Manual

SPM-D10B/PSY4

- Synchronizing System -

Version 1.1xx

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NOTE

This manual has been developed for a unit fitted with all available options. Inputs/outputs, functions, configuration screens and other details described, which do not exist on your unit may be ignored.

CAUTION !

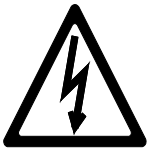
The present manual has been prepared to enable the installation and commissioning of the device. On account of the large variety of parameter settings, it is not possible to cover every possible combination. The manual are therefore only a guide. In case of incorrect entries or a total loss of functions, the default settings can be taken from the enclosed list of parameters.

1.1 Safety technology note for the user

This documentation contains the relevant information for the normal use of the product described herein. It is intended to be read by qualified staff.

Danger warning

The subsequent notes are intended to prevent personal injuries as well as damage to the described product and any connected units. Safety notes and warnings intended to prevent any danger to the life and health of users or maintenance personnel and to avoid any damage will be identified in this documentation by means of the symbols and terms listed below. Within the framework of this documentation, the signals and terms that are used have the following meaning:



DANGER !!!

The DANGER symbol draws your attention to dangers while the description indicates how to handle and/or avoid such hazards. Any non-observance may cause fatal or serious injuries as well as considerable damage to property.

WARNING !

If the warnings are not observed, the unit and any devices attached to it may be destroyed. Please take into account appropriate precautions.

CAUTION !

This symbol points to important notes concerning the mounting, installation, and connection of the unit. These note should absolutely be observed when connecting the unit.

NOTE

References to other notes and supplements as well as tables and lists are identified by means of the "I" symbol. Most of the referenced sections are included in the Annex.

Proper use

The unit must only be operated for the uses described in these manual. The prerequisite for a proper and safe operation of the product is correct transportation, storage, and installation as well as careful operation and maintenance.

1.2 Measurement data

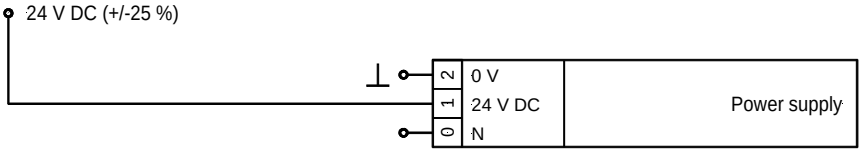
WARNING

A circuit breaker must be provided near to the device and in a position easily accessible to the operator. This must also bear a sign identifying it as an isolating switch for the unit.

NOTE

Connected inductances (e. g. Coils of operating current or undervoltage tripping devices, auxiliary contactors and power contactors) must be wired with an appropriate interference protection.

1.2.1 Power supply



Terminal	Description	A_{max}
0	Neutral point of the three-phase system or neutral terminal of the voltage transformer (Measuring reference point); → with three-conductor systems, do not connect	Sold.lug
1	Power supply: +24 V DC, 10 W	2.5 mm²
2	Power supply: 0 V reference point	2.5 mm²

1.2.2 Voltage measuring inputs

NOTE

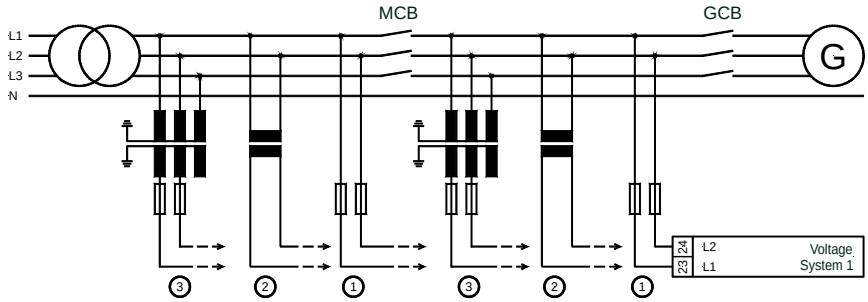
The SPM-D10B/PSY4 can operate (monitor) only one synchronization point. The voltage at terminals 23/24 (system 1) is the voltage to which the assessment of the synchronization at terminals 20/21 (system 2) refers. The synchronization voltage can be, e. g., the mains or busbar voltage.

