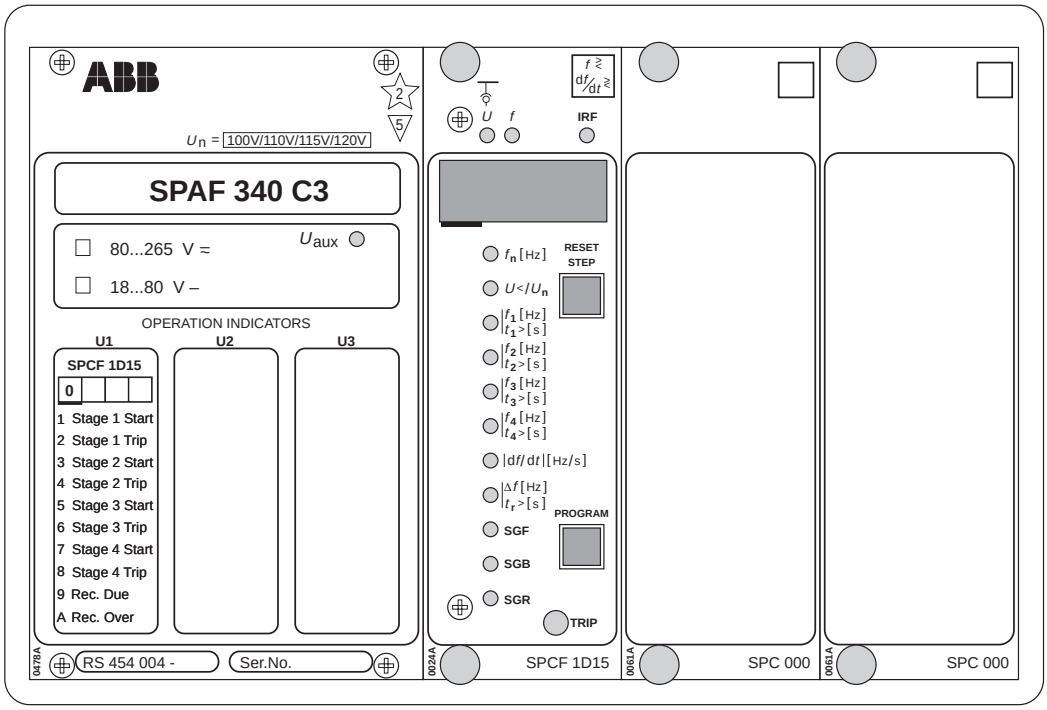
SPAF 340 C
Frequency Relay

User´s manual and Technical description



ABB

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SPAF 340 C
Frequency Relay

Contents

In addition to the general part, the complete manual of the frequency relay SPAF 340 C includes the following relay module descriptions:

Combined frequency and rate of change of frequency relay module	1MRS 750583-MUM EN
General characteristics of D-type SPC relay modules	1MRS 750066-MUM EN

Features

Single-phase four-stage combined overfrequency/underfrequency relay

Each protection stage includes a frequency rate of change function (df/dt), which can be used alone or in combination with the overfrequency/underfrequency function.

Each protection stage includes two separate adjustable timers

Recovery function

Programmable undervoltage blocking

Four rated voltages, to be selected in the software

Adjustable rated frequency

Five external control inputs enabling separate blocking of each stage, etc.

Eight freely configurable output relays and self-supervision output relay

Four trip contacts

Recording of measured data, which can be used for analysing the network condition.

Transfer of data over serial communication bus

Continuous self-supervision with internal fault diagnosis

Reading and writing of setting values via display and front panel push-buttons, a PC with setting software or from higher system levels over the serial bus.

Application

The frequency relay SPAF 340 C3 is specially designed to be used for automatic disconnection of loads in situations, where the loads connected to the network exceed the available power capacity of the network. Such a power deficiency causes the frequency of the network to drop at a rate of change that is directly proportional to the power deficiency and inversely proportional to the rotating mass of the generators connected to the network.

The SPAF 340 C3 relay allows 4-step load-shedding and is capable of operating four circuit breakers. A total of eight timers, freely selectable relay outputs and the df/dt function of the relay enable a load-shedding logic, which can sense the rate of change of the network frequency as well.

In addition, the frequency relay SPAF 340 C3 can be used for protecting generators, large synchronous motors and other electrical equipment against overfrequency and underfrequency.

Description of operation

The frequency relay SPAF 340 C is a secondary relay, which is connected to the voltage transformers of the network section to be protected. The relay incorporates one relay module: the combined frequency and rate of change of frequency module type SPCF 1D15.

Combined frequency and rate of change of frequency relay module

The relay module includes four protection stages, each of which with its own frequency function (f), its own rate of change of frequency function (df/dt) and two adjustable operate times (t and t').

When the frequency limit of a stage is set below the rated frequency, the protection stage operates as an underfrequency stage. Correspondingly, the stage has the function of an overfrequency stage, when the frequency level is set above the rated frequency. The frequency setting cannot be the same as the rated frequency.

The operation of the df/dt function of a protection stage is based on the same principle as the frequency function, which means that if a protection stage operates as an underfrequency stage, the sign of the df/dt function is negative. Then the df/dt function starts once the absolute value of the rate of frequency drop exceeds the df/dt limit. When required, the frequency function and the df/dt function can be combined so that the criteria for operation of both functions have to be fulfilled at the same time.

Once a preset condition is fulfilled, the stage starts and, at the same time, it activates a timing circuit. No start signal can be programmed for the output relays. When the stage times out, the relay produces a trip signal. The trip signal can be linked to the desired output relay.

Connections
(modified 2003-09)

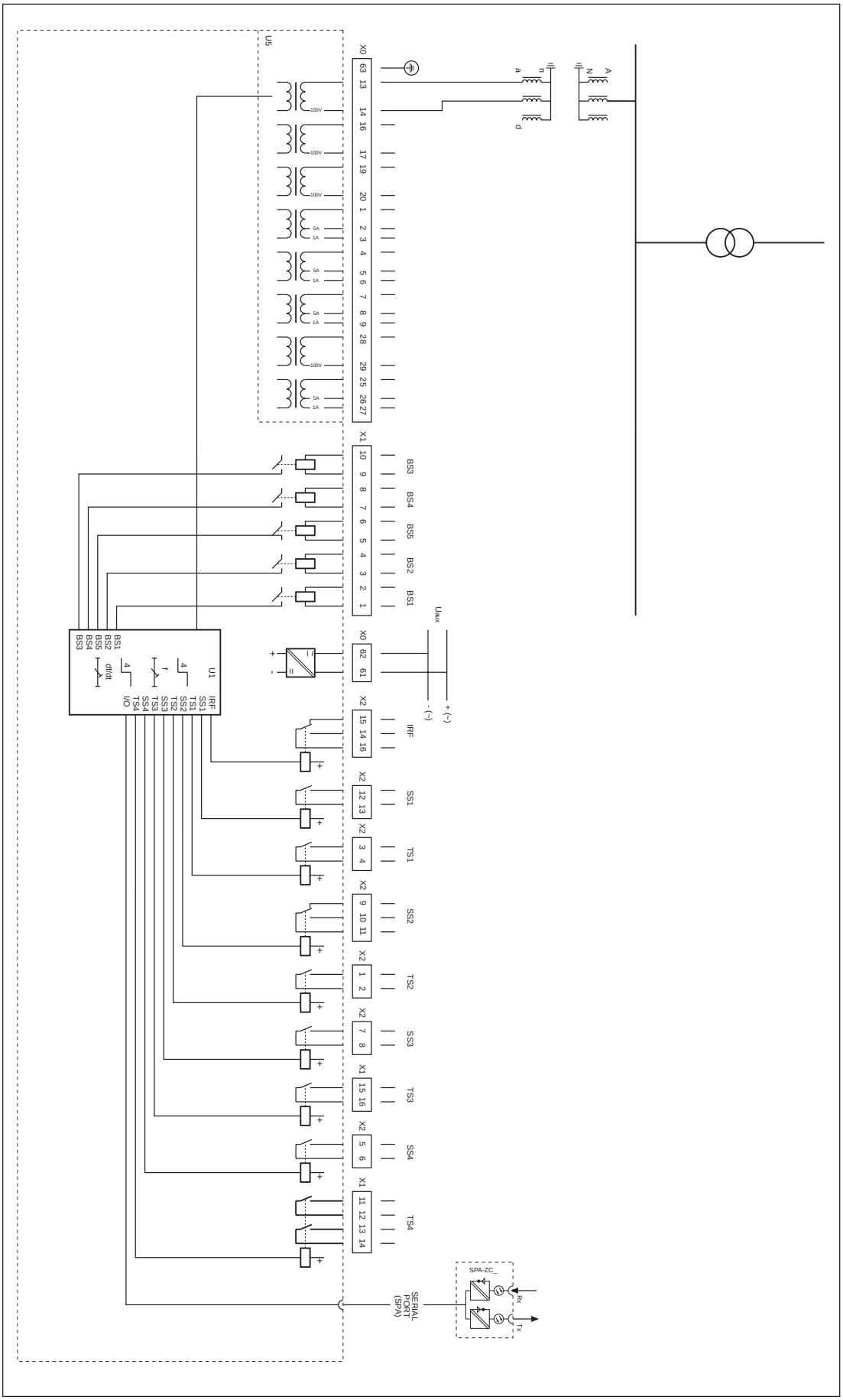


Fig. 1. Connection diagram for frequency relay SPAF 340 C

U_{aux}	Auxiliary voltage
TS1...TS4	Output relays (heavy-duty)
SS1...SS4	Output relays
IRF	Self-supervision output relay
BS1...BS5	Control signals
U1	Combined frequency and rate of change of frequency relay module
SERIAL PORT	Serial communication port
SPA-ZC_	Bus connection module
Rx/Tx	Fibre-optic cable connection

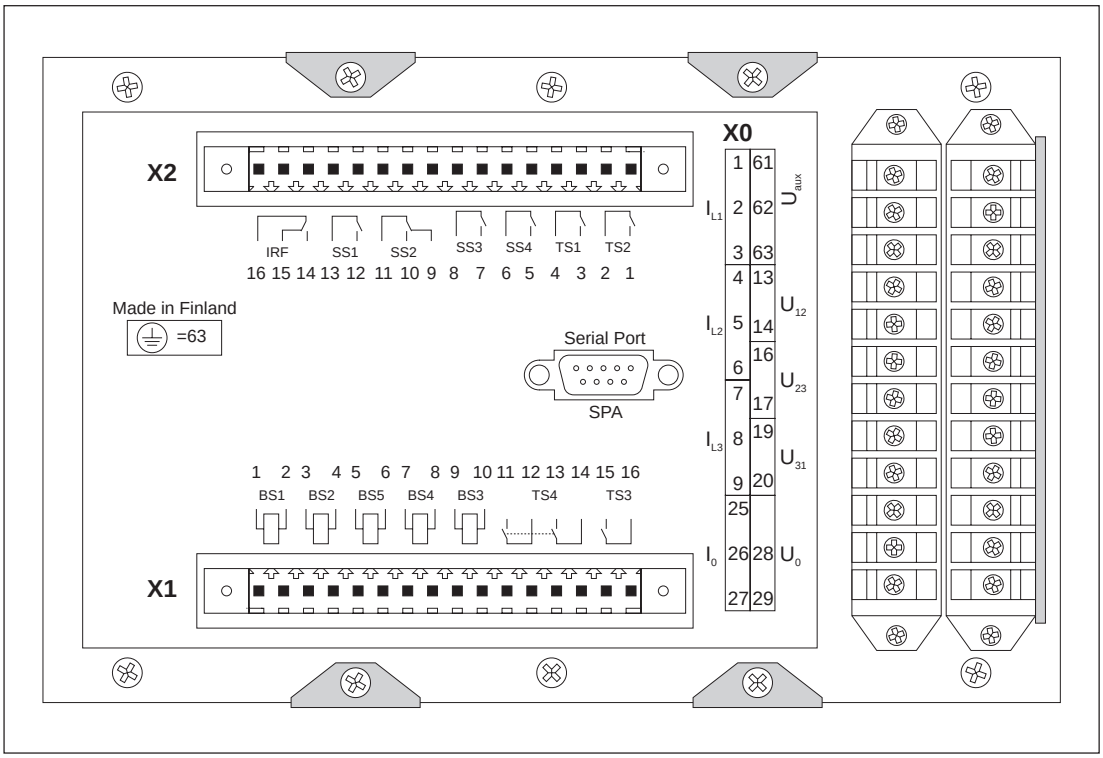


Fig. 2. Terminals of frequency relay SPAF 340 C

Specification of input and output terminals

(modified 2004-03)

Terminal group	Terminal interval	Function
X0	1-2	Phase current I_{L1} 5 A *)
	1-3	Phase current I_{L1} 1 A *)
	4-5	Phase current I_{L2} 5 A *)
	4-6	Phase current I_{L2} 1 A *)
	7-8	Phase current I_{L3} 5 A *)
	7-9	Phase current I_{L3} 1 A *)
	13-14	Phase-to-phase voltage U_{12} 100 V
	16-17	Phase-to-phase voltage U_{23} 100 V *)
	18-19	Phase-to-phase voltage U_{31} 100 V *)
	25-26	Neutral current I_0 1 A *)
	25-27	Neutral current I_0 0.2 A *)
	28-29	Residual voltage U_0 100 V *)
		*) Inputs not used by the relay module SPCF 1D15. The inputs can be used for recording the signals via the disturbance recorder SPCR 8C27.
X0	61-62	Auxiliary voltage supply. The positive pole of the DC supply is connected to terminal 61. The auxiliary voltage range is marked on the front plate.
	63	Protective earth
X1	1-2	External blocking signal BS1
	3-4	External blocking signal BS2
	5-6	External blocking signal BS5
	7-8	External blocking signal BS4
	9-10	External blocking signal BS3
X2	1-2	Output relay TS1 (heavy-duty)
	3-4	Output relay TS2 (heavy-duty)
X1	15-16	Output relay TS3 (heavy-duty)
	11-12-13-14	Output relay TS4 (heavy-duty; terminals 12 and 13 to be connected together, unless two-pole control is used)
X2	5-6	Output relay SS4
	7-8	Output relay SS3
	9-10-11	Output relay SS2
	12-13	Output relay SS1
	14-15-16	Output relay IRF

The protection relay connects to the fibre-optic data bus via the bus connection module SPA-ZC 17 or SPA-ZC 21 to be fitted to the D connector on the rear panel of the relay. The optical fibres are connected to the counter contacts Rx and Tx of the module. The selector switches of the bus connection module should be in the position "SPA".

Operation indicators

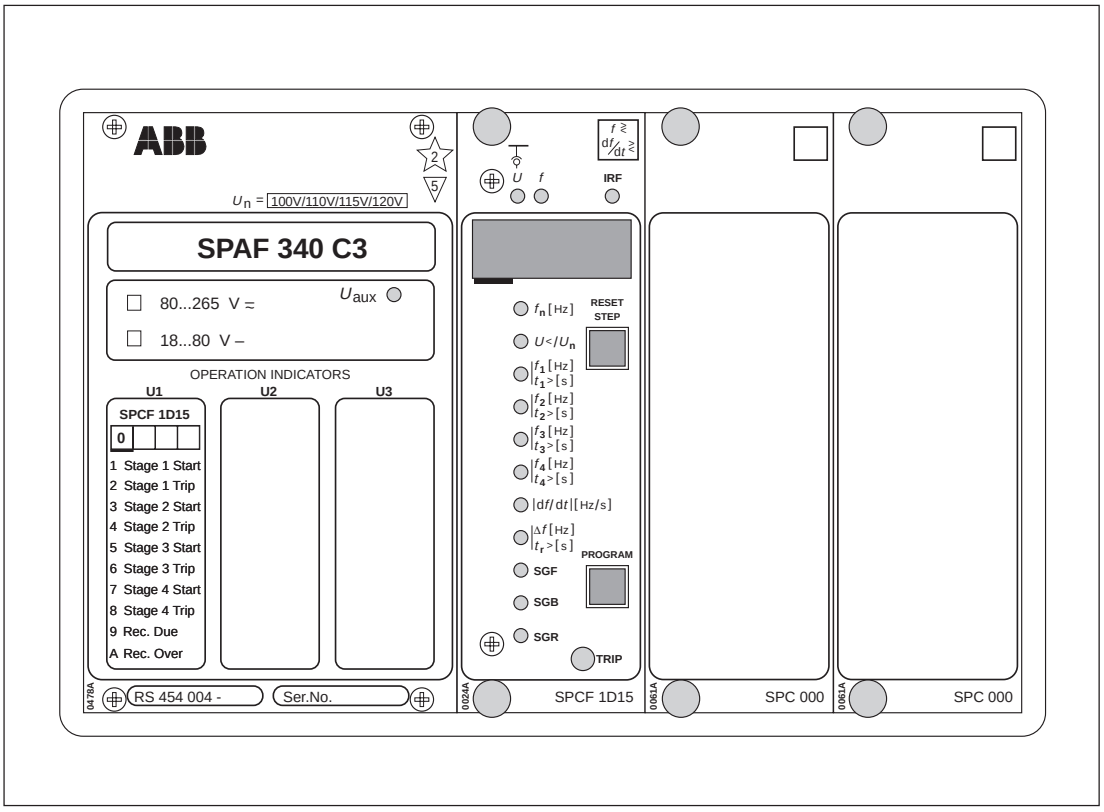


Fig. 3. Front panel of frequency relay SPAF 340 C

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

2. Measured values, settings and start and trip data are indicated on the display. Starting and tripping are indicated by a red operation code to the left of the display. The operation codes are explained in the descriptions of the relay modules and on the system panel of the frequency relay.

   Start indications can be programmed to remain lit, even though the stage resets. In general, the numbers indicating start are automatically reset, whereas trip codes have to be manually reset by pressing the RESET push-button. The TRIP indicator at the bottom part of the front panel can be set to indicate tripping of any stage. The BS_ signals can be configured to automatically reset the trip indicators. A non-reset operation indicator does not affect the operation of the relay module.

3. A measured or set value presented on the display is identified by yellow LEDs on the front panel.

4. A permanent fault detected by the self-supervision system is indicated by the IRF indicator of the concerned relay module and a fault code on the display of the relay module. The fault code should be recorded to facilitate maintenance and repair.

The operation indicators are described in more detail in the descriptions of the relay modules.

I/O module

The I/O module SPTR 9B25 of the frequency relay is located in the rear part of the relay, and placed in the same direction as the mother PC board. The module can be withdrawn after undoing the fixing screws and disconnecting the protective earth conductor and the flat cable connected to the mother PC board.

The I/O module contains the output relays (8 + IRF), the control circuits of the relays, the electronic circuits of the five control inputs and the D connector required for the serial communication. The input and output signals of the I/O module are linked to the mother PC board over the flat cable. The relay module locations U1, U2 and U3 are identical.

The output signals SS1...SS4 and TS1...TS4 of the mother PC board control an output relay with the same designation. The operation of a stage is not fixed to a specific output relay, but can be configured for the desired relay. However, it should be noted that the output relays TS1...TS4 can be used for circuit breaker control. The configuration of the switchgroups is described in the module-specific manuals.

The switchgroups of the relay modules are used for configuring the external control inputs, which can be used for blocking one or several protection stages, resetting operation indicators or selecting second settings, etc.

Power supply module

The power supply module forms the voltages required by the relay modules and the auxiliary relay module. The power supply module is situated behind the system panel of the relay and it can be withdrawn after removal of the system panel.

The power supply module is available in two versions with the following input voltages:

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

SPGU 48B2
- rated voltage U_n = 24/48/60 V dc
- operative range U = 18...80 V dc

The voltage range of the power supply module of the relay is marked on the system panel of the relay.

The power supply module is transformer-connected, i.e. the primary circuits and the secondary circuits are galvanically isolated. The primary side is protected by a fuse, F1, located on the PC board of the module. The fuse used in SPGU 240A1 is 1 A (slow) and the one used in SPGU 48B2 is 4 A (slow).

