SPOC 110 C, SPOC 111 C, SPOC 112 C
Control and measuring unit

User´s manual and Technical description

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SPOC 110 C
SPOC 111 C
SPOC 112 C
Control and measuring unit

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Features

Cubicle-based remote control interface module with serial communication facilities.

16 binary inputs for reading circuit-breaker positions, circuit-breaker truck positions, disconnector positions, contact alarms, impulse transmitters.

Two analog measuring inputs for standardized mA signals.

One analog measuring input for measuring 5 A phase current.

Four relay outputs for the control of circuit-breakers, disconnectors etc.

Serial interface for two-way serial communication including measured data, event reporting, status data, control commands, setting values, configuration parameters etc.

Sophisticated internal self-supervision system for maximum system reliability.

Application

The control and measuring (= C & M) unit SPOC is designed to be used as a cubicle-based remote control interface unit, which allows status and analog data to be transferred to the remote control system, and the control of e.g. a circuit-breaker. The C & M unit is connected to the remote control system via the serial port of the unit.

The C & M unit contains on/off (binary) inputs which enable reading of circuitbreaker and disconnector status messages and alarms delivered by the protection relays, and transfer of these data, over the serial communication bus, to the remote control system. In addition, part of these inputs can be used as pulse counter inputs.

The versions available, type SPOC 110 C, SPOC 111 C and SPOC 112 C, differ from each other only with regard to the control voltage ranges of the on/off inputs .

For the reading of the analog data the unit is provided with two mA inputs and one 5 A current measuring input. For instance measured values received from the measuring transducers of the switchgear can be read over the mA inputs. One phase current can be supervised by means of the 5 A current measuring input, which can be connected to the protection core of the current transformer. All analog signals are transmitted to the remote control system over the SPA-data bus. There is no local display on the front plate of the unit.

The unit has four contact outputs provided with NO contacts. The contacts are capable of opening and closing the circuit-breaker, so there is no need for separate intermediate relays.

When connecting an existing substation to a remote control system, the SPOC units can be fitted into the cubicles side by side with the existing protection relays. Then wiring work is required only inside the cubicle. The optical SPA-bus controls the data communication between the switchgear cubicles and the remote control system. The situation is illustrated in fig. 1 and 2.

In new substations a 500 series feeder protection package provided for SPA-bus connection is a good solution. A control unit is included in the 500 series package. If the circuit-breaker/disconnector configuration of an incoming feeder is complicated, protection relays of the 300 series can be used for protection purposes and a separate control and measuring unit SPOC for forwarding the status data and control commands.

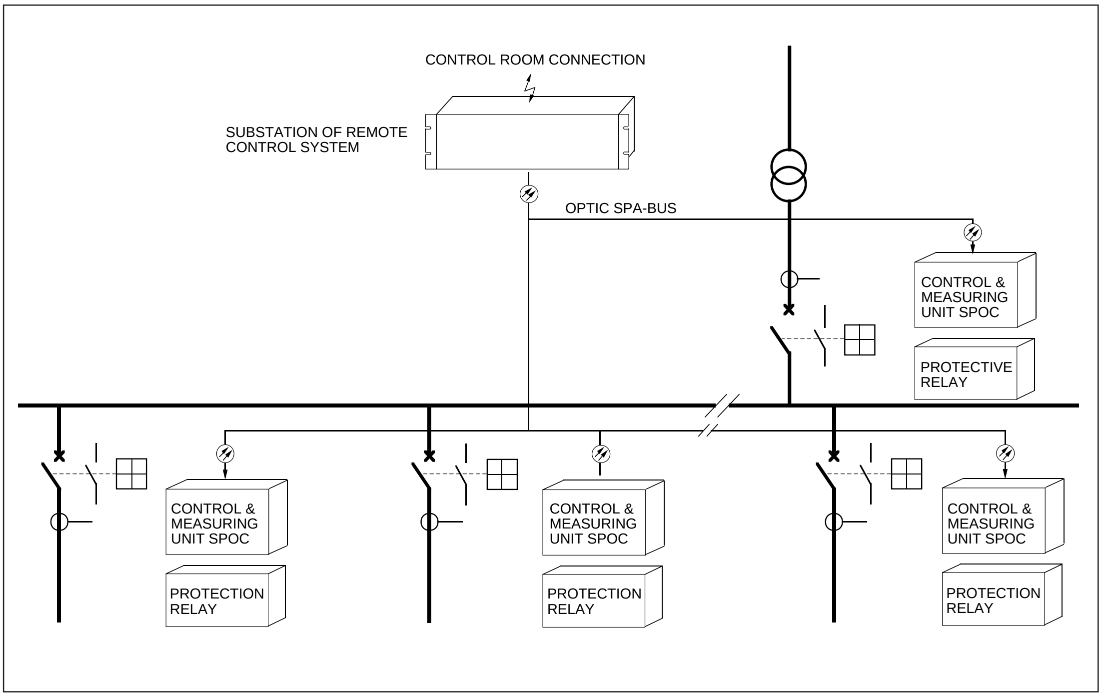


Fig. 1. The connection of an existing substation to the remote control system, using SPOC control and measuring units.

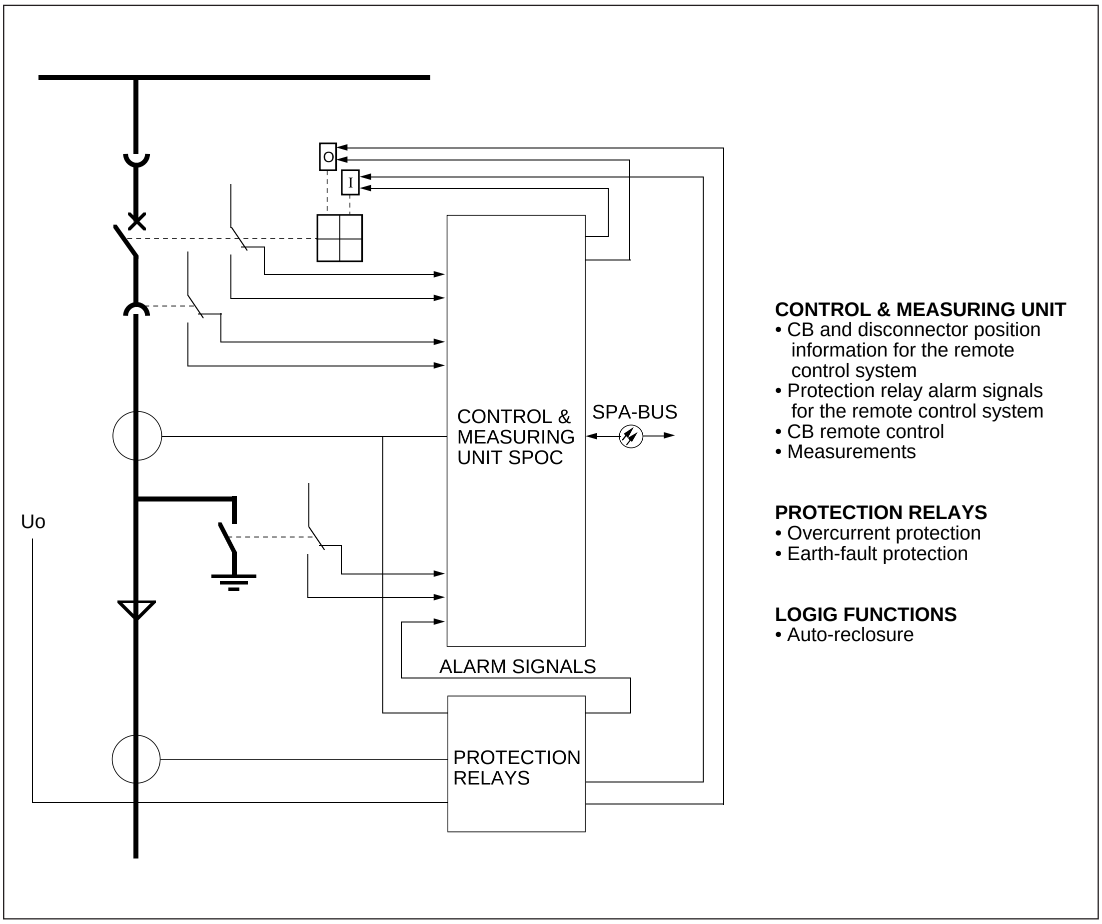


Fig. 2. Connection of the control and measuring unit SPOC and the available protection relays at an existing substation.

Description of function

General

SPOC is a control and measuring unit, the task of which is to forward control commands from the remote control system to the switchgear cubicle and status data and measured values from the switchgear cubicle to the remote control system. The communication takes place over the SPA serial data bus.

The basic functions of the control and measuring unit are illustrated by the block diagram in fig. 3.

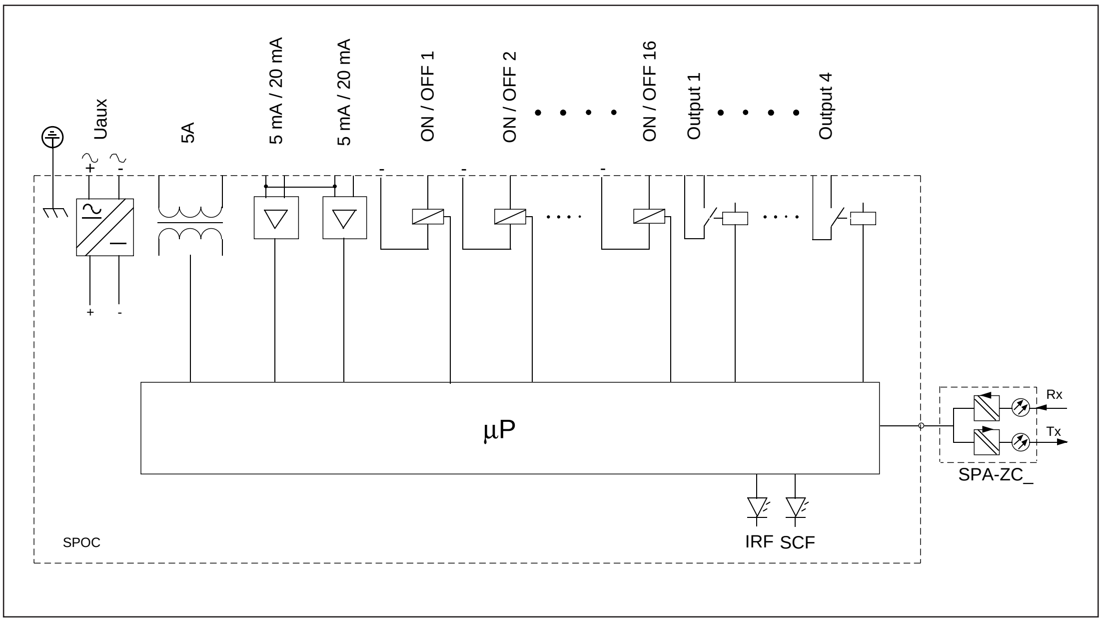


Fig. 3. Principle block diagram for the control and measuring unit SPOC.

U_{aux}	Auxiliary voltage
µP	Microprocessor module
Rx/Tx	Serial communication interface
IRF	Self-supervision indicator
SCF	Serial communication indicator

The on/off inputs can be programmed to operate as single contact inputs, as so called four-pole inputs, formed by two inputs, or as pulse counter inputs. A four-pole input always consists of two adjacent input circuits, e.g. the on/off inputs 1 and 2, 3 and 4 etc. The inputs 13...16 can operate as pulse counter inputs.

The rated current of the current measuring input is 5 A. An operating range of 0…5 mA or 0…20 mA can be selected independently for the mA inputs.

The contact outputs can be programmed to operate as either single relay outputs or double relay outputs. Outputs operating as single relay outputs can be controlled completely independently of one another. Two adjacent outputs, e.g. output 1 and 2, and output 3 and 4, can be programmed to operate as double relay outputs.

Double relay outputs are used e.g. for opening or closing the circuit-breaker. Then it is possible to operate only one of the relays of a double relay output at a time into the pick-up state, e.g. output 1 is in a pick-up state and output 2 in a drop-off state. Both outputs can be in the state of drop-off at the same time.

The functions of the inputs and outputs are specified via the SPA-bus. The same control and measuring unit can contain both single relay inputs, four-pole inputs and pulse counter inputs. In the same way the relay outputs can be programmed to operate as single relay outputs and double relay outputs.

At present, to facilitate start-up and operation, three different input/output configurations have been preprogrammed into the unit, see enclosures.

Mechanical design

The control and measuring unit SPOC is composed of Euro-card size (100 mm x 160 mm) plug-in type modules.

The plug-in modules are:
- Power supply module SPGU 240 A1 or SPGU 48 B2
- Input/output module SPTR 4B6 (SPOC 110 C), SPTR 4B7 (SPOC 111 C), SPTR 4B8 (SPOC 112 C)
- Processor module SPTO 12D4

The power supply module forms the secondary voltage required by the other modules. The input/output module contains the electronic circuitry for the on/off binary inputs and the relay outputs. The processor module, which operates as the central processing unit, incorporates the electronics required for the measuring functions etc.

To be able to withdraw the power supply, input/output and microprocessor module, the front plate of the unit must be removed.

In addition to the modules mentioned above the unit includes a connection module, type SPTE 1D1 (for SPOC 110 C), SPTE 1D2 (for SPOC 111 C), SPTE 1D3 (for SPOC 112 C), which operates as the mother PC-board of the unit. The connection module holds the card connectors for the plug-in modules and the terminal strips for the external wiring. The connection module is attached with screws to its mounting plate.

The connection module also holds the plugs for selecting the control voltage ranges of the on/off input groups and the current range of the mA inputs. The selector plugs are exposed through the opening of the mounting plate when removing the plastic cover located above the fixed terminal socket X0.

The unit is connected to the SPA-data bus by using SPA-ZC 21_ series bus interface modules which are fitted to the D-type subminiature connector located at the front edge of the microprocessor module. The bus interface module is attached to the front plate of the control and measuring unit by screws. An opening is provided on the front plate for the D-type connector.

The locations of the modules are illustrated in fig. 4.