NOTE

There are generally three different variants for connection of the measuring circuit voltage:

① Direct connection to the low voltage system,
② Connection to medium voltage via two-pole isolated transformer (e. g. in the case of a V-connection) and
③ Connection to medium voltage via single-pole isolated transformer (e. g. Y-connection).

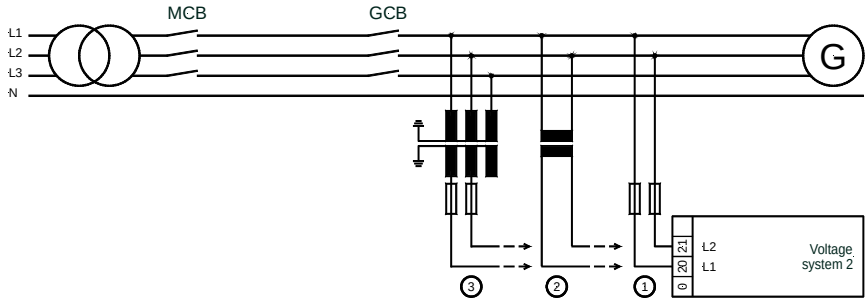
- ***System 1***



Note: Connection corresponding to the mains configuration (see connection plan).

Terminal	Measurement	Description	A_{max}
Connection to the measuring circuit voltage corresponding to variant ①, ② or ③			
23	direct or ../100 V	Synchronization voltage L1	2.5 mm²
24		Synchronization voltage L2	2.5 mm²

- ***System 2***



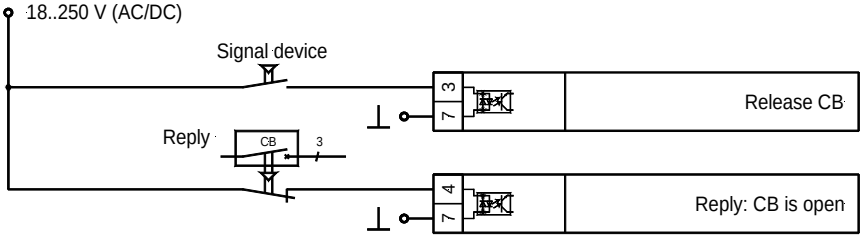
Note: Connection corresponding to the mains configuration (see connection plan).

Terminal	Measurement	Description	A_{max}
Connection to the measuring circuit voltage corresponding to the variant ①, ② or ③			
20	direct or Transformer ../100 V	Voltage system L1	2.5 mm²
21		Voltage system L2	2.5 mm²
0			Sold.lug

1.2.3 Auxiliary and control inputs

a.) Discrete inputs

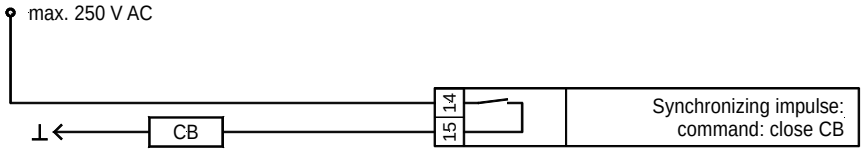
- **Control inputs**



Terminal	Accompanying Zero terminals	Name (according to DIN 40 719 Part 3, 5.8.3)	A_{max}
NO contact			
3	7	Enable CB	2.5 mm²
5		Enable isolated operation	2.5 mm²
NC contact			
4	7	Reply: CB is open	2.5 mm²