The green LED indicator U_{aux} on the front panel is lit, when the power supply module is in operation. The supervision of the voltages supplying the electronic circuits is integrated into the relay modules. A self-supervision alarm is received as soon as a secondary voltage deviates from the rated value by more than 25%. An alarm signal is also generated if the power supply module is removed or the auxiliary voltage supply to the relay is interrupted.

Technical data

(modified 2002-04)

Energizing inputs

Rated current I_n	1 A	5 A
Terminal numbers	X0/1-3 X0/4-6 X0/7-9 X0/25-27	X0/1-2 X0/4-5 X0/7-8 X0/25-28
Thermal current withstand		
- continuously	4 A	20 A
- for 10 s	25 A	100 A
- for 1 s	100 A	500 A
Dynamic current withstand		
- half-wave value	250 A	1250 A
Input impedance	<100 mΩ	<20 mΩ

Voltage inputs

Rated voltage U_n (programmable)	100 V (110 V, 115 V, 120 V)
Terminal numbers	X0/13-14, 16-17, 19-20, 28-29
Continuous voltage withstand	2 x U_n
Rated burden of voltage input at U_n	<0.5 VA

Output contacts

Trip contacts	
Terminal numbers	X2/3-4, 1-2 X1/15-16, 11-12-13-14
Rated voltage	250 V ac/dc
Continuous current carrying capacity	5 A
Make and carry 0.5 s	30 A
Make and carry 3 s	15 A
Breaking capacity for dc when the control circuit time constant L/R ≤40 ms at the control voltage levels	
- 220 V dc	1 A
- 110 V dc	3 A
- 48 V dc	5 A
Signal contacts	
Terminal numbers	X2/12-13, 9-10-11 X2/7-8, 5-6, 14-15-16
Rated voltage	250 V ac/dc
Continuous current carrying capacity	5 A
Make and carry 0.5 s	10 A
Make and carry 3 s	8 A
Breaking capacity for dc when the control circuit time constant L/R ≤40 ms at the control voltage levels	
- 220 V dc	0.15 A
- 110 V dc	0.25 A
- 48 V dc	1 A

External control inputs

Blocking/control (BS1...BS5)	
Terminal numbers	X1/1-2, 3-4, 9-10, 7-8, 5-6
External control voltage	18...250 V dc or 80...250 V ac
Current drain of activated control input	2...20 mA

Power supply module

SPGU 240A1	
Rated voltage	U_n = 100/120/230 V ac U_n = 110/125/220 V ac
Operative range	U = 80...265 V dc
SPGU 48B2	
Rated voltage	U_n = 24/48/60 V dc
Operative range	U = 18...80 V dc
Power consumption under quiescent/ operation conditions	15 W/20 W

Combined frequency and rate of change of frequency relay module SPCF 1D15

- see "Technical data" in the description of the module.

Data communication

Transmission mode	Fibre-optic serial bus
Coding	ASCII
Data transfer rate, selectable	4800 Bd or 9600 Bd
Bus connection modules for fibre-optic data transfer	
- for plastic core cables	SPA-ZC 21 BB
- for glass-fibre cables	SPA-ZC 21 MM
Modules with internal power supply unit	
- for plastic core cables	SPA-ZC 17 BB
- for glass-fibre cables	SPA-ZC 17 MM

Insulation Tests *)

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

Electromagnetic Compatibility Tests *)

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

Mechanical environmental tests

Vibration test, IEC 60255-21-1	class 2
Chock/bump test, IEC 60255-21-2	class 2
Seismic test, IEC 60255-21-3	class 2

Environmental conditions

Service temperature range	-10... +55°C
Transport and storage temperature range	-40...+70°C
Temperature influence	±0.05‰/total temperature range, frequency measurement <0.2%/°C, voltage measurement
Damp heat test	93...95%, +55°C, 6 cycles
Degree of protection by enclosure of flush-mounting relay case	IP54
Weight of fully equipped relay	6 kg

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

Applications

Example 1.
Four-step load shedding accomplished by using frequency relay SPAF 340 C3
(modified 2003-09)

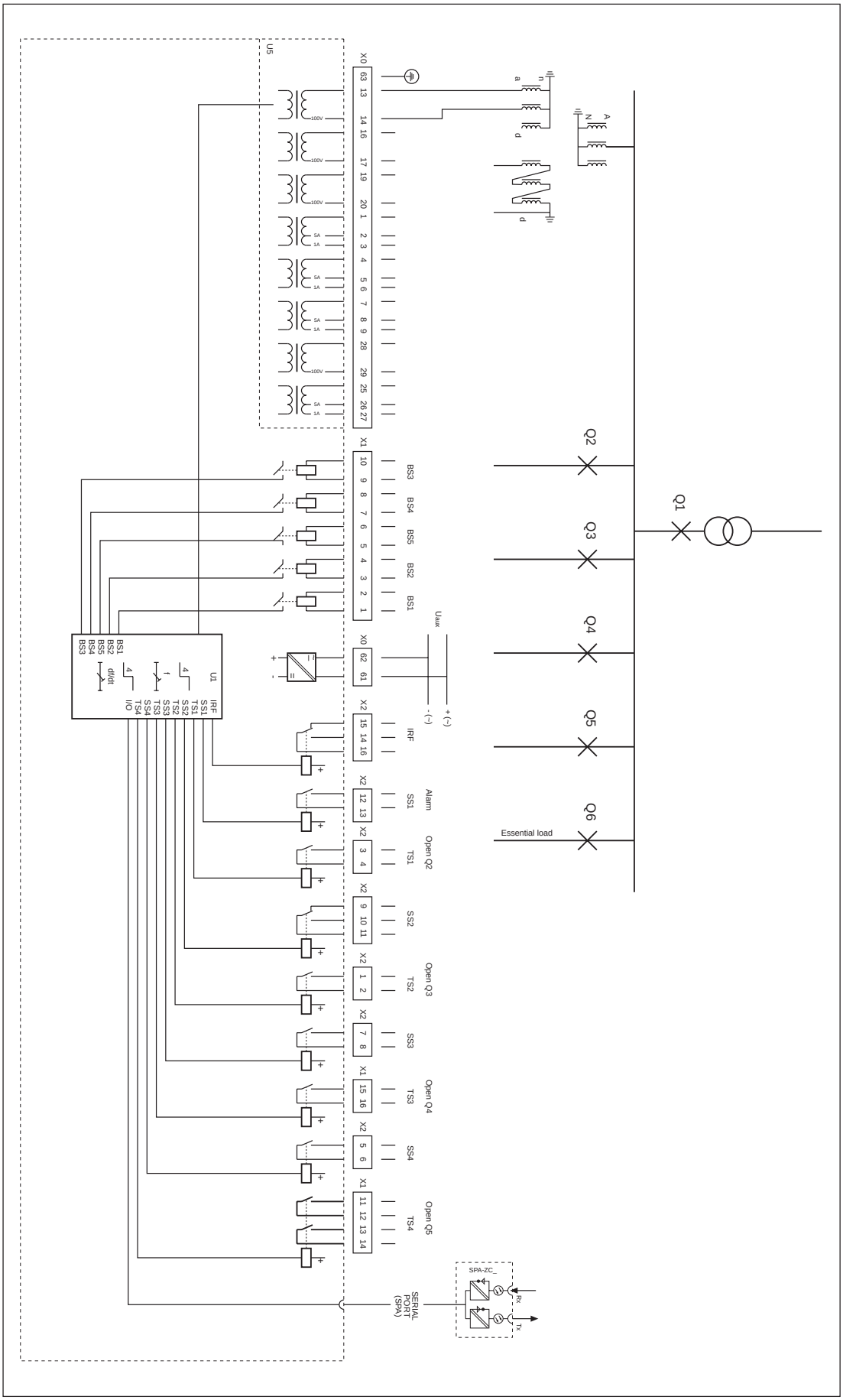


Fig. 4. Frequency relay SPAF 340 C3 used for load shedding

The relay module SPCF 1D15 incorporates four protection stages. By using all of these stages and giving each stage its own start values and operate times such a load shedding system can be achieved that senses rates of change in situations of power deficiency.

In a situation of power deficiency, the feeders are disconnected in such a sequence that the feeder of the lowest priority is the first one to be disconnected and that of the highest priority the last one to be disconnected. When a load-shedding system is constructed, it should be noticed that the feeders to be disconnected are loaded. This means that the feeders have an influence on the restoration of the power balance.

In the application of the example four protection stages are used. Each stage has two output signals with different operate times. One of the operate times is relatively long and intended to be used in situations with rather small power deficiencies and slow frequency declines. This delay allows the frequency to fall below the start level momentarily; no loads are disconnected when the power regulators are able to restore the power balance. In addition, a long operate time gives the network and the power regulators time to respond to load disconnection carried out by a higher stage.

The short operate time of the stage allows loads to be disconnected quickly in a situation of great power deficiency. The shorter operate time is connected to control the circuit breaker which should operate earlier according the protection scheme, so the load is always shed in the desired sequence. Thus, the shorter operate time of a stage always "speeds up" the operation of the previous load-shedding stage.

The start values and operate times of the stages and the timers controlling the individual circuit breakers are shown in Fig. 5. The designations used in Fig. 5 refer to Fig. 4.

Stage	Operate value	Delay	Timer	Relay output	Function
1	48.7	0.15	t_1	SS1	Alarm
		20	t_1'	TS1	Q2 open
2	48.5	0.15	t_2	TS1	Q2 open
		20	t_2'	TS2	Q3 open
3	48.3	0.15	t_3	TS2	Q3 open
		20	t_3'	TS3	Q4 open
4	48.1	0.15	t_4	TS3	Q4 open
		5	t_4'	TS4	Q5 open

Fig. 5. The settings of the stages of the frequency relay SPAF 340 C3 used for load shedding.

The above mentioned arrangement for speeding up the operation of the stages is illustrated in Fig. 6.

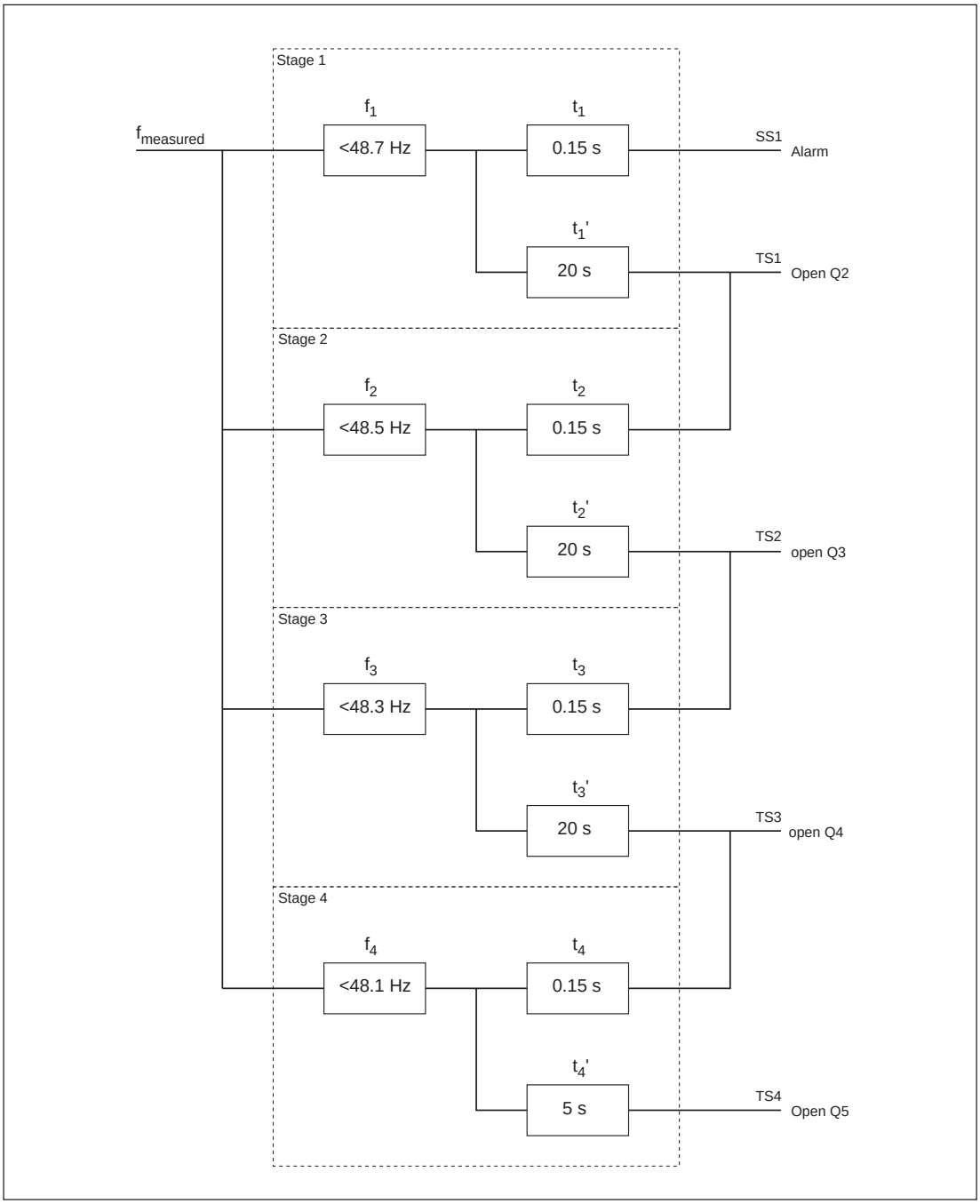


Fig. 6. Use of the timer function of frequency relay SPAF 340 C3 in a load shedding.

As shown in Fig. 7, a lower-set stage disconnects the loads of the next, higher stage, when the power declines rapidly. The advantage of this arrangement is that, when the frequency falls slowly, the power regulators have enough time to operate. When, on the other hand, the power deficiency is the result of a sudden, substantial change, the loads can be disconnected rapidly enough and in the required succession.

Figure 7 illustrates the disconnection of feeder Q2 referred to in Fig. 4, in different situations.

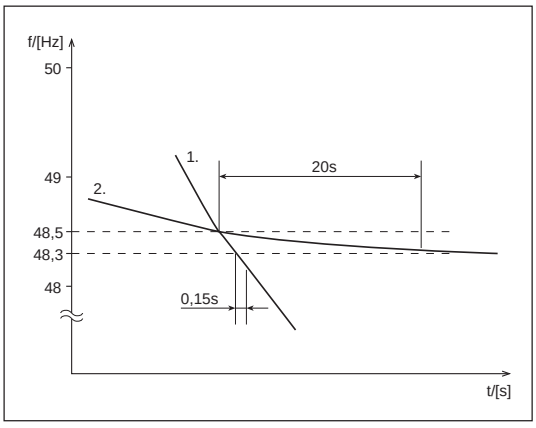


Fig. 7. Opening delay of feeder Q2 at two rates of frequency drop, example 1.

In the case described in example 1 the switches of the frequency relay SPAF 340 C3 can be configured as follows:

Switch-group	Serial comm. parameter	Checksum	Operation
SGF1	S84	1	Only frequency function
SGF2	S85	1	Only frequency function
SGF3	S86	1	Only frequency function
SGF4	S87	1	Only frequency function
SGF5	S88	255	Output continuously operated
SGF6	S89	254	SS2...SS4 and TS1...TS4 linked to TRIP LED
SGF7	S90	0	U_n = 100 V
SGB1	S91	0	No external control signals used
SGB2	S92	0	No external control signals used
SGB3	S93	0	No external control signals used
SGB4	S94	0	No external control signals used
SGB5	S95	0	No external control signals used
SGB6	S96	15	Undervoltage blocking for all stages
SGR1	S97	1	Underfrequency signal to alarm contact SS1
SGR2	S98	2	Stage 1 (timer t') linked to trip contact TS1
SGR3	S99	2	Stage 2 (timer t) linked to trip contact TS1
SGR4	S100	8	Stage 2 (timer t') linked to trip contact TS2
SGR5	S101	8	Stage 3 (timer t)linked to trip contact TS2
SGR6	S102	32	Stage 3 (timer t') linked to trip contact TS3
SGR7	S103	32	Stage 4(timer t) linked to trip contact TS3
SGR8	S104	128	Stage 4 (timer t') linked to trip contact TS4
SGR9	S105	0	No recovery function

Example 2.
Four-step load shedding logic based on the use of the frequency relay SPAF 340 C3
(modified 2003-09)

The load shedding arrangement presented in example 2 is, in principle, the same as that of example 1. The only difference is that the rate of change of frequency is used to speed up the operation of the protection.

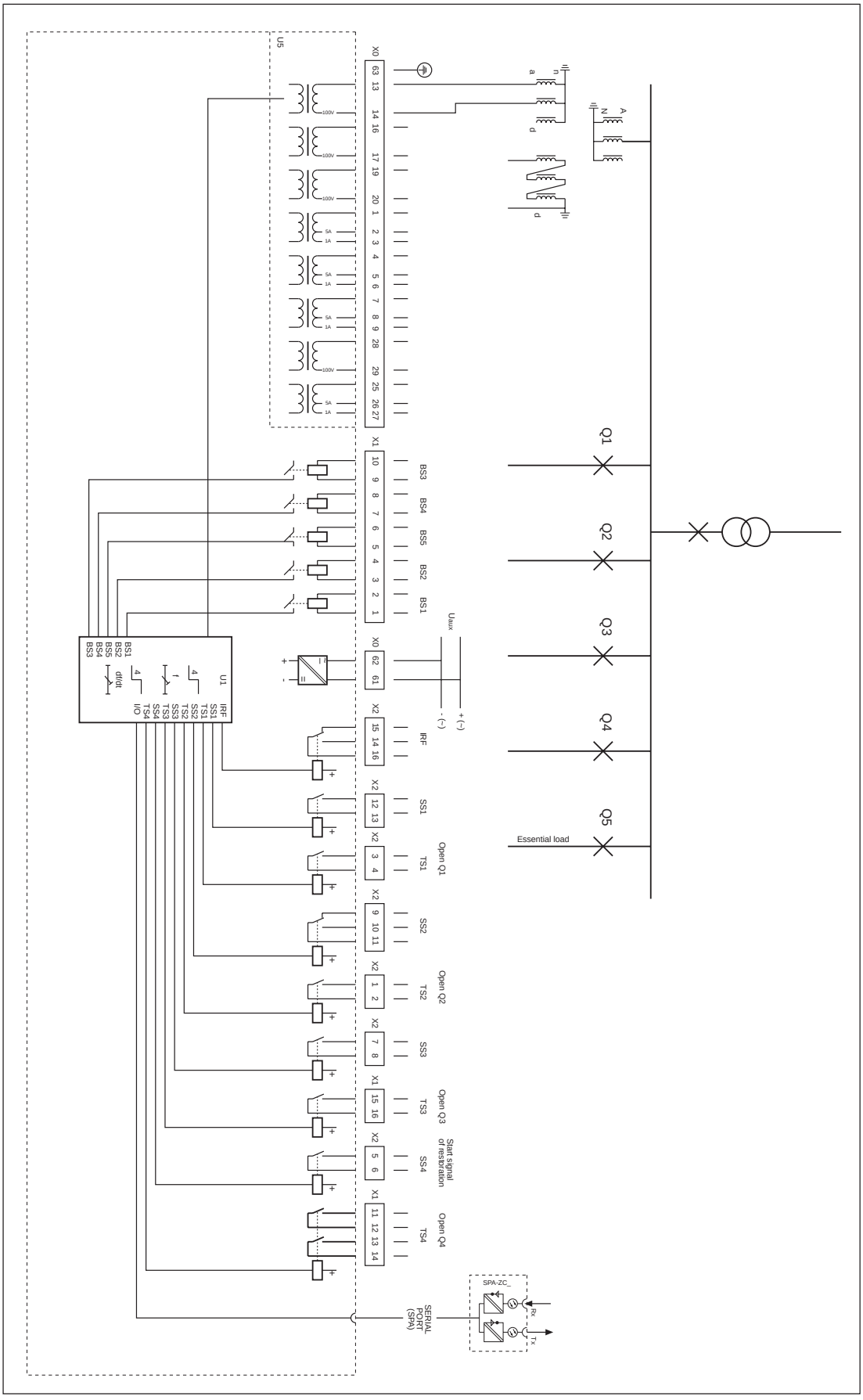


Fig. 8. Frequency relay SPAF 340 C3 used for load shedding

In addition to the normal underfrequency function, each protection stage incorporates a combined underfrequency and df/dt function. The operate time of the underfrequency function is rather long and it is intended to be used in situations where the power deficiency is small and the frequency declines slowly. The use of the underfrequency function and a long operate time is described in example 1.