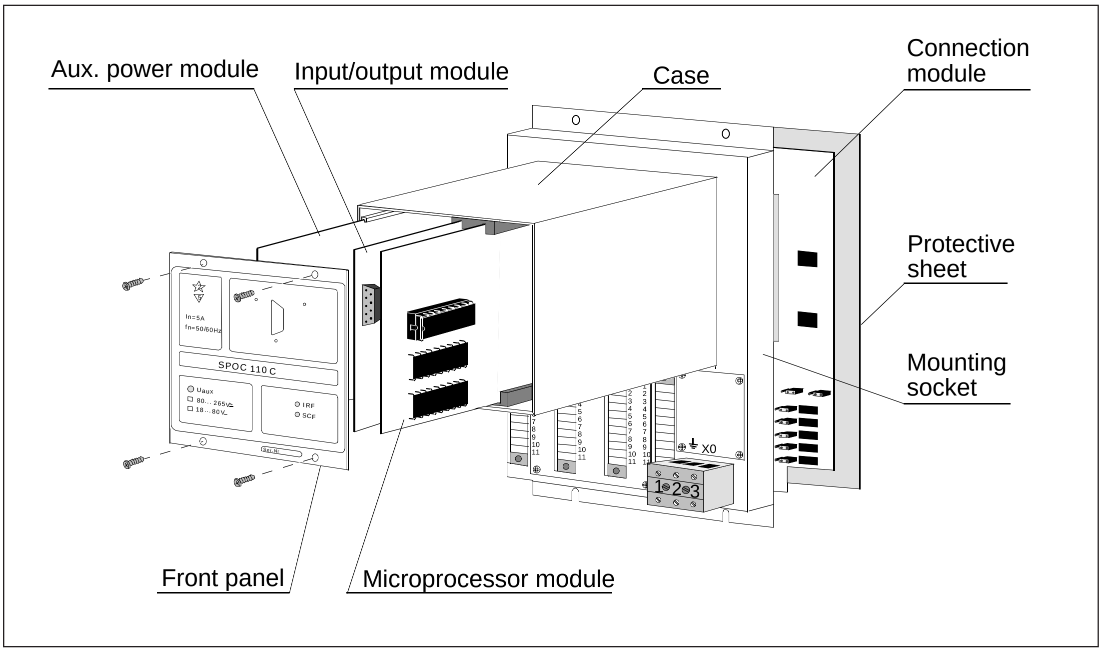


Fig. 4. Mechanical design of the control and measuring units of the SPOC 100 series.

The control and measuring modules of the SPOC 100 series are intended for panel mounting. The mounting plate is made of sheet steel and painted beige. The case is made of profile aluminium and finished in beige. The degree of protection by enclosure for the C & M units is IP20.

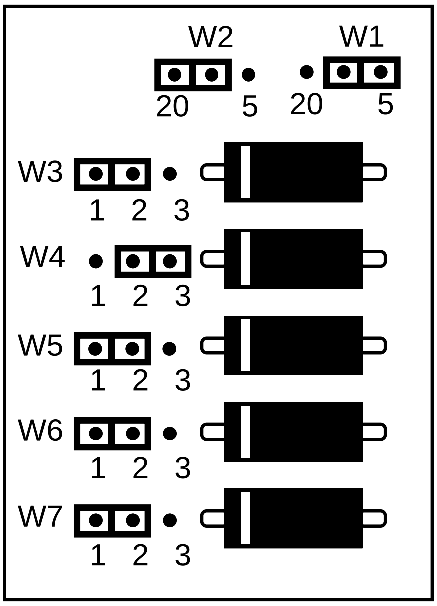
Analog inputs

The control and measuring units of the SPOC 100 series have one galvanically isolated current measuring input rated 5 A. The input is used for monitoring the actual level of one phase current. The 5 A current measuring input can be connected to the protection core of a switchgear current transformer.

Further, the unit has two mA inputs which are not galvanically isolated from the electronics. The measuring range of the mA inputs is field-selectable, i.e. 0…5 mA or 0…20 mA. The measuring ranges are selected by means of the selector jumpers located above the fixed terminal socket X0 and covered by a plastic plate. The measuring range of the mA input 1 (terminals X4/5-6) is selected with jumper W1 and that of the mA input 2 (terminals X4/7-8) with the jumper W2. When the selector jumper is in the position "5" (W1 in fig. 5), the measuring range will be 0…5 mA and when it is in the position "20" (W2 in fig. 3), the range will be 0...20 mA. On delivery from the factory, the measuring range setting of both mA inputs is 0…5 mA.

The values measured by the analog inputs are transmitted over the serial data bus to higher level equipment. The unit has no local display for analog values.

The sampling frequency of all analog inputs is 2 Hz. In addition to the momentary value of an input, the control and measuring unit calculates a 1...60 minute average value of the input signal. This average value can be read over the bus. The average value is calculated in cycles defined by the preset calculation times (S9…S11) and updated at preset updating intervals into the variables I9...I11. For instance when calculating a 15 min. average value, a new average value will be received at intervals determined by the variables S25...S27.



The settings in the adjacent figure correspond to the following ranges:

W1 5 mA
W2 20 mA

W3 80…130 V
W4 40…80 V
W5 80…130 V
W6 80…130 V
W7 80…130 V

Fig. 5. Range selector jumpers for the mA inputs and the on/off input groups.

Binary inputs

There are 16 on/off binary inputs which are galvanically separated from the electronics. The inputs are grouped into five groups in such a way that each group has a common minus terminal.

The voltage range of the on/off inputs in SPOC 110 C is either 40...80 V dc or 80...130 V dc. The voltage range is selected for the individual groups by means of the selector jumpers W3... W7, which are placed behind the same cover plate as the range selector plugs for the mA inputs. When the gap between pins 1 and 2 is bridged (W3 in fig. 5), the voltage range of the entire input group will be 80...130 V dc. When the gap between pins 2 and 3 is bridged (W4 in fig. 5), the voltage range is 40...80 V dc. All input groups have a factory default setting of 80...130 V dc.

The input voltage range of SPOC 111 C and SPOC 112 C is 20…40 V dc and 190...240 V dc respectively. Only one input voltage range is available.

The table below shows the grouping of the inputs of SPOC 110 C. The numbers of the inputs, 1...16, are equivalent to the channel numbers used in the data communication.

On/off input	Terminal Nos	Group	Range selector jumper
1	X2/1-2	1	W3
2	X2/1-3	1	W3
3	X2/1-4	1	W3
4	X2/1-5	1	W3
5	X2/1-6	1	W3
6	X2/1-7	1	W3
7	X3/1-2	2	W4
8	X3/1-3	2	W4
9	X3/1-4	2	W4
10	X3/1-5	2	W4
11	X3/1-6	2	W4
12	X3/1-7	2	W4
13	X4/1-2	3	W5
14	X4/1-3	3	W5
15	X2/9-10	4	W6
16	X3/9-10	5	W7

Table 1. Grouping of the on/off inputs of the control and measuring unit.

The on/off inputs can be programmed to operate as single contact inputs, four pole inputs or pulse counter inputs. Only adjacent inputs can operate as four-pole inputs, e.g. inputs 1-2 or 3-4 etc. The processor module monitors that the four-pole input state is rational, i.e. one pole is energized and the other pole non-energized.

When using four-pole data as status information, the "open" message (= energized input when e.g. the circuit-breaker is open) has to be wired to the terminal with odd number of the double input (e.g. input 5) and the "closed" message (= energized terminal when e.g. the circuit-breaker is closed) to the terminal with even number of the double input. This arrangement has been selected to facilitate the blocking functions to be specified between the on/off inputs and the contact outputs.

Thus, the status data of a four-pole input are formed as follows:

Status of input n+l (even parity) = "closed" message	Status of input n (odd parity) (odd parity) = "open" message	Position data
0	0	Unspecified
0	1	Open
1	0	Closed
1	1	Unspecified

Table 2.

At a change in the state of a single contact input or a four-pole input event data will be received over the serial data bus. It is also possible to block the event reporting and just read the status information over the data bus.

For the event reporting a delay can be applied to the contact and four-pole inputs. When this event delay has expired, event information is received over the bus. Should the status change reset before the delay has expired, there will be no event information. The duration of the event delay can be selected in the range of 0 or 0.1...25.0 s. With single contact output the delay is to be selected separately for NO and NC contact functions or with a four-pole output for all status changes.

When programming four-pole inputs all parameters are specified, for instance the event delays, only for the odd parity output of a double output. In the same way event reporting is received only from the odd parity input.

The state of several on/off inputs can be read at the same time as a decimal number in the so-called D/A converter function. The maximum number of D/A converters is four, so that one converter may have a maximum of 16 inputs. The inputs not desired can be masked out of each D/A converter. The remaining on/off inputs are represented by binary coded form so that input 1 = 2^0, input 2 = 2^1, input 3 = 2^2 and so on. The decimal number takes a value in the range of 0...65535.

The on/off inputs 13...16 can be programmed to operate as pulse counter inputs. A pulse input counts the incoming impulses between 0 and 29999. The number of pulses can be read over the SPA-bus.

The pulse counter can be selected to be triggered by a rising edge, a falling edge or by both edges of a pulse-shaped signal. An on/off input programmed to operate as a pulse counter input is not included in the event reporting.

A so called filtering delay by means of which the extra pulses caused by e.g. contact bounces can be applied to the pulse counter input. When the counter is triggered by e.g. a rising edge, the pulse is not accepted unless the signal is still high when the filtering delay has elapsed. The same filtering delay is used for the rising and the falling edge. The delay can be programmed in the range 5...1000 ms.

The maximum operating frequency of the pulse counter input is 50 Hz.

The values in the memory circuits of the pulse counters are not affected by interruptions in the auxiliary voltage supply, because the memory circuits are backed up by a battery.

Auto-reclose counters

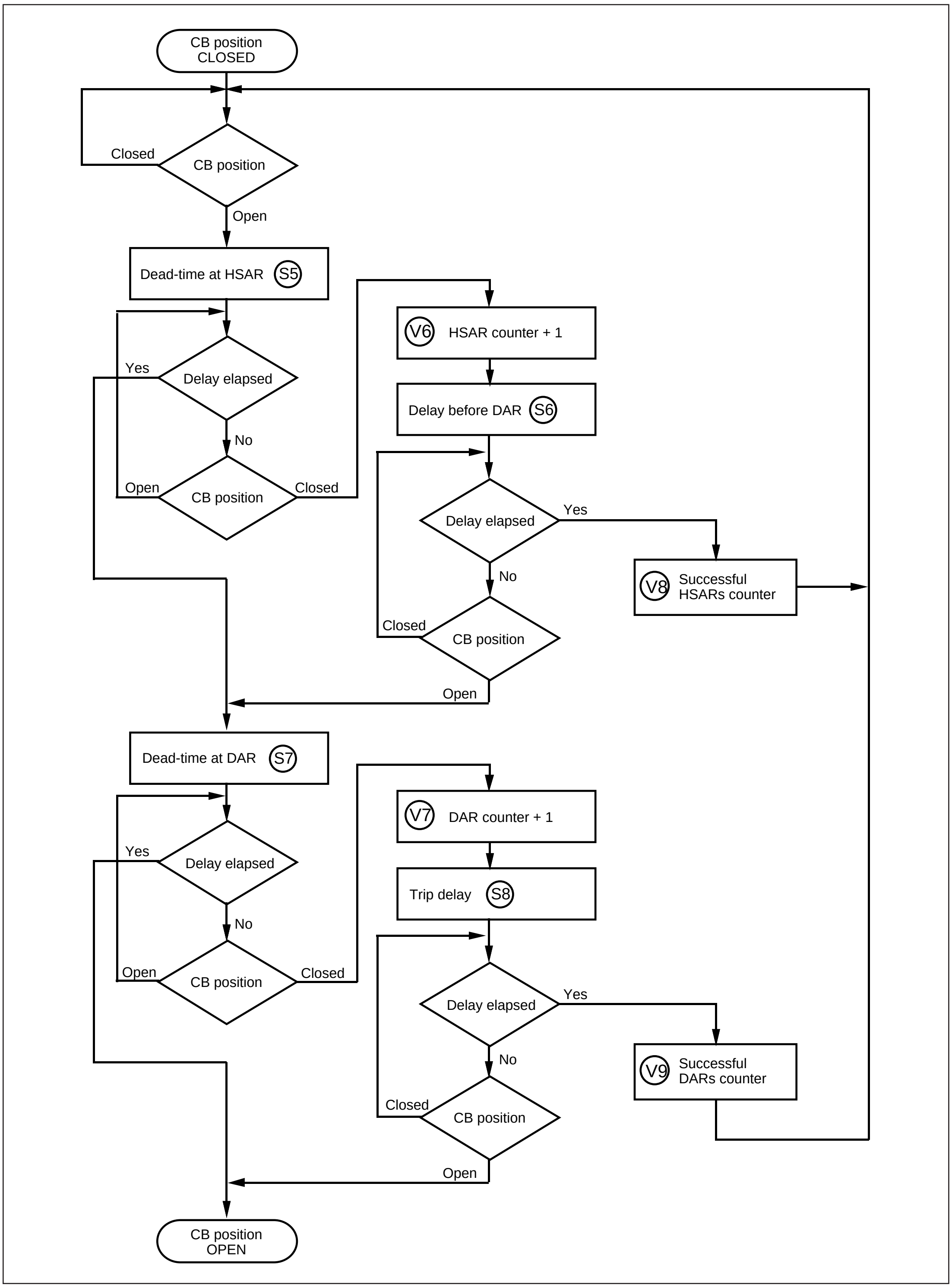


Fig. 6. Block diagram for auto-reclose counters.

The binary inputs with an odd terminal number can be used for counting the number of auto-reclosures. One input is capable of counting both successful high-speed auto-reclosures (HSAR) and successful delayed auto-reclosures (DAR).

The dead times (S5 and S7) of the HSAR and DAR sequence, the starting delay preceding the DAR sequence (S6) and the time for final tripping (S8) have to be programmed for the input used for AR counting purposes. When the circuit breaker opens, these times show whether there is a HSAR or a DAR and whether the auto-reclose function was successful or the HSAR sequence followed by a DAR sequence and eventually final tripping of the circuit-breaker.

The total number of HSARs can be concluded from the readings of the HSAR counter, the DAR counter and the number of final trippings, and the total number of DARs correspondingly from the reading of the DAR counter and the number of final trippings.

Contact outputs

The SPOC unit is provided with four contact outputs which can be used for operating the opening or closing mechanism of the circuit-breaker, without using separate intermediate relays. The outputs are normally open contacts. The control commands are given over the SPA-bus. The operation of the outputs is pulse-shaped so that a pulse length of 0.1...100 s can be programmed for each separate output.