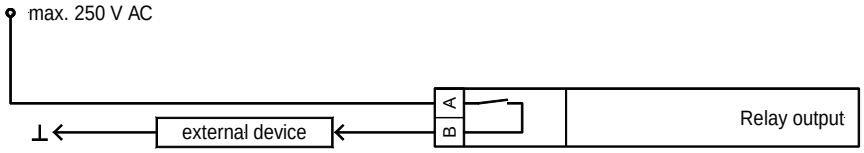
1.2.4 Auxiliary and control outputs

a.) Power circuit breakers



Root	Switched	Description	A_{max}
14	15	Synchronizing pulse / Command: close CB	2.5 mm²

b.) Others



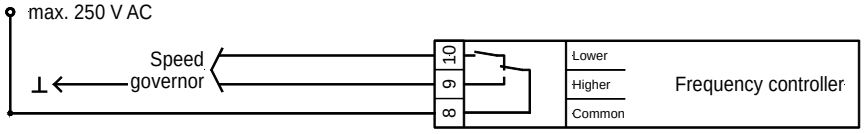
- **Alarm relay** Normally open contact function

Root	Switched	Description	A_{max}
A	***B***	**Note:** The relays close when the function is fulfilled.	
18	19	Readiness for operation	2.5 mm²

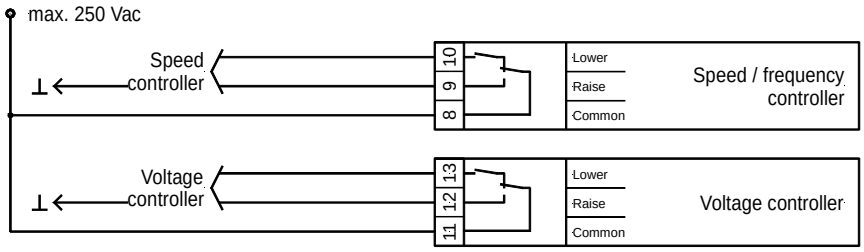
c.) Controller outputs

The controllers are configured as three-point controllers (made of a change-over contact and a normally open contact).

- **SPM-D10B/PSY4-F-D** **Speed/frequency**



- **SPM-D10B/PSY4-FU-D**



Terminal	Assignment	Description	A_{max}
8	common	Speed/frequency controller	2.5 mm²
9	higher		2.5 mm²
10	lower		2.5 mm²
11	common	**SPM-D10B/PSY4-FU-D only:** Voltage controller	2.5 mm²
12	higher		2.5 mm²
13	lower		2.5 mm²

2.1 Function table

Input signal			Function	Condition
Discrete input: "Enable isolated operation"	LED message on the front: "Closed"	LED message on the front: "Enable"		
x	**0**	**0**	No-load operation	C
0	**0**	**1**	Synchronization of the CB No-load operation	A C
0	**1**	**x**	Isolated controller OFF	
1	**0**	**1**	Synchronization of the CB Black start of the CB No-load operation	A B C
1	**1**	**x**	Isolated operation	D

0: OFF **1**: ON **x**: Signal of no significance (0 or 1)

Conditions The function of the device is also dependent, apart from the discrete input signals, on the state of the available measured voltages. The particular function must also be activated in configuration mode:

Condition		
A	Synchronization CB	- for voltages of system 1 and 2 must apply 50 % < V < 125 % of the rated voltage V_N 80 % f < 110 % of the rated frequency f_N (after respond of the time monitoring the synchronization will be interrupted)
B	Black start CB	- Parameter "Black start ON" - Voltage of system 1 must be smaller than 5 % of the rated voltage. - Voltage and frequency of system 2 must be within the configured limits for black start.
C	No-load operation	- Parameter "Automatic no load control ON" - valid for f control: Voltage system 2 > 50 % rated voltage V_N - **SPM-D10B/PSY4-FU-D only** - valid for V control: Frequency system 2 > 90 % of rated frequency f_N
D	Isolated operation	- Voltage system 2 > 50 % rated voltage V_N - **SPM-D10B/PSY4-FU-D only -** valid for v control: Param. “Voltage controller in isolated operation ON”

2.2 LED "Closed" flashes

Incorrect signal state of the "Reply: CB is open" on terminal 4.