The operate time of the combined underfrequency and df/dt function is short. This combined protection is intended to be used in situations where a power deficiency occurs suddenly, that is, the frequency falls rapidly. In cases, where just the frequency function and a long operate time are used, the frequency may suddenly fall so much that it is dangerous for the generators.

When the df/dt function is combined with the frequency function, the operation of the protection can be speeded up, allowing the loads to be disconnected early enough and further development of the power deficiency to be halted.

The rate of change of frequency function can be used alone, but it is always safer to use it in conjunction with the underfrequency function. During normal network operation in the rated frequency range fast frequency swings may occur. If the df/dt function in combination with a short operate time is used, without the underfrequency function, these swings may result in tripping. The designations used in Fig. 9 refer to Fig. 8.

Stage	Timer	Function	Setting f [Hz]	Setting df/dt [Hz/s]	Delay [s]	Relay output	Operation
1	t_1	<f and <df/dt	48.8	-1	0.20	TS1	Q1 open
	$t_{1'}$	<f	48.8		5.00	TS1	Q1 open
2	t_2	<f and <df/dt	48.3	-1	0.20	TS2	Q2 open
	$t_{2'}$	<f	48.3		5.00	TS2	Q2 open
3	t_3	<f and <df/dt	47.8	-1	0.20	TS3	Q3 open
	$t_{3'}$	<f	47.8		5.00	TS3	Q3 open
4	t_4	<f and <df/dt	47.5	-1	0.20	TS4	Q4 open
	$t_{4'}$	<f	47.5		5.00	TS4	Q4 open

Fig. 9. Settings of the protection stages of frequency relay SPAF 340 C3 used for load shedding

The start values and the operate times of the individual protection stages and the timers controlling the individual circuit breakers are shown in Fig. 9.

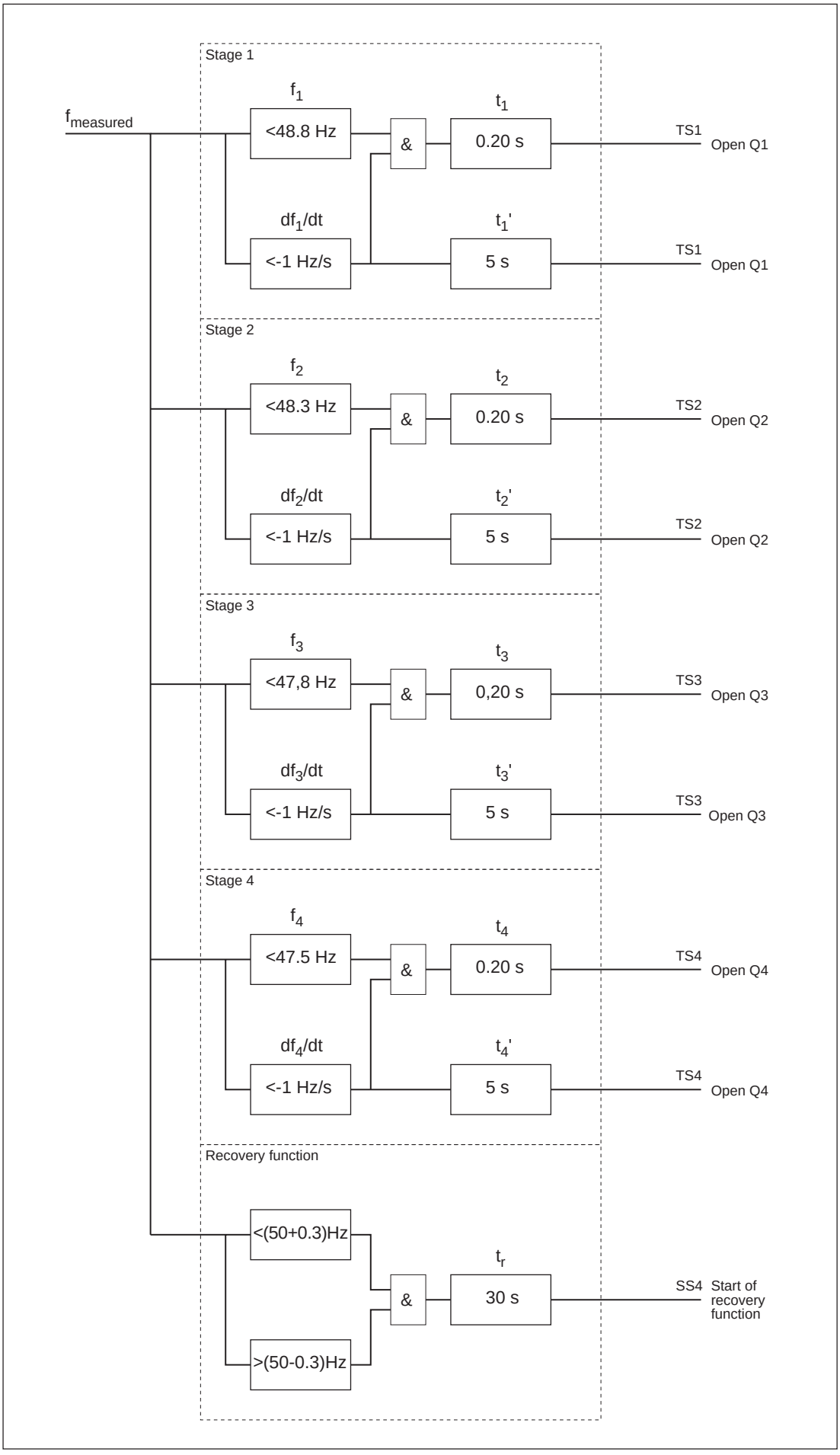


Fig. 10. Configuration of the relay module SPCF 1D15.

The recovery function is also used in example 2. Once a protection stage has issued a trip signal the recovery function is activated and, at the same time, the normally operated output of the recovery function drops out. When the frequency has returned to a normal value within the selected range, the operate time of the recovery stage starts. Should the frequency remain within the permitted range throughout the operate time, the recovery function operates and the corresponding output picks up. If the frequency deviates from the setting range during the operate time of the recovery function, the timer stops and then continues when the frequency returns to normal. The operate time of the recovery function is reset to zero, if one of the protection stages delivers a trip signal during the operate time.

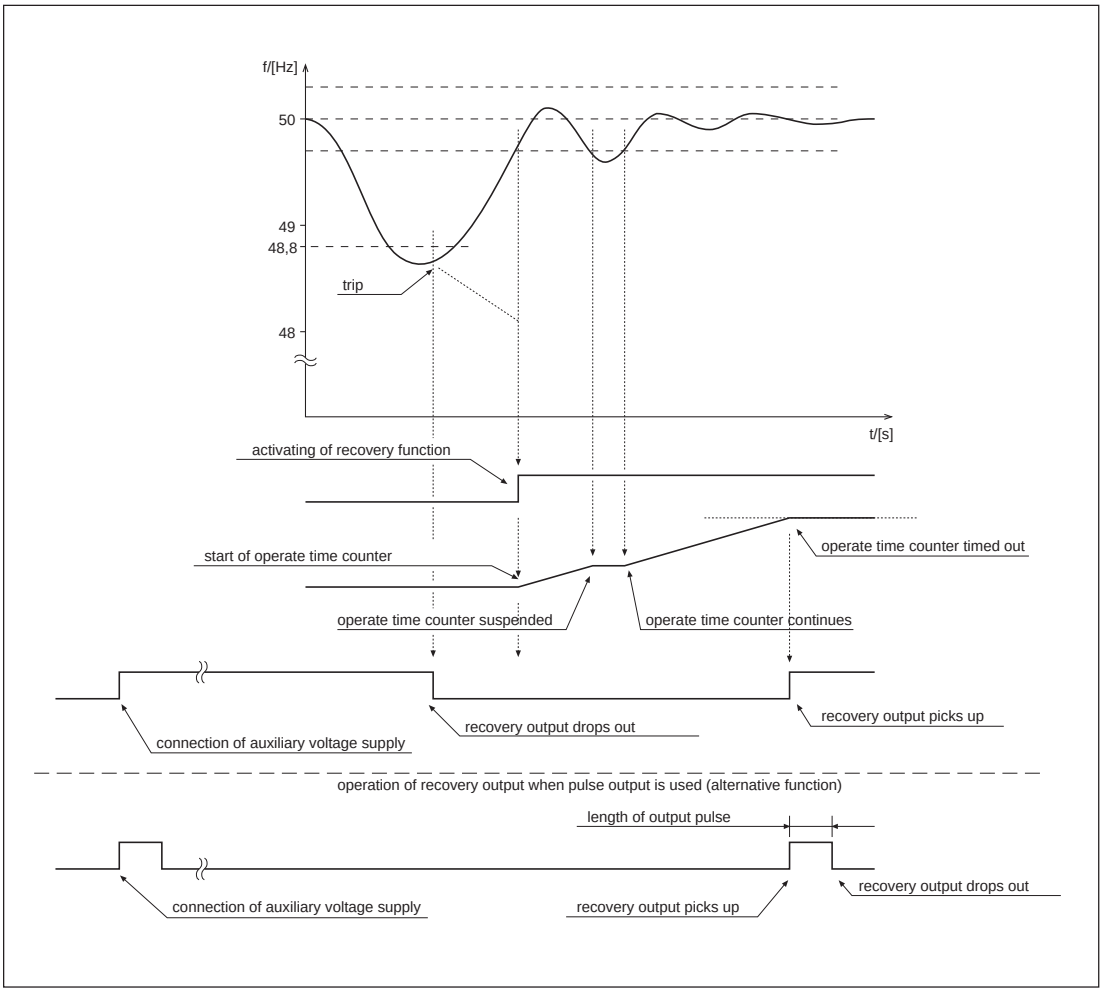


Fig. 11. Operation of recovery stage

In the case described in example 2 the switches of the frequency relay SPAF 340 C3 can be configured as follows:

Switch-group	Serial comm. parameter	Checksum	Operation
SGF1	S84	2	Combined frequency and df/dt function
SGF2	S85	2	Combined frequency and df/dt function
SGF3	S86	2	Combined frequency and df/dt function
SGF4	S87	2	Combined frequency and df/dt function
SGF5	S88	255	Outputs continuously operated
SGF6	S89	254	SS2...SS4 and TS1...TS4 linked to TRIP LED
SGF7	S90	0	U_n = 100 V
SGB1	S91	0	No external control signals
SGB2	S92	0	No external control signals
SGB3	S93	0	No external control signals
SGB4	S94	0	No external control signals
SGB5	S95	0	No external control signals
SGB6	S96	15	Undervoltage blocking for all stages
SGR1	S97	2	Stage 1 linked to trip contact TS1
SGR2	S98	2	Stage 1 linked to trip contact TS1
SGR3	S99	8	Stage 2 linked to trip contact TS2
SGR4	S100	8	Stage 2 linked to trip contact TS2
SGR5	S101	32	Stage 3 linked to trip contact TS3
SGR6	S102	32	Stage 3 linked to trip contact TS3
SGR7	S103	128	Stage 4 linked to trip contact TS4
SGR8	S104	128	Stage 4 linked to trip contact TS4
SGR9	S105	64	Recovery output linked to contact SS4

Testing

The relay should be subjected to regular tests in accordance with national regulations and instructions. The manufacturer recommends an interval of five years between the tests.

The test should be carried out as a primary test, which includes the entire protection arrangement, from the instrument transformers to the circuit breakers.

The test can also be carried out as a secondary injection test. Then the relay has to be disconnected during the test procedure. However, it is recommended to check the function of the signal and trip circuits as well.

Note!
Make sure that the secondary circuits of the current transformers under no condition open or are open, when the relay is disconnected and during the test procedure.

The test is recommended to be carried out using the normal setting values of the relay and the energizing inputs used. When required, the test can be extended to include more setting values.

As the settings of the relay modules affect the operation of the relay (overfrequency/underfrequency relay) and thus also the test procedure, these instructions describe the general features of the test procedure. The test procedure presented here applies to the underfrequency relay. A voltage supply unit allowing voltage and frequency to be regulated is recommended to be used. In addition, instruments for measuring voltage, frequency and time are required.

During the test procedure the relay records frequencies, rates of change of frequency, voltages and relay operations. If the recorded data is used for the collection of information for longer time periods (for example, AR counters), these registers should be read before the test procedure is started. After the test the registers are reset and, if required, the readings of the AR counters can be restored.

The relay settings may have to be changed during testing. A PC program is recommended to be used to read the relay settings before the test is started.

Testing of the combined frequency and rate of change of frequency relay module SPCF 1D15

The protection stages are tested with respect to:
- start value
- trip time
- trip indication, output relay operation

General

Start value

Test the start value by gradually dropping the frequency, starting from the rated value, until the relay starts. Record the frequency required for starting. The value should be within the permitted tolerances.

If the resetting value is to be tested as well, drop the frequency, until the relay starts, and then increase the frequency again, until the relay resets.

When multi-stage protection relays are tested, the operation of the higher-set stages may cause problems to the testing of lower-set stages. Then it is generally necessary to delay the operation of the higher-set stages by changing the setting values, or totally block the operation of the higher stages by reconfiguring the SGR switches. In such a case it is recommended to start the test from the lowest stage and then proceed to higher-set stages. The advantage of this method is that the original settings of the stages really are restored, because otherwise the test cannot be carried out successfully.

Trip time

Apply a voltage of rated frequency to the relay. Then drop the frequency of the voltage to a value below the setting value. The frequency of the supply voltage should be such that the difference between the trip level and the frequency of the supply voltage is about twice the difference between the rated frequency and the trip level. However, the absolute value of the rate of change of frequency must not exceed 70 Hz/s, because the relay perceives such a situation as a disturbance and delays tripping by two cycles. The operate time is the time from the moment the frequency starts changing, until the relay operates. The accuracy of the operate times should be within the permitted tolerances.

The resetting time is the time measured from the moment the current switch is opened, until the relay resets.

Maintenance and repairs

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

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

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

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

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

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

Spare parts

Combined frequency and rate of change of frequency relay module	SPCF 1D15
Power supply modules	
- U = 80...265 V ac/dc (operative range)	SPGU 240A1
- U = 18...80 V dc (operative range)	SPGU 48B2
I/O module	SPTR 9B25
Case (including connection module)	SPTK 8B17
Bus connection module	SPA-ZC 17_ SPA-ZC 21_

Order numbers

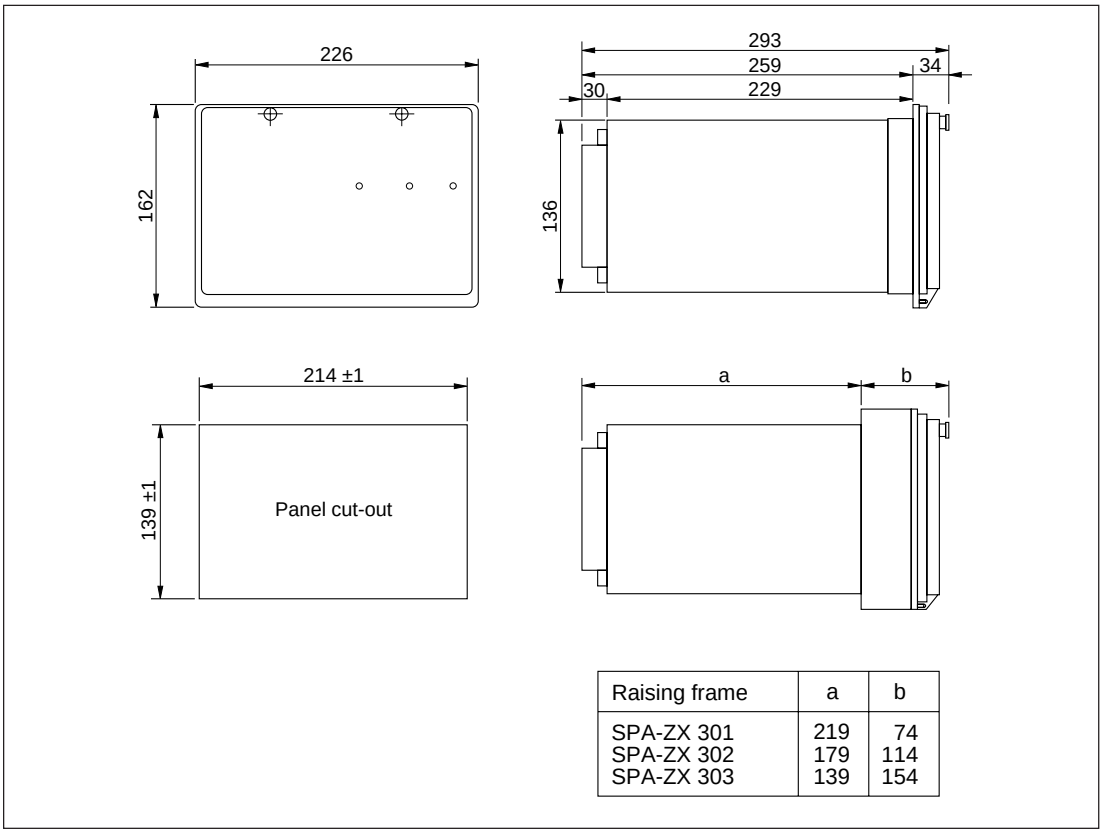
Frequency relay SPAF 340 C3 without test adapter:	RS 454 004-AA, CA
Frequency relay SPAF 340 C3 with test adapter RTXP 18:	RS 454 204-AA, CA

The letter combinations of the order number indicate the rated frequency f_n and the auxiliary voltage U_{aux} of the protection relay:

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

Dimension drawings and mounting

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



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

Fig. 12. Dimension and mounting drawings for frequency relay SPAF 340 C.

The relay case is made of profile aluminium and painted grey.

The rubber gasket fitted to the mounting collar provides an IP 54 degree of protection by enclosure between the relay case and the mounting base.

The hinged cover of the case is made of transparent, UV-stabilized polycarbonate polymer and provided with two sealable locking screws. The rubber gasket of the cover provides an IP 54 degree of protection between the case and the cover.

The required input and output circuits are connected to the screw terminals on the rear panel. Terminal block X0 consists of screw terminals fitted to the rear panel of the relay. The terminal blocks X1 and X2 are provided with disconnectable multi-pole screw terminals. The male parts of the disconnectable terminal blocks are attached to the I/O module. The female parts are included in the delivery. The female part can be secured to the male part with fixing accessories and screws.

Measured data, auxiliary voltage and protective earth are wired to the terminal block X0. Each terminal screw is dimensioned for one wire of maximum 6 mm^2 or two wires of maximum 2.5 mm^2.

Binary input and output signals are connected to the multi-pole terminal blocks X1 and X2. Each screw terminal is dimensioned for one wire of maximum 1.5 mm^2 or two wires of maximum 0.75 mm^2.

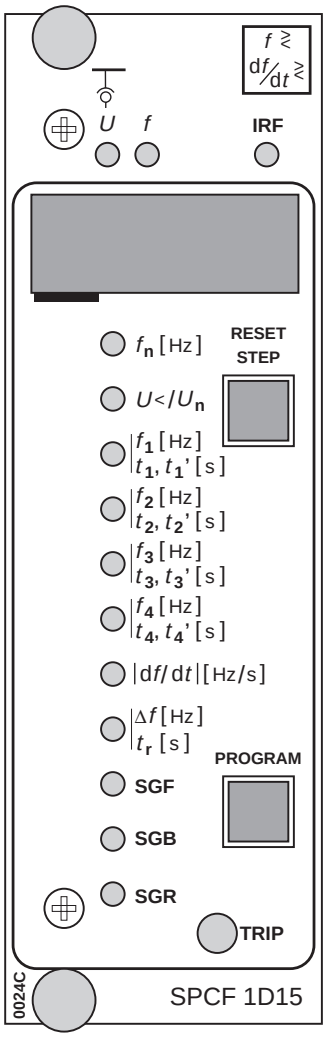
The 9-pole D-type connector is intended for serial communication.