The relay outputs can be controlled either individually or in pairs. Relays programmed to operate as single relay outputs can, quite independently of each other, be operated into a pick-up state. Of the relays programmed to operate as double outputs only one relay at a time can be programmed to be in a pickup state. However, it is possible to program a separate pulse length for the two contacts.

Outputs 1-2 and 3-4 can be programmed to operate as double outputs. The table below shows the terminal numbers of the outputs.

Output	Terminal number	Double output
1	X1/1-2	1
2	X1/4-5	1
3	X1/7-8	2
4	X1/10-11	2

Table 3. Outputs, terminal numbers and double outputs.

When operating the circuit-breaker or the disconnector, the first output (1 or 3) of the double outputs is intended to be wired so as to operate as opening command contact and the second (2 or 4) as closing command contact. This arrangement facilitates the blockings to be programmed between the on/off inputs and the relay outputs.

An output can be blocked from one or several single inputs or four-pole inputs. A blocking established from a single input is active as long as the terminals of the blocking input are energized. A blocking established from a four-pole input is active if the status data is unspecified or e.g. the earthing disconnector is closed. The blocking affects the operation (closing command) of the even output of the double output.

The outputs can be controlled in two different ways, either through a direct or a secured control. At a direct control the commands O1…O4 are used to close the output contact, which picks up immediately when the command has passed through. When using a secured control the concerned output is, initially, set into a state of alert and after that the command is executed.

Both ways of control are permitted for the control of single outputs and double outputs. At a secured control a state of alert for closing both contacts of the double output can be defined. The microprocessor module does not, however, execute such a command.

Programming switches

Additional functions required by individual applications are selected by means of the programming switches of switchgroup S1 located on the PCB of the microprocessor module. To be able to program the switches, the front plate of SPOC must be removed and the microprocessor module withdrawn.

Switch	Function
S1/1	Selection of initialization state for the data communication. When S1/1 = 0 (OFF), the data communication address and transfer rate of the unit are defined by variables V200 and V201. When S1/1 = 0 (ON), the address of the unit is 1 and the data transfer rate is 9600 baud. This feature is useful when the address and the data transfer rate of the unit are unknown. In such a case a new address can be set for the unit by using variable V200.
S1/2	Selection of data communication handshaking. When S1/2 = 0, no handshaking signals are available in the D-type connector and bus interface modules SPA-ZC 21_ or SPA-ZC 11 have to be used for connecting the unit to the data bus. When S1/2 = 1, RS-232C data bus handshaking signals are available in the D-type connector located on the front plate of the SPOC unit. This feature is used when connecting the control and measuring module e.g. to a modem. A bus interface module type SPA-ZC11 is required for the connection to a RS-232C data bus.
S1/3	Selection of SPA/ANSI protocol. When S1/3 = 0, a SPA protocol is used for the data communication of SPOC. When S1/3 = 1, an ANSI protocol is used for the data communication of SPOC.
S1/4...8	Intended for future needs. To be in the position 0.

The checksum of the switchgroup can be read over the serial data bus (V155). The 8-bit binary code formed by the switches is presented as a decimal number in the range 0…255, where each position combination of the switches is represented by an unequivocal number. Switch 1 represents the most significant bit and switch 8 the less significant one.

Operation indicators

The front plate of the control and measuring unit SPOC contains three operation indicators.

The green operation indicator U_{aux} is lit when the auxiliary voltage is connected to the unit and the power supply module is operating.

The red IRF operation indicator is lit when a permanent fault has been detected by the self-supervision system of the unit. As long as the unit is faulty, the operation indicator has a flash sequence of about 20 seconds on 10 seconds off, 20 seconds on etc.

The yellow SCF indicator is the operation indicator for the data communication functions of the unit. In a normal situation, when the unit is connected to a station control data communicator over the serial data bus and the data communication is operating, the indicator is dark. At interruptions on the serial communication the indicator flashes at a 1 second sequence.

During the storing of the input/output configuration into the EEPROM memory, the flash sequence is three times as fast as during a serial communication failure.

The front edge of the microprocessor module holds four green indicators, called diagnostics indicators. The indicators are revealed when removing the front plate of the control and measuring unit. The indicators are designated H3, H4, H5 and H6, from the top. The H6 indicator flashes when the microprocessor program runs normally. When a persistent fault is detected by the self-supervision system, the nature of the fault is shown by these indicators glowing with a steady light, see section "Fault location".

Auxiliary power supply module

For proper operation the control and measuring unit needs a continuous auxiliary voltage supply. From the external auxiliary voltage the power supply module forms the voltages required by the input/output module and the connection module.

The power supply module is a separate relay module located behind the front plate of the SPOC unit. The module can be withdrawn after removing the front plate.

The power supply module is a transformer connected, i.e. galvanically isolated primary and secondary side, flyback-type DC/DC converter. The primary side of the power supply module is protected with a fuse, F1, located on the PC-board of the module. Fuse size 1 A (slow).

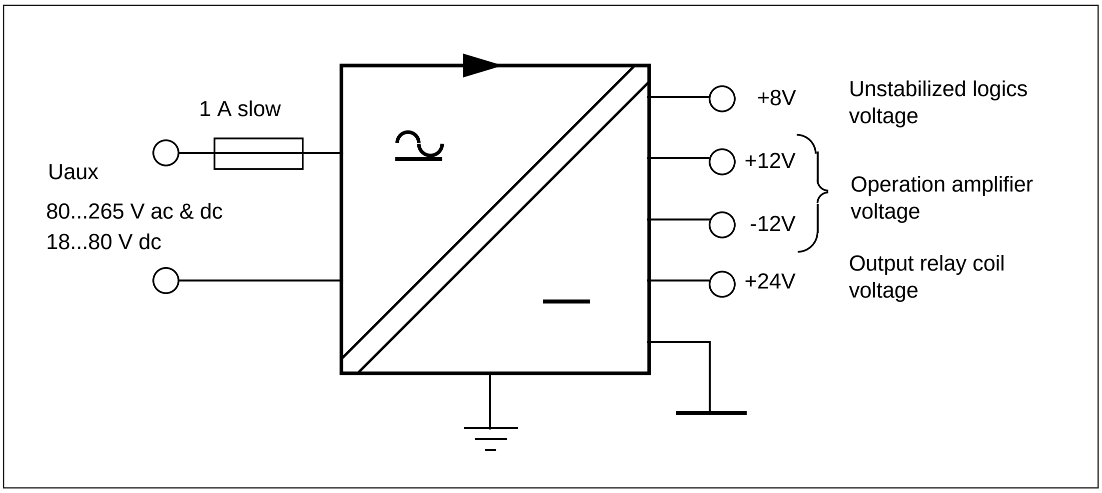


Fig. 7. Voltage levels of the power supply module.

The power supply module forms the secondary voltages required by the other modules; that is +24 V, ±12 V and +8 V. The output voltages ±12 V and +24 V are stabilized in the power supply module, while the +5 V required by the microprocessor module is stabilized by the stabilizer of the µP-module.

The green LED indicator on the front plate is lit when the power supply module is in operation.

There are two versions of power supply modules available. The secondary sides of the two models are identical, only the input voltage is different.

Insulation test voltage between primary and secondary side and protective earth
2 kV, 50 Hz, 1 min

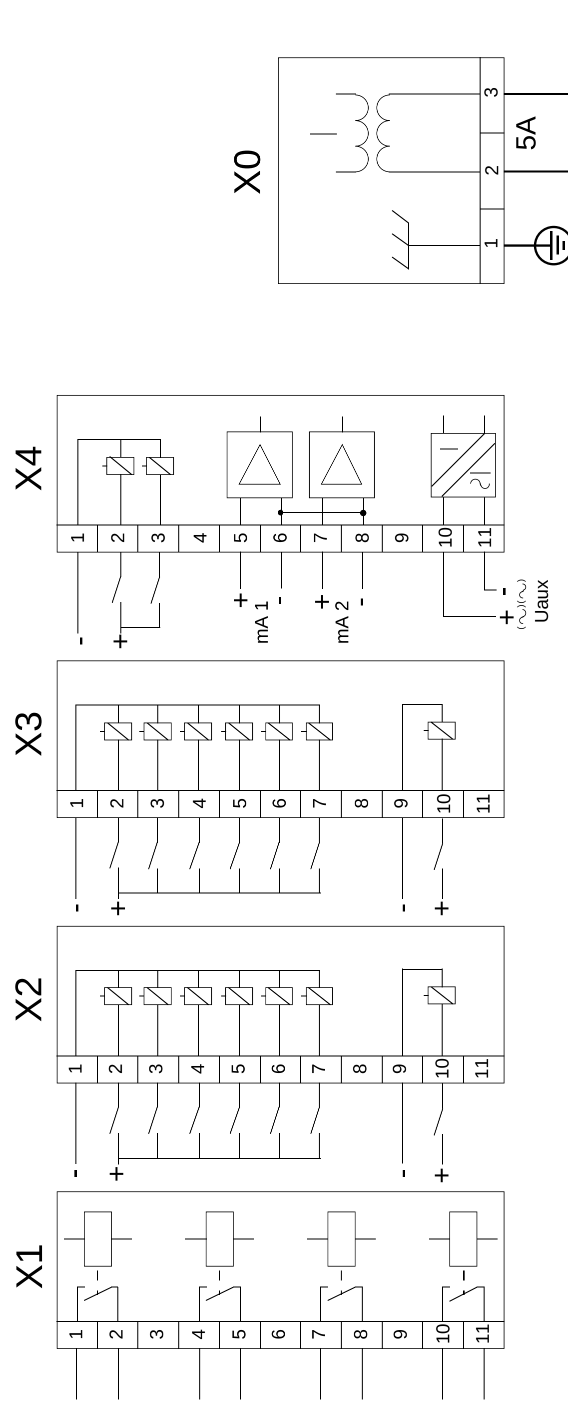
Rated power P_n 15 W

Voltage ranges of the power supply modules
- SPGU 240 A1 U_{aux} = 80... 265 V dc
- SPGU 48 B2 U_{aux} = 18...80 V dc

The SPGU 240 A1 module can be used for both ac and dc voltages. The SPGU 48 B2 version is designed for dc voltages only. The voltage range of the power supply module is marked on the front plate of the control and measuring unit.

Application

Connection diagram



U_{aux}	= auxiliary voltage
L_	= phase conductor with current transformer
mA1, mA2	= mA measuring input
–	= – terminal of binary signal input
+	= + terminal of binary signal input
XO	= fixed screw terminal socket
X1…X4	= detachable screw terminal connector
Rx/Tx	= serial interface

Fig. 8. Connection diagram for the control and measuring units of the SPOC 100 series.

Number and use of terminals X0…X4:

Con-nector	Terminal number	Function
X0	1	Protective ground
	2-3	5 A current measuring input
Xl	1-2	Relay output 1. Can couple with output 2
	4-5	Relay output 2. Can couple with output 1
	7-8	Relay output 3. Can couple with output 4
	10-11	Relay output 4. Can couple with output 3
X2	1-2	On/off input 1. Can make a four-pole input with input 2
	1-3	On/off input 2. Can make a four-pole input with input 1
	1-4	On/off input 3. Can make a four-pole input with input 4
	1-5	On/off input 4. Can make a four-pole input with input 3
	1-6	On/off input 5. Can make a four-pole input with input 6
	1-7	On/off input 6. Can make a four-pole input with input 5
	9-10	On/off input 15. Can make a four-pole input with input 16 Can also operate as a pulse counter
X3	1-2	On/off input 7. Can make a four-pole input with input 8
	1-3	On/off input 8. Can make a four-pole input with input 7
	1-4	On/off input 9. Can make a four-pole input with input 10
	1-5	On/off input 10. Can make a four-pole input with input 9
	1-6	On/off input 11. Can make a four-pole input with input 12
	1-7	On/off input 12. Can make a four-pole input with input 11
	9-10	On/off input 16. Can make a four-pole input with input 15 Can also operate as a pulse counter
X4	1-2	On/off input 13. Can make a four-pole input with input 14 Can also operate as a pulse counter
	1-3	On/off input 14. Can make a four-pole input with input 13 Can also operate as a pulse counter
	5-6	mA input 1
	7-8	mA input 2
	10-11	Auxiliary voltage supply The positive lead (+) of the dc supply is connected to terminal 10.

The other terminals are not in use in SPOC.

Mounting and dimension drawing

The control and measuring units of the SPOC 100 series are designed for surface mounting. The units are bolted to the mounting panel by means of four screws. Machine screws M5 x 10/ 10 or corresponding steel screws are recommended to be used.

The units are normally mounted in a vertical position as shown in fig. 9. Unless there is enough space on the rear wall, the units can be mounted on the bottom of the switchgear or the inside of the door.