Possible faults:
- Reply present (= 0 V)
  voltages system 1 and system 2 not synchronous
- Reply missing (= 24 V)
  voltages system 1 and system 2 synchronous

If the LED is flashing, one must check to see whether the input on terminal 4 is correctly wired. For the wiring to be correct, there must be a **closed power circuit breaker** on the input in question **0 V**.

2.3 Control inputs

Enable CB
Terminal 3

Release for operation of the power circuit breaker
To enable the synchronization operation or a black start, this input must be set.

Reply: CB is open
Terminal 4

With this input the unit is signaled the status of the power circuit breaker. The input must be set if the circuit breaker is open. (The status of this input is proved on plausibility and is signaled by LED “Closed”.

Enable isolated operation
Terminal 5

Set ..... • Enable frequency/voltage control in the case of **missing** "Reply: CB is open" (the LED "Closed" on the front **lights up**).
• Enable black start for **present** "Reply: CB is open" (the LED "Closed" on the front **does not light up**).

Reset ..... • Shut down frequency/voltage controller in the event of a **missing** "Reply: CB is open" (the LED "Closed" on the front **lights up**).

2.4 Control outputs

Command: close CB
Terminals 14/15

By setting this relay the power circuit breaker (CB) will be closed. The relay drops out after the pulse is output.

Readiness for operation
Terminals 18/19

The relay contact is closed if the unit signals readiness for operation. The relay drops out if one of the following events occur:
a) The internal self monitoring has indicated a fault. Then a proper working of the unit can not be guaranteed and from other side appropriate steps must be taken.
b)The synchronization time monitoring is switched on and has responded.

2.5 Potential separation between the power supply and the discrete inputs

By means of an appropriate external wiring, the common reference point of the discrete inputs (terminal 7) can be electrically isolated from the supply voltage (0 V, terminal 2). This is necessary, for example, if the discrete inputs are not to be driven with +24 Vdc and an electrical isolation of the control voltage (e. g. 220 Vdc, 220 Vac) must be guarantee for the power supply.

Wiring should be made as follows:

- Reference points connected with 0 V:
  Bridge between terminal 7 and terminal 2 (0 V)
- Reference point of the discrete inputs potential-free:
  Terminal 2: 0 V (Power supply)
  Terminal 7: 0 V or N (control voltage)

2.6 Operating states

2.6.1 No load operation

The frequency and the voltage *(SPM-D10B/PSY4-FU-D only)* of system 2 are controlled to the configured setpoint value by operating accordingly the relays of the three-position controller for speed and voltage *(SPM-D10B/PSY4-FU-D only*; see also chapter 2.1 "Function table" on page 7). The circuit breaker is open.

2.6.2 Synchronization

The voltage of system 2 is controlled to the voltage of system 1 in its frequency and amplitude *(SPM-D10B/PSY4-FU-D only)* by operating accordingly the relays of the three-position controller for speed and voltage *(SPM-D10B/PSY4-FU-D only)*. With consideration of the switcher time element the add-on command for the circuit breaker is output in the synchronous point. The synchronization occurs under the following conditions (see also chapter 2.1 „Function table“ on page 7):

- The unit is in automatic mode,
- the synchronous function is set,
- the frequency and the voltage *(SPM-D10B/PSY4-FU-D only)* are within the predetermined limits (see also chapter 2.1 “Function table” on page 7),
- the input "Enable CB" is set and
- the input "Reply: CB is open" is set,
- the synchronization time monitoring is not set or has not responded.

2.6.3 Black Start

Output of a add-on command for the circuit breaker without synchronization, if the following conditions are fulfilled:

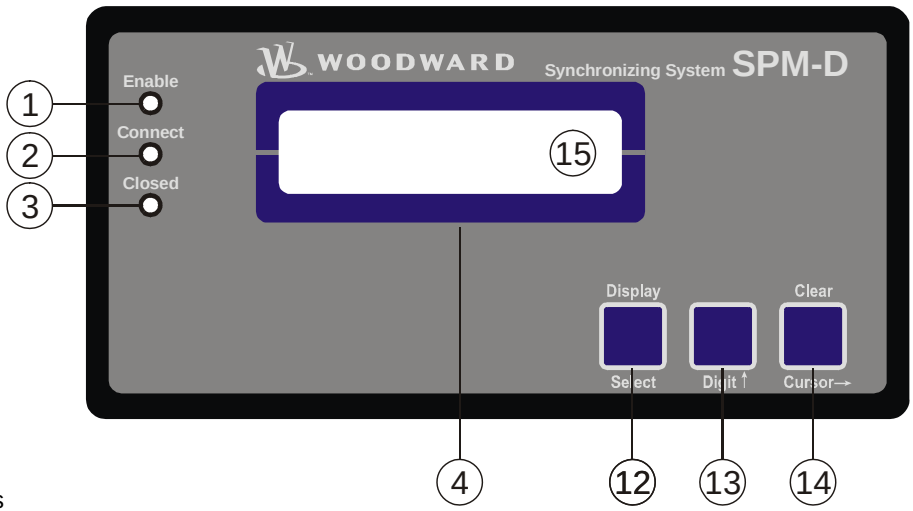
- The unit is in automatic mode;
- the parameter "**black start**" has been set to "**ON**",
- the voltage of system 1 is not available ($U_{System1}$ < 5 % U_N),
- the voltage and frequency of system 2 are within the configured limits,
- the input "Isolated operation" is set,
- the input "Enable CB" is set and
- the input "Reply: CB is open" is set.

2.6.4 Isolated operation

The frequency and the voltage *(SPM-D10B/PSY4-FU-D only)* of system 2 are controlled on the configured set value by operating accordingly the relays of the three-position controller for speed and voltage *(SPM-D10B/PSY4-FU-D only*; see also chapter 2.1 "Function table" on page 7). The circuit breaker is open. To activate the voltage controller the parameter "Voltage controller in isolated operation" has to be configured to ON *(SPM-D10B/PSY4-FU-D only).*

3.1 Pressure-sensitive front membrane

The pressure-sensitive membrane of the front panel consists of a plastic coating. All keys have been designed as touch-sensitive membrane switch elements. The display is an LC display, comprising 2 × 16 characters, which are indirectly illuminated in green. Contrast of the display is infinitely variable by a rotary potentiometer at the left side.



Thomas

Light-emitting diodes

① "Enable" ..... Enable CB
② "Connect" ..... Connection pulse
③ "Closed" ..... Reply: CB is closed

Buttons

⑫ "Display" ..... Scroll display
⑫ "Select" ..... Confirm selection
⑬ "Digit“ ..... Increase digit
⑭ "Clear" ..... Acknowledge alarms
⑭ "Cursor" ..... Input cursor 1 to the right

Display

④ "Synchronism" ..... Synchronism system 1 and 2
⑮ "LC display" ..... LC display

3.2 Light-emitting diodes

① ***.....LED " Enable"***

Enable circuit breaker **Color "GREEN"**

The light emitting diode "Enable" indicates that the circuit breaker is enabled for operation. The status of the LED corresponds with the status of the discrete input “Enable CB”.

② ***.....LED " Connect "***

Connection pulse **Color "GREEN"**

The light-emitting diode “Connect" indicates that the unit gives a add-on pulse to the circuit breaker. The condition of the LED corresponds with the condition of the relay “Command: close CB”.

③ ***.....LED "Closed"***

Circuit breaker is closed **Color "GREEN"**

The LED “Closed” signals the reply of the circuit breaker. The LED is illuminated if the discrete input “Reply: CB is open” is not set and it expires if the discrete input is set (see also chapter 2.2 “LED "Closed" flashes” on page 7).

In order to facilitate the setting of the parameters, the buttons have an "AUTOROLL function". It allows to switch to the next setting and configuration screens, the digits, or the cursor position. The "AUTOROLL function" will only be activated when the user depresses the corresponding keys for a certain period of time.

⑫ ***..... BUTTON "Display..Select"***

Display↓..Select

Automatic ..... "Display" Pressing this button advances the display of the operating and alarm messages.