Ordering information

	Example
1. Number and type designation	10 SPAF 340 C units
2. Order number	RS 454 004 -AA
3. Auxiliary voltage	U_{aux} = 110 V dc
4. Accessories	10 bus connection modules SPA-ZC 17 MM2A
6. Special requirements	–

SPCF 1D15
Combined Frequency and Rate of Change of Frequency Relay Module

User´s manual and Technical description



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SPCF 1D15
Combined Frequency and Rate of Change of Frequency Relay Module

Contents

Features

Four protection stages, each of which can be used for either overfrequency or underfrequency protection. Any stage can be set out of operation.

Each protection stage incorporates a rate of change of frequency function, which can be used alone or together with the overfrequency/underfrequency function. When required, the rate of change of frequency function can be disconnected.

Each protection stage is provided with two adjustable timers

Programmable recovery function

Programmable undervoltage blocking

Programmable rated frequency

Output relay matrix allowing any trip signal to be linked to the desired output signal

Digital display of measured and set values and data recorded at the instant of a fault

Reading and writing of setting values via display and front panel push-buttons, a PC with setting software, or from higher system levels over the serial bus

Continuous self-supervision of electronics and microprocessor operation. On detection of a permanent fault, the self-supervision system delivers a control signal to the signal relay and blocks the other outputs.

Description of operation

Filtering of energizing input

The relay module contains two filters: a lowpass filter for voltage measurement and a bandpass filter for frequency measurement. The purpose of the filters is to suppress the harmonics of the measured signal. Fig. 1 illustrates harmonics suppression as a function of frequency.

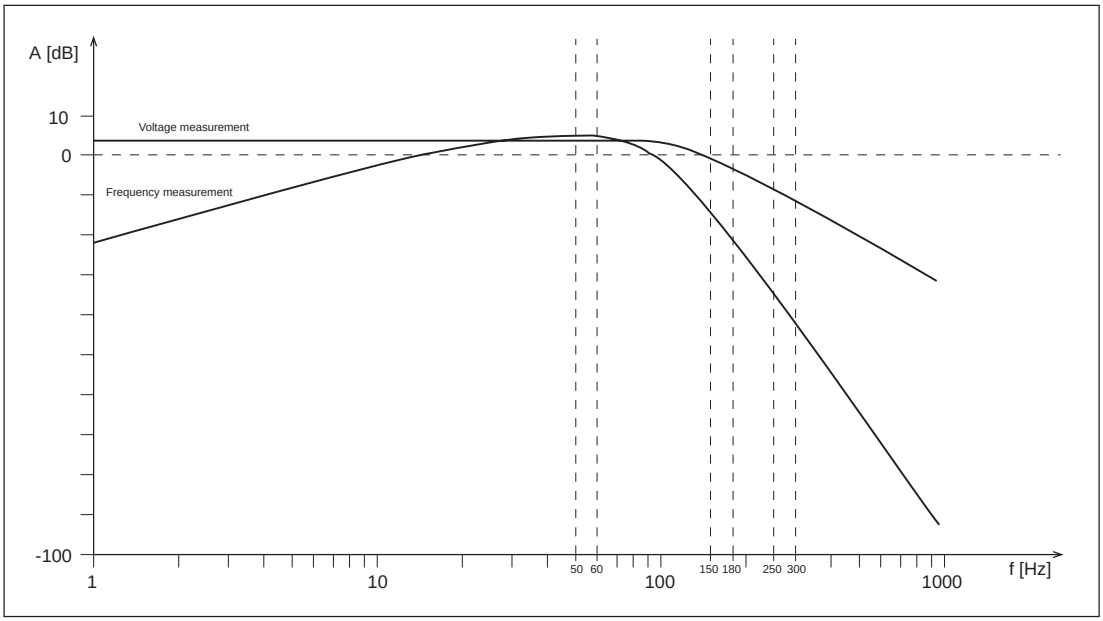


Fig. 1. Harmonics suppression of the energizing input of relay module SPCF 1D15

Frequency measurement

Frequency measurement is based on measuring the time between the zero crossings of a signal. The frequency is calculated as a moving average so that the length of the averaging can be selected by the customer. The number of cycles to be used for the calculation can be selected in the range from 3 to 20 cycles.

When the calculation is based on three cycles, the measurement response time will be short and, consequently, the trip time as well. On the other hand, when twenty cycles are used the response time will be long, but the effect of the noise possibly occurring in the signal will be small.

In addition to the filtering described above, the trip time of the relay is affected by the rated frequency selected. The minimum trip time of the relay is obtained from the formula:

$$t_{min} = n \frac{-3f_n + 254}{10} + \frac{85}{2} \text{ [ms]},$$

where n is the number of cycles used and f_n the rated frequency. However, the minimum trip time is at least 100 ms. Should a trip time shorter than the calculated time be set for the relay, the setting will be ignored.

Rate of change of frequency measurement

The calculation of the rate of change of frequency is based on two successive frequency values, calculated as moving values over three cycles. Changing of the number of cycles to be used in the frequency measurement does not affect the measurement of the rate of change of frequency.

When the rate of change of frequency function is used, the minimum trip time is 150 ms.

Overfrequency

When the setting value is above the rated frequency programmed, the protection stage operates as an overfrequency stage. The setting value cannot be the same as the rated frequency.

Once the frequency exceeds the setting value of the stage concerned, the stage starts and, at the same time, a start indicating operation code appears on the display. Should the stage still be operated, when the operate time of the stage expires, it trips, delivering the configured trip signal.

The tripping of the stages can be prevented by applying an external control signal BS1...BS5 to the relay module. The switchgroups SGB1... SGB5 are used for configuring the external blocking signals. In addition, the undervoltage blocking function (switchgroup SGR6) can be used for blocking the stage.

Underfrequency

A protection stage has the function of an underfrequency stage, when the setting value is below the rated frequency. The setting value cannot be the same as the rated frequency.

The underfrequency stage operates in the same way as the overfrequency stage, but starts, when the frequency falls below its setting value.

Rate of change of frequency

Each protection stage incorporates a rate of change of frequency (df/dt) function, which can be used alone or together with the frequency function.

The operation principle of the rate of change of frequency function is the same as that of the overfrequency/underfrequency stage. This means that if the frequency setting of this particular stage is above the rated frequency, the rate of change of the frequency has to be positive to make the df/dt function become true. Correspondingly, the rate of change of frequency has to be negative, if the stage has the function of an underfrequency stage. The same principle also applies, when the df/dt function is used alone, without the frequency function.

When the df/dt function is used alone, the stage starts once the absolute value of the rate of change of the frequency is greater than the setting value of the stage. At the same time as the stage starts, a start indicating code appears on the display. Should the protection stage still be operated, when the set operate time expires, it trips, delivering the programmed trip signal.

When the df/dt function is used together with the frequency function, the stage starts when the operation criteria for both functions, i.e. the df/dt function and the frequency function, are fulfilled at the same time. Should the protection stage still be operated (both conditions for operation fulfilled), when the set operate time expires, the stage trips, delivering the configured trip signal.

The rate of change of frequency function is recommended to be used together with the frequency function.

The minimum trip time is 150 ms, when the rate of change of frequency function is used. This means that if the rate of change of frequency function is enabled with the SGF switches, the minimum operate time of the timer is 150 ms. When the frequency function is used alone, the minimum operate time is 100 ms.

Recovery function

In addition to the four protections stages the module incorporates a recovery stage. This recovery stage can be used to control the desired output relay when, after tripping of the protection stage, the frequency returns to normal and remains within the setting range throughout the operate time of the recovery function.

The permitted limits for recovery is defined as a frequency window, the centre of which is the programmed rated frequency of the module. The limit to be set is the maximum permitted frequency deviation from the rated frequency ($f_n \pm f_r$) of the module.

The timer of the recovery function resets and remains reset as long as one single protection stage selected is in a tripped condition. At the same time the normally activated recovery output resets. After resetting, the operate time is calculated for the time when the frequency remains within the specified limits. When the operate time elapses, the recovery function operates and the output is activated. At the same time, an operation code indicating activation of the recovery function appears on the display.

An external control signal can be used to prevent both recovery functions in progress and the start of new ones.

Output signals

Switchgroups SGR1...SGR9 can be used to link the start or trip signal of any protection stage to the desired outputs SS1...SS4 or TS1...TS4.

Two output operation modes, i.e. a continuously energized or a pulse-mode output operation can be selected for the output signals SS1...SS4 and TS1...TS4(switches SGF5/1...8). A continuously energized output remains active as long as the protection stage controlling it is active. When a pulse output is used, the output remains active only as long as the preprogrammed pulse is present, even though the protection stage controlling the output stays active.

Resetting of the output relays appears from the table in paragraph "Resetting".

The TRIP indicator on the front panel can be set to indicate activation of any output signal. The operation indicator remains lit, when the output signal resets. The switchgroup SGF6 is used for selecting these functions.

Second setting

Either the main settings or the second settings can be selected as the actual setting values used. Shifting between main setting and second setting values can be done in three ways as follows:

1. Over the serial bus, using command V150.
2. By using any external control signal.
3. Via the push-buttons of the relay module, in subregister 4 of register A. When the value of subregister 4 is 0, the main settings are used and when the value is 1, the second setting values are used.

The main and second settings can be read and set over the serial bus, by using the S parameters. The push-buttons on the front panel can be used for reading and setting only the actual setting values used. When the second settings are in use, the indicator of the selected setting is flashing.

Note.
If external control signals have been used for selecting the main setting or the second setting, shifting between the settings cannot be done over the serial bus or with the push-buttons on the front panel.

Resetting

The push-buttons on the front panel, an external control signal or a serial communication parameter can be used for resetting the operation codes on the display and the registers of the relay module. See the table below.

Way of resetting	Resetting of indicators	Resetting of registers
RESET	x	
PROGRAM (display dark)	x	
RESET & PROGRAM	x	x
External control signal BS1...5, when		
SGF_/7 = 1	x	
SGF_/8 = 1	x	x
Parameter V102	x	x

Block diagram

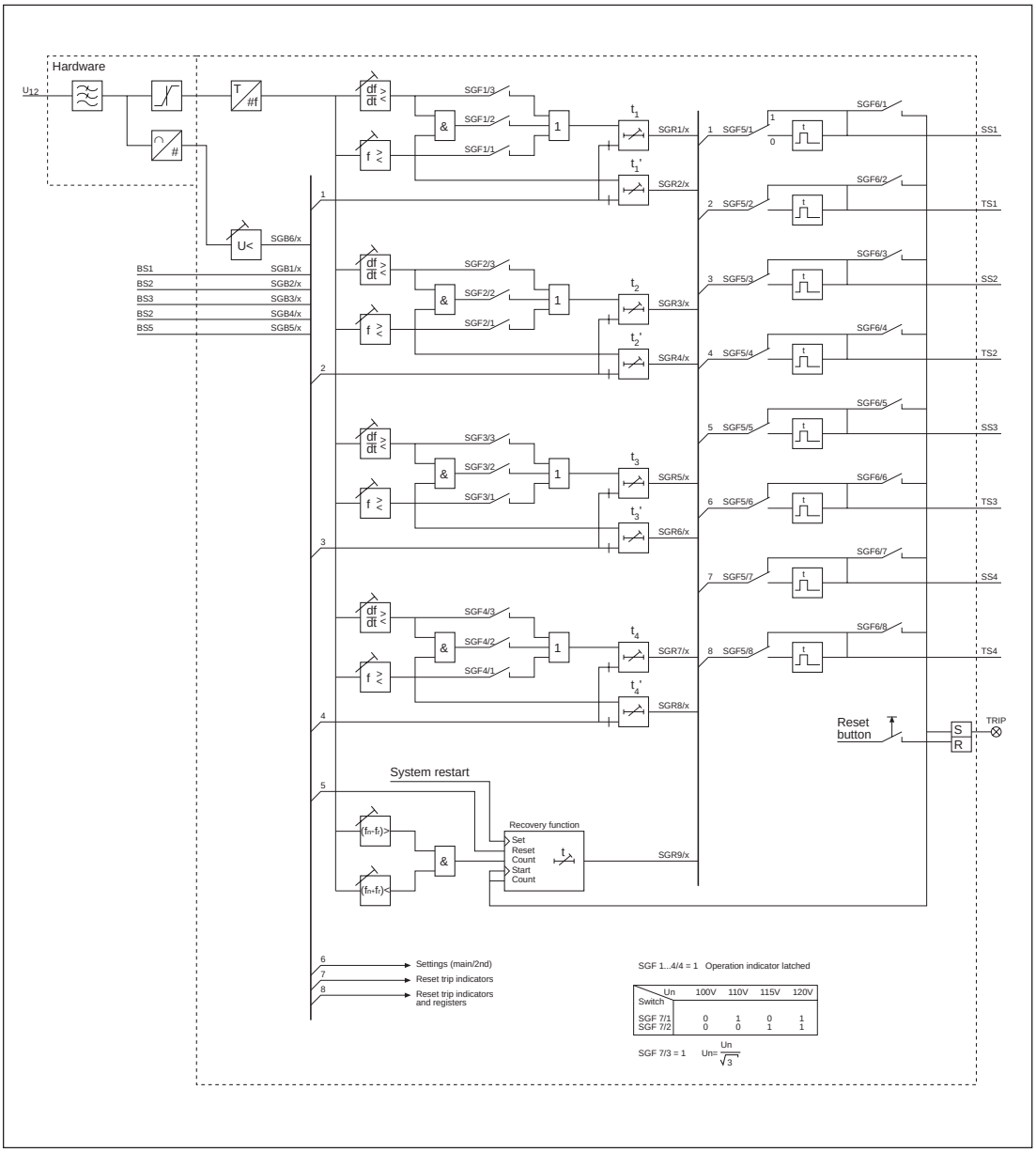


Fig. 2. Block diagram for the combined frequency and rate of change of frequency relay module SPCF 1D15

U12	Phase-to-phase voltage
BS1...BS5	External control signals
SGF1...SGF7	Switchgroups for relay configuration
SGB1...SGB6	Switchgroup for external control signals
SGR1...SGR9	Switchgroup for output relay matrix
TS1...TS4	Output signals
SS1...SS4	
TRIP	Red operation indicator

Note!
All input and output signals of the relay module are not necessarily wired to the terminals of each protection relay containing this module. The signals wired to the terminals are shown in the signal diagram of the concerned protection relay.

Front panel

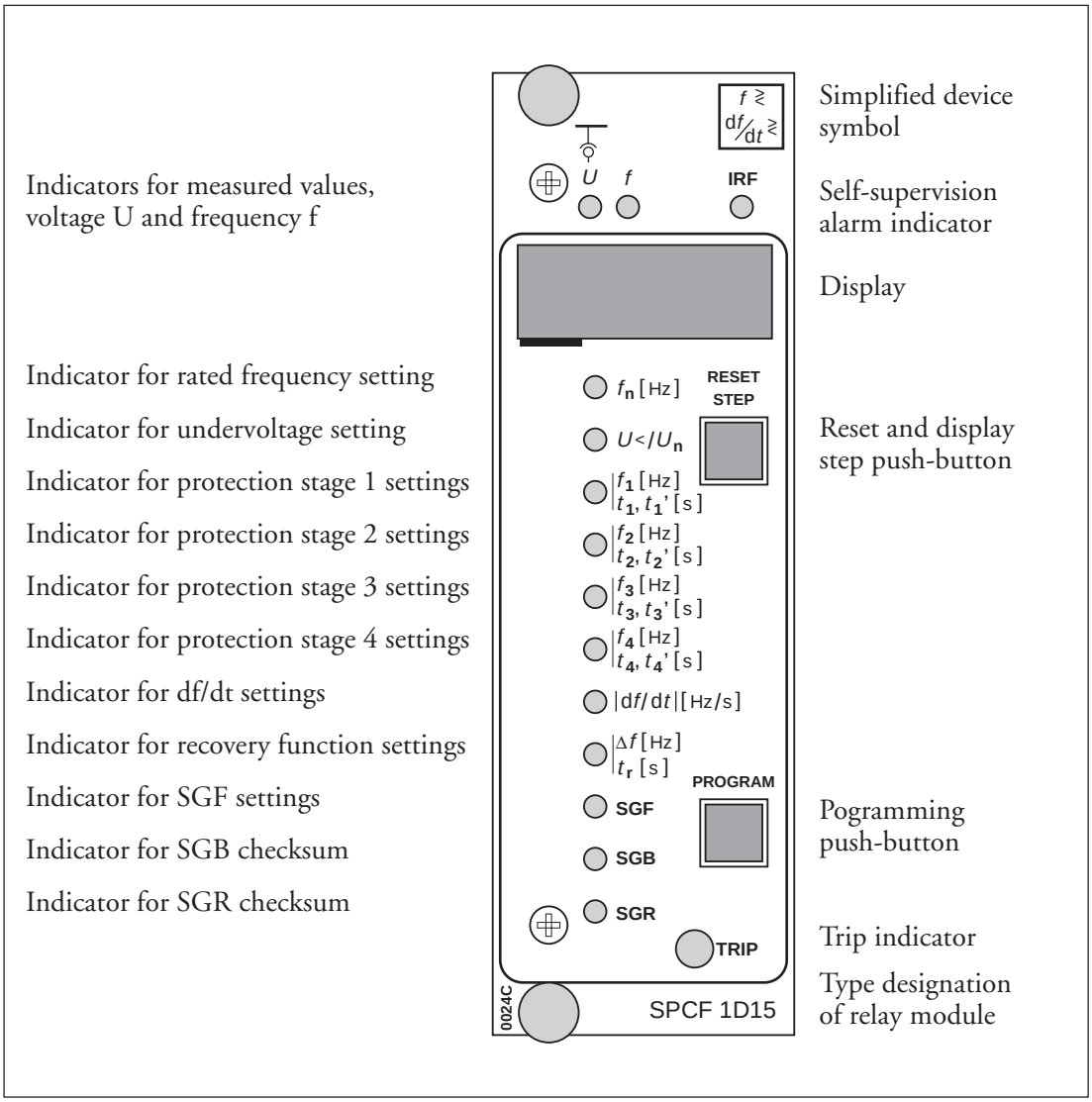


Fig.3. Front panel of the combined frequency and rate of change of frequency relay module SPCF 1D15

Operation indicators

Each protection stage has its own red start and trip operation code, presented as a number on the display. In addition, at the right bottom corner of the relay module, there is a TRIP indicator that is shared by all the protection stages. The switchgroup SGR6 is used for programming this TRIP indicator.

The operation code indicating tripping and the red TRIP indicator remain lit, when the relay has delivered a trip signal. Thus the tripping stage is easily identified. The trip code and the operation indicator remain lit, even though the stage that caused tripping resets, and have to be separately reset. The start indicating code numbers, on the other hand, go out once the protection stage resets. Should the stage provide a trip signal before resetting, the start indicating numbers turn to indicate tripping. When required, the start indicating numbers can be set to remain start indicators (switches SGF1...4/4).

The operation indicators, which require separate resetting, are reset via the push-buttons on the front panel of the relay, with an external control signal, or over the serial communication bus, see the table in "Description of operation". Non-reset operation indicators do not affect the operation of the relay module.

The table below gives an explanation of the symbols of the start and trip indicating code numbers presented on the display and with the serial communication parameter V10.