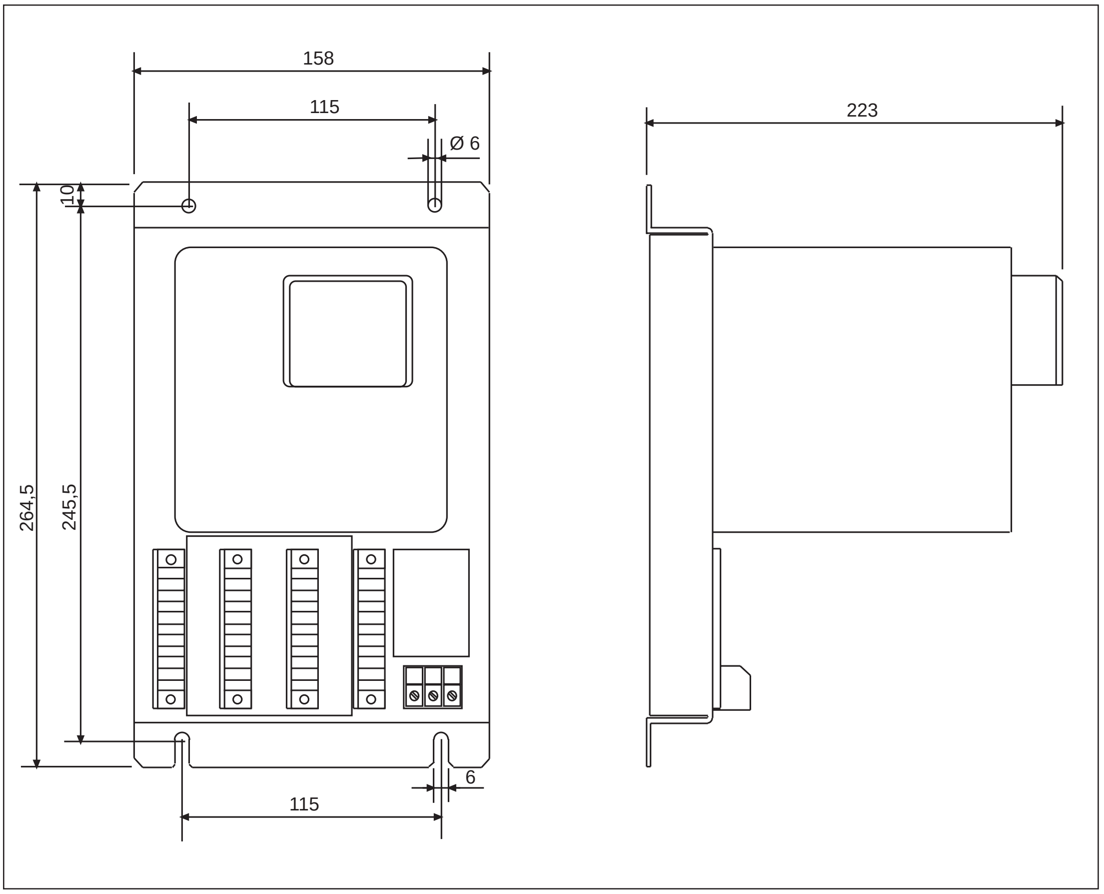


Fig. 9. Mounting drawing and dimensions of the control and measuring unit SPOC.

The optical cables of the serial communication bus run downwards from the bus interface module SPA-ZC when the unit is mounted as illustrated in fig. 9. Since the cables have a minimum permissible bending radius of 30...40 mm, enough space should be left around the terminal socket. Further, it should be checked that the door mounted instruments do not cause too sharp bendings to the optical cables.

Connections

All field cables are connected to the terminals on the mounting plate. The terminal socket X0 is a fixed screw connector, the terminal strips X1…X4 are detachable multi-pole terminal blocks. The conductors are connected to the multi-pole terminal blocks through screw joints.

The multi-pole terminal blocks consist of two parts. The male parts are firmly attached to the mother PC-board located on the mounting plate. The detachable female parts, to which the conductors are connected, and their mounting accessories are included in the delivery of the control and measuring unit.

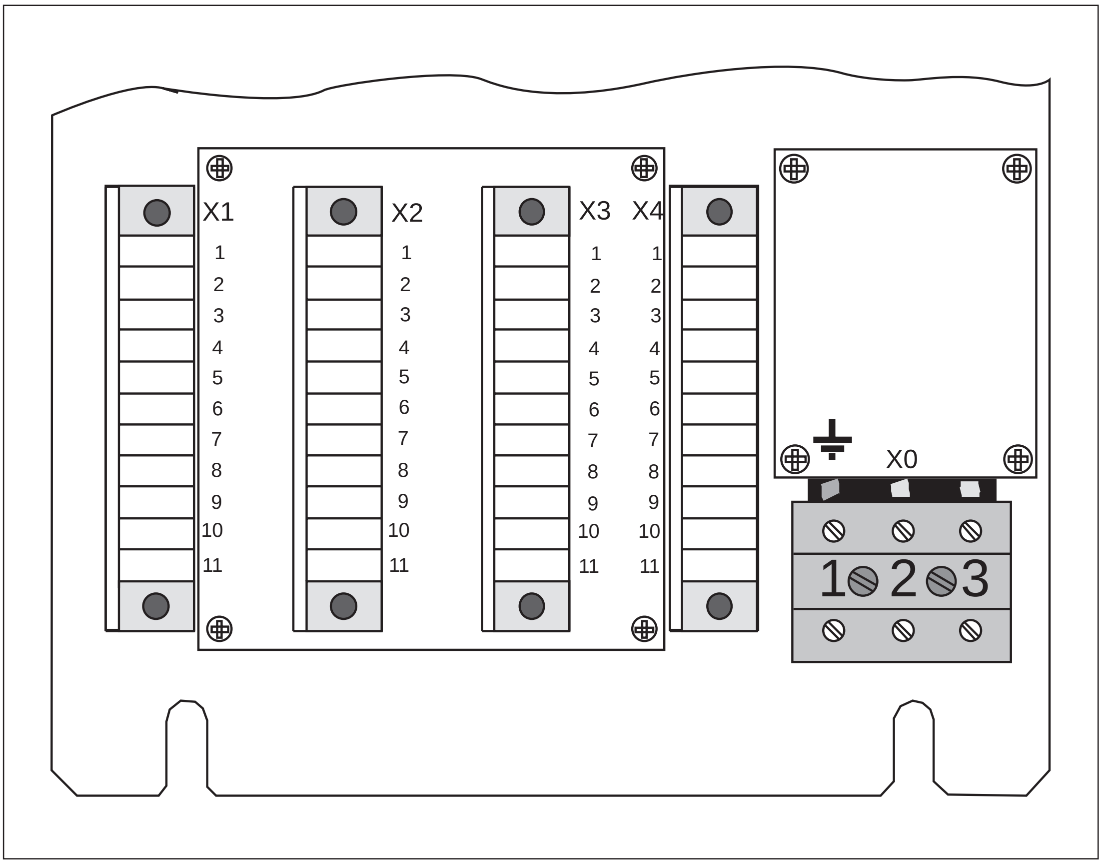


Fig. 10.

The protective earth and the 5 A current signal are connected to the control and measuring unit via the X0 socket. Each screw terminal is dimensioned for one maximum 4 mm^2 conductor.

The contact outputs are located on the multi-pole terminal block X1. The incoming on/off data are connected to the multi-pole terminal blocks X2...X4. In addition, the two mA signals and the auxiliary voltage are connected to the terminal block X4. The screw joint is dimensioned for one maximum 1.5 mm^2 conductor or two maximum 0.75 mm^2 conductors.

All measured data, status and control data are transferred over the SPA-bus. SPA-ZC series bus interface modules are used for connecting the unit to the communication bus. The bus interface module is fitted to the D-type connector located in the opening of the front plate of the control and measuring unit, and attached to the front plate by means of three screws included in the delivery.

The optical SPA-bus is available in two versions, i.e. one based on glass-fibre and the other on plastic-fibre cables. Several SPACOM units can be connected to the same SPA-bus loop. The terminals of the fibre-optic cables are connected to the counter terminals Rx and Tx of the bus interface module and the cables are linked from one unit to another and to the substation level control data communicator.

Start-up

1. Auxiliary voltage

Check the input voltage range of the power supply module before switching on the auxiliary voltage. The voltage range is marked on the front plate of the control and measuring unit.

2. Voltage ranges of on/off binary input groups

Before connecting the status data to the on/off inputs, check the operative voltage ranges of the input groups. As to SPOC 110 C the input groups have been given an operative voltage range setting of 80...130 V dc at the factory, but the range 40…80 V dc may be defined by jumper selection. For the C & M unit SPOC 111 C the binary input voltage range is 20...40 V dc and for SPOC 112 C it is 190...240 V dc.

The ranges are selected separately for the individual groups by using the range selector jumpers located under the plastic plate above the fixed terminal socket. The range selector jumpers are accessible after undoing the four screws of the plastic plate.

lnformation on grouping of the inputs, numbering of the selection jumpers and programming is given on page 7 and 8.

3. Operative ranges of mA inputs

Check the measuring ranges of the mA inputs if these are to be taken in use. Both mA inputs have been given an operative range of 0...5 mA at the factory.

The measuring ranges are selected with the range selector plugs situated behind the same plate as the voltage range selector plugs. The numbering of the plugs and instructions for programming are given on page 7.

4. Address of control and measuring unit

To make it possible for higher level equipment of the SPACOM system to identify a certain protection module or control module, each module must have an individual address.

During testing at the factory, the control and measuring unit SPOC has been given an address number. The address number is equivalent to the two last figures of the serial number if the last figures are 10...99. If the serial number terminates in 00…09, the given address will be 100…109.

The address can be changed by writing a new address into the variable V200 by using the old address. The new address has to be stored in the EEPROM memory by giving variable V151 the value of 1, by using the new address.

Should the address of some reason be unknown, a new address, 1, can be enforced by turning switch 1 of switchgroup S1, located in the microprocessor module, into the position 1. Then V200 can be given the new address, which has to be stored in the EEPROM memory by giving variable V151 the value of 1 (the address will still be 1). Finally, S1/1 is turned into the position 0 and the module responds at the new address.

5. Input/output configuration

An input/output default configuration 1 has been programmed for the control and measuring unit during testing at the factory This configuration can be used as such, or, for instance, some disconnectors can be left unconnected, in which case no parameters have to be changed.

lf one of the other default configurations would be preferred, it can be selected by giving variable V3 the number of the desired configuration, i.e. 2 or 3 The new configuration has to be stored in the EEPROM memory by giving variable V151 the value of 1. The SCF indicator flashes during the storing procedure.

The programmed default configuration 1 can be changed by giving the concerned parameters the required values and storing the new configuration by means of variable V151. The other default configurations can be changed by, initially, giving variable V3 the required configuration number and then changing the necessary parameters. Finally, the changed configuration has to be stored by means of variable V151. Check that the new configuration has been stored successfully by disconnecting the auxiliary voltage.

Event codes

The substation control data communicator can read the event data from the control and measuring unit. The event data are the changes in he state of the on/off inputs. On request, the unit writes out the event codes in the format time (ss.sss) and event code. The event codes are in the SPA protocol based channels which are formed by the on/off inputs. Channel 1 is represented by the on/off input l, channel 2 by the on/off input 2 etc.

lf an on/off input has been programmed to operate as a single relay input, it has the event codes E1 and E2. The codes of a four-pole input, El…E4 are available only on the odd channel of the double input, i.e. on the channel l, 3, etc. The pulse counter inputs are not included in the event reporting.

Further, the event codes E50 and E51, which are common to the unit, are available on channel 0.

Channel	Code	Event	Remarks
1…16	E1	Status change 1 --> 0	Single relay input
1…16	E2	Status change 0 --> 1	Single relay input
Odd numb.	E1	Status change xx --> 01 (open)	Four-pole input
Odd numb.	E2	Status change xx --> 10 (closed)	Four-pole input
Odd numb.	E3	Status change xx --> 11 (undefined)	Four-pole input
Odd numb.	E4	Status change xx --> 00 (undefined)	Four-pole input
0	E50	Restarting of the unit	
0	E51	Overflow of the event register of the unit	
0	E52	Temporary disturbance in the data communication	
0	E53	No response from the unit via the serial bus	
0	E54	The unit responds again via the serial bus	

NOTE!
In the SPACOM system the event codes E52... E54 are formed by the substation level control data communicator.

On/off input status in the table above:
Status 0 = on/off input non-energized
Status 1 = on/off input energized

The status of a four-pole input is expressed so that the most significant bit indicates the status of an even number input ("closed" message) and the less significant bit the status of an odd number input ("open" message). Thus status 01, i.e. the "closed" message equals non-energized and the "open" message equals energized input, is considered to be a status where the controlled object, e.g. a circuit-breaker, is open.

An input related delay (V1...V4) can be programmed for the event reporting. If the change in the state persists long enough to exceed the time delay (see page 9), an event report will be delivered. An event delay can be programmed for all changes in the state of both a single relay input and a four-pole input.

Blocking of the event reporting (S2) can be programmed for the single contact inputs and four-pole inputs. Then changes in the state of the inputs do not cause any event reporting. Blocking of a four-pole input is programmed for the odd input of the input pair. The input programmed to operate as a pulse counter input is automatically excluded from the event reporting.

The event buffer of the unit has a capacity of 20 events. The buffer is emptied when the substation level control data communicator is reading the events. If there are lots of events and the control data communicator is not able to read them fast enough, the event buffer will overflow. Should there be a change in the state of an on/off input in an overflow situation, that bit in variable V121 which corresponds to this input sets.

Variable V121 can take the values 0…FFFF, on/off input 1 is the less significant bit and input 16 the most significant one. Variable V121 is reset by giving it the value 0 (zero).

Remote transfer data

All the input data of the control and measuring unit SPOC are read and the output contacts are controlled over the serial bus. In addition the parameterizing of the unit can be made over the serial bus. Data referring to the on/off inputs are available on channels 1...16, the rest of the data are on channel 0.

