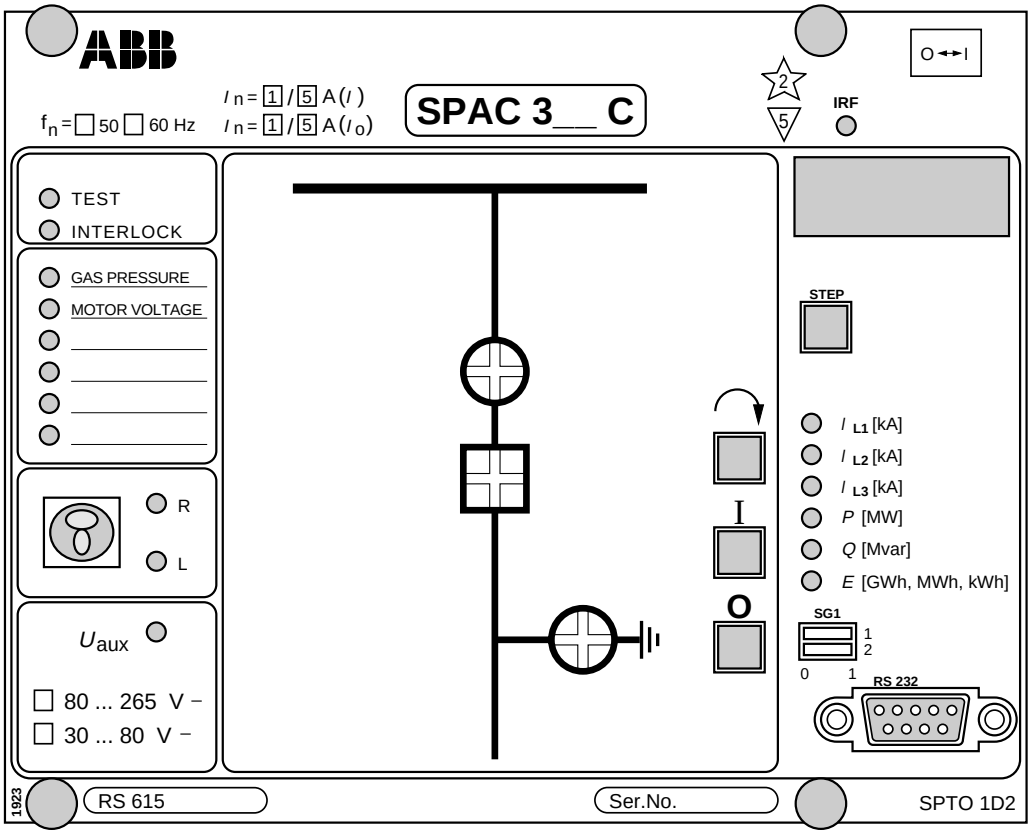
SPTO 1D2
Control module

User´s manual and Technical description



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SPTO 1D2
Control module

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Description of functions

Control functions

The control module type SPTO 1D2 reads binary input signals and indicates the status of these signals locally and remotely. The control module also performs OPEN and CLOSE commands.

The input channels 1…3 are used for reading status information of circuit breakers and disconnectors (objects). Each of these channels includes two physical inputs, one for object open and one for object closed information.The module indicates the status information locally on the front panel by means of LED indicators and transfers the information to station level equipment via the SPA bus.

The control module is able to read the status information of maximum 3 objects. The front panel has a matrix of status indication LEDs. The configuration indicated by these LEDs is freely programmable by the user.

Input channels 4…13 consist of one physical binary input. These channels are used mainly to transfer binary signals other than circuit breaker and disconnector status information over the SPA bus to the remote control system. There is a local LED indication for the input channels 4…9 on the front panel.

The control module is able to give OPEN and CLOSE commands for one object. The commands may be given by means of the local push-buttons, via the SPA bus or the input channels 4…13. The output is a pulse with programmable pulse lenght.

An enable signal must be given by an interlocking program before the OPEN or CLOSE output pulse can be activated. The enable signal is given on the basis of the status of input channels 1…3 and 4…13 and the programmed logic.

The signalling outputs, SIGNAL 1…3, can be used to indicate the status of input channels 4…13. The selected output is active as long as the input channel is active.

The outputs OPEN, CLOSE or SIGNAL1…3 can be controlled by the conditional direct output control program. The program is similar to that of interlocking. The user can define when an output is to be activated. This is depending on the status of inputs 1…3 and 4…13 and the programmed logic. The output is active as long as the program gives the output signal.

Measurement functions

The control module SPTO 1D2 is able to measure three phase currents and two mA signals. The mA inputs are used for measuring active and reactive power. External measuring transducers are needed.

Input channel 7 can be used as a pulse counter for energy pulses. Energy can also be calculated on the basis of the measured power.

The measured signals can be scaled and they are indicated locally and over the SPA bus as actual values.

Block diagram

Simplified block diagram of the control module SPTO 1D2 is shown in Fig. 1.

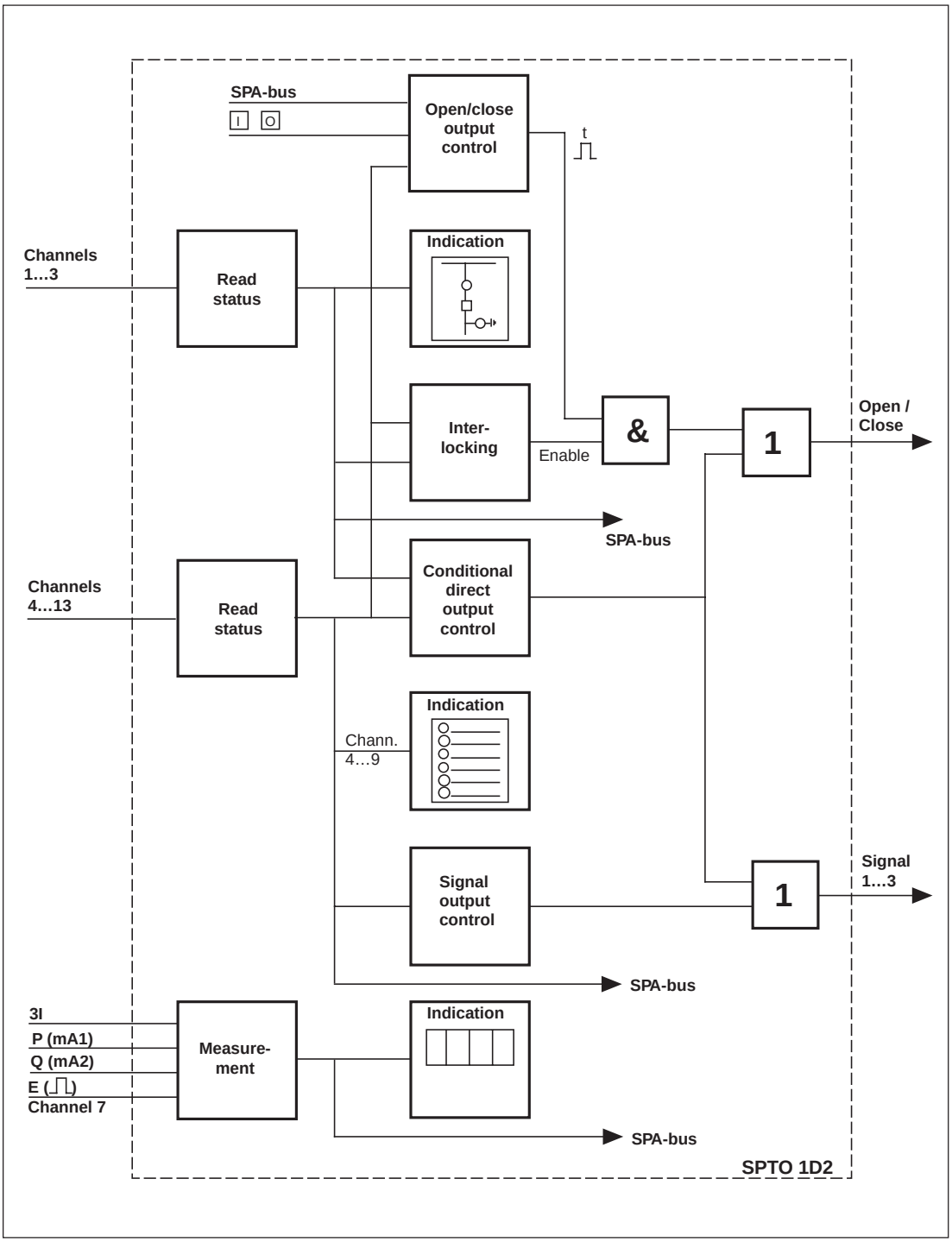

Fig. 1. Block diagram of the control module SPTO 1D2.

Front panel

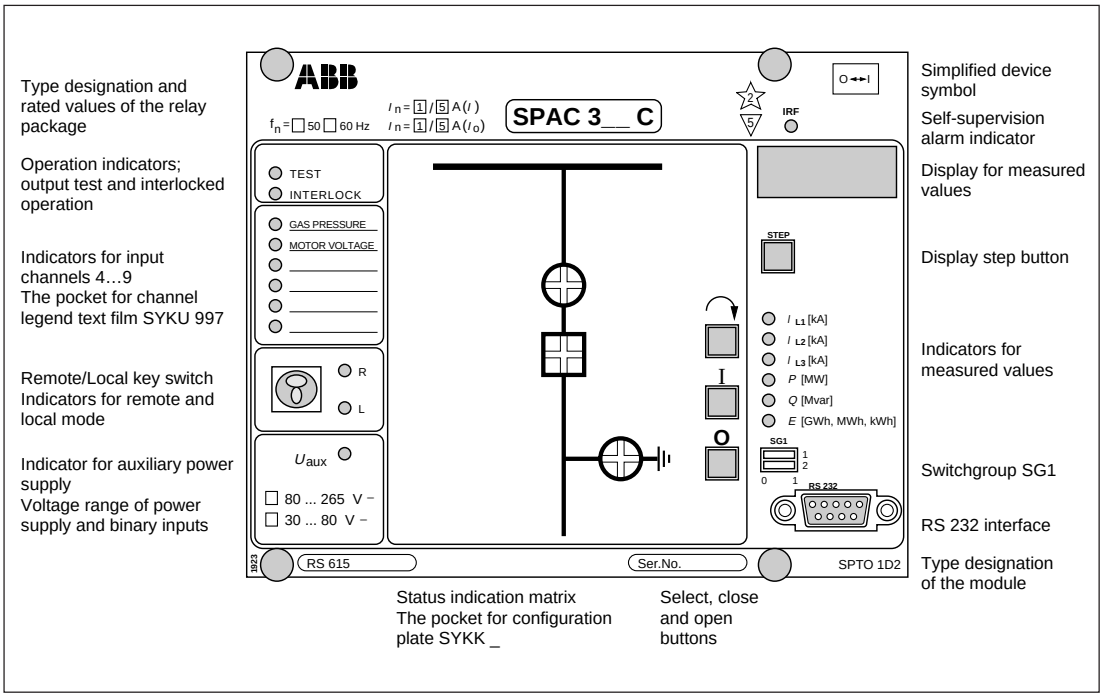

Fig. 2. Front panel of the control module SPTO 1D2 without the configuration plate SYKK __ and the channel legend text foil SYKU 997.