Configuration ..... "Select" The jump to the next input screen occurs. If the originally displayed value has been changed by the buttons "Digit" or "Cursor", then the newly set value is saved by pressing the "Select" button. By pressing this button again, the user causes the system to display the next entry screen.

⑬ ***..... BUTTON "Digit↑"***

Digit ↑

Configuration ..... "Digit↑" This button is used to raise the cursor position one digit from where the cursor is. The increase is restricted by the admissible limits see list of parameters included in the Annex. In case the maximum number is reached which can be set, the number automatically returns to the lowest admissible number.

⑭ ***..... BUTTON "Clear..Cursor"***

Clear..Cursor

Automatic ..... "Clear" By pressing this button all fault messages are deleted if they are no longer detected.

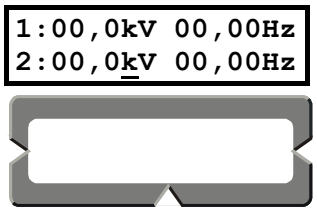
Configuration ..... "Cursor→" This button is used to move the cursor one position to the right. When the last right-hand position is reached, the cursor automatically moves to the first position left-hand of the value to be entered.

⑮ ..... ***DISPLAY "LC display" "Synchronism"***

LC display

The two-line LC display may be used to retrieve performance quantities when the automatic mode is activated. While in configuration mode, the individual parameters are indicated (see below).

3.4.1 Automatic mode

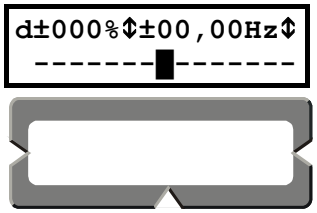


Double voltage and double frequency display, phase position

The voltages of both systems 1 and 2 are displayed. The arbor in the lower line shows the phase position between system 1 and system 2. Are both systems synchronous the arbor is positioned above the indentation of the display frame. The arbor would only be displayed during system 1 and system 2 are both within the admissible range for the synchronization (see chapter 2.1, condition A).

1.....Voltage and frequency of system 1

2.....Voltage and frequency of system 2



Voltage and frequency difference, phase position

The difference voltages and difference frequencies between both systems 1 and 2 are displayed. A positive difference means that system 2 has a larger value than system 1. The voltage difference shown in % is related to the voltage transformer rated value of system 2. Right hand to the % sign a blinking arrow shows the activity of the voltage controller (*SPM-D10B/PSY4-FU-D only*), right hand to the unit "Hz" the activity of the frequency controller is displayed. If the point of the arrow shows to the top the controller outputs "higher" impulses; if the point of the arrows shows to the bottom the controller outputs "lower" impulses. The frequency of the blinking arrows do not represent the controller outputs frequency. The sign in the lower line shows the phase position between system 1 and system 2. Are both systems synchronous the sign is sitting above the indentation of the display frame. All above described values would only be displayed during system 1 and system 2 are both within the admissible range for the synchronization (see chapter 2.1, condition A).

3.4.2 Automatic mode Fault display

Fault display, lower line

The indications are displayed according to the following list:

Type of fault	**xxxxxxxxxxxxxxxx**
Synchronization time of the CB is exceeded	**Synchron. time**

The input screens can be scrolled, when you are in configuration mode (simultaneously pressing "Digit" and "Cursor"), via "Select". If the "Select" button is pressed for a longer period of time, the scroll function will be activated, and the screens will be browsed rapidly. Please make sure that it is possible to scroll in the reverse direction of the last four configuration screens. To do this you must simultaneously press the buttons "Select" and "Cursor". If no entry, modification or any other action is carried out for about 10 minutes, the unit automatically returns to the automatic mode.

```
SPRACHE/LANGUAGE
      english
```

Language selection **German/English**

Selection of the language.

```
Software version
     x.xxxx
```

Software version

Display of the software version.

The unit is equipped with a three-level code and configuration hierarchy, which enables it to visualize various configuration screens for different users. A distinction is made between:

Code level 0 (CS0) User: Third party
This code level enables no access whatsoever to the parameters.