Data	Channel	Code	Data direct .	Values	N . B
Bit form value of current 5 A	0	I1	R	0…1023, 839 = 5 A	
Bit form value of current value of mA input 1	0	I2	R	0…1023, 839 = 5 mA or 20 mA	
Bit form value of current value of mA input 2	0	I3	R	0…1023, 839 = 5 mA or 20 mA	
Bit form value of the average value of the 5 A input	0	I9	R	0…1023, 839 = 5 A	*1)
Bit form value of the average value of the mA input 1	0	I10	R	0…1023, 839 = 5 mA or 20 mA	*1)
Bit form value of the average value of the mA input 2	0	I11	R	0…1023, 839 = 5 mA or 20 mA	*1)
Minute counter of the 5 min average value function	0	I17	R	0…59 min	*2)
Minute counter of the mA input 1 average value function	0	I18	R	0…59 min	*2)
Minute counter of the mA input 2 average value function	0	I19	R	0…59 min	*2)
Calculation time of 5 A current average value	0	S9	RW(e)	1…60 min, 0 = no calculation	
Calculation time of average value of mA input 1	0	S10	RW(e)	1…60 min 0 = no calculation	
Calculation time of average value of mA input 2	0	S11	RW(e)	1…60 min 0 = no calculation	
Updating time of value of 5 A input	0	S25	RW(e)	1…60 min	*2)
Updating time of value of mA input 1	0	S26	RW(e)	1…60 min	*2)
Updating time of value of mA input 2	0	S27	RW(e)	1…60 min	*2)
Number of input/output configuration	0	V3	RW	1…7 = default configurations 1…7 8 = configuration stored in EEPROM	
Testing of operation indicators SCF and H3…H6	0	V4	W	0 = LEDs off 1 = LEDs on	

Data	Channel	Code	Data direct .	Values	N . B
Common resetting of pulse counters	0	V8	W	1 = resetting of pulse counters	
Resetting of average value calculation of the analog channels	0	V9	W	1 = starting average calculations and minute counters from zero	
Direct control of output relays 1…4	0	O1… O4	W	1 = output relays 1…4 into pick-up state	
Specification of function of outputs 1 and 2	0	V10	RW(e)	0 = double relay output 1 = single relay output	
State of alert for control of output 1 (secured control)	0	V11	RW	0 = contact open 1 = contact closed	*3)
State of alert for control of output 2 (secured control)	0	V12	RW	0 = contact open 1 = contact closed	*3)
Annulling of state of alert for control of outputs 1 and 2	0	V13	W	1 = annulling of states of readiness	
Execution of control of outputs 1 and 2 (secured control)	0	V14	W	1 = execution of controls	
Control pulse length of output 1	0	V15	RW(e)	0.1…100.0 s	
Control pulse length of output 2	0	V16	RW(e)	0.1…100.0 s	
Blocking of control of output 2	0	V17	RW(e)	0 = no blocking 1…16 = numbers of channels causing blocking (see section "Contact outputs")	
Specification of function of outputs 3 and 4	0	V20	RW(e)	0 = double relay output 1 = single relay output	
State of alert for control of output 3 (secured control)	0	V21	RW	0 = contact open 1 = contact closed	*3)
State of alert for control of output 4 (secured control)	0	V22	RW	0 = contact open 1 = contact closed	*3)
Annulling of states of alert for control of outputs 3 and 4	0	V23	W	1 = annulling of states of alert	
Execution of control of outputs 3 and 4 (secured control)	0	V24	W	1 = execution of control	
Control pulse length of output 3	0	V25	RW(e)	0.1…100.0 s	
Control pulse length of output 4	0	V26	RW(e)	0.1…100.0 s	

Data	Channel	Code	Data direct .	Values	N . B
Blocking of control of output 4	0	V27	RW(e)	0 = no blockings 1…16 = numbers of blocking input channels (see page 11)	
State of on/off inputs 1…16	1…16	I1	R	0 = input non-energized 1 = input energized	
State of double relay inputs MSB = state of even number input LSB = state of odd number input	1.3…15	I2	R	0 = 0 0 unspecified 2 = 0 1 open 1 = 1 0 closed 3 = 1 1 unspecified	*4)
Specification of on/off inputs 1…16	1…16	S1	RW(e)	0 = single relay input 1 = four-pole input *5) State 1 to be programmed for odd number inputs n only, in which case n+1 is the pair of it 2 = pulse counter input *6) 3 = input not in use	
Event reporting of on/off inputs 1…16	1…16	S2	RW(e)	0 = reporting per mitted 1 = reporting blocked	*5)
Triggering edge of pulse counter	13…16	S3	RW(e)	0 = rising edge 1 = falling edge 2 = any change in the state	
Filtering delay of pulse counter input	13…16	S4	RW(e)	5…1000 ms in steps of 5 ms. See section "Binary inputs"	
Dead time of HSAR	1.3…15	S5	RW(e)	0.0…99.9 s	*8)
Starting time preceding DAR	1.3…15	S6	RW(e)	0.0…99.9 s	*8)
Dead time of DAR	1.3…15	S7	RW(e)	0…999 s	*8)
Delay before final tripping	1,3…15	S8	RW(e)	0.0…99.9 s	*8)
Event reporting delay of on/off input, change 1 -> 0	1…16	V1	RW(e)	0 or 0.1…25.0 s at 0.1 s steps	*5)
Event reporting delay of on/off input, change 0 -> 1	1…16	V2	RW(e)	0 or 0.1…25.0 s at 0.1 s steps	*5)
Event reporting delay of four-pole input, change xx -> 01 (open)	1.3…15	V1	RW(e)	0 or 0.1…25.0 s at 0.1 s steps	*5)
Event reporting delay of four-pole input, change xx -> 10 (closed)	1.3…15	V2	RW(e)	0 or 0.1…25.0 s at 0.1 s steps	*5)

Data	Channel	Code	Data direct .	Values	N . B
Event reporting delay of four-pole input, change xx -> 00	1.3…15	V3	RW(e)	0 or 0.1…25.0 s at 0.1 s steps	*5)
Event reporting delay of four-pole input, change xx -> 1 1	1.3…15	V4	RW(e)	0 or 0.1…25.0 s at 0.1 s steps	*5)
Value of pulse counters 13…16	13…16	V5	R	0…29999	
Resetting of pulse counters 13…16	13…16	V5	W	0 = resetting	
HSAR counter	1.3…15	V6	RW(e)	0…999	*8)
DAR counter	1.3…15	V7	RW(e)	0…999	*8)
Mask of D/A converter 1 in hexadecimal form	0	V101	RW(e)	0…FFFF	*7)
Mask of D/A converter 2 in hexadecimal form	0	V102	RW(e)	0…FFFF	*7)
Mask of D/A converter 3 in hexadecimal form	0	V103	RW(e)	O…FFFF	*7)
Mask of D/A converter 4 in hexadecimal form	0	V104	RW(e)	O…FFFF	*7)
Value of D/A converter 1	0	V111	R	65535	*7)
Value of D/A converter 2	0	V112	R	65535	*7)
Value of D/A converter 3	0	V113	R	65535	*7)
Value of D/A converter 4	0	V114	R	65535	*7)
Value of on/off inputs in hexadecimal form	0	V120	R	O…FFFF Input 1 = less significant Input 16 = most significant	
Overflow bits of event register in hexadecimal form	0	V121	R	O…FFFF See section "Event codes "	
Resetting of over flow bits of event register	0	V121	W	0 = resetting	
Storing of information in non-volatile memory	0	V151	W	1 = storing	
Selection of operational state of programming switches S1 (for factory testing)	0	V154	RW	0 = switch settings due 1 = switch settings not due	
Checksum of programming switches S1	0	V155	R	0…255 See section "Programming switches"	

Data	Channel	Code	Data direct .	Values	N . B
Activation of the self-supervision system	0	V165	W	1 = self-supervision is activated and the IRF LED is lit in about 10 s, in further 30 s the self-supervision resets	
Data communication address of the unit	0	V200	RW(e)	1…899	
Data transfer rate	0	V201	RW(e)	2 = 9600 Bd 3 = 4800 Bd 4 = 2400 Bd 5 = 1200 Bd 6 = 300 Bd	
Delay of CTS handshaking signal (required only in an RS handshaking state)	0	V202	RW(e)	5…1000 ms CPU rounds off to the nearest 5 ms	
Program version label	0	V205	R	e.g. 033A	
Identification label of input/ output configuration	0	V206	RW(e)	10 ASCII characters	
Reading of event register	0	L	R	Time, channel number and event code	
Rereading of event register	0	B	R	Time, channel number and event code	
Type designation of microprocessor unit	0	F	R	e.g. SPTO 12D4	
Reading of unit status message	0	C	R	0 = normal state 1 = unit reset and restarted 2 = overflow of event register 3 = events 1 and 2 together	
Resetting of unit status data	0	C	W	0 = resetting	

The data transfer codes L, B and C are to be used for the event data transmission between the unit and the substation control data communicator. The event register can be read only once by means of the L-command. If, for instance, a fault occurs in the data communication, the contents of the event register once read by the L-command can be reread by using the B-command. When required, the B-command can be repeated.

All the data presented in the table above are read and written by using the unit's own address. A common address can also be used for writing data to the unit. In such a case several units are able to execute the same command simultaneously. The data to be written at the common address 900 are presented in the following table.

Data	Channel	Code	Data direct .	Values	N . B
Execution of control command (secured control)	0	V251	W	1 = states of alert executed	
Annulling of states of alert	0	V252	W	1 = states of alert annulled	
Resetting of average value measurements	0	V253	W	1 = starting of average value calculation and minute counter from zero	
Resetting of pulse counters	0	V254	W	1 = pulse counters are reset	

R = data to be read from the unit
W = data to be written to the unit
(e) = data to be stored into the non-volatile memory using variable V151, after being changed

The unit has been given the "Default configuration 1 " at the factory, see enclosure 2. The data marked with (e) are default values of configuration 1.

*1) After the auxiliary voltage has been connected, the values I9...I11 are zero until the calculation time (S9…S11) of the average value has elapsed.

*2) The counters I17...I19 counts the minutes starting from zero for the time determined by variables S25…S27. At the moment determined by the variables S25...S27 the counters return to zero and the variables I9...I11 are updated with the new average value. The average values of the analog signals are calculated for the time cycle determined by the variables S9…S11.

*3) At the control of double outputs any combination of the state of alert is permitted. Not until the control is executed it is checked whether the control determined by the state of alert is permitted or if some kind of blocking is alert. At a double output the odd number output operates as an opening contact and the even number output as a closing contact.

The state of alert is annulled in about 120 s unless an execution command is received. The state of alert is always annulled when a control command has been carried out.

*4) A double input consists of an odd input number (2n+1) and an even input number (2n+1)+1. The command 12 can be used for reading the status of any input of the double input. 12 can be read regardless of the operation of the input, i.e. if it is programmed to operate as a single relay input or part of a four-pole input.

*5)The information can be read only from the odd number input of the fourpole input or written only to the odd number input of the four-pole input.

*6) Only the on/off inputs 13...16 can be programmed to operate as pulse counter inputs.

*7) Any of the on/off inputs can be linked to an D/A converter. The inputs to be included are selected with the mask word. The mask word is formed by 16 bits so that the most significant bit is input number 16 and the less significant is input number 1. The mask word is given in hexadecimal form.

An input is excluded from the D/A converter by writing a 0 for the concerned input in the mask work. Correspondingly, it is included by writing a 1 instead of 0.

*8) Regarding the variables S5...S8, V6 and V7 of the HSAR and DAR the reading and writing function can be directed to the even channel only.

Technical data
(modified 2003-08)

5 A energizing input

Rated current	5 A
Thermal withstand capability	
- continuously	15 A
- for 1 s	300 A
Input impedance	<20 mΩ
Rated frequency	50/60 Hz
Measurement range	0…1.2 x I_n
Measuring accuracy	±1 % of rated value
Operating modes	Instantaneous value measurement, 1…60 min average value measurement

mA inputs

Quantity	2
Measurement ranges	0…5 mA or 0…20 mA
Measuring accuracy	±1% of max. value of measurement range
Operating modes	Instantaneous value measurement, 1…60 min average value measurement

Binary inputs

Quantity	16; divided in groups of 6 + 6 + 2 + 1 + 1 so that each group has a common minus terminal
Input voltage range	40…130 V dc SPOC 110 C 20…40 V dc SPOC 111 C 190…240 V dc SPOC 112 C
Typical current drain	2…5 mA
Programming possibilities	Single relay input, max. 16 inputs Four-pole input, max. 8 Pulse counter inputs, max. 4 Counting range 0…29999 pulses, triggering to be selected for rising or falling edge or any change in the state. The pulse counters are battery backed up. D /A converter operation, max. 4, allowing on/off status readout as a decimal number

Contact outputs

Quantity	4 separate NO contacts
Rated voltage	250 V dc
Carry continuously	5 A
Make and carry for 0.5 s	30 A
Make and carry for 3 s	15 A
Breaking capacity for dc when the control circuit time constant L/R < 40 ms at 48/110/220 V dc	5 A/3 A/1 A
Operating mode	Pulse-shaped control signal, pulse length to be programmed in the range 0.1…100 s
Programming possibilities	Single relay output double relay output consisting of two contacts

Power supply module

Supply module type	
- SPGU 240 A1	80…265 V ac/dc
- SPGU 48 B2	18…80 V dc
Power consumption	Approx. 10 W

Data transmission

Transmission mode	Fibre optic serial bus
Data code	ASCII
Selectable data transfer speed	300, 1200, 2400, 4800 or 9600 Bd
Bus interface unit	SPA-ZC21_ _ , SPA-ZC17_ _ or SPA-ZC11_ _

Test voltages

Test points	5 A current input Binary input groups Contact outputs Auxiliary voltage input
Insulation test voltage, between terminal groups and terminals to the relay frame as per IEC 60255-5 and SS 436 15 03	2 kV, 50 Hz, 1 min
Impulse test voltage, between terminal groups and terminals to the relay frame as per IEC 60255-5 and SS 436 15 03	5 kV, 1.2/50 μs, 0.5 J
High frequency interference test voltage, between terminal groups and terminals to the relay frame as per IEC 60255-6 and SS 436 15 03	2.5 kV, 1 MHz
Spark interference test voltage, between terminal groups and terminals to the relay frame as per SS 436 15 03	4…8 kV

Environmental conditions

Specified ambient service temperature range	-10…+55°C
Transport and storage temperature range	-40…+70°C
Long term damp heat withstand according to IEC 60068-2-3	<95% at 40°C for 56 days/a
Degree of protection by enclosure of the device case	IP20
Mass of the unit	Approx. 2.5 kg

Spare parts
(modified 2003-08)

Microprocessor module	SPTO 12D4
Input/output module	SPTR 4B6 (SPOC 110C), SPTR 4B7 (SPOC 111C), 1MRS 119019 (SPOC 112C)
Power supply module	
- U_{aux} = 80…265 V ac/dc	SPGU 240 A1
- U_{aux} = 18…80 V dc	SPGU 48 B2
Connection module	SPTE 1D1 (SPOC 110 C), SPTE 1D2 (SPOC 111 C), SPTE 1D3 (SPOC 112 C)
Female parts of detachable multi-pole connectors X1…X4, with accessories	SPA-ZT2 Note! Included in the delivery of the unit
Bus interface modules	SPA-ZC21_ _ SPA-ZC17_ _ SPA-ZC11_ _

Ordering data

	Example
1. Quantity and type designation	5 SPOC 110 C units
2. Auxiliary voltage	U_{aux} = 110 V dc
3. Accessories	5 bus interface modules SPA-ZC 21BB 2 fibre-optic cables SPA-ZF LL 10 4 fibre-optic cables SPA-ZF LL 5
4. Special requirements	–

Maintenance and testing

Due to the lack of wearing components electronic devices need no preventive maintenance. The slow ageing of the components is not perceivable in practice. Cleaning of the contacts of the PC-board connectors may, however, prevent possible contact faults.

The best preventive maintenance is to keep the ambient temperature and the relative humidity within the given specifications. In addition, it is important that the atmosphere around the equipment does not contain too much dust or corrosive gases.

The plug-in modules of the control and measuring unit; the microprocessor module, the input/output module and the power supply module contain integrated circuits and should therefore be handled with great care. Withdrawn modules must be protected against discharge of static electricity.