Object status indicators

The front panel has 16 LED indicators for local status indication. The indicators are arranged as a 4 x 4 matrix. Three of these indicators can be used simultaneously in the control module SPTO 1D2. The combination of indicators used is freely programmable by the user, see chapter "Configuration".

In front of the indicators there is a pocket for a separate plastic configuration plate type SYKK_. The bottom of the pocket is open. By changing the configuration plate and programming a new indicator combination different kinds of bays can be described.

The circuit breakers and disconnectors of the bay are shown on the configuration plate. The configuration plate has a transparent window in front of the indicators that are in use. The unused indicators are hidden.

One object indicator is composed of four LEDs, two vertical and two horizontal. Two of the LEDs are red and two are green. The red LEDs are vertical and the green LEDs horizontal in columns 1 and 3, see Fig. 6. In the columns 2 and 4 the green LEDs are vertical and the red LEDs horizontal. Due to this system both colours can be used to indicate either open or closed status.

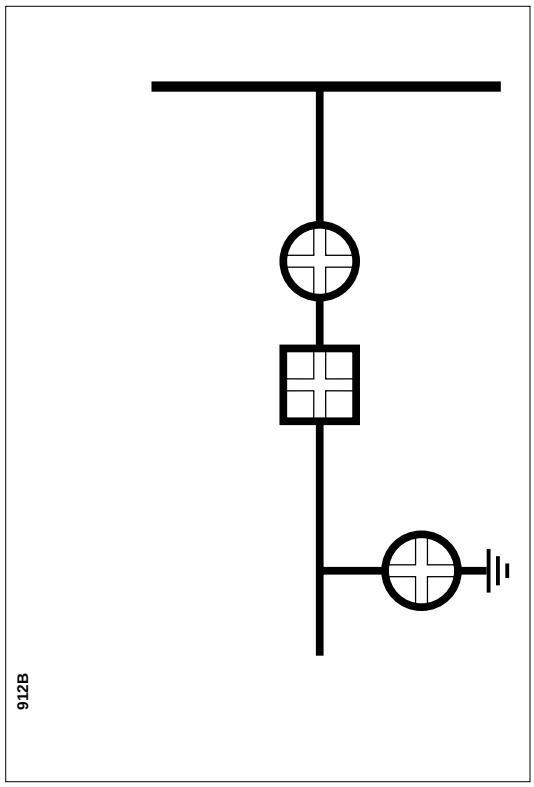

Fig. 3. Example of plastic configuration plate SYKK _. The size of the plate is 72 x 106.5 mm.

Indicators for input channels 4…9

The status of the input channels 4...9 is indicated locally on the front panel. Channel 4 refers to the upmost red indicator and channel 9 to the lowest one.

An input can be defined to be active at high state (NO contact) or active at low state (NC contact). The LED is lit when the input is active.

The indication of the active status of the input channels 4…9 can separately be programmed to be memory controlled. If an input channel indicator is memory controlled the LED indicator remains lit until the channel is locally reset by pressing the push-buttons STEP and SELECT simultaneously or by remote control via the serial interface using the parameter S5, which is given the value 0 or 1.

The front panel has a pocket for a text legend foil, SYKU 997, on which the user can write the desired input legend text. The left side of the pocket is open. An empty text legend foil is delivered with the relay package.

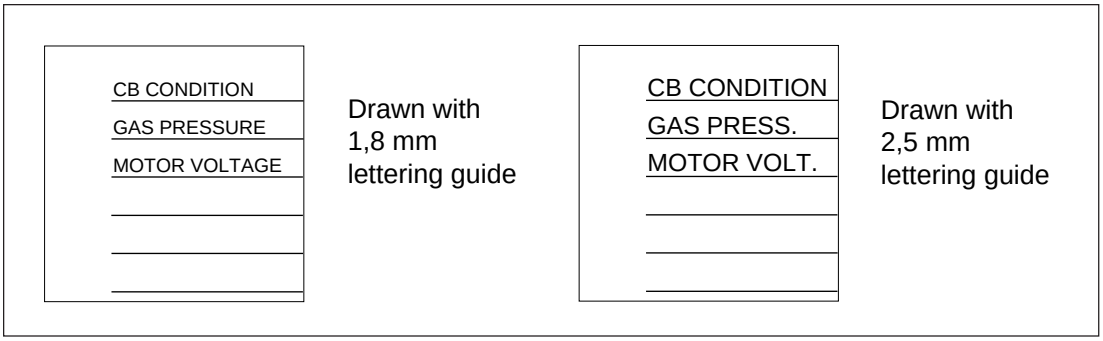

Fig. 4. Example of text legend foil SYKU 997. The foil is shown in actual size, width 33.5 mm and height 34 mm.

Operation indicators

The control module includes two red operation indicators showing the status of the module itself. These LEDs are normally dark. The indicators have the following function:

Indicator	Function
TEST	Is lit when the switch SG1/1=1. Then the interlockings are out of use
INTERLOCK	Is lit when a local control command is given and the operation of an object is inhibited by the interlocking program. This LED can be switched off by pressing the SELECT push-button or it is automatically switched off after a timeout of about 30 seconds When the control module is in the programming mode and the interlockings are in use the indicator lights and it is switched off when the operation mode is entered or when the interlockings are set out of use.

The green indicator U_{aux} indicates that an external power supply voltage is connected and the power supply module of the unit is operating. The input voltage range of the digital inputs and the power supply module is marked below the U_{aux} indicator.

REMOTE/LOCAL key switch

To be able to use the local OPEN and CLOSE push-buttons, the key switch must be in the position LOCAL, indicated by the yellow LED L. All remote controls via the serial communication are inhibited, but control operations via input channels 4…13 or control operations by the conditional direct output control function are allowed.

Accordingly, to be able to control an object via the serial communication, the key switch must be in the REMOTE position indicated by the yellow LED R. When the key switch is in the REMOTE position, local push-button controls are inhibited.

The key can be removed both in local and in remote position.

∩ , I and O push-buttons

The local control sequence is started by pressing the push-button ∩ (SELECT). After that the LED indicator of the object which has been defined controllable starts flashing.

If the object is closed the indicator for closed position starts flashing and if the object is open the indicator for open position starts flashing. The indicator remains flashing until a control command is given or a timeout of 10 s has elapsed.

The closing or opening command is given by using the I (close) or O (open) push-button. Depending on the status of inputs 1…3 and 4…13 and the interlocking program logic the control module executes the selected command or turns on the INTERLOCK-LED indicating that the operation is interlocked.

The lenght of the the control output pulse can be programmed within the range 0.1…100 s.

Switchgroup SG1

Switch	Function
SG1/1	Switch SG1/1 is used to inhibit interlocking during testing When SG1/1=0, the interlockings are in use When SG1/1=1, the interlockings are not in use and the red TEST- LED is lit. All control operations are allowed. NOTE! This switch position should be used for testing purposes only!
SG1/2	Switch SG1/2 is not in use and should be in position 0.

Display of measured values and serial communication parameters

The displayed items can be stepped through by pressing the STEP push-button. The measured values are indicated by the three green digits at the extreme right. A yellow LED indicator below the STEP push-button shows, when lit, which measured value is indicated on the display.

Indicator	Data to be displayed
I_{L1} [kA]	The measured phase current I_{L1} in actual kiloamperes. The range is 0.000…999 kA, 0.000 is indicated as .000
I_{L2} [kA]	The measured phase current I_{L2} in actual kiloamperes. The range is 0.000…999 kA, 0.000 is indicated as .000
I_{L3} [kA]	The measured phase current I_{L3} in actual kiloamperes. The range is 0.000…999 kA, 0.000 is indicated as .000
P [MW]	The measured active power in megawatts. Both positive and negative values are indicated. The positive values have no sign but the negative sign is indicated by the red digit
Q [MVar]	The measured reactive power in megavars. Both positive and negative values are indicated. The positive values have no sign but the negative sign is indicated by the red digit
E [GWh,MWh,kWh]	The measured active energy. The energy is displayed in three parts; in gigawatthours, in megawatthours and in kilowatthours

Also the serial communication parameters are indicated by the four-digit display. The address of the data to be displayed is indicated by the red digit at the extreme left of the display.

Red digit	Data to be displayed
A	Serial communication address. May have a value within the range 0…254. The default value is 99.
b	Serial communication baudrate. May have values 4.8 or 9.6 kBd. The default value is 9.6 kBd.
C	Serial communication monitor. If the device is connected to a data communicator and the communication system is operating the monitor reading is 0, otherwise the numbers 0…255 are rolling in the display

Continuous display of one measured value or automatic display switch-off after a 5 minutes timeout can be selected.