Operation code	Parameter V10	Symbol	Explanation
1	1	Stage 1 Start	Stage 1 started
2	2	Stage 1 Trip	Stage 1 tripped
3	3	Stage 2 Start	Stage 2 started
4	4	Stage 2 Trip	Stage 2 tripped
5	5	Stage 3 Start	Stage 3 started
6	6	Stage 3 Trip	Stage 3 tripped
7	7	Stage 4 Start	Stage 4 started
8	8	Stage 4 Trip	Stage 4 tripped
9	9	Rec. Due	Recovery function in progress, timer is running
A	10	Rec. Over	Recovery function operated

Once the self-supervision system of the relay has detected a permanent fault, the self-supervision alarm indicator IRF is lit. At the same time, the relay module delivers a control signal to the self-supervision contacts of the relay assembly. In addition, in most fault cases, a fault code consisting of a red number one (1) and a green code number appears on the display of the module. This fault code, which cannot be removed from the display by resetting, gives a fault diagnosis. The code number should always be stated, when service is ordered.

Settings
(modified 2004-03)

The setting values are indicated by the three digits to the right on the display. A LED indicator in front of the setting value symbol on the front panel indicates the setting value displayed at the moment. The factory setting is given in brackets. The symbol "//" indicates that the setting is found in a submenu.

Setting	Description	Setting range (Factory setting)
f_n [Hz]	Rated frequency	30.00...65.00 Hz (50 Hz)
	//Number of cycles to be used in frequency measurement	3...20 (6 cycles)
U</U_n	Setting value of undervoltage blocking as a multiple of the rated voltage U_n used.	0.30...0.90 x U_n (0.60 x U_n)
f_1 [Hz]	Setting value and operate times of stage 1	25.00...70.00 Hz (51.00 Hz)
t_1 [s]		0.1...300 s (0.50 s) *)
t'_1 [s]		0.1...300 s (0.15 s) *)
f_2 [Hz]	Setting value and operate times of stage 2	25.00...70.00 Hz (49.00 Hz)
t_2 [s]		0.1...300 s (1.00 s) *)
t'_2 [s]		0.1...300 s (0.15 s) *)
f_3 [Hz]	Setting value and operate times of stage 3	25.00...70.00 Hz (48.00 Hz)
t_3 [s]		0.1...300 s (20.00 s) *)
t'_3 [s]		0.1...300 s (0.15 s) *)
f_4 [Hz]	Setting value and operate times of stage 4	25.00...70.00 Hz (47.00 Hz)
t_4 [s]		0.1...300 s (1.00 s) *)
t'_4 [s]		0.1...300 s (0.15 s) *)
Idf/dt [Hz/s]	df/dt setting values for all of the four stages	0.2 ...±10.0 Hz/s (1.0 Hz/s)
f_r [Hz]	Setting value and operate time of recovery function	0.10...10 Hz (0.20 Hz)
t_r [s]		(10 min)

*) Note!
The setting of operation time $t_1 \ldots t_4$ and $t'_1 \ldots t'_4$ = 0.10…300 s is available from program version SW 131 F and later.

Configuration switches

The switches SGF1...7, SGB1...6 and SGR1...9 are used for selecting additional functions required for a specific application. The numbers of the switches, 1…8, and the positions, 0 and 1, are indicated on the display during the setting procedure. In normal service, only the checksums of the switchgroups are indicated on the display. The checksums are found in the main menu of the relay modules, see "Menu chart". The tables also show the factory settings of the switches and the checksum ∑ of the factory setting. The calculation of the checksum is described in the end of this paragraph.

Switchgroups SGF1…4

Switch	Function	Factory setting
SGF1...4/1	Frequency function alone is used	1
SGF1...4/2	Both frequency and df/dt function in use	0
SGF1...4/3	The df/dt function alone is used	0
SGF1...4/4	Operation mode for the start indicating codes of the separate protection stages. When the switch is in position 0, the start indicating operation code is automatically reset when the fault disappears. When the switch is in position 1, the code remains lit, even though the fault disappears.	0
SGF1…4/5-8	Not in use	0
∑ SGF1		1

Switchgroup SGF5 *(modified 97-01)*

The switches of switchgroup SGF5 are used for selecting the operation mode of the output signals SS1...SS4 and TS1...TS4. When the switch is in the position 1, a control signal is continuously applied to the output. This means that the output is active as long as the stage that controls it is active. When, on the other hand, the switch is in position 0, the output is active only as long as the preset pulse is present. When the pulse disappears, the output resets, even though the stage that controls it remains active.

Switch	Function	Factory setting
SGF5/1	Continuously activated/pulse-mode output, signal SS1	1
SGF5/2	Continuously activated/pulse-mode output, signal TS1	1
SGF5/3	Continuously activated/pulse-mode output, signal SS2	1
SGF5/4	Continuously activated/pulse-mode output, signal TS2	1
SGF5/5	Continuously activated/pulse-mode output, signal SS3	1
SGF5/6	Continuously activated/pulse-mode output, signal TS3	1
SGF5/7	Continuously activated/pulse-mode output, signal SS4	1
SGF5/8	Continuously activated/pulse-mode output, signal TS4	1
∑SGF5		255

Switchgroup SGF6

Selection of the output signal controlling the TRIP indicator on the front panel. When the switch linked to a certain signal is in position 1, the TRIP indicator is lit once the signal is activated. At the same time the concerned signal starts the recovery function, provided the recovery output is in use (selected with SGR9/_).

Switch	Function	Factory setting
SGF6/1	The SS1 signal activates the TRIP indicator and starts the recovery function.	0
SGF6/2	The TS1 signal activates the TRIP indicator and starts the recovery function.	1
SGF6/3	The SS2 signal activates the TRIP indicator and starts the recovery function.	0
SGF6/4	The TS2 signal activates the TRIP indicator and starts the recovery function.	1
SGF6/5	The SS3 signal activates the TRIP indicator and starts the recovery function.	0
SGF6/6	The TS3 signal activates the TRIP indicator and starts the recovery function.	0
SGF6/7	The SS4 signal activates the TRIP indicator and starts the recovery function.	0
SGF6/8	The TS4 signal activates the TRIP indicator and starts the recovery function.	0
∑ SGF6		10

Switchgroup SGF7

The switchgroup SGF7 is used for selecting the rated voltage of the relay module.

Switch	Rated voltage				Factory setting
	100 V	110 V	115 V	120 V	
SGF7/1	0	1	0	1	0
SGF7/2	0	0	1	1	0
SGF7/3	When the switch is in position 1, the selected rated voltage is divided by √3. Then the following voltages are received: 57.7 V	63.5 V	66.4 V	69.3 V	0
SGF7/4...8	Not in use				0
∑ SGF7					0

Switchgroups SGB1...6

The switchgroups SGB1...6 are used for configuring the control signals BS1…BS5. The matrix below can be used for the programming. The control signals and the desired functions are linked to each other, for instance, by circling the intersection of the lines. Each intersection is marked with the number of the switch to be used and the weighting factor of the switch is given under the matrix. By adding the weighting factors of the switches selected in each switchgroup, the checksums shown to the right of the matrix are received.

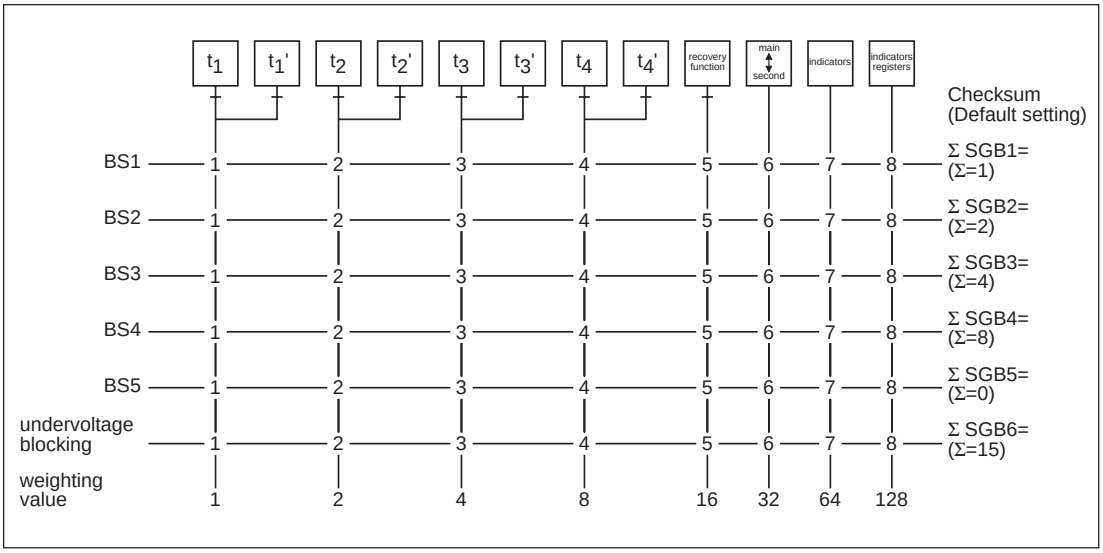


Fig. 4. Control signal matrix for relay module SPCF 1D15

Switch	Function	Factory setting
SGB_/1...4	Blockings to be applied to the separate protection stages using control signals BS1...BS6. When a switch is in position 1, tripping by the concerned protection stage will be blocked, when the control signal is activated.	
SGB_/5	Blockings to be applied to the recovery stage using control signals BS1...BS6	
SGB_/6	Switching between main settings and second settings If an external control input is used, the main setting values are active when no control voltage is applied to the input, whereas the second setting values are active, when the control input is energized.	
SGB_/7	Resetting of front panel operation indicator	
SGB_/8	Resetting of front panel operation indicator and registers	
∑ SGB1		1
∑ SGB2		2
∑ SGB3		4
∑ SGB4		8
∑ SGB5		0
∑ SGB6		15

Switchgroups SGR1...9

The switchgroups SGR1...9 serve for configuring the start and trip signals of the protection stages as desired output signals SS1...SS4 or TS1...TS4.

The matrix below can be used for the programming. The start and trip signals are linked to the desired output signal SS1...SS4 or TS1... TS4, for example, by circling the intersection of the signal lines. Each intersection is marked with the number of the switch to be used and the weighting factor of the switch is given under the matrix. By adding the weighting factors of the switches selected in each switchgroup, the checksums shown to the right of the matrix are received.

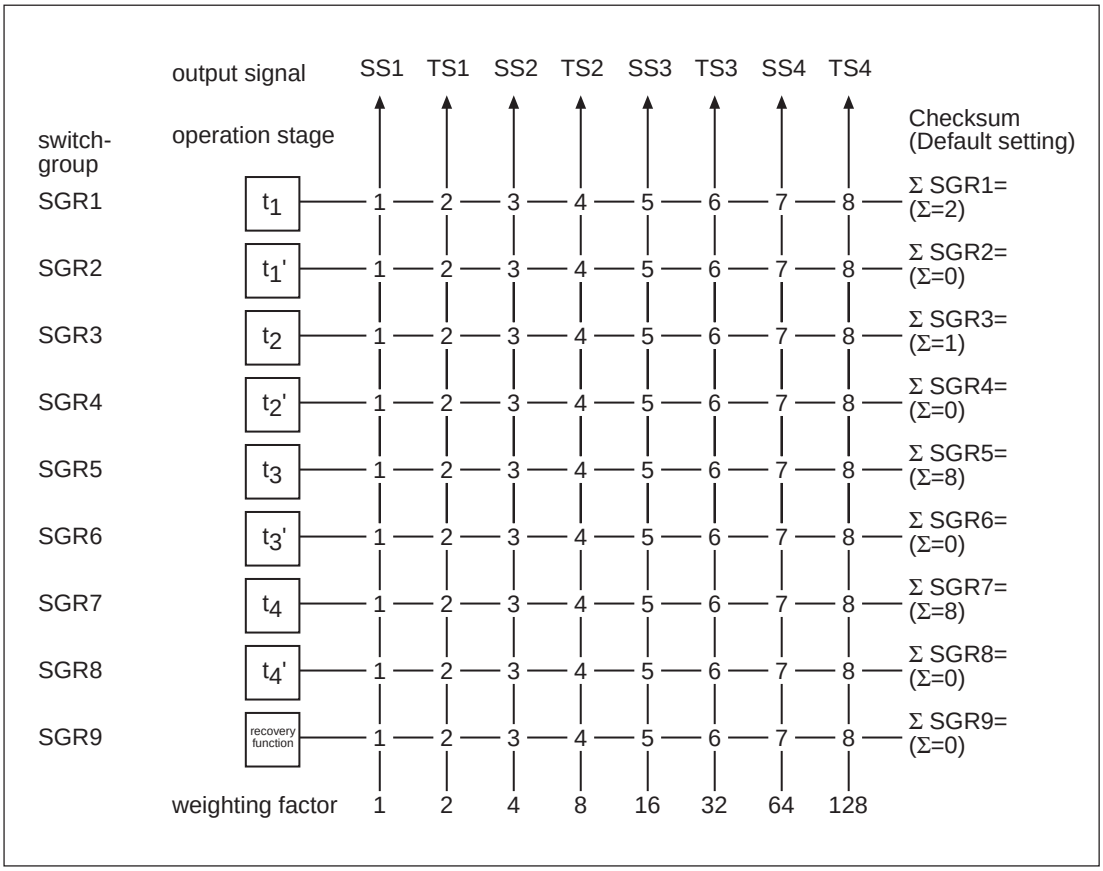


Fig. 5. Output relay matrix for relay module SPCF 1D15.

Example of checksum calculation

Switch	Weighting factor		Position		Value
SGF1/1	1	x	1	=	1
SGF1/2	2	x	0	=	0
SGF1/3	4	x	1	=	4
SGF1/4	8	x	0	=	0
SGF1/5	16	x	0	=	0
SGF1/6	32	x	0	=	0
SGF1/7	64	x	1	=	64
SGF1/8	128	x	0	=	0
Checksum Σ of switchgroup SGF1					69

Measured data

The values measured are indicated by the three green digits to the right. An exception, however, is the measured frequency, for the indication of which all of the four digits of the display can be used, see "Menu chart". The measured value being presented on the display is indicated by the yellow LEDs above the display.

LED indicator	Measured data	Measuring range
U	Measured phase-to-phase voltage U_{12} as a multiple of the rated voltage U_n of the energizing input used.	0.0...1.40 x U_n
f	Frequency of the phase-to-phase voltage U_{12}	20.00...75.00 Hz

Recorded data

(modified 2002-06)

The left-most number of the display shows the register address and the other three numbers the value recorded. The structure of the registers is presented in the section "Menu chart".

Register/ STEP	Recorded information
1	The measured phase-to-phase voltage U_{12} as a multiple of the rated voltage U_n. The register is updated once a protection stage trips. Then the previous values are moved one step forward in the memory stack, the oldest value being lost. The five latest values are stored in the memory: the most recent value in the main register and the other four values in the subregisters.
2	Register 2 records the frequency measured. The function of the register is the same as that of register 1.
3	Register 3 records the rate of change of frequency measured. The function is the same as that of register 1.
4	Register 4 records the maximum and minimum frequency and rate of change of frequency. The maximum rate of change of frequency is the maximum positive derivative of the frequency. Correspondingly, the minimum rate of change of frequency is the maximum negative derivative of the frequency. The order of the register is: f_{min}, df_{min}/dt, f_{max} and df_{max}/dt.
5	Register 5 records the number of the stage that performed tripping and the timer from which tripping originated. The stages are numbered from 1 to 4 and the timers from 1 to 2, so possible values will be 0, 11, 12, 21, 22, 31, 32, 41 and 42. The function of the register is the same as that of register 1.
6	Start counters for stages 1...4.
0	Display of external control inputs. The number to the right on the display indicates the status of the external control signals of the relay module. Each control signal has its own weighting factor. The number indicated on the display is the added weighting values of the active signals as follows:

Weighting value	Active signal				
	BS1	BS2	BS3	BS4	BS5
0					
1	x				
2		x			
4			x		
8				x	
16					x

<table>
<tr><th>Register/
STEP</th><th>Recorded information</th></tr>
<tr><td></td><td>The switchgroups SGB1...5 are used for configuring the external control inputs.

From this register the TEST mode can be entered. In the TEST mode the trip signals can be activated one by one. The table below shows the signal to be activated plus the corresponding LED indicator.

<table>
<tr><th>LED indicator</th><th>Signal to be activated</th></tr>
<tr><td>f_n [Hz]
U</U_n
f_1 [Hz]
t_1 [s]
f_2 [Hz]
t_2 [s]
f_3 [Hz]
t_3 [s]
f_4 [Hz]
t_4 [s]
Idf/dtI [Hz/s]
f_r [Hz]
t_r [s]
SGF</td><td>Stage 1, output t_1
Stage 1, output $t_{1'}$
Stage 2, output t_2

Stage 2, output $t_{2'}$

Stage 3, output t_3

Stage 3, output $t_{3'}$

Stage 4, output t_4
Stage 4, output $t_{4'}$

Output of recovery stage</td></tr>
</table>
The function is described in detail in "General characteristics of D type relay modules".</td></tr>
<tr><td>A</td><td>Address code of the relay module, required for serial communication. Register A includes the following subregisters:
1. Setting of the data transfer rate of the relay module: 4.8 or 9.6 kBd. Default setting: 9.6 kBd.
2. Bus traffic monitor. If the relay module is connected to a data communication system and the data communication operates correctly, the value of the monitor is 0. Otherwise the numbers 0...255 are rolling.
3. Password required for remote setting. The password (parameter V160) should always be entered before a setting value can be changed over the serial bus.
4. Selection of main or second settings (0 = main settings, 1 = second settings). Default setting: 0.</td></tr>
</table>

When the display is dark, access to the beginning of the main menu is admitted by pressing the STEP button for 1 s, and to the end of the menu, by pressing the STEP button for less than 0.5 s.

The values recorded in registers 1...6 can be reset via the push-buttons on the front panel, an external control signal, or a serial communication parameter, see "Resetting" in the section "Description of operation". In addition, the registers are cleared by an auxiliary power supply failure. The setting values, the address code, the data transfer rate and the password of the relay module are stored in a non-volatile memory and, consequently, not affected by voltage supply failures. Instructions for setting the address code and data transfer rate are given in "General characteristics of D type relay modules".