The control and measuring unit incorporates a self-testing system continuously monitoring the microprocessor software and the function of the electronics around the microprocessor. The input circuits and the contacts of the output relays are not included in the supervision system.

I f a permanent fault is detected by the self-testing system, the controls of the output relays are blocked, the red IRF indicator is lit and the communication to the SPA-bus is interrupted. Most faults can be eliminated by replacing one of the modules of the unit.

Trouble-shooting

If such a fault occurs in the control and measuring unit that the IRF indicator is lit or the serial communication is interrupted, the following measures can be taken to locate the fault:

- If neither the IRF indicator, nor the green U_{aux} indicator is on, the power supply module is faulty or the auxiliary supply fails. Store the auxiliary voltage supply, change the polarity of the dc power supply or replace the power supply module.

- If the IRF indicator is lit, remove the front plate and check the four green diagnostics lamps, from the top H3, H4, H5 and H6, at the front edge of the microprocessor module.

  - If H3 is lit with a steady light, the RAM circuit, i.e. circuit D5, is faulty.
  - If H4 is lit with a steady light, the EEPROM parameter memory circuit D2 is faulty. When changing the EEPROM memory, the parameters must be reprogrammed and stored into the EEPROM memory.
  - If H5 is lit with a steady light, the EPROM program memory circuit is faulty. When ordering a new EPROM, the text of the adhesive tape on the circuit should be stated.
  - If H6 is lit with a steady light, the control of the output contacts fails. Then the microprocessor module or the input/output module is faulty or the round cable connecting the two modules has come loose or is defective. Check the cable or contact the service department.

- If the red IRF indicator is lit and the green diagnostics indicators are dark, contact the service department.

- If the yellow SCF indicator on the front plate is lit with a steady light, the S1/1 switch on the microprocessor module has been left in the position 1. In this case the address of the module is one (1) and the data transfer rate is 9600 Bd. The address and the data transfer rate, which have been programmed into the variables V200 and V201, are obtained by turning switch S1/1 into position 0.

- If the SCF indicator flashes slowly, the data communication has been interrupted. Replace the bus interface module and check the optical fibres of the serial bus.

Enclosure 1.

ANSI-connection

General

When the programming switch S1/3 of the microprocessor module is in the position 1, the SPOC unit communicates by using an ANSI protocol. A bus interface module type SPA-ZC11 has to be used for connecting the unit to the data bus. The interface module is presented in publication 34 SPACOM 6 EN1.

The ANSI X3.28 halfduplex protocol used is presented e.g. in the manual "Allen-Bradley: 1771-811 PLC-2-family/RS-232-C Interface module 1771-KG; User's Manual".

The electrical connection complies with RS 232C

The data transfer speed has a setting range of 3000…9600 Bd (V201). A BCC (= Block Check Character) fault checking method is used, including even parity. The character length is always 8 bits, including one stop bit.

The address of the SPOC unit (V200) and the master unit (V132) can be set in the range 1...254. The SPOC unit transfers all information using the address of the master unit.

Command types used and value of the STS byte

The command types used in the protocol have been listed in table 1. In the response message of the SPOC unit the STS byte (status) may take the values mentioned in table 2.

Command type	Command byte	SPOC accepts	SPOC communicates to the master
Unprotected Block Read	01	yes	
Unprotected Block Write	08	yes	yes
Unprotected Bit Write	05	yes	yes
Protected Block Write	00	yes	
Protected Bit Write	02	yes	

Table 1. Commands transmitted by and approved by SPOC.

STS byte	Purpose
00	No faults
10	Fault in CMD, FNC, SIZE or message length
50…59	Address fault or conversion fault

Table 2. Interpretation of STS byte.

Message formate

The protocol which is character-oriented uses the following ASCII control codes extended to eight bits by adding a zero to bit 7.

SOH = 01H, STX = 02H, ETX = 03H,
EOT = 04H, ENQ = 05H, ACK = 06H,
DLE = 10H, NAK = 15H

In addition, a block check character (BCC), facilitating the detection has been added to the end of each message

The normal host message formate when using a halfduplex protocol is:
DLE SOH STN DLE STX DST SRC CMD STS TNS data DLE ETX BCC

The normal slave (SPOC) message formate when using a halfduplex protocol is:
DLE STX DST SRC CMD STS TNS data DLE ETX BCC

Other messages:

ACK message:	DLE ACK
Polling message:	DLE ENQ STN BCC
EOT message:	DLE EOT

Special message:

NAK message:	DLE NAK

STN	= slave station number
DST	= destination station number
SRC	= source station number
CMD	= command byte
TNS	= transaction number (16 bit)
ADDR	= data address (16 bit)
data	= data bytes
SIZE	= read block length in bytes

In the response message the CMD byte is the same as the CMD byte of the command message + 40H.

NOTE!
The value of the data "10H" (= DLE) in data transmission is "10H 10H", to make it distinct from the control code DLE.

Operation principle

The communication is based on the command/response principle. The communication between the SPOC unit and the master is illustrated in fig. 11.

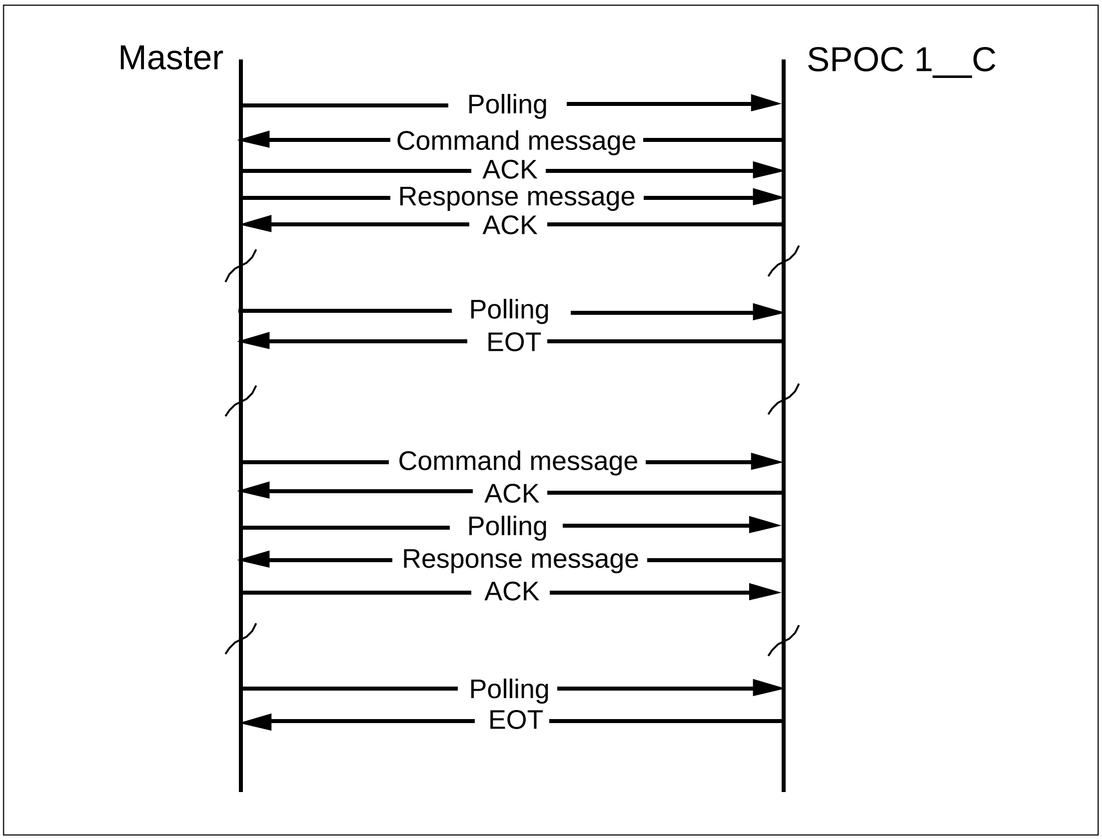


Fig. 11. Communication between a master and the C & M unit when using a halfduplex protocol.

Processing of the C & M data in the master unit

The on/off input data (DI) and the analog measured values (AI) of the control and measuring unit are used for updating the data presented by the host unit. All these updated data should be stored in the data base of the host unit as well. The data transmitted by the control and measuring unit are used for updating the data base and the display of the host unit. To secure the data congruity between the host unit and the data bases of C & M unit, the host unit sometimes has to make an extra interrogation in addition to the normal polling. This updating procedure is also required when restarting the host unit.

The events provided with time tagging are written out with the event printer. For this reason the host unit must be provided for a SPACOM event processing procedure which gives, for the output purpose, the event codes arriving from the C & M unit a suitable text.

The control data (DO) are transmitted from the control displays of the host unit.

The parameter data are processed in display routines and command procedures which must be capable of processing SPACOM messages based on ASCII codes.

Data transfer

Address map

The data transfer of the host unit is based on an address map. The map specifies the address area, through which the host unit is able to present different types of data included in the data base of the control and measuring unit.

The address map of the C & M unit specifies the following address areas:

Data type	Initial address (word address) dec.	oct.	Length (word)	Mode of presentation
DI/DO data:				
DI data	01	01	1	16 bits binary
DO data				
- double output 1	501	765	1	16 bits binary
- double output 2	502	766	1	16 bits binary
AI data:				
5 A inst. value	1001	1751	1	16 bits binary
mA-1 inst. value	1002	1752	1	16 bits binary
mA-2 inst. value	1003	1753	1	16 bits binary
5 A average value	1011	1763	1	16 bits binary
mA-1 average value	1012	1764	1	16 bits binary
mA-2 average value	1013	1765	1	16 bits binary
Pulse counters (13, 14, 15, 16)	1021	1775	4	16 bits binary
Special messages:				
Parameter data buffer	2000	3720	167	ASCII (SPACOM message)
Time	2300	4374	9	BCD (3-digit)
Event data	2400	4540	4	32 data bits + timetag

DI and DO word bits

The 0 bit of the DI word (digital input) represents the status of on/off input 1 and bit 15 the status of on/off input 15.

The figure below presents the bits of the DO word (digital output).

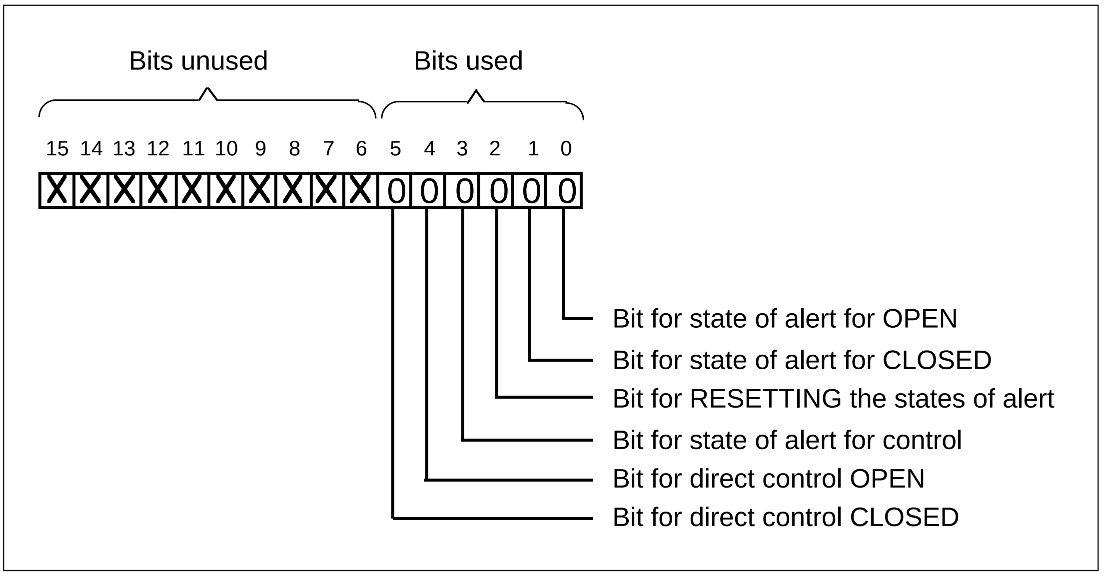


Fig. 12. Bit explanation of control word.

By setting a one (1) in the place of a bit, the concerned operation will be activated. One command can be used for setting one bit only. The digital outputs can be read too. Then the bits 2...15 are always zeros (0) and the bits 0 and 1 show the states of alert for control.

Data reading

The host unit can read the Dl, DO and Al data from the address areas.

The data are read by using the read command:
DST SRC CMD STS TNS ADDR SIZE
(CMD = 01H)

The response message is presented in the format:
DST SRC CMD STS TNS data
(max. 244 bytes)
(CMD = 41 H)

Data writing

The host unit is able to set bits in the address area of a DO. Only one bit at a time can be set by means of one command.

A data bit is written by using the write command:
DST SRC CMD STS TNS ADDR
Setmask Resetmask
(CMD = 05H or 02H)

The response message is presented in the format:
DST SRC CMD STS TNS
(CMD = 45H or 42H)

The 8-bit setmask is used for setting one bit of a DO word. The 8-bit resetmask is used for resetting one bit of a DO word. Bits of a DO word cannot be set and reset by the same command.

Transfer of changed DI and AI data

The new states of changed DI inputs (V130) or the changed analog input values are transferred from the control and measuring unit to the host unit. Analog data is transferred if the difference between the new value and the old one is greater than or equal to the specified delta value (S17...S19).

It is also possible to block the transmission of changed values completely, see parameters V130 and S17…S19.

The DI word bits are transmitted to the host unit by using the write command:
DST SRC CMD STS TNS ADDR Setmask Resetmask ADDR+1 Setmask Resetmask
(CMD = 05 H)

The response message is presented in the format:
DST SRC CMD STS TNS
(CMD = 45H)

An analog value is transmitted by using the write command:
DST SRC CMD STS TNS ADDR data
(CMD = 08H)

The response message is presented in the format:
DST SRC CMD STS TNS
(CMD = 48H)

If the data transfer to the host unit does not proceed properly, some changed data may disappear. The C & M unit always transmits the last data.

NOTE!
To secure the congruity between the data bases of the host unit and the C & M unit, the master unit should read the data from the data base of the C & M unit always when the host unit is started up and also regularly during normal service.

Event data transfer

All events are transmitted from the buffer to the host unit if the event enable parameter is set to zero (0), V131 channel 0. One message contains one event. The transmissions of the events are made by using the address 2400 dec. of the address map.