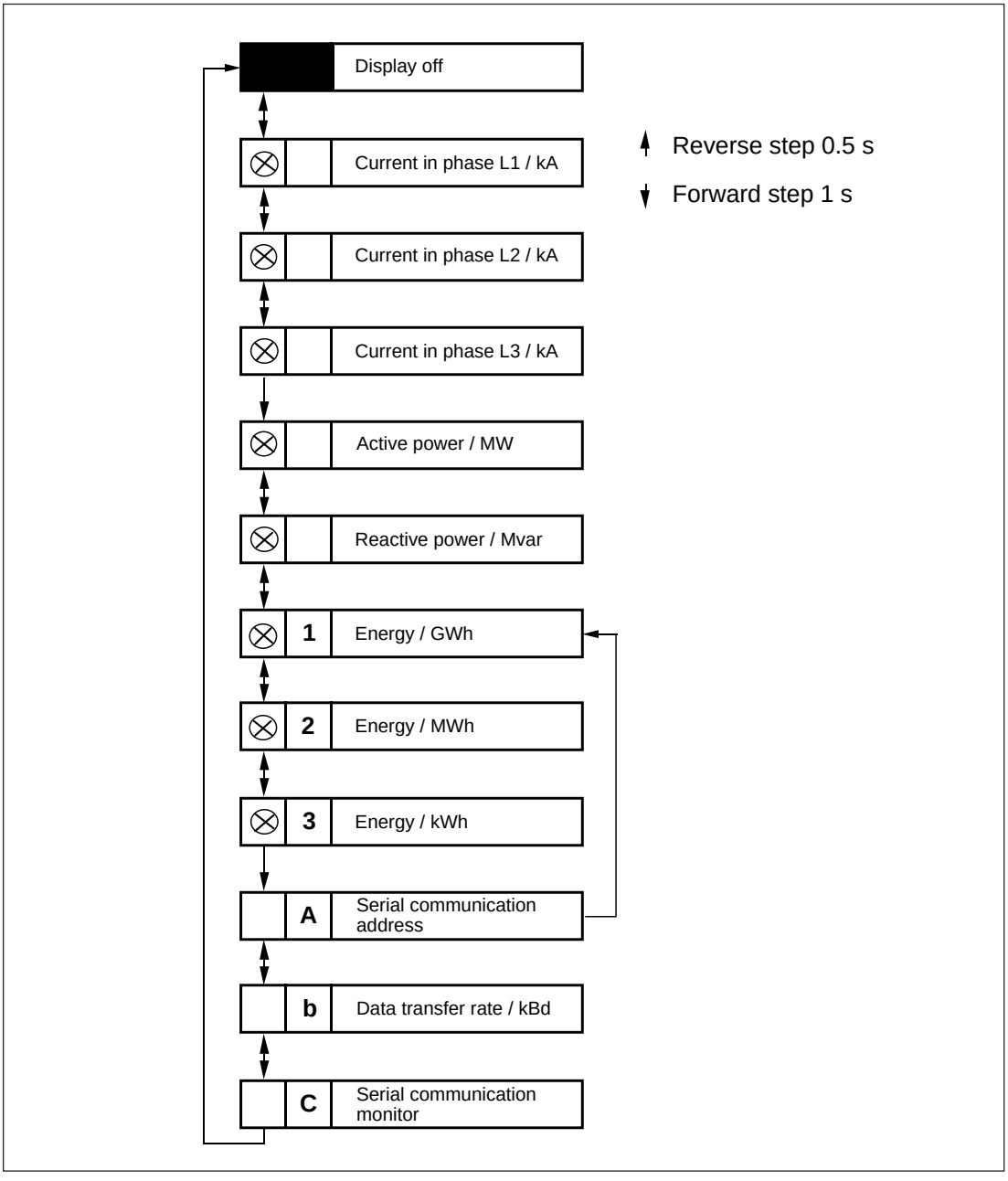

Fig. 5. Display menu of the control module SPTO 1D2.

RS 232 interface

The 9-pin RS 232 interface on the front panel is to be used for programming the control module from a terminal or a PC. The control module SPTO 1D2 supervises the serial communication of the feeder terminal. This enables protection modules of the same terminal to be set via the RS 232 interface.

If a terminal or a PC is connected to the RS 232 interface the SPA-bus interface on the rear panel of the feeder terminal is disconnected. When using the RS 232 interface, the SPA-bus protocol has to be used.

The following serial communication parameters should be used:

- Number of data bits, 7
- Number of stop bits, 1
- Parity, even
- Baudrate, 9.6 kilobauds as a default

The next table shows the signal names and pin numbers of the cable to be used between the RS 232 interface and a programming device.

RS 232 interface of SPTO 1D2		Programming device		
Signal name	Pin number 9-pin male conn.	Pin number 9-pin female conn.	Pin number 25-pin male conn.	Signal name
Data receive	2	3	2	Data transmit
Data transmit	3	2	3	Data receive
Ground	5	5	7	Ground
DSR	6	4	20	DTR

The control module SPTO 1D2 is able to indicate the status of maximum 3 objects (circuit breakers or disconnectors) and to control (open or close) one object.

The control module can be used for different circuit breaker / disconnector / earth-switch configurations within the above mentioned limits. The configuration can be defined freely by using configuration commands explained below or by choosing a suitable default configuration. Each default configuration uses a fixed interlocking scheme.

The default configurations and interlockings are explained in the appendixes 1…3. If the configuration or the interlocking is not suitable for a certain application then both must be programmed by the user.

After factory testing the default configuration and interlocking 1 has been selected for the control module. Another default configuration is chosen by writing the configuration number for variable S100 via the SPA bus.

Normally the control module is in the run mode which means that the interlocking program is executed. When programming a configuration or selecting a new default setting the control module must be in the program mode (S198=0).

Example 1: Selection of the default configuration and interlocking 2 instead of default 1.

```
>99WS198:0:XX
    ;Change into program mode
>99WS100:2:XX
    ;Select the default 2
>99WS198:1:XX
    ;Change into run mode
>99WV151:1:XX
    ;Store the programmed parameters
```

If variable S100 is 0, the configuration is freely programmable. In this case all indicators are initially set out of use. In a freely programmable configuration, only the objects to be used must be programmed.

The three input channels 1…3 can be used to read status data of circuit breakers and disconnectors. The input channel numbers are used when programming the feeder terminal configuration.

The front panel indicators are numbered from 101 to 116. These numbers are used when programming the feeder terminal configuration. The positions and the numbers of the indicators in the matrix are shown in Fig. 6.

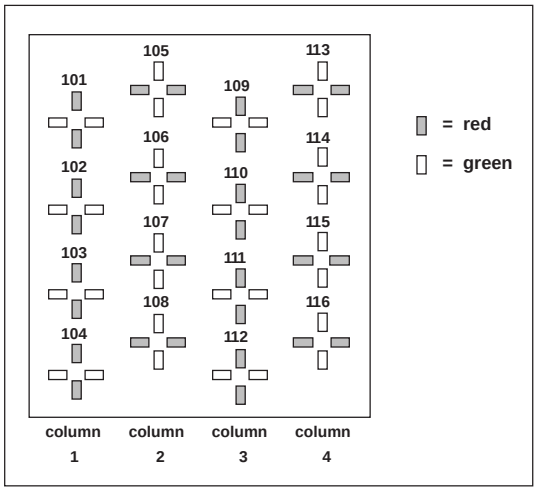

Fig. 6. Position, number and colour of the indicators on the front panel of SPTO 1D2.

The control module has two outputs, OPEN and CLOSE, for controlling one object. The control outputs have their own codes, 20 and 21, which have to be used when programming a configuration. The corresponding operation is given in the following table.

Output code	Operation
20	OPEN
21	CLOSE

For the correspondence between the input and output codes and the rear panel terminal numbers see chapter "Connection diagram" in the user´s manual of the feeder terminal.

When programming a configuration an indicator number, a four-pole input number and an output code are linked together using one SPA protocol command.

The setting parameters S101…S116 which refer to the indicator numbers 101…116 are reserved for the configuration commands. As an output number either the code of OPEN output or CLOSE output can be used. Also some other parameter, such as type of object and position of open and closed status indicators, are defined in the SPA protocol command.

Example 2: Indicator 109 (S109) indicates the status read via input channel 2. Output 20 is used for opening the object which means that output 21 must be used for closing the same object. The object is a circuit breaker and the closed status is indicated by vertical red LEDs.

The command has the formula:

>99 WS 109:1,1,2,20,1:XX

- Type of object
  0 = not circuit breaker
  1 = circuit breaker
- Output code
  0 = object is not controlled
  20 = code of OPEN output
  21 = code of CLOSE output
  Note! Either 20 or 21 can be used if the object is to be controlled.
- Input channel number
  Channels 1…3
- Defines the vertical/horizontal position of open/closed indication
  0 = vertical LEDs indicate open status (horizontal LEDs indicate closed status)
  1 = vertical LEDs indicate closed status (horizontal LEDs indicate open status)
- Defines the use of object indicator
  0 = not used
  1 = used
- Number of object indicator
- Write Setting
- Data communication address
  Default value is 99

Syntax rules for programming the configuration for SPTO 1D2:

1. The programming has to be done in the program mode.
2. Maximum three objects can be configured (three settings in the range of S101…S116).
3. Only input channel numbers 1…3 are accepted. Each number can be used only once.
4. If an object indicator is not used, no other values need to be given.
5. Output code 20 or 21 can be given only once. If the output code is 0, the definition of the object (CB/other object) need not be given.
6. Only one object can be defined to be a circuit breaker.

Example 3: To program a configuration similar to the default configuration 1 (indicator 109 CB truck, indicator 110 CB and indicator 116 earth-switch), the following commands are required:

```
>99WS198:0:XX
    ; Change into program mode
>99WS100:0:XX
    ; Change into freely programmable mode
>99WS109:1,1,1,0:XX
    ; CB truck : vertical red LEDs indicate
      closed status, input channel 1, not
      controlled
>99WS110:1,1,2,20,1:XX
    ; Circuit breaker : vertical red LEDs
      indi cate closed status, input channel 2,
      controlled
>99WS116:1,1,3,0:XX
    ; Earth-switch : horizontal red LEDs
      indicate closed status, input channel 3,
      not controlled
>99WV151:1:XX
    ; Store the programmed parameters
```

After this also the interlocking program must be written before opening or closing of the circuit breaker is possible. See Chapter "Interlocking".