Code level 1 (CS1) User: Customer
This code level entitles the user to change a few selected parameters. Changing a password is not possible in this case.

Code level 2 (CS2) User: Commissioner
With code level 2 the user acquires all access rights, and therefore has direct access to all parameters (displaying and changing). In addition, the user may also set the password for levels 1 and 2 in this level.

```
Enter code
number      XXXX
```

Enter code number **0..9999**

On accessing the configuration mode, a code number, which identifies the various users, is first requested. The displayed number XXXX is a random number (RN). If the random number is confirmed by “Select” without changing the item’s code level remains as it was. If the code number of level 1 or level 2 is input, the unit changes into code level CS1 or CS 2 and accordingly the parameter can be changed. If an incorrect code number is input, the code level is set to code level 0.

NOTE

Two hours after input of the code number the code level returns automatically to CS0!

The present code number for code level 1 (CS1) is "0001" !
The present code number for code level 2 (CS2) is "0002" !

Only in code level 2 the pass word protection can be switched off!

```
Password
Protection    ON
```

Password protection **ON/OFF**

ON .....Access to configuration is attained by entering the appropriate password (Code level 0/1/2). If an incorrect code number has been entered, configuration is blocked.

OFF .....Access to configuration screens is permanently set to code level 2 and the code number is not queried.

WARNING !

Incorrect entries may lead to wrong measured results and cause the destruction of the generator!

```
Rated frequency
      fn=00.0Hz
```

System rated frequency **48.0..62.0 Hz**

The rated frequency of the systems 1 and 2 (respectively of the public network) is transferred here to the unit. This parameter depends on the three-phase system in the relevant country.

```
Generator freq.
 f set  = 00.0Hz
```

Setpoint frequency **48.0..62.0 Hz**

The setpoint frequency of system 2 is entered in this screen and is needed for the frequency controller in isolated and no-load operation.

```
Voltage System 1
secondary   000V
```

Secondary voltage system 1 (measuring transducer) **50..440 V**

The secondary voltage of system 1 is set here in V. This entry serves to indicate the primary voltages in the display. In the case of measured voltages of 400 V without a measurement transducer, 400 V must be set here.

```
Voltage System 2
secondary   000V
```

Secondary voltage of system 2 (measuring transducer) **50..440 V**

Secondary voltage of system 2 is set here in V. This entry serves to indicate the primary voltages in the display. In the case of measured voltages of 400 V without a measurement transducer, 400 V must be set here.

```
Voltage System 1
primary 00.000kV
```

Primary voltage of system 1 (measuring transducer) **0.1..65.0 kV**

The primary voltage of system 1 is set here in kV. The entry is used to output the primary voltages on the display. In the case of measured voltages of 400 V without a measurement transducer, 0.40 kV must be set here.

```
Voltage System 2
primary 00.000kV
```

Primary voltage of system 2 (measuring transducer) **0.1..65.0 kV**

The primary voltage of system 2 is set her in kV. The entry is used to output the primary voltages on the display. In the case of measured voltages of 400 V without a measurement transducer 0.40 kV must be set here.

```
Rated voltage
      Un = 000V
```

Rated voltage **70..420 V**

This value is used to define the permitted limits for synchronization.

```
Voltage System 2
setpoint    000V
```

SPM-D10B/PSY4-FU-D only

Setpoint voltage system 2 **50..440 V**

This value of the voltage specifies the setpoint of the voltage of system 2 for no-load and isolated operation.

4.3 Controller configuration

The parameters of the controller are modified by entering values in the following screens.

WARNING !

An incorrect input can lead to uncontrolled controller actions and destroy the generator!

4.3.1 No-load control

```
Automatic idle
Running          ON
```

Automatic no-load control **ON/OFF**

ON .....With the circuit breaker open and no release of the circuit breaker, frequency and if applicable voltage are controlled (see also chapter 2.1 “Function table” on page 7).