The principles for creation of events have been described in the section "Event codes".

If the data transfer to the host unit proves unsuccessful, transmissions are repeated until a successful transmission is secured.

The event data are sent to the master unit by using the write command:
DST SRC CMD STS TNS ADDR data
(4 words) (CMD = 08H)

The response message is presented in the following format:
DST SRC CMD STS TNS (CMD = 48H)

The event data are presented in the following format:

Event data identifier	Time tag
32 bits	2 x 16 bits

The format of the event data identifier is:

Byte 3	Byte 2	Byte 1	Byte 0
00000000	0UUUUUUU	UUUccccc	ccEEEEEE
	ANSI device addr. (10 bits)	Channel (7 bits)	Event No. (6 bits)

The binary format of the time tag is:

Byte 7	Byte 6	Byte 5	Byte 4
msb	lsb	minutes	seconds
milliseconds			

In a message to be transmitted the first byte to be transmitted is 0 and the last one is byte 7.

NOTE !
By using the arithmetic operation below the different parts of the 32-bit integer of the event data identifier can be separated:

- ANSI device address = identifier/8192
- channel = (identifier/64) mod 128
- event number = identifier mod 64 (mod = modulo = remainder)

Transfer of parameters

The host machine communicates with the control and measuring unit over the "parameter data buffer" using the SPACOM presentation format. The design of the buffer is shown in the figure below.

Initial address of buffer ADR = 2000	Message to the SPACOM unit	80 bytes
Initial address of buffer + 40 words ADR = 2040	Response message from the SPACOM unit	255 bytes

Fig. 13. Parameter data buffer.

Initially the master unit writes the SPACOM message at the beginning of the buffer to the address 2000 and then it reads the SPACOM response message from the buffer address 2040.

The host machine can write SPACOM messages to the parameter buffer using the write command:
DST SRC CMD STS TNS ADDR <SPACOM message> (CMD = 08H or 00H)

The response message is presented in the format:
DST SRC CMD STS TNS
(CMD = 48H or 40H)

The host machine can read the SPACOM response messages using the read command:
DST SRC CMD STS TNS ADDR SIZE
(CMD = 01 H)

The response message is presented in the format:
DST SRC CMD STS TNS
<SPACOM message> (CMD = 41 H)

Time transfer

The host machine can set the address map of the real time clock of the control and measuring unit through the address area "Time".

The time is set by using the write command:
DST SRC CMD STS TNS ADDR data
(9 words) (CMD = 08H or 00H)

The response message is presented in the format:
DST SRC CMD STS TNS
(CMD = 48H or 40H)

Time is presented in the following format:
word 0 = status (always 0)
word 1 = week day (1…7)
word 2 = year (0…99)
word 3 = month (1…12)
word 4 = day (1…31)
word 5 = hour (0…23)
word 6 = minute (0…59)
word 7 = second (0…59)
word 8 = millisecond (always 0)

Every word is a 3-character BCD number which is presented as follows:

0s00xxxx xxxxxxxx
3 characters
(sign)
(always 0)

The time address in the address map is 2300 dec.

NOTE!
The time setting (9 words) has to be transmitted in one group in the write command. Each time setting may cause some irregularity in the time tagging of the events. A time setting cycle of 24 hours is recommended.

Parameters referring to SPACOM messages

The parameters presented in the section "Remote transfer data" can be used in a SPACOM message. Apart from these ANSI control and measuring unit has some other parameters which are presented in the following table.

Data	Channel	Code	Data direct .	Values	Default configurat. 1	2	3
Delat value of 5 A current measurement	0	S17	RW(e)	1…1023 0 = no updating	10	10	10
Delta value of mA input 1	0	S18	RW(e)	(see S17)	10	10	10
Delta value of mA input 2	0	S19	RW (e)	(see S17)	10	10	10
Updating mask of digital inputs	0	V130	RW(e)	0000…FFFF 1 = no updating 0 = updating MSB = channel 16 LSB = channel 1	8000	8FC0	8C00
Events enable	0	V131	RW(e)	0 = l =	0	0	0
Address of master unit	0	V132	RW(e)	0…255	193	193	193
Real time clock	0	S100	RW	YY-MM-DD HH.MM;SS,SSS YY = Year MM = Month DD = Day HH = Hour MM = Minute SS = Second SSS = Millisecond			

Programming switches for ANSI communication

When using the ANSI protocol, the programming switch S1/3 has to be in the position ON, i.e. S1/3 = 1.

When S1/3 is in the ON position, the configuration switch S1/1 has the following function:

OFF: The data communication address (STN) and rate are received from the SPACOM variables V200 and V201.

ON: The STN address is 17 (11H) and the data transfer rate is 1200 baud.

The switches S1/4…S1/8 have to be in the OFF (0) position.

Default configuration 1

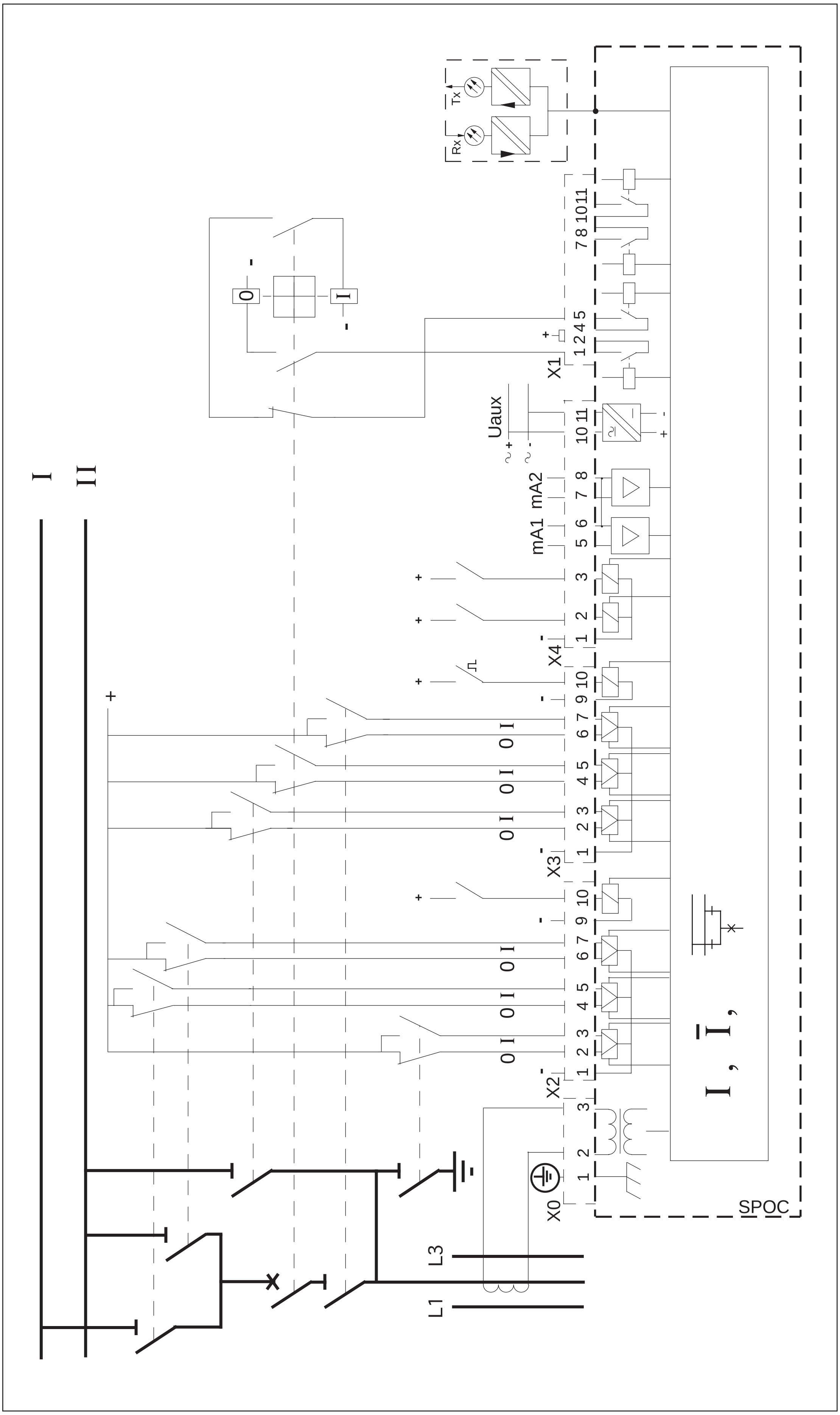


Fig. 14. Default configuration 1.

The default configuration 1 is mainly intended for use in double-busbar systems with feeder cubicles provided with by-pass disconnectors. Default configuration 1 is also adapted for other cubicles including the same amount of or less disconnectors than illustrated in fig. 14.

During testing at the factory the Default configuration 1 has been programmed into the EEPROM of the control and measuring unit. If the configuration has been altered or if an other configuration later is to be changed back to Default configuration 1, the Default configuration 1 is reprogrammed into the EEPROM by giving variable V3 the value 1 and storing the configuration into the EEPROM by giving variable V151 the value 1.

In the Default configuration 1 the inputs 1 and 2, 3 and 4, 5 and 6, 7 and 8, 9 and 10, and 11 and 12 have been programmed to operate as four-pole inputs. The on/off inputs 13, 14 and 15 have been programmed to operate as single relay inputs and input 16 as a pulse counter input. The contact outputs have been programmed to form two double relay outputs, of which outputs 1 and 2 are used for controlling the circuit-breaker.

When using the Default configuration 1, the status data of the earthing disconnector have to be connected to the on/off inputs 1 and 2 (X2/1-2 and X2/1-3) and the status data of the circuit-breaker to inputs 9 and 10 (X3/1-4 and X3/1-5). The status data of the disconnectors can be connected to the other four-pole inputs.

For the event of the status changing into unspecified, a suitable event delay has been applied to each four-pole input. In such a case, for instance when controlling the earthing disconnector, there will be no unwanted event reporting of an unspecified position.

No blockings have been programmed.

Single relay inputs can be used for instance for forwarding contact alarm signals from the protection relays to the remote control system.

The following table shows the selected default values of the Default configuration 1.

Information	Channel	Code	Value	Function
Calculation times for average values of analog inputs	0	S9…511	15	Calculation of 15 min average value
Updating time of analog inputs	0	525…527	15	Average value buffer updated every 15 min
Function of outputs 1…4	0	V10, V20	0	Double outputs 1 +2, and 3+4
Length of control pulses	0	V15, V16 V25, V26	1.0	Control pulses 1s
Blocking of the control of outputs 2 and 4	0	V17, V27	0	No blockings
Mask of D/A-converter 1	0	V101	FFFF	Incl. all inputs
Mask of D/A-converter 2	0	V102	03FF	Incl. inputs 1…10
Mask of D/A-converter 3	0	V103	00FF	Incl. inputs 1…8
Mask of D/A-converter 4	0	V104	003F	Incl. inputs 1…6
Configuration identification	0	V206		"ROM 1 CONF"
Specification of inputs	1, 3, 5, 7, 9, 11	S1	1	Four-pole inputs
Specification of inputs	13. . .15	S1	0	Single inputs
Specification of input	16	S1	2	Pulse counter

Information	Channel	Code	Value	Function
Event reporting	1, 3, 5, 7, 9, 11, 13, 14, 15	S2	0	Reporting permitted
Pulse counter triggering	16	S3	0	Rising edge
Filtering delay of pulse counter	16	S4	20	Delay 20 ms
Dead time of the HSAR cycle	1, 3, 5, 7, 9, 11, 13, 15	S5	0.3	Delay 0.3 s
Starting delay preceding the DAR cycle	1, 3, 5, 7, 9, 11, 13, 15	S6	0.5	Delay 0.5 s
Dead time of the DAR cycle	1, 3, 5, 7, 9, 11, 13, 15	S7	125	Delay 125 s
Tripping delay	1, 3, 5, 7, 9, 11, 13, 15	S8	0.5	Delay 0.5 s
Event delay (open)	1, 3, 5, 7, 9, 11, 13, 14, 15	Vl	0	No delay
Event delay (closed)	1, 3, 5, 7, 9, 11, 13, 14,	V2	0	No delay
Event delay (unspecified)	1	V3, V4	10.0	Delay 10 s
Event delay (unspecified)	3, 5, 7, 11	V3, V4	2.0	Delay 2 s
Event delay (unspecified)	9	V3, V4	0.2	Delay 0.2 s
HSAR counter	1, 3, 5, 7, 9, 11, 13, 15	V6	0	Counter reset
DAR counter	1, 3, 5, 7, 9, 11, 13, 15	V7	0	Counter reset