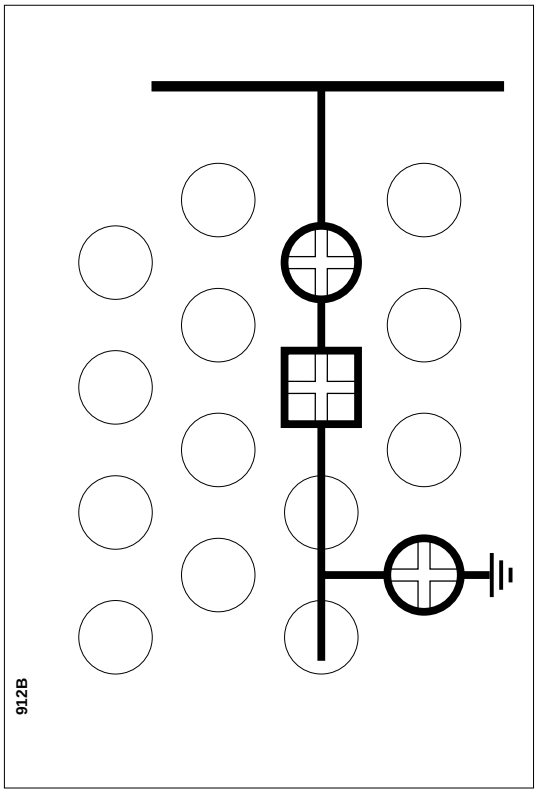

Fig. 7. Configuration programmed in the example number 3.

The programmed configuration can be read indicator by indicator or with a single command.

Example 4: To read the configuration of indicators 101…116 with one command only.

```
>99RS101/116:XX
```

This command will give all the setting values of every indicator (101 to 116), including those not configured into the system. The parameters of indicators not in use are zero.

Interlocking

An interlocking program is used to inhibit the closing or opening command for a controllable object in certain situations. In practice, in the control module SPTO 1D2, the interlocking enables the control operations, i.e. everything that is not enabled by the interlocking program is inhibited.

The default configurations have their own default interlocking programs, see appendixes 1…3. If a default interlocking related to a default configuration is not suitable, both configuration and interlocking must be programmed by the user.

The interlocking system of the control module reads the status of input channels 1…3 and 4…13. The interlocking program enables the opening or closing of a controllable object but a separate open or close command must be given via the local push-buttons, the serial bus or the input channels 4…13.

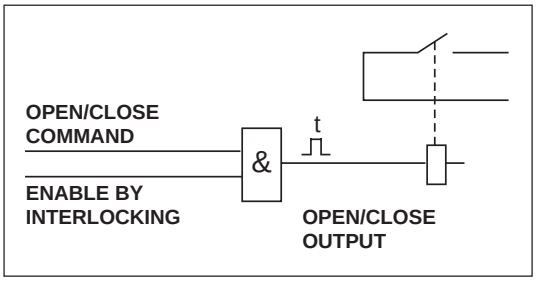

Fig. 8. Operation principle of OPEN and CLOSE outputs.

When the parameter S198 = 0, the module is in the program mode, and when the parameter S198 = 1, the module is in the run mode. In the run mode the interlocking program is executed and it cannot be changed by the operator. The operations enabled by the interlocking program can be carried out.

In the program mode the interlocking program is not executed and program changes can be done. In this mode the control of the objects is not allowed, except in the case that interlockings are completely out of use. The interlocking is programmed or a default interlocking is selected in the program mode.

The interlocking logic, when used, is always operative both in local and remote control mode and if the control commands are given via input channels 4…13. The interlocking program is executed every 20 ms. With setting S199 the interlocking can be taken completely out of use.

Example 5: In example 3 a configuration was programmed. If the interlockings are not used the programming continues with the following commands:

```
>99WS199:0:XX
    ;Disable interlockings
>99WV151:1:XX
    ;Store the programmed parameters
```

In this case when the interlockings are not programmed, the value 1 cannot be given for the parameter S198. However, the status indication and object control operate as normal because the interlockings are disabled.

The interlockings are programmed via the SPA bus using the language according to the DIN 19239 standard. The structure of a program command is:

OPERATION is a logic command
OPERAND is a code of an input or an output or a number of a temporary or a special register

The following logic commands are used:

LOAD	Reads the status of an input or a register
LOADN	Reads the inverted status of an input or a register
AND	And operation
ANDN	And not operation
OR	Or operation
ORN	Or not operation
OUT	Writes to an output or a register
END	End of the program

For inputs 1…3 a separate operand code is defined for each status, open, closed or undefined. The activated status of inputs 4…13 can be used as an operand in the logic.

In SPTO 1D2 the following operand values can be used with operations LOAD, LOADN, AND, ANDN, OR, ORN :

1…3 = input channel number
; Code of an input, if the status " closed" should be used
101…103 = input channel number + 100
; Code of an input, if the status "undefined" should be used
201…203 = input channel number + 200
; Code of an input, if the status "open" should be used
4…13 = input channel number
; Code of an input, if the status "active" should be used
70…89 ; Number of a temporary register
60 and 61 ; Number of a special register
62 ; Position information of the L/R key switch

In SPTO 1D2 the following operand values can be used with operation OUT:

20 or 21 ; Code of an output
70…89 ; Number of a temporary register

The input channel numbers and the output codes are those defined when programming the configuration.

The two special registers, 60 and 61, have constant values; register 60 is always zero (0) and register 61 one (1). Register 62 is used for position information of the L/R key switch; register 62 is one (1) when the L/R key switch is in REMOTE position and zero (0) when the key switch is in LOCAL position. The registers 70...89 are used as temporary data storage during the interlocking program execution.

Example 6: How to store the result of a logic operation into a temporary register.

```
>99WM200:LOAD 201:XX
   ;Read the open status of an object wired
    to the input 1
>99WM201:AND 202:XX
   ;Read the open status of an object wired
    to the input 2
>99WM202:OUT 70:XX
   ;Write the result of the logic operation
    into register 70
```

After these commands register 70 is 1, if both objects are open.

Example 7: How to use input channels 4…13 in the logic.

```
>99WM200:LOAD 1:XX
   ;Read the closed status of an object wired
    to input 1
>99WM201:AND 4:XX
   ;Read the active status of input channel 4
>99WM202:OUT 20:XX
   ;Enable output 20
```

After these commands the OPEN output (code 20) is enabled if object 1 is closed and input channel 4 is activated.

Syntax rules for programming the interlocking for SPTO 1D2:

1. The interlockings have to be programmed in the program mode.
2. With the interlocking program the operator defines when the opening and closing of an object is allowed.
3. The setting parameters M200…M300 are used. A setting parameter is equal to the row number of the interlocking program.
4. The program always begins at M200 and must not include empty lines.
5. The program always begins with the command LOAD or LOADN.
6. The last command of the program must be END.
7. One operand can be used only once with the OUT command.
8. Before the LOAD and LOADN commands, except for the first command, the OUT command should be used.
9. Before the END command an OUT command should be used.

Example 8: Programming of an interlocking logic. This example is related to example 3, the circuit breaker is to be controlled.

The following rules are given for the interlocking:

- Opening of the circuit breaker is always allowed.
- Closing of the circuit breaker is allowed when the CB truck is in the isolating position or in the service position and the earth-switch is open.

Instead of these written interlocking conditions, a logic diagram can be used:

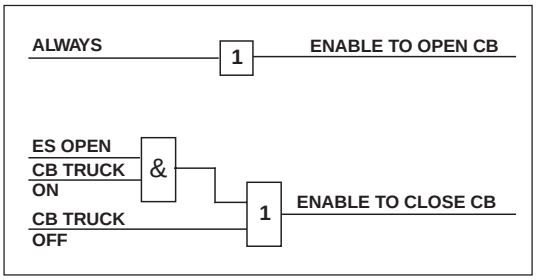

Fig. 9. Simple logic diagram for the interlocking logic for example 8

Below a detailed logic diagram is drawn.

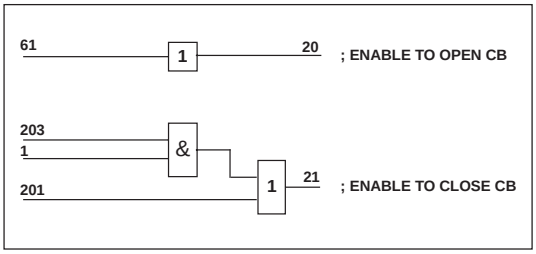

Fig. 10. Detailed logic diagram of the interlocking logic for example 8

The actual commands are written on the basis of the detailed logic diagram. As a default the program area M200…M300 is filled with END commands. The interlocking commands given by the operator are written over these END commands.

A configuration was programmed in example 3. If the interlockings described above are taken into use the programming continues with the following commands.

```
>99WM200:LOAD 61:XX
    ; Read the value of special register 61
      (the value is always 1)
>99WM201:OUT 20:XX
    ; Always enable the open command of
      the CB
>99WM202:LOAD 1:XX
    ; Read the closed status of the CB truck
>99WM203:AND 203:XX
    ; Read the open status of the earth-switch
>99WM204:OR 201:XX
    ; Read the open status of the CB truck
>99WM205:OUT 21:XX
    ; Enable the close command of the CB
>99WM206:END:XX
    ; End of interlocking program

>99WS198:1:XX
    ; Change interlocking program into run
      mode
>99WS199:1:XX
    ; Enable interlockings
>99WV151:1:XX
    ; Store the programmed parameters
```

The program is automatically compiled, when changing back into the run mode. If there are syntax errors in the program, the compiling will not be passed and the interlocking stays in the program mode. First the syntax errors must be corrected and then the interlocking system can be changed into the run mode.

The interlocking program can be by-passed in two ways;

- For testing purposes the switch SG1/1 on the front panel can be turned on. Then the interlocking program is interrupted and opening/closing of an object is always enabled.
- If the interlocking logic is to be taken out of use permanently , then variable S199 can be set to 0. Then the opening or closing of an object is always enabled.

The interlocking system does not affect the tripping signal of the protection.

Conditional Direct Output Control

The Conditional Direct Output Control logic controls the outputs OPEN, CLOSE and SIGNAL1…3. Outputs not used for controlling an object or for signalling the activation of inputs 4…13 can be controlled by the Conditional Direct Output Control function.

The outputs are activated on the basis of the programmed logic and the status of input channels 1…3 and 4…13. The controlled output remains active as long as the statuses of the inputs which caused the operation do not change.