Menu chart
(modified 97-01)

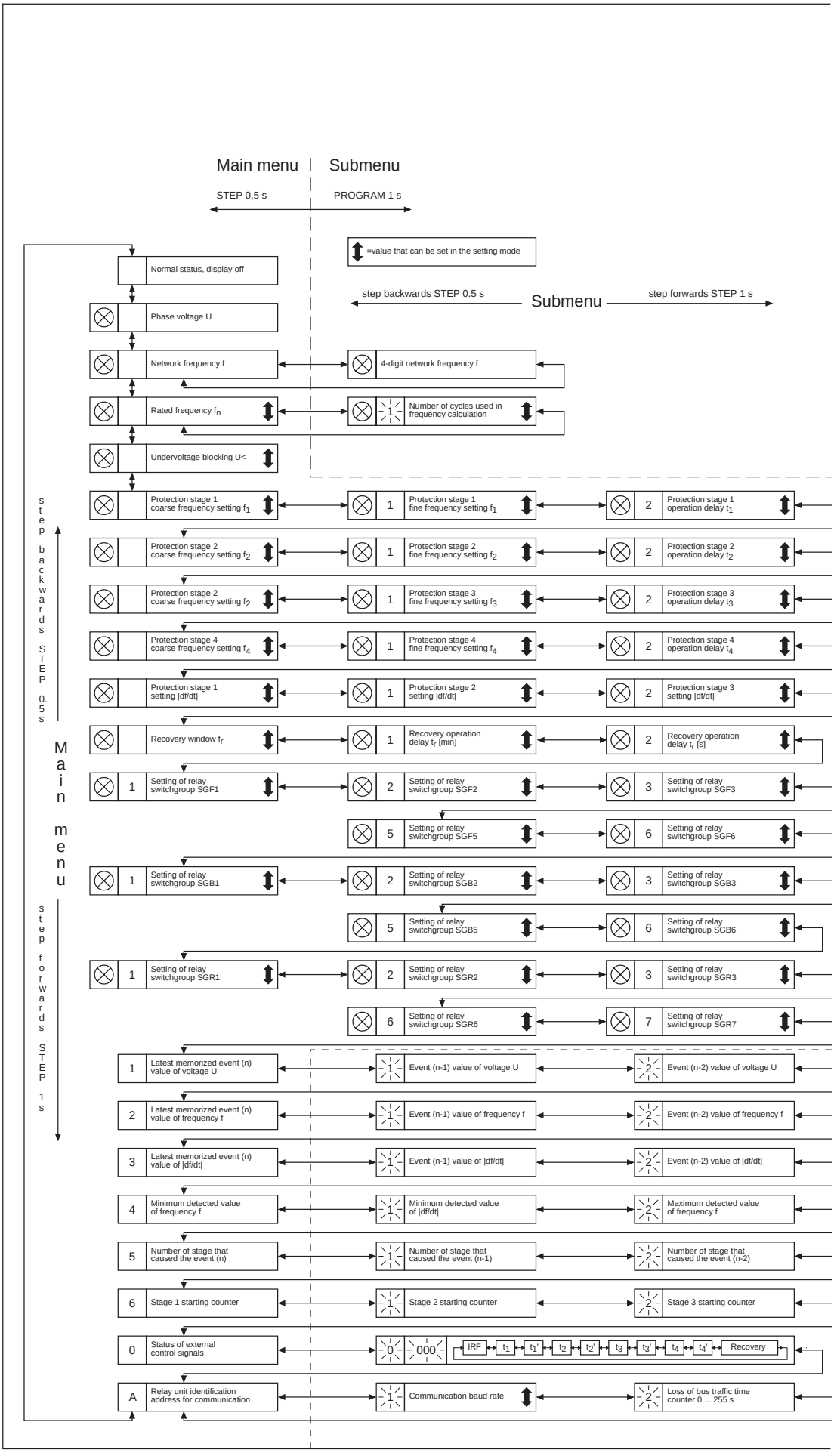
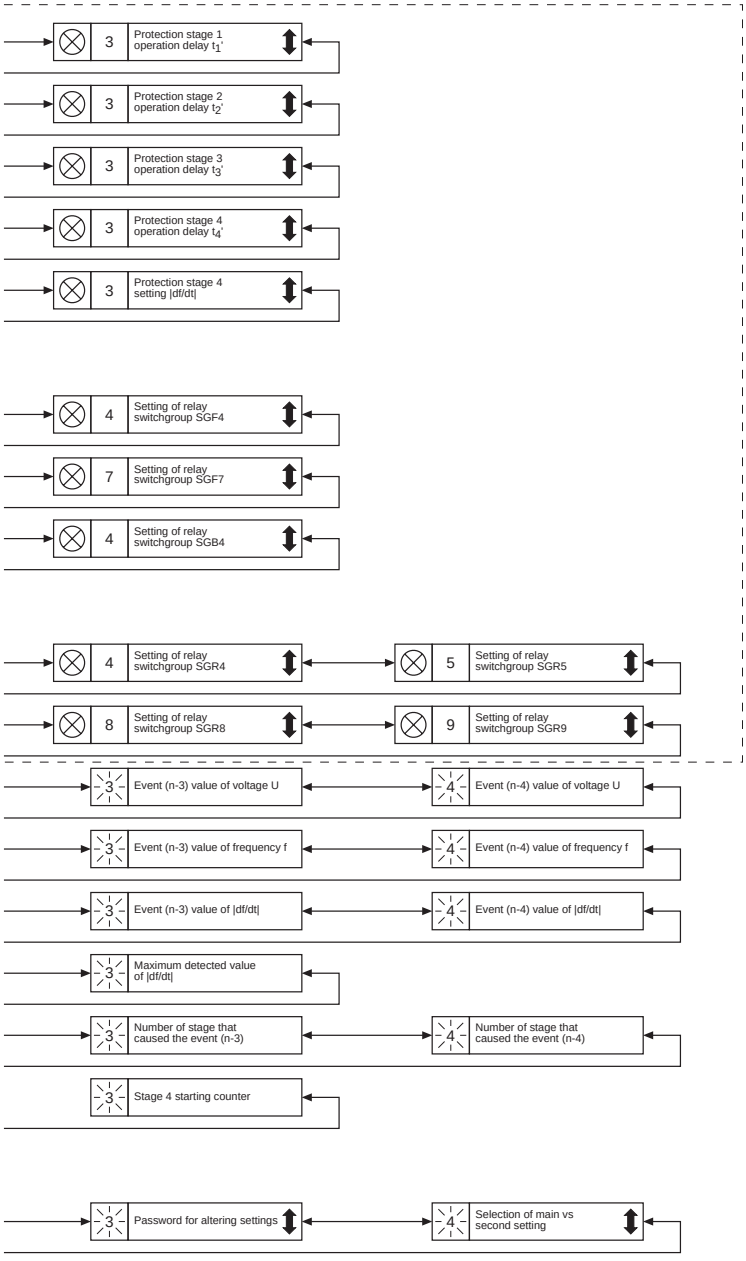


Fig. 6. Menu chart for relay module SPCF 1D15

The procedure for entering a submenu or a setting mode, the configuration of the module and the use of the TEST mode are described in detail in "General characteristics of D type relay modules". Below a short guide:

Desired step or function	Push-button	Action
One step forward in main menu or submenu	STEP	Press for more than 0.5 s
Rapid browse forward in main menu	STEP	Keep depressed
One step backward in main menu or submenu	STEP	Press less than 0.5 s
Entering a submenu from the main menu	PROGRAM	Press for 1 s (activated when the button is released)
Entering or quitting a setting mode	PROGRAM	Press for 5 s
Incrementing a value in the setting mode	STEP	
Moving the cursor in the setting mode	PROGRAM	Press for 1 s
Storing a setting value in the setting mode	STEP & PROGRAM	Press simultaneously
Resetting of memorized values	STEP & PROGRAM	



Technical data
(modified 2004-03)

Frequency function

Rated frequency	30.00...65.00 Hz
Measuring range	20.00...75.00 Hz
Setting range	25.00...70.00 Hz
Number of cycles to be used for frequency measurement	3...20 cycles
Operation accuracy	±10 mHz
Minimum voltage to be measured	0.25 x U_n

Rate of change of frequency function

Setting range	0.2...10.0 Hz/s
Operation accuracy	±150 mHz/s

Timer function

Setting range *)	0.1...300.0 s
Operate time accuracy	±1% or ±30 ms

Undervoltage blocking

Measuring range	0...1.40 x U_n
Setting range	0,30...0.90 x U_n
Operation accuracy (in the range 25...70 Hz)	±3% of setting value

Recovery function

Setting range (max. deviation from rated frequency)	0.1...10.0 Hz
Operate time	1 s...120 min 59 s
Operate time accuracy	±1% or ±30 ms

*) The minimum operate time depends on the rated frequency and the number of cycles to be used in the frequency measurement. See frequency measurement in "Description of operation".

Serial communication parameters

Event codes

Event codes have been defined for starting and tripping of the separate protection stages and for the output signal states. The event codes can be transmitted to higher system levels over the serial bus. An event to be communicated is marked with the factor 1. An event mask is formed by adding the weighting factors of the events communicated.

Event mask	Codes	Setting range	Factory setting
V153	E1...E6	0...63	21
V154	E7...E12	0...63	21
V155	E13...E18	0...63	21
V156	E19...E24	0...63	21
V157	E25...E32	0...255	85
V158	E33...E40	0...255	85
V159	E41...E45	0...31	11

Event codes of protection relay module SPAF 1D15:

Code	Event	No. representing the event	Factory setting
E1	Starting of stage 1	1	1
E2	Resetting of stage 1	2	0
E3	Tripping of stage 1, timer 1	4	1
E4	Tripping of stage 1 (timer 1) reset	8	0
E5	Tripping of stage 1, timer 2	16	1
E6	Tripping of stage 1 (timer 2) reset	32	0
	Event mask V153, factory setting		21
E7	Starting of stage 2	1	1
E8	Resetting of stage 2	2	0
E9	Tripping of stage 2, timer 1	4	1
E10	Tripping of stage 2 (timer 1) reset	8	0
E11	Tripping of stage 2, timer 2	16	1
E12	Tripping of stage 2 (timer 2) reset	32	0
	Event mask V154, factory setting		21
E13	Starting of stage 3	1	1
E14	Resetting of stage 3	2	0
E15	Tripping of stage 3, timer 1	4	1
E16	Tripping of stage 3 (timer 1) reset	8	0
E17	Tripping of stage 3, timer 2	16	1
E18	Tripping of stage 3 (timer 2) reset	32	0
	Event mask V155, factory setting		21
E19	Starting of stage 4	1	1
E20	Resetting of stage 4	2	0
E21	Tripping of stage 4, timer 1	4	1
E22	Tripping of stage 4 (timer 1) reset	8	0
E23	Tripping of stage 4, timer 2	16	1
E24	Tripping of stage 4 (timer 2) reset	32	0
	Event mask V156, factory setting		21

Code	Event	No. representing the event	Factory setting
E25	Output signal SS1 activated	1	1
E26	Output signal SS1 reset	2	0
E27	Output signal SS2 activated	4	1
E28	Output signal SS2 reset	8	0
E29	Output signal SS3 activated	16	1
E30	Output signal SS3 reset	32	0
E31	Output signal SS4 activated	64	1
E32	Output signal SS4 reset	128	0
	Event mask V157, factory setting		85

E33	Output signal TS1 activated	1	1
E34	Output signal TS1 reset	2	0
E35	Output signal TS2 activated	4	1
E36	Output signal TS2 reset	8	0
E37	Output signal TS3 activated	16	1
E38	Output signal TS3 reset	32	0
E39	Output signal TS4 activated	64	1
E40	Output signal TS4 reset	128	0
	Event mask V158, factory setting		85

E41	Recovery function in progress	1	1
E42	Recovery function stops	2	1
E43	Recovery function interrupted	4	0
E44	Recovery function output operates	8	1
E45	Recovery function output resets	16	0
	Event mask V159, factory setting		11

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

Explanation
0 Not included in event reporting
1 Included in event reporting
* No code number, always communicated
- cannot be programmed

The codes E50...E54 and the events represented by these cannot be excluded from event reporting.

The event codes E52...E54 are generated by a control data communicator (for instance SRIO 1000M)

Remote transfer data
(modified 2004-03)

In addition to the event codes, input data (I data), output data (O data), setting values (S data) memorized data (V data), and some other data can be read from the module over the serial bus. The values of parameters marked with "W" can be changed over the SPA bus.

When a setting value is to be changed, either via the push-buttons on the front panel or over the serial bus, the relay module checks whether the given parameter value is legal. A value outside the permitted setting range will be ignored, in which case the old setting will be retained.

To change a setting parameter over the serial bus a password in the range 1- 999 will generally be needed. The factory setting is 1.

The password is opened by giving the serial communication parameter V160 a numerical value. The parameter V161 is used for closing the password. The password is also closed by a power supply failure.

The push-buttons of the relay module or a command given over the serial bus can be used for changing the password. To be able to change the password over the serial bus, the password first has to be opened. The new password is entered using the parameter V161. When the push-buttons are used for changing the password, the new password is written over the old one in subregister 3 of register A.

Should the wrong password be given seven times in succession, the password turns into zero and can no longer be opened over the serial bus. Then it can be given a new value only using the push-buttons.

R = data to be read from the module
W = data to be written to the module
(P) = writing enabled through a password

Input data

The parameters I1...I4 can be used for reading measured values (R) and status data of external control signals.

Data	Parameter	Values
Phase-to-phase voltage U_{12}	I1	0.00...1.4 x U_n
Network frequency	I2	20.00...75.00 Hz
Rate of change of frequency df/dt	I3	-10.0...+10.0 Hz/s
External control signals BS1...BS5	I4	0...31 Variable value explained in "Recorded information"

Outputs

Status data of protection stages

Protection stage/operation	Parameter (R)	Weighting factor
Frequency function of stage 1 started	O1	1
Stage 1 tripped, operate time t_1,		2
Stage 1 tripped, operate time t_1		4
df/dt function of stage 1 started		8
Frequency function of stage 2 started	O2	1
Stage 2 tripped, operate time t_2,		2
Stage 2 tripped, operate time t_2		4
df/dt function of stage 2 started		8
Frequency function of stage 3 started	O3	1
Stage 3 tripped, operate time t_3,		2
Stage 3 tripped, operate time t_3		4
df/dt function of stage 3 started		8
Frequency function of stage 4 started	O4	1
Stage 4 tripped, operate time t_4,		2
Stage 4 tripped, operate time t_4		4
df/dt function of stage 4 started		8
Recovery function started, timer is running	O5	1
Recovery function operated		2
Undervoltage blocking		4

Output signals

Output signal	O6 (R,W,P)	Weighting factor
Output signal SS1		1
Output signal TS1		2
Output signal SS2		4
Output signal TS2		8
Output signal SS3		16
Output signal TS3		32
Output signal SS4		64
Output signal TS4		128

Setting values

Setting	Actual values (R) (R,W,P)	Main sett. values (R,W,P)	Sec. sett. values	Setting range
Rated frequency f_n	S1	S61	S121	30.0...65.0 Hz
Number of counting cycles used	S2	S62	S122	3...20 cycles
Undervoltage blocking setting value U<	S3	S63	S123	0.30...0.90 x U_n
Start value f_1, stage 1	S6	S66	S126	25.00...70.00 Hz
Start value f_2, stage 2	S7	S67	S127	25.00...70.00 Hz
Start value f_3, stage 3	S8	S68	S128	25.00...70.00 Hz
Start value f_4, stage 4	S9	S69	S129	25.00...70.00 Hz

Setting	Actual values (R) (R,W,P)	Main sett. values (R,W,P)	Sec. sett. values	Setting range
Operate time t_1, stage 1	S10	S70	S130	0.10...300.00 s **)
Operate time t'_1, stage 1	S11	S71	S131	0.10...300.00 s *)
Operate time t_2, stage 2	S12	S72	S132	0.10...300.00 s **)
Operate time t'_2, stage 2	S13	S73	S133	0.10...300.00 s *)
Operate time t_3, stage 3	S14	S74	S134	0.10...300.00 s **)
Operate time t'_3, stage 3	S15	S75	S135	0.10...300.00 s *)
Operate time t_4, stage 4	S16	S76	S136	0.10...300.00 s **)
Operate time t'_4, stage 4	S17	S77	S137	0.10...300.00 s *)
Start value Idf/dtI, stage 1	S18	S78	S138	0.2...10.00 Hz/s
Start value Idf/dtI, stage 2	S19	S79	S139	0.2...10.00 Hz/s
Start value Idf/dtI, stage 3	S20	S80	S140	0.2...10.00 Hz/s
Start value Idf/dtI, stage 4	S21	S81	S141	0.2...10.00 Hz/s
Start value f_r of recovery function	S22	S82	S142	0.1...10.0 Hz
Operate time t_r of recovery function	S23	S83	S143	1 s...120 min 59 s
Checksum, SGF1	S24	S84	S144	0...255
Checksum, SGF2	S25	S85	S145	0...255
Checksum, SGF3	S26	S86	S146	0...255
Checksum, SGF4	S27	S87	S147	0...255
Checksum, SGF5	S28	S88	S148	0...255
Checksum, SGF6	S29	S89	S149	0...255
Checksum, SGF7	S30	S90	S150	0...255
Checksum, SGB1	S31	S91	S151	0...255
Checksum, SGB2	S32	S92	S152	0...255
Checksum, SGB3	S33	S93	S153	0...255
Checksum, SGB4	S34	S94	S154	0...255
Checksum, SGB5	S35	S95	S155	0...255
Checksum, SGB6	S36	S96	S156	0...255
Checksum, SGR1	S37	S97	S157	0...255
Checksum, SGR2	S38	S98	S158	0...255
Checksum, SGR3	S39	S99	S159	0...255
Checksum, SGR4	S40	S100	S160	0...255
Checksum, SGR5	S41	S101	S161	0...255
Checksum, SGR6	S42	S102	S162	0...255
Checksum, SGR7	S43	S103	S163	0...255
Checksum, SGR8	S44	S104	S164	0...255
Checksum, SGR9	S45	S105	S165	0...255
Length of control pulse SS1	S46	S106	S166	0.1...20.0 s
Length of control pulse TS1	S47	S107	S167	0.1...20.0 s
Length of control pulse SS2	S48	S108	S168	0.1...20.0 s
Length of control pulse TS2	S49	S109	S169	0.1...20.0 s
Length of control pulse SS3	S50	S110	S170	0.1...20.0 s
Length of control pulse TS3	S51	S111	S171	0.1...20.0 s
Length of control pulse SS4	S52	S112	S172	0.1...20.0 s
Length of control pulse TS4	S53	S113	S173	0.1...20.0 s

*) The minimum operate time depends on the rated frequency and the number of cycles used for the measurement. See "Frequency measurement" in the section "Description of operation".

**) If the df/dt function is in use the setting range is 0.15...300.00 s

The setting of operation time is available from program version SW 131 F and later.

Measured and recorded parameter values

Measured value	Code	Data direction	Value
Number of starts, stage 1	V1	R	0...255
Number of starts, stage 2	V2	R	0...255
Number of starts, stage 3	V3	R	0...255
Number of starts, stage 4	V4	R	0...255
Number of trips, stage 1	V5	R	0...255
Number of trips, stage 2	V6	R	0...255
Number of trips, stage 3	V7	R	0...255
Number of trips, stage 4	V8	R	0...255
Number of recovery operations	V9	R	0...255
Red operation code of display	V10	R	0...10
Minimum df/dt measured	V60	R	0.0...-10.0 Hz/s
Minimum frequency measured	V61	R	20.00...75.00 Hz
Maximum df/dt measured	V62	R	0.0...10.0 Hz/s
Maximum frequency measured	V63	R	20.00...75.00 Hz

The parameters V11...V54 can be used to read (R) the five latest values recorded. Event n is the most recent value recorded, event n-1 the previous value, and so on.

Recorded data	Event					Measuring range
	n	n-1	n-2	n-3	n-4	
Voltage U	V11	V21	V31	V41	V51	0.0...1.4 x U_n
Frequency f	V12	V22	V32	V42	V52	20.00...75.00 Hz
Frequency rate of change |Idf/dtI|	V13	V23	V33	V43	V53	0.0...±10.0 Hz/s
No. of tripped stage and output	V14	V24	V34	V44	V54	0, 11, 12, 21,22, 31, 32, 41, 42 *)

*) 11 to be understood as stage 1 timer t_1, 32 as stage 3 timer $t_{3'}$, etc.

Measured value	Code	Data direction	Value
Remote resetting of recorded data	V102	W	1 = resetting
Remote control of setting	V150	R,W	0 = main settings active 1 = second setting active
Event mask for stage 1	V153	R,W	0...63, see "Event codes"
Event mask for stage 2	V154	R,W	0...63, see "Event codes"
Event mask for stage 3	V155	R,W	0...63, see "Event codes"
Event mask to stage 4	V156	R,W	0...63, see "Event codes"
Event mask for output signals	V157	R,W	0...255, see "Event codes"
Event mask for output relays	V158	R,W	0...255, see "Event codes"
Event mask for recovery function	V159	R,W	0...31, see "Event codes"
Opening of password	V160	W	1...999
Changing or closing of password	V161	W(P)	0...999
Activation of self-supervision system	V165	W	1 = self-supervision activated and IRF LED is lit
EEPROM formatting	V167	W(P)	2 = formatting
Address of relay module	V200	R,W	1...254
Data transfer rate	V201	R,W	4800 or 9600 Bd
Program version	V205	R	131_
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
Type designation of relay module	F	R	SPCF 1D15
Reading of relay module status data	C	R	0 = normal status 1 = module been subject to automatic reset 2 = overflow of event register 3 = events 1 and 2 together
Resetting of module status data	C	W	0 = resetting
Reading and setting of time	T	R,W	00.000...59.999

The event register can be read only once using the L code. Should a fault occur, say, in the data transfer, the B command can be used to re-read the contents of the register. When required, the B command can be repeated. In general, the control data communicator reads the event data and forwards the information to an output device. Under normal conditions the event register of the relay module is empty. The control data communicator also resets abnormal status data, so this data is normally zero.