Enclosure 3

Default configuration 2

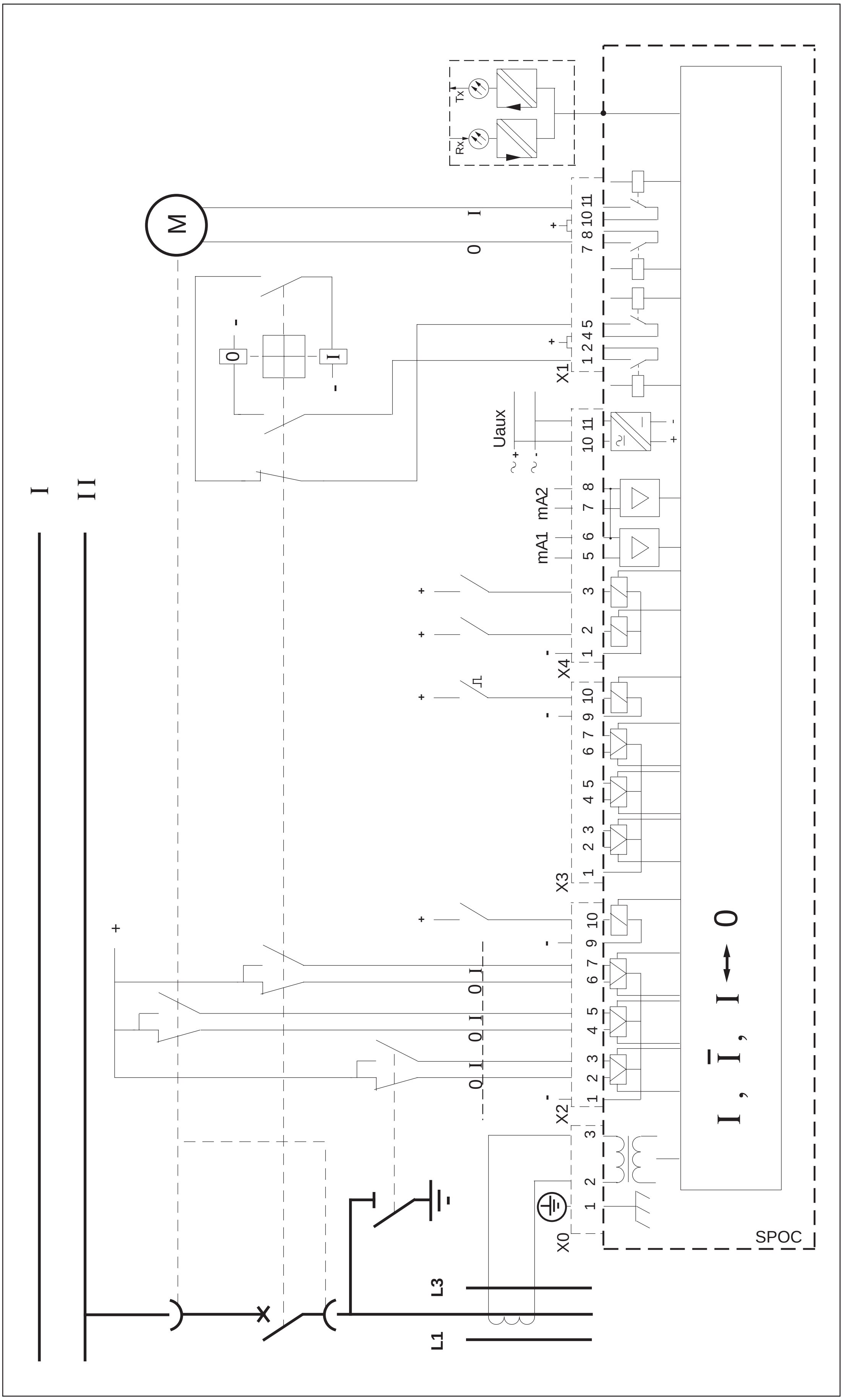


Fig. 15. Default configuration 2.

The default configuration is intended mainly for use in single busbar systems with feeder cubicles provided with a motor controlled truck. The configuration can also be used for feeders in single-busbar systems where only the circuit-breaker is controlled by the remote control system.

The Default configuration 2 is activated by, initially, giving variable V3 the value of 2 and then storing the configuration into the EEPROM by giving variable V151 the value of 1.

In the Default configuration 2 the inputs 1 and 2, 3 and 4, and 5 and 6 have been programmed to operate as four-pole inputs. The on/off inputs 13, 14 and 15 have been programmed to operate as single relay inputs and input 16 as a pulse counter input. The on/off inputs 7...12 have been set out of use.

The relay outputs have been programmed to operate as two double relay outputs, of which the relays 1 and 2 are used for controlling the circuit-breaker and relays 3 and 4 for controlling the motor moving the truck.

When using the Default configuration 2, the status data of the earthing disconnector should be connected to the on/off inputs 1 and 2 (X2/1-2 and X2/1-3), the status data of the truck to inputs 3 and 4 (X2/1-4 and X2/1-5) and the circuit-breaker status data to inputs 5 and 6 (X2/1-6 and X2/1-7).

For the event of the status data changing into unspecified, a suitable event delay for the circuit-breaker, disconnector or the earthing disconnector has been applied to each four-pole input. In such a case, for instance when controlling the earthing disconnector, there will be no unwanted event reporting of an unspecified status.

No control blockings have been programmed.

Single relay inputs can be used e.g. for forwarding of the contact alarm signals from the protection relays to the remote control system.

The following table shows the selected default values of the Default configuration 2.

Information	Channel	Code	Value	Function
Calculation times for average values of analog inputs	0	S9…S11	15	Calculation of 15 min average value
Updating time of analog inputs	0	S25…S27	15	Average value buffer updated every 15 min
Function of outputs 1…4	0	V10, V20	0	Double outputs 1+2, and 3+4
Length of control pulses	0	V15, V16 V25, V26	1.0	Control pulses 1.0 s
Blocking of con trol of outputs 2 and 4	0	V17, V27	0	No blockings
Mask of D/A-converter 1	0	V101	FFFF	Incl. all inputs
Mask of D/A-converter 2	0	V102	03FF	Incl. inputs 1…10
Mask of D/A-converter 3	0	V103	00FF	Incl. inputs 1…8
Mask of D/A-converter 4	0	V104	003F	Incl. inputs 1…6
Configuration identification	0	V206		"ROM 2 CONF"
Specification of outputs	1, 3, 5	S1	1	Four-pole inputs
Specification of inputs	7…12	S1	3	Not in use
Specification of inputs	13…15	S1	0	Single inputs
Specification of input	16	S1	2	Pulse counter

Information	Channel	Code	Value	Function
Event reporting	1, 3, 5 and 13…15	S2	0	Reporting permitted
Event reporting	7…12	S2	1	Reporting blocked
Pulse counter triggering	16	S3	0	Rising edge
Filtering delay of pulse counter	16	S4	20	Delay 20 ms
Dead time of the HSAR cycle	1, 3, 5, 7, 9, 11, 13, 15	S5	0.3	Delay 0.3 s
Starting delay preceding the DAR cycle	1, 3, 5, 7, 9, 11, 13, 15	S6	0.5	Delay 0.5 s
Dead time of the DAR cycle	1, 3, 5, 7, 9, 11, 13, 15	S7	125	Delay 125 s
Tripping delay	1, 3, 5, 7, 9, 11, 13, 15	S8	0.5	Delay 0.5 s
Event delay (open)	1, 3, 5 and 13…15	V1	0	No delay
Event delay (closed)	1, 3, 5 and 13…15	V2	0	No delay
Event delay (unspecified)	1	V3, V4	10.0	Delay 10.0 s
Event delay (unspecified)	3	V3, V4	2.0	Delay 2.0 s
Event delay (unspecified)	5	V3, V4	0.2	0.2 s
HSAR counter	1, 3, 5, 7, 9, 11, 13, 15	V6	0	Counter reset
DAR counter	1, 3, 5, 7, 9, 11, 13, 15	V7	0	Counter reset

Enclosure 4

Default configuration 3

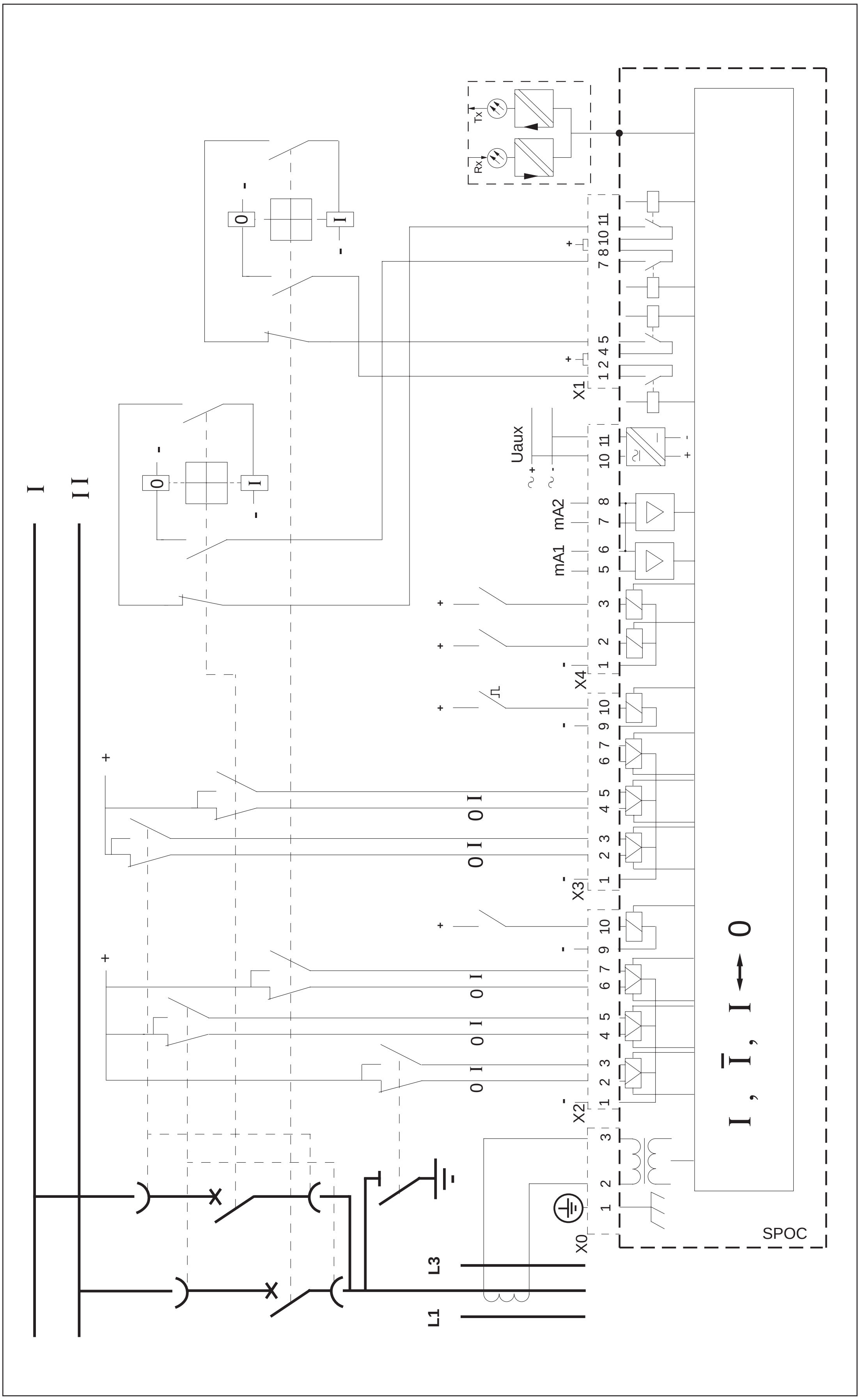


Fig. 16. Default configuration 3.

The Default configuration 3 is intended to be used mainly for duplex feeders equipped with truck circuit-breakers. The default configuration is also adapted to be used for e.g. simplex feeders when only one circuit-breaker and truck is connected to the control and measuring module.

The Default configuration 3 is activated by, initially, giving variable V3 the value of 3 and then storing the configuration into EEPROM by giving variable V151 the value of 1.

In the Default configuration 3 the inputs 1 and 2, 3 and 4, 5 and 6, 7 and 8, and 9 and 10 have been programmed to operate as four-pole inputs. The on/off inputs 13, 14 and 15 have been programmed to operate as single relay inputs and input 16 as a pulse counter input. The on/off inputs 11 and 12 have been set out of use.

The relay outputs have been programmed to operate as two double relay outputs used for controlling the circuit-breakers.

When using the Default configuration 3, the status data of the earthing disconnector should be connected to the on/off inputs 1 and 2 (X2/1-2 and X2/1-3), the status data of the trucks to inputs 3 and 4 (X2/1-4 and X2/1-5), 7 and 8 (X3/1-2 and X3/1-3). The circuit-breaker status data are connected to inputs 5 and 6 (X2/1-6 and X2/1-7) and 9 and 10 (X3/1-4 and X3/1-5).

For the event of the status data changing into unspecified, a suitable event delay for the circuit-breaker, disconnector or the earthing disconnector has been applied to each four-pole input. In such a case, for instance when controlling the earthing disconnector, there will be no unwanted event reporting of an unspecified status.

No control blockings have been programmed.

Single relay inputs can be used e.g. for forwarding contact alarm signals from the protection relays to the remote control system.

The following table shows the selected default values of the Default configuration 3.

Information	Channel	Code	Value	Function
Calculation times for average values of analog inputs	0	S9…S11	0	Calculation of 15 min average value
Updating time of analog inputs	0	S25…S27	15	Average value buffer updated every 15 min
Function of outputs 1…4	0	V10, V20	0	Double outputs 1 +2, and 3+4
Length of control pulses	0	V15, V16 V25, V26	1.0	Control pulses 1 s
Blocking of the control of outputs 2 and 4	0	V17, V27	0	No blockings
Mask of D/A-converter 1	0	V101	FFFF	Incl. all inputs
Mask of D/A-converter 2	0	V102	03FF	Incl. inputs 1…10
Mask of D/A-converter 3	0	V103	00FF	Incl. inputs 1…8
Mask of D/A-converter 4	0	V104	003F	Incl. inputs 1…6
Configuration identification	0	V206		"ROM 3 CONF"
Specification of inputs	1, 3, 5, 7, 9	S1	1	Four-pole inputs
Specification of inputs	11, 12	S1	3	Not in use
Specification of inputs	13…15	S1	0	Single inputs
Specification of input	16	S1	2	Pulse counter

Information	Channel	Code	Value	Function
Event reporting	1, 3, 5, 7, 9, 13…15	S2	0	Reporting permitted
Event reporting	11, 12	S2	1	Reporting blocked
Pulse counter triggering	16	S3	0	Rising edge
Filtering delay of pulse counter	16	S4	20	Delay 20 ms
Dead time of the HSAR cycle	1, 3, 5, 7, 9, 11, 13, 15	S5	0.3	Delay 0.3 s
Starting delay preceding the DAR cycle	1, 3, 5, 7, 9, 11, 13, 15	S6	0.5	Delay 0.5 s
Dead time of the DAR cycle	1, 3, 5, 7, 9, 11, 13, 15	S7	125	Delay 125 s
Tripping delay	1, 3, 5, 7, 9, 11, 13, 15	S8	0.5	Delay 0.5 s
Event delay (open)	1, 3, 5, 7, 9, 13…15	V1	0	No delay
Event delay (closed)	1, 3, 5, 7, 9, 13…15	V2	0	No delay
Event delay (unspecified)	1	V3, V4	10.0	Delay 10 s
Event delay (unspecified)	3, 7	V3, V4	2.0	Delay 2 s
Event delay (unspecified)	5, 9	V3, V4	0.2	Delay 0.2 s
HSAR counter	1, 3, 5, 7, 9, 11, 13, 15	V6	0	Counter reset
DAR counter	1, 3, 5, 7, 9, 11, 13, 15	V7	0	Counter reset

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