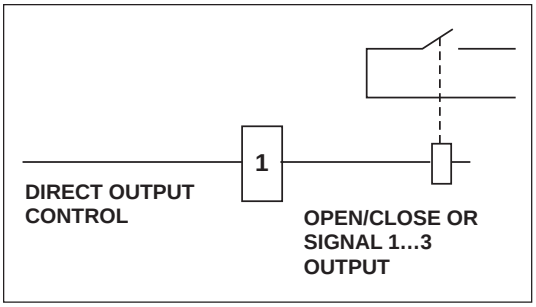

Fig. 11. Operation principle of Conditional Direct Output Control.

The programming principles and the program structure of the Conditional Direct Output Control are the same as those of the interlocking logic. The differences between these two logic programs are;

- The codes of OPEN and CLOSE outputs
- The outputs SIGNAL1…3 can be controlled by the Conditional Direct Output Control program.

The output codes are:

Output code	Definition
220	OPEN
221	CLOSE
22	SIGNAL 1
23	SIGNAL 2
24	SIGNAL 3

The Direct Output Control program is written after the interlocking program by using the SPA protocol commands M200…M300. These two programs have a common END command.

Example 9: An interlocking logic was programmed in example 8. In this example a Conditional Direct Output Control logic is added for SIGNAL 3 output.

The SIGNAL 3 output will be activated when:

- The CB truck is in the isolated position and input channel 4 is activated

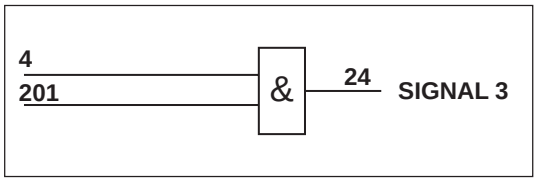

Fig. 12. Detailed logic diagram of the Conditional Direct Output Control logic for the example number 9.

The described Conditional Direct Output Control logic is effectuated with the following commands.

```
…
    ;Interlocking logic command lines
     M200…M205
>99WM206:LOAD 201:XX
    ;Read the open status of the CB truck
>99WM207:AND 4:XX
    ;Read the active status of input 4
>99WM208:OUT 24:XX
    ;Activate the SIGNAL3 output
>99WM209:END:XX
    ;End of program

>99WS198:1:XX
    ;Change the program into run mode
>99WS199:1:XX
    ;Effectuate the program
>99WV151:1:XX
    ;Store the programmed parameters
```

Input channels 4…13

The input channels 4…13 are used to read binary signals other than circuit breaker and disconnector status information. The binary signals can be external contact signals or internal binary signals, e.g. starting and tripping signals of protective relay modules. For the definition of internal and external signals see chapter "Intermodular control signal exchange" in the user´s manual of the feeder terminal.

The status of the binary inputs 4…13 can be read via the serial bus. The status of the input channels 4…9 is also indicated locally by LEDs on the front panel. A LED is lit when the corresponding input becomes active and the LED is switched off when the corresponding input becomes inactive.

Each input channel can be defined to be active at high state or at low state by using parameter S2. The high state activity means that an input is considered to be active if there is a voltage connected to the corresponding external input or if a protective relay module has activated its output signal. Low state activity is the opposite to high state activity. As a default all the inputs are active at high state.

The following features are related to input channels 4…13:

- Events are formed by status changes
- The channels can be used to activate the OPEN or CLOSE output pulse
- The channels can be used to inhibit the OPEN or CLOSE output pulse
- The channels can be used to activate one of the outputs SIGNAL1…3
- The channels may be included in the interlocking program logic
- The channels may be included in the Conditional Direct Output Control logic
- Channel 7 can be used as an energy pulse counter, see chapter "Scaling of measurements".

When using an input channel one signal output (SIGNAL1…3) and one control output (OPEN or CLOSE) can be activated simultaneously. Accordingly one signal output can be activated and one control output inhibited simultaneously. The output to be activated or inhibited is defined by parameters S3 and S4.

The position of the R/L keyswitch is without significance when the control outputs (OPEN or CLOSE) are controlled via inputs 4…13, but a check with the blocking logics is always made before a control action.

If an input channel is defined to control a signal output, the output is activated as long as the input is active. The length of the opening and closing pulse is defined by the SPA bus variables V5 and V6 respectively and they are not depending on the input pulse length.

Example 10: Programming of input 8. The programming can be done in the run mode.

```
>99W8S2:1:XX
    ; Define input 8 to be active at high state
>99W8S3:22:XX
    ; Configure input 8 to activate the SIG-
      NAL1 output
>99W8S4:20:XX
    ; Configure input 8 to activate the OPEN
      output pulse
>99WV151:1:XX
    ; Store the programmed parameters
```

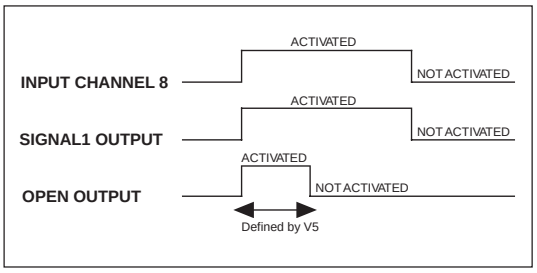

Fig. 13. Operation of outputs SIGNAL1 and OPEN when input channel 8 in example 10 is activated.

If an input channel is used for inhibiting a control command the opening or closing of an object is inhibited as long as the input is active. If the interlockings are out of use (S199=0), the input channels 4…13 cannot be used to inhibit the OPEN and CLOSE outputs.

If the input 7 is operating as an energy pulse counter, it cannot be used for other purposes. As a default the input channels 4…13 are operating in a general input mode, but are not activating or inhibiting any outputs.

Outputs

The control module SPTO 1D2 has five outputs: three signal outputs (SIGNAL1…3) and two control outputs (OPEN and CLOSE). For programming the outputs are coded in the following way:

Output	Output code	Remarks
OPEN	20	For configuration and interlocking
OPEN	220	For Conditional Direct Output Control
CLOSE	21	For configuration and interlocking
CLOSE	221	For Conditional Direct Output Control
SIGNAL1	22	
SIGNAL2	23	
SIGNAL3	24	

The OPEN and CLOSE outputs can be controlled in four ways:
- Locally by using the OPEN and CLOSE push-buttons
- Remotely by commands over the serial bus
- Remotely via the binary inputs 4…13, see chapter "Input channels 4…13"
- By the Conditional Direct Output Control logic, see chapter "Conditional Direct Output Control"

To define the object to be controlled via the outputs OPEN and CLOSE, see chapter "Configuration".

When using the three first ways of operation the OPEN and CLOSE outputs give pulses. Before the output is activated the interlocking logic must enable the operation.

The pulse lengths for opening and closing outputs are defined with the SPA bus variables V5 and V6. The definitions have to be made only for the channel on which the object to be controlled is located. As a default the object to be controlled is located on channel 2.

The pulse lenght can be set in the range 0.1... 100 s with a time resolution of 0.1 s. As a default the values for V5 and V6 of channel 2 are 0.1 s.

Example 11: The pulse lenghts can be programmed in the run mode. In default configuration 1 the object to be controlled is defined to be a CB in channel 2. To change the open and close pulse lengths from 0.1 s the following SPA bus commands are used:

```
>99W2V5:0.5:XX
    ;Set the open pulse length to 0.5 seconds
>99W2V6:0.2:XX
    ;Set the close pulse length to 0.2 seconds
>99WV151:1:XX
    ;Store the programmed parameters
```

The open and close commands are given via the serial communication to the channel on which the object is located. The OPEN and CLOSE outputs can be controlled via the serial communication by using two different procedures:

- Direct control: An output command is given by using the parameter O1. When the parameter has been given the value 0 (open) or 1 (close) the corresponding output pulse is delivered, if enabled by the interlocking.
- Secured control: First an output is set into a state of alert by using parameter V1 for opening and parameter V2 for closing. After that the corresponding output command is executed by using parameter V3. The output pulse is given if the interlocking enables it. The state of alert is cancelled after the execute command. The state of alert can also be cancelled by using parameter V4.

When the Conditional Direct Output Control logic is used for controlling the OPEN and CLOSE output, the output is activated as long as the statuses of the inputs which have caused the operation remain unchanged.

The operation of outputs OPEN and CLOSE can be inhibited in two ways:
- By the interlocking program logic, see chapter "Interlocking"
- By input channels 4…13, see chapter "Input channels 4…13"

The outputs SIGNAL1…3 can be controlled in two ways:
- By input channels 4…13, see chapter "Input channels 4…13"
- By the Conditional Direct Output Control logic, see chapter "Conditional Direct Output Control"

The control module SPTO 1D2 includes a self-supervision system which has its own output, IRF. The output is active when auxiliary power is connected and the self-supervision system has not detected any fault. The output signal goes low if the auxiliary power supply is switched off or a permanent fault is detected. The self-supervision output is connected to the common IRF output of the feeder terminal.

Scaling of measurements

The control module is able to measure three phase currents, active and reactive power and energy. The phase currents are measured via the 1 A or 5 A current inputs of the feeder terminal. For measuring active and reactive power the module includes two mA-inputs. The output signals of external measuring transducers are wired to these two inputs. Energy can be measured in two ways; by using input 7 as a pulse counter or integrating the measured power. If the pulse counter is used an external energy meter with a pulse output is needed.

Phase currents

The three phase currents are displayed locally and transferred in actual kiloamperes via the serial bus. To be able to do this the current measurement must be scaled. The scaling is based on the entered rated current of the primary side of the primary current transformer.

Example 12: Scaling of the phase current measurement.

The nominal current of the primary side of the primary current transformers is 400 A. The current must be given in amperes. The scaling factor is 400.00.

```
>99WS9:400.00:XX
    ; Set scaling factor S9 to 400.00
>99WV151:1:XX
    ; Store the programmed parameters
```

The scaling factor can be programmed within the range 0.00…10000.00. The default value of variable S9 after factory testing is 200.00.

Active and reactive power

The value of the active power is displayed locally and transferred in actual megawatts via the serial bus. Correspondingly the value of the reactive power is displayed locally and transferred in actual megavars via the serial bus. Both negative and positive power values can be measured.

The power measurement is enabled or disabled by means of parameter S91. As a default power measurement is disabled (S91=0). The input signal range of the mA-inputs is -20…20 mA.