Fault codes

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

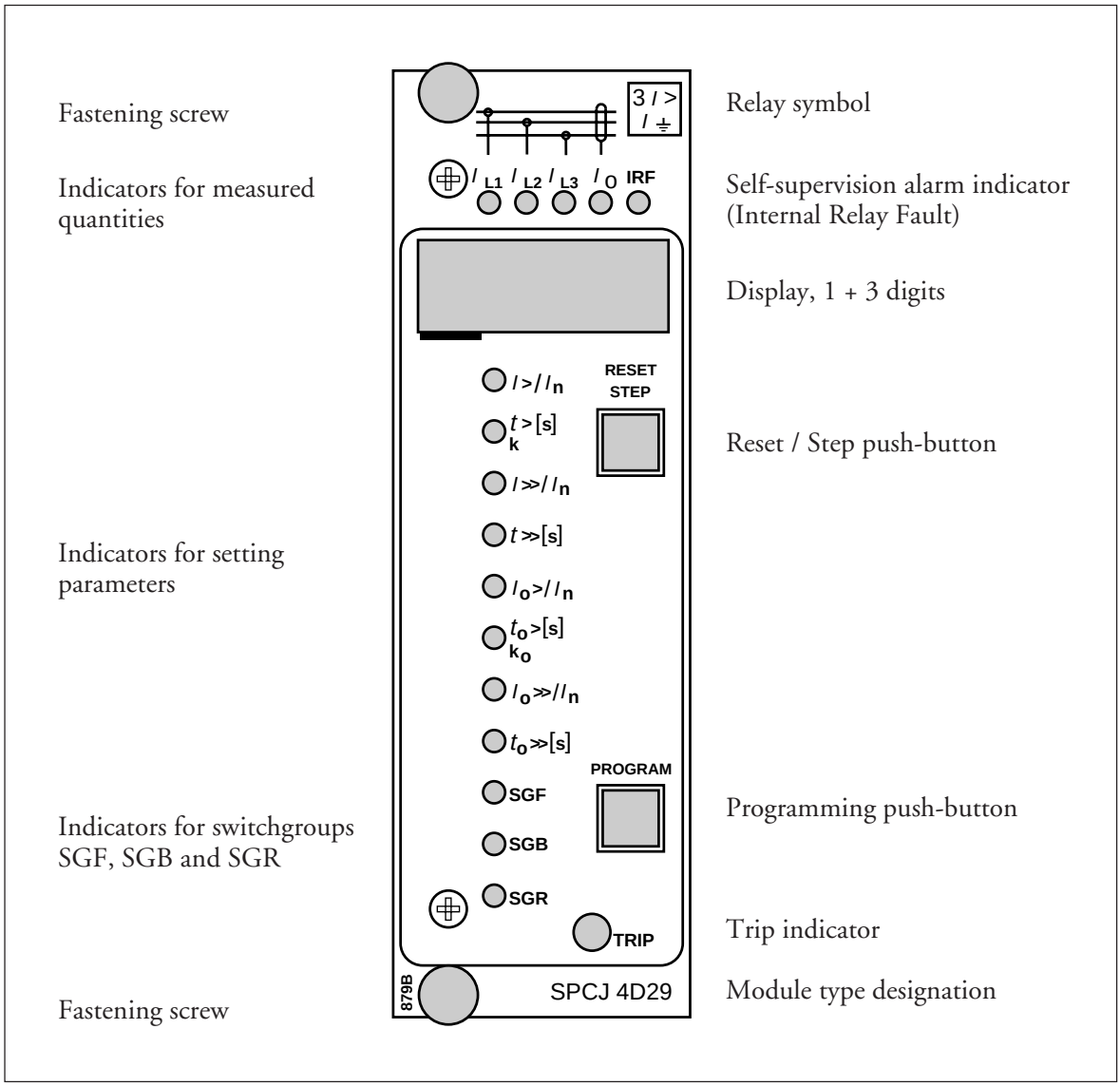
In most fault situations, a fault code consisting of a red digit one (1) to the left and a green code number appears on the display of the relay module. The fault code indicates the fault type and cannot be reset. To facilitate maintenance and repair it should be recorded and stated, when service is ordered.

The fault codes of the protection relay module SPCF 1D15 are explained in the following table:

Fault code	Explanation
4	Faulty or missing control circuit
30	Faulty program memory
41	Half-cycle detector faulty
50	Internal RAM memory faulty
51	Parameter memory (EEPROM) block 1 faulty
52	Parameter memory (EEPROM) block 2 faulty
53	Parameter memory (EEPROM) block 1 and 2 faulty
56	Parameter memory (EEPROM) key faulty. To be formatted by writing V167=2.
195	Measured value too low in reference channel
203	Measured value too high in reference channel

General characteristics of D-type relay modules

User´s manual and Technical description



1MRS 750066-MUM EN

Issued 95-04-12
Version A (replaces 34 SPC 3 EN1)
Checked JH
Approved TK

General characteristics of D type relay modules

Contents

Control push-buttons

The front panel of the relay module contains two push buttons. The RESET / STEP push button is used for resetting operation indicators and for stepping forward or backward in the display main menu or submenus. The PROGRAM push button is used for moving from a certain position in the main menu to the corresponding submenu, for entering the setting mode of a certain parameter and together with the STEP push button for storing the set values. The different operations are described in the subsequent paragraphs in this manual.

Display

The measured and set values and the recorded data are shown on the display of the protection relay module. The display consists of four digits. The three green digits to the right show the measured, set or recorded value and the leftmost red digit shows the code number of the register. The measured or set value displayed is indicated by the adjacent yellow LED indicator on the front panel. When a recorded fault value is being displayed the red digit shows the number of the corresponding register. When the display functions as an operation indicator the red digit alone is shown.

When the auxiliary voltage of a protection relay module is switched on the module initially tests the display by stepping through all the segments of the display for about 15 seconds. At first the corresponding segments of all digits are lit one by one clockwise, including the decimal points. Then the center segment of each digit is lit one by one. The complete sequence is carried out twice. When the test is finished the display turns dark. The testing can be interrupted by pressing the STEP push button. The protection functions of the relay module are alerted throughout the testing.

Display main menu

Any data required during normal operation are accessible in the main menu i.e. present measured values, present setting values and recorded parameter values.

The data to be shown in the main menu are sequentially called up for display by means of the STEP push button. When the STEP push button is pressed for about one second, the display moves forward in the display sequence. When the push button is pressed for about 0.5 seconds, the display moves backward in the display sequence.

From a dark display only forward movement is possible. When the STEP push button is pushed constantly, the display continuously moves forward stopping for a while in the dark position.

Unless the display is switched off by stepping to the dark point, it remains lit for about 5 minutes from the moment the STEP push button was last pushed. After the 5 minutes' time-out the dispaly is switched off.

Display submenus

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 protection relay module.

A submenu is entered from the main menu by pressing the PROGRAM push button for about one second. When the push button is released, the red digit of the display starts flashing, indicating that a submenu has been entered. 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 the STEP push button is pushed for one second and backward when it is pushed for 0.5 seconds. The main menu has been re-entered when the red display turns dark.

When a submenu is entered from a main menu of a measured or set value indicated by a LED indicator, the indicator remains lit and the address window of the display starts flashing. A submenu position is indicated by a flashing red address number alone on the dispaly without any lit set value LED indicator on the front panel.

Selector switch-groups SGF, SGB and SGR

Part of the settings and the selections of the operation characteristic of the relay modules in various applications are made with the selector switchgroups SG_ . The switchgroups are software based and thus not physically to be found in the hardware of the relay module. The indicator of the switchgroup is lit when the checksum of the switchgroup is shown on the display. Starting from the displayed checksum and by entering the setting mode, the switches can be set one by one as if they were real physical switches. At the end of the setting procedure, a checksum for the whole switchgroup is shown. The checksum can be used for verifying that the switches have been properly set. Fig. 2 shows an example of a manual checksum calculation.

When the checksum calculated according to the example equals the checksum indicated on the display of the relay module, the switches in the concerned switchgroup are properly set.

Switch No	Pos.		Weigth		Value
1	1	x	1	=	1
2	0	x	2	=	0
3	1	x	4	=	4
4	1	x	8	=	8
5	1	x	16	=	16
6	0	x	32	=	0
7	1	x	64	=	64
8	0	x	128	=	0
	Checksum		Σ	=	93

Fig. 2. Example of calculating the checksum of a selector switchgroup SG_.

The functions of the selector switches of the different protection relay modules are described in detail in the manuals of the different relay modules.

Settings

Most of the start values and operate times are set by means of the display and the push buttons on the front panel of the relay modules. Each setting has its related indicator which is lit when the concerned setting value is shown on the display.

In addition to the main stack of setting values most D type relay modules allow a second stack of settings. Switching between the main settings and the second settings can be done in three different ways:

1) By command V150 over the serial communication bus
2) By an external control signal BS1, BS2 or RRES (BS3)
3) Via the push-buttons of the relay module, see submenu 4 of register A.

Setting mode

Generally, when a large number of settings is to be altered, e.g. during commissioning of relay systems, it is recommended that the relay settings are entered with the keyboard of a personal computer provided with the necessary software. When no computer nor software is available or when only a few setting values need to be altered the procedure described below is used.

The registers of the main menu and the submenus contain all parameters that can 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 PROGRAM push button, until the whole display starts flashing. This position indicates the value of the parameter before it has been altered. By pressing the PROGRAM push button the programming sequence moves forward one step. First the rightmost digit starts flashing while the rest of the display is steady. The flashing digit is set by means of the STEP push button. The flashing cursor is moved on from digit to digit by pressing the PROGRAM push button and in each stop the setting is performed with the STEP push button. After the parameter values have been set, the decimal point is put in place. At the end the position with the whole display flashing is reached again and the data is ready to be stored.

A set value is recorded in the memory by pressing the push buttons STEP and PROGRAM simultaneously. Until the new value has been recorded a return from the setting mode will have no effect on the setting and the former value will still be valid. Furthermore *any attempt to make a setting outside the permitted limits for a particular parameter will cause the new value to be disqualified and the former value will be maintained.* Return from the setting mode to the main menu or a submenu is possible by pressing the PROGRAM push button until the green digits on the display stop flashing.

NOTE! During any local man-machine communication over the push buttons and the display on the front panel a five minute time-out function is active. Thus, if no push button has been pressed during the last five minutes, the relay returns to its normal state automatically. This means that the display turns dark, the relay escapes from a display mode, a programming routine or any routine going on, when the relay is left untouched. This is a convenient way out of any situation when the user does not know what to do.

Before a relay module is inserted into the relay case, one must assure that the module has been given the correct settings. If there however is any doubt about the settings of the module to be inserted, the setting values should be read using a spare relay unit or with the relay trip circuits disconnected. If this cannot be done the relay can be sett into a non-tripping mode by pressing the PROGRAM push button and powering up the relay module simultaneously. The display will show three dashes "- - -" to indicate the non-tripping mode. The serial communication is operative and all main and submenues are accessible. In the non-tripping mode unnecessary trippings are avoided and the settings can be checked. *The normal protection relay mode is entered automatically after a timeout of five minutes or ten seconds after the dark display position of the main menu has been entered.*

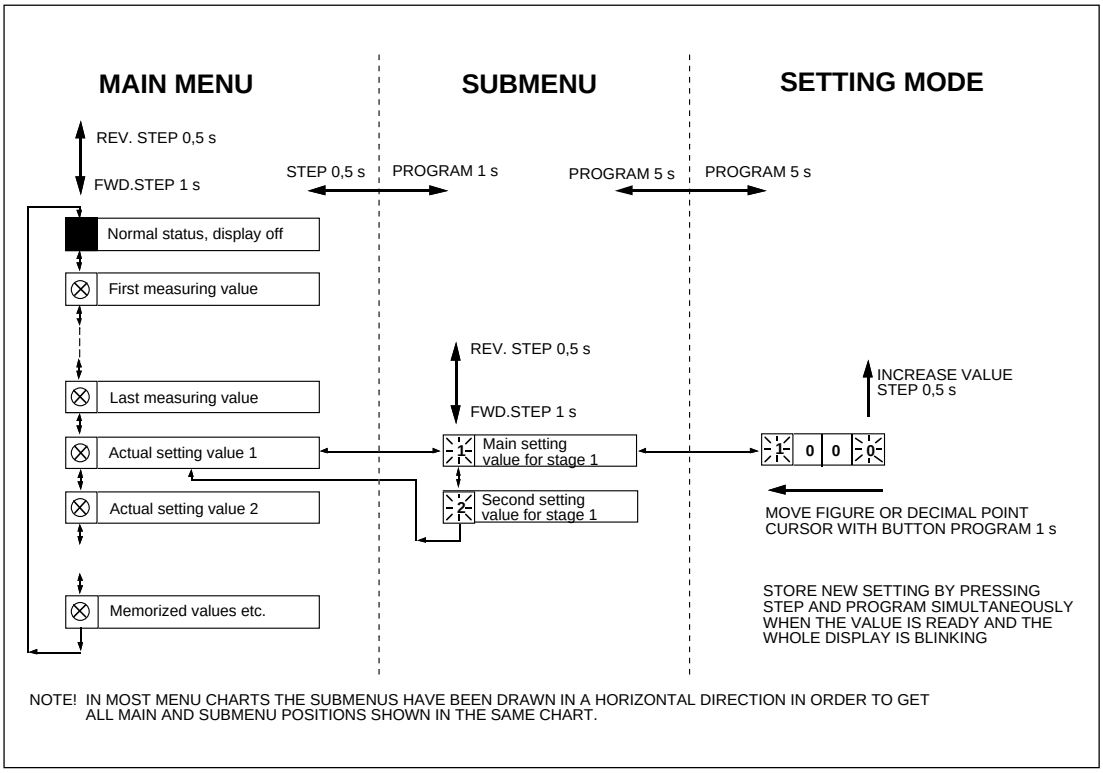


Fig.3. Basic principles of entering the main menus and submenus of a relay module.

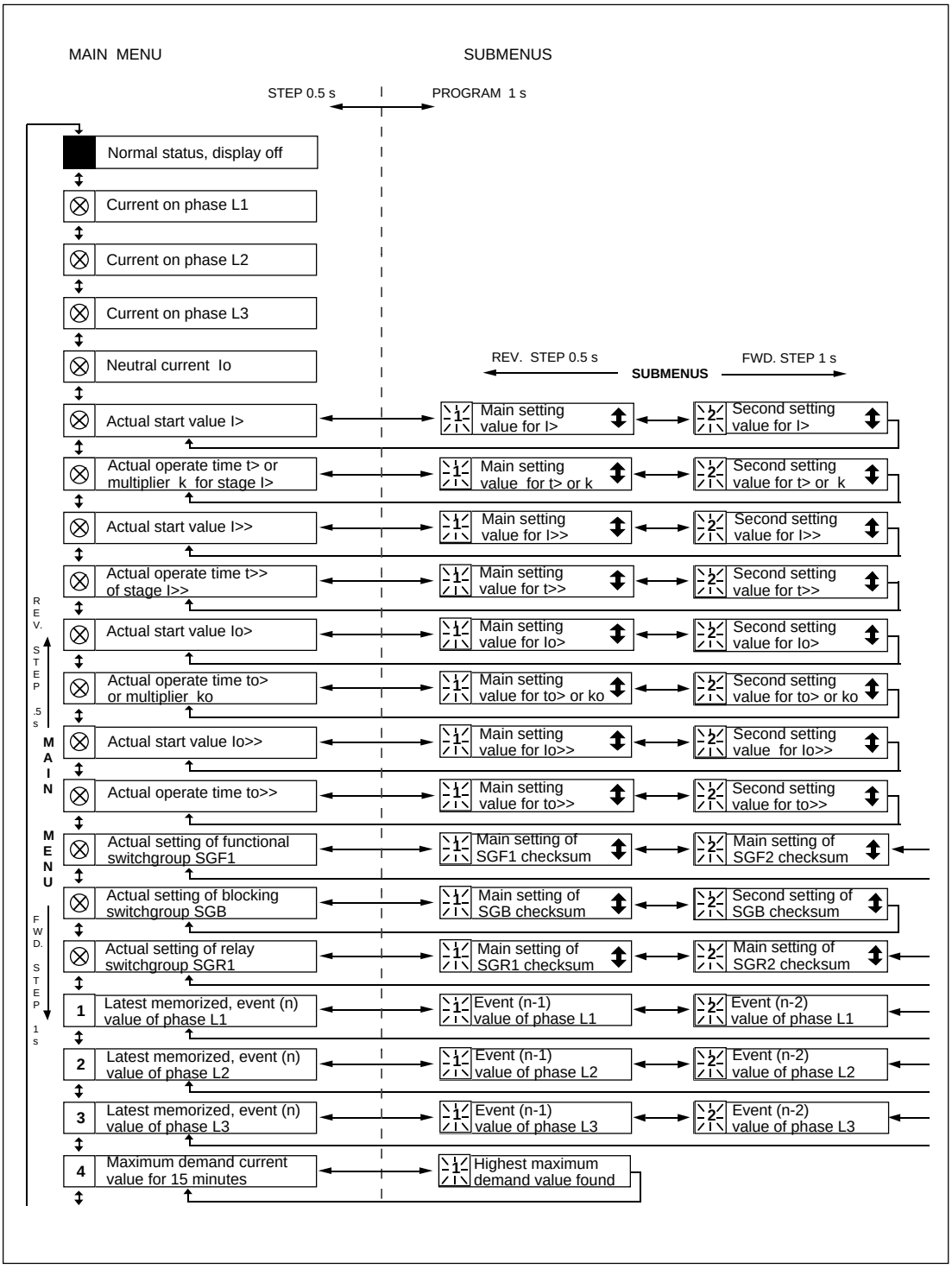
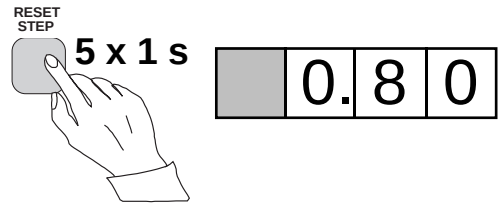


Fig. 4. Example of part of the main and submenus for the settings of the overcurrent and earth-fault relay module SPCJ 4D29. The settings currently in use are in the main manu and they are displayed by pressing the STEP push button. The main menu also includes the measured current values, the registers 1...9, 0 and A. The main and second setting values are located in the submenus and are called up on the display with the PROGRAM push button.

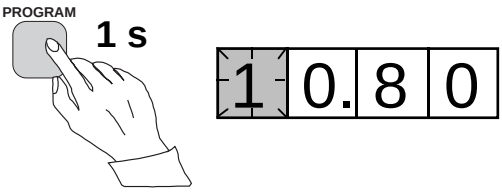
Example 1

Operation in the setting mode. Manual setting of the main setting of the start current value I> of an overcurrent relay module. The initial value for the main setting is 0.80 x I_n and for the second setting 1.00 x I_n. The desired main start value is 1.05 x I_n.

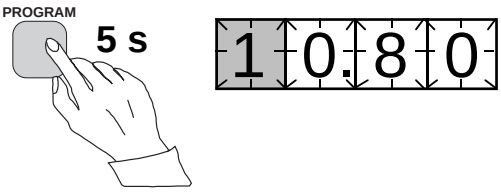
a)
Press push button STEP repeatedly until the LED close to the I> symbol is lit and the current start value appears on the display.



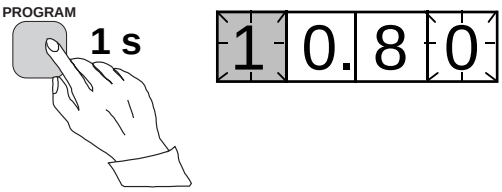
b)
Enter the submenu to get the main setting value by pressing the PROGRAM push button more than one second and then releasing it. The red display digit now shows a flashing number 1, indicating the first submenu position and the green digits show the set value.