The following setting parameters are used for scaling the inputs:

S12 = Low limit of the mA signal related to active power, sign
S13 = High limit of the mA signal related to active power, sign
S14 = Low limit of the mA signal related to reactive power, sign
S15 = High limit of the mA signal related to reactive power, sign
S16 = Value of active power corresponding to the mA signal at low limit, sign
S17 = Value of active power corresponding to the mA signal at high limit, sign
S18 = Value of reactive power corresponding to the mA signal at low limit, sign
S19 = Value of reactive power corresponding to the mA signal at high limit, sign

After the power measurement has been enabled the low and high limits of the mA signals are given and then the corresponding values of active and reactive power.

Example 13: The scale of the measured active power ranges from -50 to 135 MW and the corresponding mA range is -20…20 mA.

```
>99WS91:1:XX
    ; Enable power measurement
>99WS12:-20:XX
    ; Set low limit of the mA signal
>99WS13:+20:XX
    ; Set high limit of the mA signal
>99WS16:-50.00:XX
    ; Set value of power corresponding to
      the mA signal -20 mA
>99WS17:+135.00:XX
    ; Set value of power corresponding to
      the mA signal 20 mA
>WV151:1:XX
    ; Store the programmed parameters
```

Example 14: The scale of the measured reactive power ranges from 0 to 2.2 Mvar and the corresponding mA range is 4...20 mA.

```
>99WS91:1:XX
    ; Enable power measurement
>99WS14:+4:XX
    ; Set the low limit of the mA signal
>99WS15:+20:XX
    ; Set the high limit of the mA signal
>99WS18:+0.00:XX
    ; Set the value of power corresponding
      to the mA signal 4 mA
>99WS19:+2.20:XX
    ; Set the value of the power corresponding
      to the mA-signal 20 mA
>99WV151:1:XX
    ; Store the programmed parameters
```

The scaled active and reactive power can be transmitted to the remote control system as SPA-bus variables V3 and V4 for the active power and reactive power respectively.

Energy

Input channel 7 can be used for counting energy pulses. The measured energy is displayed locally by three digits in three parts; in kilowatthours, in megawatthours and in gigawatthours. Correspondingly, the energy value can be read via the serial bus in three parts with maximum three digits (parameters V8…V10) but also in one part in kilowatthours with maximum nine digits (parameter V5). Before the pulse counter can be used the energy measurement must be enabled by variable S92. As a default energy is not measured (S92=0).

The following parameters must be defined for channel 7:

S1 = definition of channel 7
- 0 = general ON/OFF input (default)
- 1 = pulse counter without local indication with front panel LED
- 2 = pulse counter with local indication with front panel LED

S2 = pulse direction
- 0 = negative pulse
- 1 = positive pulse (default)

The following parameters must be defined for channel 0:

S3 = definition of kWh value per pulse, range 0.01…1000 kWh per pulse. Default value is 1.

Example 15: Measurement of energy via the pulse counter.

```
>99WS92:1:XX
    ; Enable energy measurement
>99WS3:5:XX
    ; Set energy value 5 kWh per pulse
>99W7S1:1:XX
    ; Set input 7 as a pulse counter without
      local indication
>99W7S2:1:XX
    ; Set a positive polarity of pulses
>99WV151:1:XX
    ; Store the programmed parameters
```

The energy can also be integrated by using the measured active and reactive power. In this case the measured active energy in one direction is displayed locally whereas the measured active and reactive energy can be read in both directions via the serial bus.

The integration is used automatically if the energy measurement is enabled by parameter S92 but input channel 7 is not defined as a pulse counter.

Example 16: Measurement of energy by integrating the measured power. Initially the measurement of power must be enabled and scaled, see examples 13 and 14.

```
>99WS92:1:XX
    ; Enable energy measurement
>99WV151:1:XX
    ; Store the programmed parameters
```

Event codes

Over the SPA bus substation level data communicator can read the event data, change in status, produced by the control module SPTO 1D2. The events are represented by the event codes e.g. E1…E11. The control module transmits its event data in the format:

<time> <channel number><event code>

where time = ss.sss (seconds and parts of second)
channel number = 0...13
event code = E1...E54, depending on the channel

Most of the event codes and the events represented by these may be included in or excluded from the event reporting by writing an event mask (V155) to the module. The event mask is a binary number coded to a decimal number. Each channel (0...13) has its own event mask.

Each event code is represented by a number. An event mask is formed by multiplying the number either by 1, which means that event is included in the reporting, or by 0, which means that event is not included in the reporting, and finally adding up the results of multiplications.

Example 17: Calculation of the event mask.

Channel	Event code	Event	Number representing the event	Event factor	Result of multiplication
2	E1	Change in status: xx ->10 (open)	1	x 1	= 1
2	E2	Change in status: xx ->01 (close)	2	x 1	= 2
2	E3	Change in status: xx ->11 (undefined)	4	x 0	= 0
2	E4	Change in status: xx ->00 (undefined)	8	x 1	= 8
2	E5	OPEN output activated	16	x 1	= 16
2	E6	OPEN output reset	32	x 0	= 0
2	E7	CLOSE output activated	64	x 1	= 64
2	E8	CLOSE output reset	128	x 0	= 0
2	E9	Output activation inhibited	256	x 1	= 256
2	E10	Output activation fault	512	x 0	= 0
2	E11	Attempt to activate an output without open/close selection	1024	x 0	= 0
Event mask V155 for channel 2					347

The event mask V155 of channel 0 and channels 4…13 may have a value within the range 0…15 and the event mask of channels 1…3 within the range 0…2047. The default values are shown in the next table.

Channels 1...13 have a setting S20, which enables or inhibits the event reporting of the corresponding channel. The default value is 0, which means that event reporting is allowed according to event mask.

The settings S10...S13 for channels 1...3 and settings S10 and S11 for channels 4…13 define the event delays. The event delays are used for filtering out unwanted events when status data is changing. An event code is generated only if the status data is stable for a longer time than the corresponding delay time, e.g. the event code E4 "change in status: xx -> 00" can be filtered out when the status of an object is changing from open to close and vice versa. The time marking of a delayed event is the actual event time added with the delay time.

The control module has the following event codes:

Channel	Code	Event	Number representing event	Default value of event factor
0	E1	Key switch to LOCAL position	1	1
0	E2	Key switch to REMOTE position	2	1
0	E3	Output test switch SG1/1 ON	4	0
0	E4	Output test switch SG1/1 OFF	8	0
				V155 = 3
1…3	E1	Change in status; xx -> 10 (open)	1	1
1…3	E2	Change in status; xx -> 01 (closed)	2	1
1…3	E3	Change in status; xx ->11 (undefined)	4	0
1…3	E4	Change in status; xx ->00 (undefined)	8	0
1…3	E5	OPEN output activated	16	1
1…3	E6	OPEN output reset	32	0
1…3	E7	CLOSE output activated	64	1
1…3	E8	CLOSE output reset	128	0
1…3	E9	Output activation inhibited 1)	256	1
1…3	E10	Output activation fault 2)	512	1
1…3	E11	Trying to activate an output without open/close selection 3)	1024	1
				V155 = 1875
4…13	E1	Input channel activated	1	1
4…13	E2	Input channel reset	2	1
4…13	E3	SIGNAL1…3 output activated	4	0
4…13	E4	SIGNAL1…3 output reset	8	0
				V155 =3
0	E50	Restarting	*	-
0	E51	Overflow of event register	*	-
0	E52	Temporary disturbance in data communication	-	
0	E53	No response from the module over the data communication	*	-
0	E54	The module responds again over the data communication	*	-

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

In the SPACOM system the event codes E52…E54 are formed by the station level control data communicator.

1) Event E9, output activation inhibited, is given when the operation is inhibited by the interlocking program or by an input channel 4…13.

2) Event E10, output activation fault, is given if the status of the controlled object does not change during the time of the output pulse.

3) Event E11, attempt to activate an output without an open/close selection, is given when a secured control is made in a situation where the state of alert has not been defined.

If all the parameters are programmed at the same time the following instructions should be used when changing between program and run mode and when storing the parameters.

As a default the parameters related to interlocking and configuration have the following values:

S100 = 1
Default configuration and interlocking 1
S198 = 1
The interlocking program is in run mode
S199 = 1
Interlockings are in use

The following examples illustrate the programming.

Example 18: Select another configuration and interlocking than default 1.

```
>99WS198:0:XX
    ; Change into program mode
>99WS100:2:XX
    ; Select the default 2
>99WS198:1:XX
    ; Change into run mode
.
    ; Change other parameters
.
.
>99WV151:1:XX
    ; Store the programmed parameters
```

Example 19: Select a user defined configuration and interlocking.

```
>99WS198:0:XX
    ; Change into program mode
>99WS100:0:XX
    ; Change into freely programmable mode
>99WS101:…
    ; Configuration commands
.
.
.
>99WM200:…
    ; Interlocking program
.
.
.
>99WS198:1:XX
    ; Change into run mode
.
    ; Change other parameters
.
.
>99WV151:1:XX
    ; Store the programmed parameters
```

Serial communication parameters

Apart from the event codes the substation level data communicator is able to read, over the SPA-bus, all input data (I-data) of the module, setting values (S-data), information recorded in the memory (V-data), and some other data. Further, part of the data can be altered by commands given over the SPA-bus.

Data	Channel	Code	Data direction	Values
Current in phase L1 (x I_n)	0	I1	R	0.00…2.50 x I_n
Current in phase L2 (x I_n)	0	I2	R	0.00…2.50 x I_n
Current in phase L3 (x I_n)	0	I3	R	0.00…2.50 x I_n
Active power (bits)	0	I4	R	-1023…1023 bits
Reactive power (bits)	0	I5	R	-1023…1023 bits
Current in phase L1 (A)	0	I6	R	0…9999 A
Current in phase L2 (A)	0	I7	R	0…9999 A
Current in phase L3 (A)	0	I8	R	0…9999 A
Status of an object	1…3	I1	R	0 = undefined (inputs 00) 1 = closed 2 = open 3 = undefined (inputs 11)
Closed status of an object	1…3	I2	R	0 = not closed 1 = closed
Open status of an object	1…3	I3	R	0 = not open 1 = open
Status of inputs 4…13	4…13	I1	R	0 = not active 1 = active
Direct output write	1…3	O1	W	0 = open 1 = close
Open select (secured operation)	1…3	V1	RW	0 = non select 1 = select
Close select (secured operation)	1…3	V2	RW	0 = non select 1 = select
Execute selected open/close operation	1…3	V3	W	1 = execute selected operation
Cancel selected open/close operation	1…3	V4	W	1 = cancel selected operation
Open pulse length	1…3	V5	RW(e)	0.1…100.0 s
Close pulse length	1…3	V6	RW(e)	0.1…100.0 s
Execute selected open/close operation (common addr. 900)	0	V251	W	1 = execute all selected operations
Cancel selected open/close operations (common addr. 900)	0	V252	W	1 = cancel all selected operations
kWh value per pulse	0	S3	RW(e)	0.01…1000 kWh per pulse
Position of switch SG1/1	0	S6	R	0 = operation position (SG1/1=0) 1 = interlockings off (SG1/1=1)
Object indication mode	0	S7	RW(e)	0 = continuous display 1 = automatic switch-off after 10 min.
Display indication mode	0	S8	RW(e)	0 = continuous display 1 = automatic switch-off after 5 min.

Data	Channel	Code	Data direction	Values
Scaling of current measurement	0	S9	RW(e)	0.00…10000.00
Low limit for mA signal of active power	0	S12	RW(e)	-20…+20 mA
High limit for mA signal of active power	0	S13	RW(e)	-20…+20 mA
Low limit for mA signal of react. power	0	S14	RW(e)	-20…+20 mA
High limit for mA signal of react. power	0	S15	RW(e)	-20…+20 mA
Active power corresponding to the mA signal at low limit	0	S16	RW(e)	- 999.99…+999.99
Active power corresponding to the mA signal at high limit	0	S17	RW(e)	- 999.99…+999.99
Reactive power corresponding to the mA signal at low limit	0	S18	RW(e)	- 999.99…+999.99
Reactive power corresponding to the mA signal at high limit	0	S19	RW(e)	- 999.99…+999.99
Power measurement	0	S91	RW(e)	0 = no power measurement 1 = power is measured
Energy measurement	0	S92	RW(e)	0 = no energy measurement 1 = energy is measured
Configuration and interlocking	0	S100	RW(e)	0 = freely programmable configuration and interlocking program 1 = default 1 2 = default 2 10 = default 10
Configuration of objects (format; value 1, value 2, input No, output No, value 3)	0	S101 : S116	RW(e)	- value 1; 0 = indicator not used 1 = indicator used - value 2; 0 = vertical LEDs indicate open status 1 = vertical LEDs indicate closed status - input number; 1…3 = input number 1…3 - output number; 0 = not controlled object 20 or 21 = outputs 20 and 21 used - value 3; 0 =object other than a CB 1 = object is a CB
Program/run mode selection	0	S198	RW(e)	0 = program mode 1 = run mode
Interlocking selection	0	S199	RW(e)	0 = no interlockings 1 = interlockings in use 2 = for future use

Data	Channel	Code	Data direction	Values
Interlocking and Conditional Direct Output Control program (format; operation, operand)	0	M200 : M300	RW(e)	operation = LOAD, LOADN AND, ANDN OR, ORN OUT END operands for interlocking = status closed (1…3) or active (4…13) status undefined (101…103) status open (201…203) No. of output (20 or 21) No. of memory (70…89) operands for Conditional Direct Output Control = status closed (1…3) or active (4…13) status undefined (101…103) status open (201…203) No of output (22…24, 220 or 221) No of memory (70…89)
Event delay; —>10 (open)	1…3	S10	RW(e)	0.0, or 0.1…60.0 s
Event delay; —>01 (close)	1…3	S11	RW(e)	0.0, or 0.1…60.0 s
Event delay; —>11 (undefined)	1…3	S12	RW(e)	0.0, or 0.1…60.0 s
Event delay; —>00 (undefined)	1…3	S13	RW(e)	0.0, or 0.1…60.0 s
Use of input 7	7	S1	RW(e)	0 = general mode 1 = pulse counter without indication 2 = pulse counter with indication
Operation direction of inputs 4…13	4…13	S2	RW(e)	0 = active at low state 1 = active at high state
Signal output activation by inputs 4…13	4…13	S3	RW(e)	0 = no SIGNAL output 22 = SIGNAL1 output is activated 23 = SIGNAL2 output is activated 24 = SIGNAL3 output is activated
Operation of OPEN and CLOSE outputs by inputs 4…13	4…13	S4	RW(e)	0 = no activation or inhibit 20 = activate OPEN output 21 = activate CLOSE output 120 = inhibit OPEN output 121 = inhibit CLOSE output

Data	Channel	Code	Data direction	Values
Memory controlled function of the indicators of the binary inputs	4…9	S5	RW(e)	0 = not memory controlled 1 = memory controlled
Event delay; —>activated	4…13	S10	RW(e)	0.0, or 0.1…60.0 s
Event delay; —>reset	4…13	S11	RW(e)	0.0, or 0.1…60.0 s
Event reporting	1…13	S20	RW(e)	0 = event reporting enabled 1 = event reporting inhibited
Active power (MW)	0	V3	R	-999.99…+999.99 MW
Reactive power (Mvar)	0	V4	R	-999.99…+999.99 Mvar
Active energy (kWh)	0	V5	RW	0…999999999 kWh
Status of the local/remote key switch	0	V6	R	0 = local 1 = remote
Active energy (kWh)	0	V8	RW	0…999 kWh
Active energy (MWh)	0	V9	RW	0…999 MWh
Active energy (GWh)	0	V10	RW	0…999 GWh
Active energy; reversed (kWh)	0	V11	RW	0…999 kWh
Active energy; reversed (MWh)	0	V12	RW	0…999 MWh
Active energy; reversed (GWh)	0	V13	RW	0…999 GWh
Reactive energy (kvarh)	0	V14	RW	0…999 kvarh
Reactive energy (Mvarh)	0	V15	RW	0…999 Mvarh
Reactive energy (Gvarh)	0	V16	RW	0…999 Gvarh
Reactive energy; reversed (kvarh)	0	V17	RW	0…999 kvarh
Reactive energy; reversed (Mvarh)	0	V18	RW	0…999 Mvarh
Reactive energy; reversed (Gvarh)	0	V19	RW	0…999 Gvarh
Data store into EEPROM	0	V151	W	1 = store, takes about 5 s
Load default values after EEPROM failure	0	V152	RW(e)	0 = enable to load default values 1 = inhibit to load default values
Event mask	0	V155	RW(e)	0…15
Event mask	1…3	V155	RW(e)	0…2047
Event mask	4…13	V155	RW(e)	0…15
Activation of self-supervision output	0	V165	W	0 = reset 1 = activate
Internal fault code	0	V169	R	Fault code
Data communication address	0	V200	RW(e)	1…255
Data transfer rate	0	V201	RW(e)	4800, 9600
Program version symbol	0	V205	R	E.g. 054 A

Data	Channel	Code	Data direction	Values
Type designation of the module	0	F	R	SPTO 1D2
Reading of event register	0	L	R	Time, channel number and event code
Re-reading of event register	0	B	R	Time, channel number and event code
Reading of module status information	0	C	R	0 = normal state 1 = module been subject to automatic reset 2 = overflow of event register 3 = events 1 and 2 together
Resetting of module status information	0	C	W	0 = resetting
Time reading and setting	0	T	RW	0.000…59.999 s

R = Data which can be read from the unit
W = Data which can be written to the unit
(e) = Data which has to be stored into EEPROM (V151) after having been changed

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

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

Default values of the parameters

The parameters stored in the EEPROM have been given default values after factory testing. All the default values have been stored in the EEPROM by pressing the push-buttons STEP and SELECT at the same time as the auxiliary power supply was connected. The push-buttons have to be pressed until the display is lit.

The following table gives the default values of the parameters.

Parameter	Channel	Code	Default value
Open pulse lenght	2	V5	0.1 s
Close pulse lenght	2	V6	0.1 s
kWh value per pulse	0	S3	1 kWh per pulse
Object indication mode	0	S7	0 = continuous display
Display indication mode	0	S8	0 = continuous display
Scaling of current measurement	0	S9	200.00
Low limit of mA-signal of active power	0	S12	+4 mA
High limit of mA-signal of active power	0	S13	+20 mA
Low limit of mA-signal of react. power	0	S14	+4 mA
High limit of mA-signal of react. power	0	S15	+20 mA
Active power corresponding to the mA-signal at low limit	0	S16	+0.00
Active power corresponding to the mA-signal at high limit	0	S17	+999.99
Reactive power corresponding to the mA-signal at low limit	0	S18	+0.00
Reactive power corresponding to the mA-signal at low limit	0	S19	+999.99
Power measurement	0	S91	0 = no power measurement
Energy measurement	0	S92	0 = no energy measurement
Configuration and interlocking	0	S100	1 = default configuration and interlocking 1
Configuration of objects	0	S101 : S116	default configuration 1, see appendix 1
Program/run mode selection	0	S198	1 = run mode
Interlocking selection	0	S199	1 = interlockings in use
Interlocking program	0	M200 : M300	default interlocking 1, see appendix 1
Event delay; —>10 (open)	1…3	S10	0.0 s
Event delay; —>01 (close)	1…3	S11	0.0 s
Event delay; —>00, —>11	1 and 3	S12	10.0 s
Event delay; —>00, —>11	2	S12	0.2 s
Use of input 7	7	S1	0 = general mode
Operation direction of intputs 4…13	4…13	S2	1 = active at high state
Signal output activation by inputs 4…13	4…13	S3	0 = no signal output
Operation of OPEN and CLOSE outputs by inputs 4…13	4…13	S4	0 = no activation or inhibit
Memory controlled function of the indicators of the binary inputs	4…9	S5	0 = not memory controlled

Parameter	Channel	Code	Default value
Event delay; —>activated	4…13	S10	0.0 s
Event delay; —>reset	4…13	S11	0.0 s
Event reporting	1…13	S20	0 = event reporting enabled
Load default values after EEPROM failure	0	V152	1 = inhibited
Event mask	0	V155	3
Event mask	1…3	V155	1875
Event mask	4…13	V155	3
Data communication address	0	V200	99
Data transfer rate	0	V201	9600

Technical data

Control functions

- status indication for maximum 3 objects, e.g. circuit breakers, disconnectors, earth switches
- configuration freely programmable by the user
- remote or local control (open and close) for one object
- output pulse length programmable, 0.1…100.0 s
- 10 other binary inputs to read contact data other than status information
- feeder oriented interlocking freely programmable, the 3 status inputs and 10 other binary inputs may be included
- the 10 binary inputs may be used to operate the OPEN and CLOSE outputs
- three signal outputs, can be controlled by the 10 binary inputs