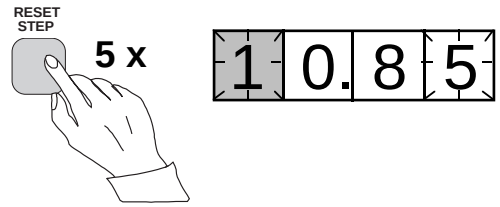
c)
Enter the setting mode by pressing the PROGRAM push button for five seconds until the display starts flashing.



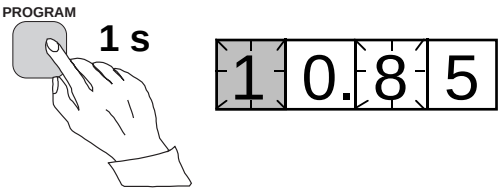
d)
Press the PROGRAM push button once again for one second to get the rightmost digit flashing.



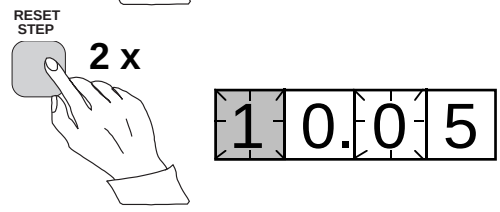
e)
Now the flashing digit can be altered. Use the STEP push button to set the digit to the desired value.



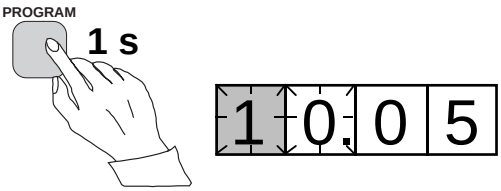
f)
Press the PROGRAM push button to make the middle one of the green digits flash.



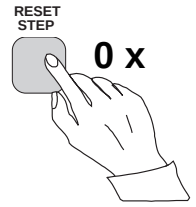
g)
Set the middle digit with of the STEP push button.

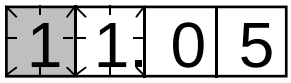


h)
Press the PROGRAM push button to make the leftmost green digit flash.

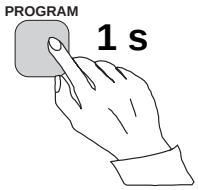


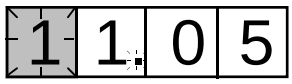
i)
Set the digit with the STEP push button.



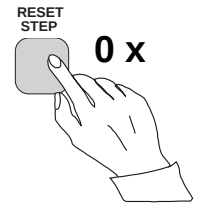


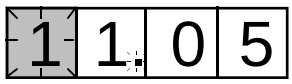
j)
Press the PROGRAM push button to make the decimal point flash.



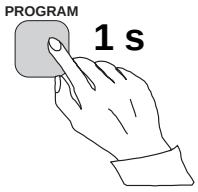


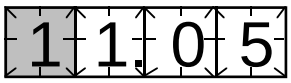
k)
If needed, move the decimal point with the STEP push button.



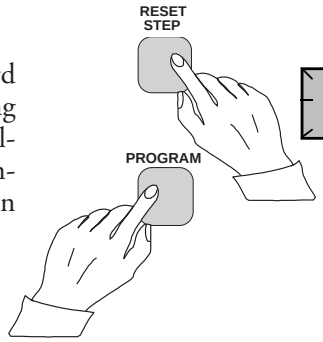


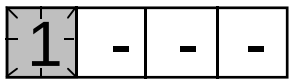
l)
Press the PROGRAM push button to make the whole display flash. In this position, corresponding to position c) above, one can see the new value before it is recorded. If the value needs changing, use the PROGRAM push button to alter the value.



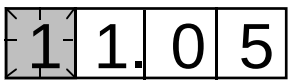


m)
When the new value has been corrected, record it in the memory of the relay module by pressing the PROGRAM and STEP push buttons simultaneously. At the moment the information enters the memory, the green dashes flash once in the display, i.e. 1 - - -.

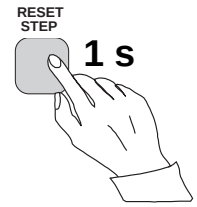


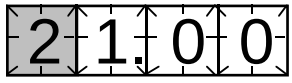


n)
Recording of the new value automatically initiates a return from the setting mode to the normal submenu. Without recording one can leave the setting mode any time by pressing the PROGRAM push button for about five seconds, until the green display digits stop flashing.



o)
If the second setting is to be altered, enter submenu position 2 of the setting I> by pressing the STEP push button for approx. one second. The flashing position indicator 1 will then be replaced by a flashing number 2 which indicates that the setting shown on the display is the second setting for I>.



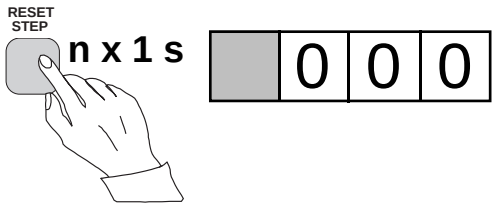


Enter the setting mode as in step c) and proceed in the same way. After recording of the requested values return to the main menu is obtained by pressing the STEP push button until the first digit is switched off. The LED still shows that one is in the I> position and the display shows the new setting value currently in use by the relay module.

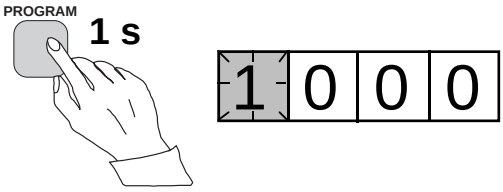
Example 2

Operation in the setting mode. Manual setting of the main setting of the checksum for the switchgroup SGF1 of a relay module. The initial value for the checksum is 000 and the switches SGF1/1and SGF1/3 are to be set in position 1. This means that a checksum of 005 should be the final result.

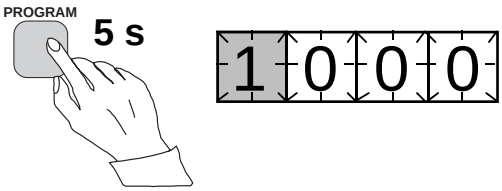
a)
Press push button STEP until the LED close to the SGF symbol is lit and the checksum appears on the display.



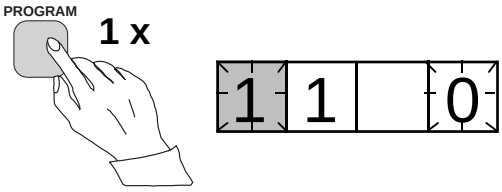
b)
Enter the submenu to get the main checksum of SGF1 by pressing the PROGRAM push button for more than one second and then releasing it. The red display now shows a flashing number 1 indicating the first submenu position and the green digits show the checksum.



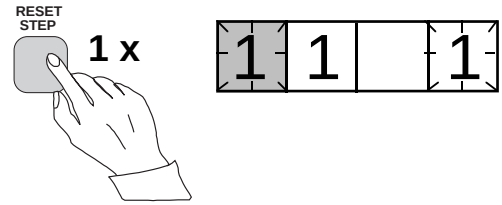
c)
Enter the setting mode by pressing the PROGRAM push button for five seconds until the display starts flashing.



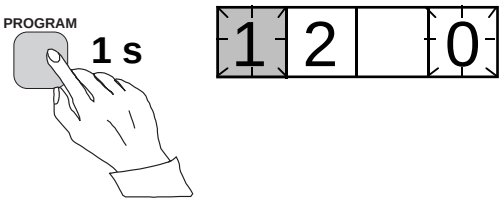
d)
Press the PROGRAM push button once again to get the first switch position. The first digit of the display now shows the switch number. The position of the switch is shown by the rightmost digit.



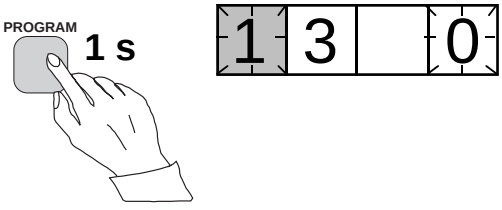
e)
The switch position can now be toggled between 1 and 0 by means of the STEP push button and it is left in the requested position 1.



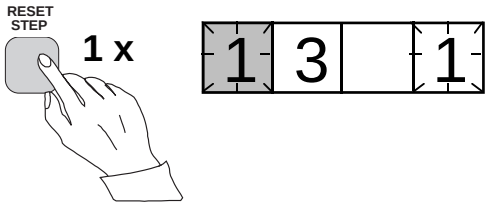
f)
When switch number 1 is in the requested position, switch number 2 is called up by pressing the PROGRAM push button for one second. As in step e), the switch position can be altered by using the STEP push button. As the desired setting for SGF1/2 is 0 the switch is left in the 0 position.



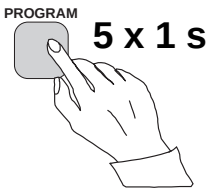
g)
Switch SGF1/3 is called up as in step f) by pressing the PROGRAM push button for about one second.



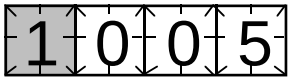
h)
The switch position is altered to the desired position 1 by pressing the STEP push button once.



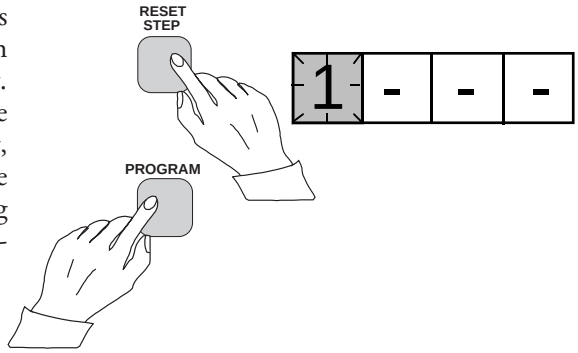
i)
Using the same procedure the switches SGF 1/ 4...8 are called up and, according to the example, left in position 0.



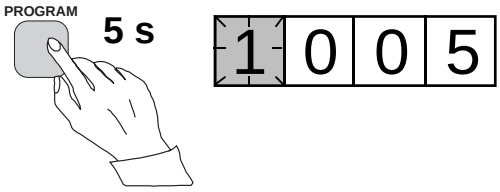
j)
In the final setting mode position, corresponding to step c), the checksum based on the set switch positions is shown.



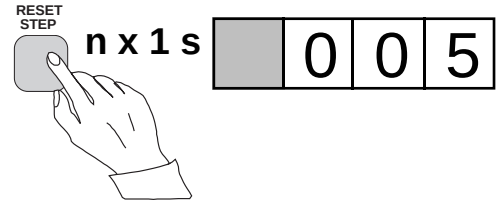
k)
If the correct checksum has been obtained, it is recorded in the memory by pressing the push buttons PROGRAM and STEP simultaneously. At the moment the information enters the memory, the green dashes flash in the display, i.e.1 - - -. If the checksum is incorrect, the setting of the separate switches is repeated using the PROGRAM and STEP push buttons starting from step d).



l)
Recording the new value automatically initiates a return from the setting mode to the normal menu. Without recording one can leave the setting mode any time by pressing the PROGRAM push button for about five seconds, until the green display digits stop flashing.



m)
After recording the desired values return to the main menu is obtained by pressing the STEP push button until the first digit is turned off. The LED indicator SGF still shows that one is in the SGF position and that the display shows the new checksum for SGF1 currently in use by the relay module.



Recorded information

The parameter values measured at the moment when a fault occurs or at the trip instant are recorded in the registers. The recorded data, except for some parameters, are set to zero by pressing the push buttons STEP and PROGRAM simultaneously. The data in normal registers are erased if the auxiliary voltage supply to the relay is interrupted, only the set values and certain other essential parameters are maintained in non-volatile registers during a voltage failure.

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

All D 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, status information and other signals. The codes are explained in the manuals of the different relay modules.

Register A contains the address code of the relay modul which is reqiured by the serial communication system.

Submenu 1 of register A contains the data transfer rate value, expressed in kilobaud, of the serial communication.

Submenu 2 of register A contains a bus communication monitor for the SPAbus. If the protection relay, which contains the relay module, is linked to a system including a contol data communicatoe, for instance SRIO 1000M and the data communication system is operating, the counter reading of the monitor will be zero. Otherwise the digits 1...255 are continuously scrolling in the monitor.

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

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

In order to secure the setting values, all settings are recorded in two separate memory banks within the non-volatile memory. Each bank is complete with its own checksum test to verify the condition of the memory contents. If, for some reason, the contents of one bank is disturbed, all settings are taken from the other bank and the contents from here is transferred to the faulty memory region, all while the relay is in full operation condition. If both memory banks are simultaneously damaged the relay will be be set out of operation, and an alarm signal will be given over the serial port and the IRF output relay

Trip test function

Register 0 also provides access to a 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 then will operate one by one during the testing.

When pressing the PROGRAM push button for about five seconds, the green digits to the right start flashing indicating that the relay module is in the test position. The indicators of the settings indicate by flashing which output signal can be activated. The required output function is selected by pressing the PROGRAM push button for about one second.

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

Setting I>	Starting of stage I>
Setting t>	Tripping of stage I>
Setting I>>	Starting of stage I>>
Setting t>>	Tripping of stage I>>
etc.	
No indication	Self-supervision IRF

The selected starting or tripping is activated by simultaneous pressing of the push buttons STEP and PROGRAM. The signal remains activated as long as the two push butttons are pressed. The effect on the output relays depends on the configuration of the output relay matrix switches.

The self-supervision output is activated by pressing the STEP push button 1 second when no setting indicator is flashing. The IRF output is activated in about 1 second after pressing of the STEP push button.

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

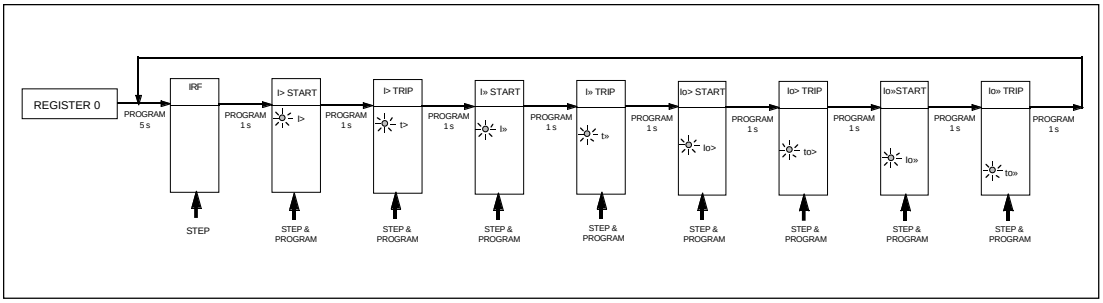


Fig. 5. Sequence order for the selection of output signals in the Trip test mode

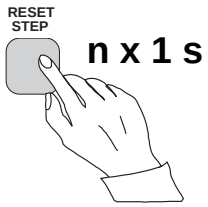
If, for instance, the indicator of the setting t> is flashing, and the push buttons STEP and PROGRAM are being pressed, the trip signal from the low-set overcurrent stage is activated. Return to the main menu is possible at any stage of the trip test sequence scheme, by pressing the PROGRAM push button for about five seconds.

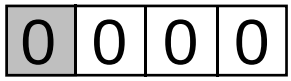
Note!
The effect on the output relays then depends on the configuration of the output relay matrix switchgroups SGR 1...3.

Example 3

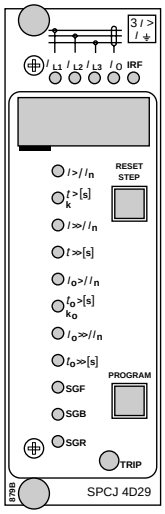
Trip test function. Forced activation of the outputs.

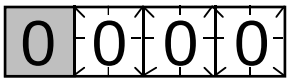
a)
Step forward on the display to register 0.





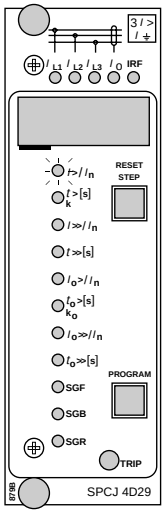
b)
Press the PROGRAM push button for about five seconds until the three green digits to the right.

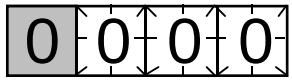




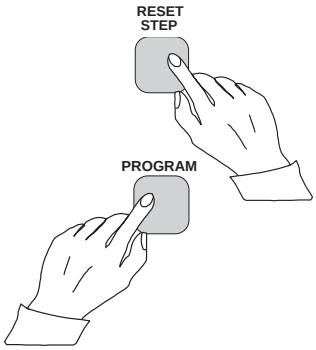
c)
Hold down the STEP push button. After one second the red IRF indicator is lit and the IRF output is activated. When the step push button is released the IRF indicator is switched off and the IRF output resets.

d)
Press the PROGRAM push button for one second and the indicator of the topmost setting start flashing.

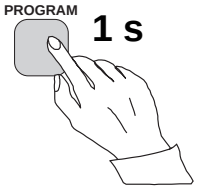


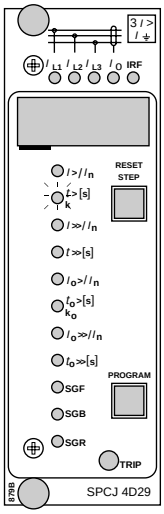


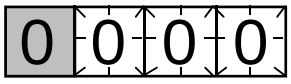
e)
If a start of the first stage is required, now press the push-buttons PROGRAM and STEP simultaneously. The stage output will be activated and the output relays will operate according to the actual programming of the relay output switchgroups SGR.



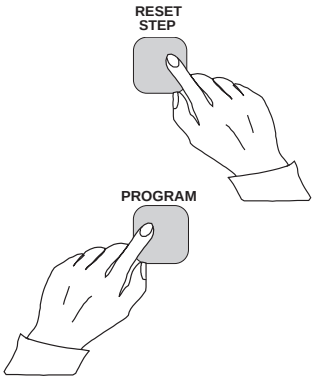
f)
To proceed to the next position press the PROGRAM push button for about 1 second until the indicator of the second setting starts flashing.

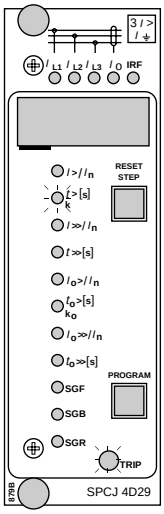


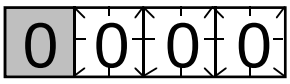




g)
Press the push buttons PROGRAM and STEP simultaneously to activate tripping of stage 1 (e.g. the I> stage of the overcurrent module SPCJ 4D29). The output relays will operate according to the actual programming of the relay switchgroups SGR. If the main trip relay is operated the trip indicator of the measuring module is lit.







h)
The starting and tripping of the remaining stages are activated in the same way as the first stage above. The indicator of the corresponding setting starts flashing to indicate that the concerned stage can be activated by pressing the STEP and PROGRAM buttons simultaneously. For any forced stage operation, the output relays will respond according to the setting of the relay output switchgroups SGR. Any time a certain stage is selected that is not wanted to operate, pressing the PROGRAM button once more will pass by this position and move to the next one without carrying out any operation of the selected stage.

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

Operation indication

A relay module is provided with a multiple of separate operation stages, each with its own operation indicator shown on the display and a common trip indicator on the lower part of the front plate of the relay module.

The starting of a relay stage is indicated with one number which changes to another number when the stage operates. The indicator remains glowing although the operation stage resets. The indicator is reset by means of the RESET push button of the relay module. An unreset operation indicator does not affect the function of the protection relay module.

In certain cases the function of the operation indicators may deviate from the above principles. This is described in detail in the descriptions of the separate modules.

Fault codes

In addition to the protection 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.

Shortly after the self-supervision system detects a permanent fault in the relay module, the red IRF indicator on the front panel is lit . At the same time the module puts forward a control signal to the output relay of the self-supervision system of the protection relay.

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 figure "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. When in a fault mode, the normal relay menus are operative, i.e. all setting values and measured values can be accessed although the relay operation is inhibited. The serial communication is also operative making it possible to access the relay information also from a remote site. The internal relay fault code shown on the display remains active until the internal fault possibly disappears and can also be remotely read out as variable V 169.

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