Measurements

- measurement of three phase currents
- phase current measuring range 0…2.5 x I_n
- phase current measuring accuracy better than ±1 % of I_n
- two mA inputs for measuring active and reactive power
- mA input range -20…20 mA, can be limited by programming
- power measuring accuracy better than ±1 % of maximum value of measuring range
- one pulse counter input for energy pulse counting, maximum frequency 25 Hz
- energy can also be calculated on the basis of measured power
- all measured values can be scaled to actual primary values
- local display or remote reading of measured values

Appendix 1

Default configuration and interlocking 1

Default configuration and interlocking 1 is selected by giving variable S100 the value 1. The other parameters have the values given in the chapter "Default values of the parameters"

Configuration

The configuration has three objects, a circuit breaker, a circuit breaker truck and an earth-switch. The close state is indicated with red colour and the open state with green colour. The following inputs, indicators and outputs are used:

- Circuit breaker;
  input channel 2, indicator 110, controlled by OPEN (20) and CLOSE (21) output
- Circuit breaker truck;
  input channel 1, indicator 109, not controlled
- Earth-switch;
  input channel 3, indicator 116, not controlled

The configuration commands are:

S109:1,1,1,0,0
S110:1,1,2,20,1
S116:1,0,3,0,0

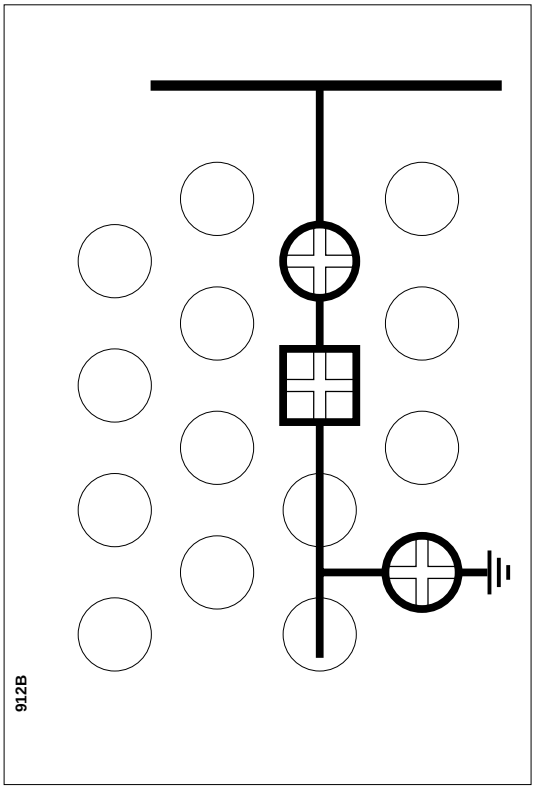

Fig. 14. Default configuration 1.

Interlocking

The following rules apply for interlocking:

- The CB can always be opened.
- The CB can be closed if the CB truck is in the isolated position or if the CB truck is in the service position and the earth-switch is open.

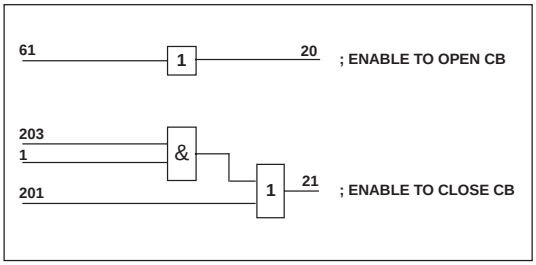

Fig. 15. Logic diagram for the default interlocking 1.

The interlocking program has the following formula:

M200:LOAD 61
M201:OUT 20
M202:LOAD 1
M203:AND 203
M204:OR 201
M205:OUT 21
M206:END

Appendix 2

Default configuration and interlocking 2

Default configuration and interlocking 2 is selected by giving variable S100 the value 2. The other parameters have the values given in the chapter "Default values of the parameters"

Configuration

The configuration has three objects, a circuit breaker, a circuit breaker truck and an earth-switch. The close state is indicated with red colour and the open state with green colour. The following inputs, indicators and outputs are used:

- Circuit breaker;
  input channel 2, indicator 110, controlled by OPEN (20) and CLOSE (21) output
- Circuit breaker truck;
  input channel 1, indicator 109, not controlled
- Earth-switch;
  input channel 3, indicator 116, not controlled

The configuration commands are:

S109:1,1,1,0,0
S110:1,1,2,20,1
S116:1,0,3,0,0

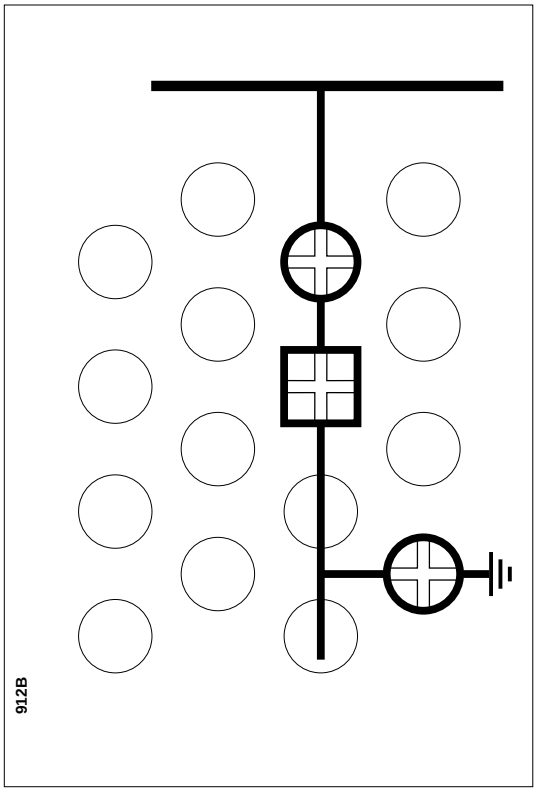

Fig. 16. Default configuration 2.

Interlocking

The following rules apply for interlocking:

- The CB can always be opened.
- The CB can be closed if the CB truck is in service position, the CB is open and the earth-switch is open.

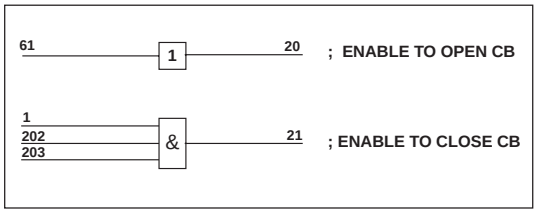

Fig. 17. Logic diagram for the default interlocking 2.

The interlocking program has the following formula:

M200:LOAD 61
M201:OUT 20
M202:LOAD 1
M203:AND 202
M204:AND 203
M205:OUT 21
M206:END

Appendix 3

Default configuration and interlocking 10

Default configuration and interlocking 10 is selected by giving variable S100 the value 10. The other parameters have the values given in the chapter "Default values of the parameters".

Configuration

The configuration has three objects, a circuit breaker, a circuit breaker truck and an earth-switch. The close state is indicated with green colour and the open state with red colour. This default is the same as default 1, but the colours of the object indicators are reversed. The following inputs, indicators and outputs are used:

- Circuit breaker;
  input channel 2, indicator 107, controlled by OPEN (20) and CLOSE (21) output
- Circuit breaker truck;
  input channel 1, indicator 106, not controlled
- Earth-switch;
  input channel 3, indicator 104, not controlled

The configuration commands are:

S106:1,1,1,0,0
S107:1,1,2,20,1
S104:1,0,3,0,0

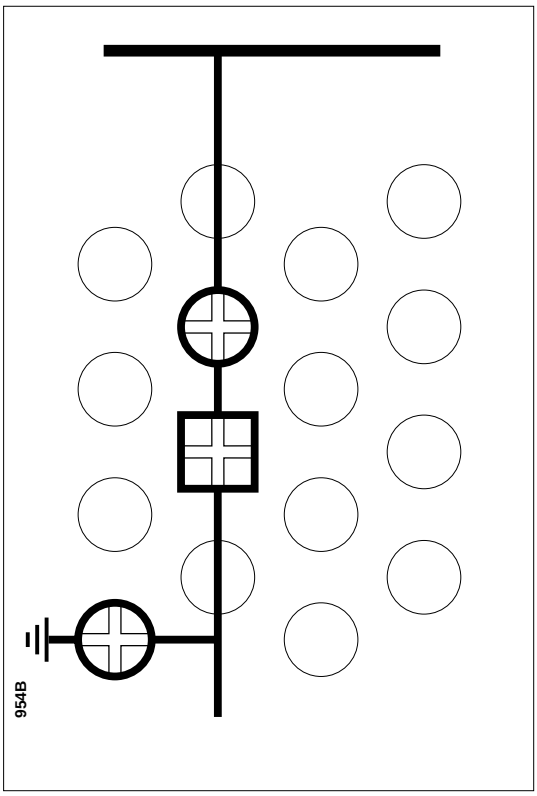

Fig. 18. Default configuration 10.

Interlocking

The interlocking is defined with the following rules:

- The CB can always be opened.
- The CB can be closed if the CB truck is in the isolated position or if the CB truck is in the service position and the earth-switch is open.

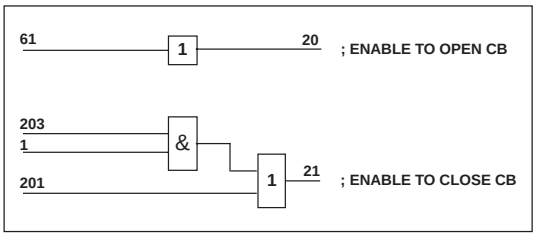

Fig. 19. Logic diagram for the default interlocking 10.

The interlocking program has the following formula:

M200:LOAD 61
M201:OUT 20
M202:LOAD 1
M203:AND 203
M204:OR 201
M205:OUT 21
M206:END

ABB Oy
Substation Automation
P.O.Box 699
FIN-65101 VAASA
Finland
Tel. +358 (0)10 22 11
Fax.+358 (0)10 22 41094
www.abb.com/substationautomation

1MRS 750748-MUM EN