OFF .....With the circuit breaker open, frequency and if applicable voltage are controlled according to the following conditions (see also chapter 2.1 “Function table” on page 7):

- CB release is present:
  Frequency and if applicable voltage are controlled.
- Release CB is not present:
  No control is carried out.

4.3.2 Frequency controller

```
Freq. controller
            ON
```

Frequency controller **ON/OFF**

ON .....The frequency of system 2 is controlled. The frequency is controlled in various manners depending on the task (isolated operation / synchronization). The subsequent screens of this option are displayed.

OFF .....Control is not carried out, and the subsequent screens of this option are not displayed.

```
Freq.controller
Ramp   00,0Hz/s
```

Frequency controller setpoint ramp **0,1..99,9 Hz/s**

The change in setpoint is supplied to the controller via a ramp. The slope of the ramp is used to alter the rate at which the controller modifies the setpoint value. The more rapidly the change in the setpoint is to be carried out, the greater the value input here must be.

```
Freq. controller
Dead band=0.00Hz
```

Frequency controller insensitivity **0.02..1.00 Hz**

Isolated operation The setpoint frequency of system 2 is controlled in such a manner that, in its adjusted state, the actual value deviates from the setpoint frequency setting (setpoint from mask setting) by the set sensitivity value at most.

Synchronization... The frequency of system 2 is controlled in such a manner that, in its adjusted state, the differential frequency reaches the set sensitivity value at most. The frequency of system 1 is used as the setpoint value increased by the value of the adjustable offset.

```
Freq. controller
Time pulse>000ms
```

Minimum frequency controller ON period **10..250 ms**

The minimum ON period of the relay should be selected in such a manner that the downstream adjustment facility responds reliably to the pulse that has been set according to the set time. The smallest possible time must be set in order to ensure optimum control behavior.

```
Freq. controller
Gain Kp = 00.00
```

Frequency controller gain **0.1..99.9**

The gain factor K_p influences the operating time of the relays. By increasing the factor, the operating time can be increased in the event of a certain control deviation.

4.3.3 Voltage controller (SPM-D10B/PSY4-FU-D only)

```
Volt. controller
              ON
```

Voltage controller **ON/OFF**

ON .....Generator voltage control is carried out. The generator voltage is controlled in various manners depending on the task (no load / isolated operation / synchronization). The subsequent screens of this option are displayed.

OFF .....Control is not carried out, and the subsequent screens of this option are not displayed.

```
Volt. controller
Isolated op.  ON
```

Voltage controller isolated mode **ON/OFF**

ON .....In the operation mode isolated operation the voltage controller is activated.

OFF .....In the operation mode isolated operation the voltage controller is inactive. The frequency controller is not affected by this setting.

```
Volt. controller
dead band= 00.0%
```

Voltage controller insensitivity **0.1..25.0 %**

The dead band given in % is related to the voltage transformer rated value of the voltage system 2.

No load/Isolated operation The voltage is controlled in such a manner that, in its adjusted state, the actual value deviates from the setpoint voltage setting (setpoint from mask setting) by the set sensitivity value at most.

Synchronization...The generator voltage is controlled in such a manner that, in its adjusted state, the differential voltage reaches the set sensitivity value at most. The mains or busbar voltage is used as the setpoint value.

```
Volt. controller
time pulse>000ms
```

Minimum voltage controller ON period **20..250 ms**

The minimum ON period of the relay should be selected in such a manner that the downstream adjustment facility responds reliably to the pulse that has been set according to the set time. The smallest possible time must be set in order to ensure optimum control behavior.

```
Volt. controller
gain   Kp=00.0
```

Voltage controller gain factor **0.1..99.9**

The gain factor K_p influences the operating time of the relays. By increasing the factor, the operating time can be increased in the event of a certain control deviation.

4.3.4 Synchronization functions

```
Synchronizing
functions   ON
```

Synchronization functions **ON/OFF**

ON .....A synchronization of the frequency of system 1 is carried out. The add-on command for the CB is carried out with little positive slip. The subsequent screens of this function are displayed.

OFF .....No synchronization occurs, and the subsequent screens of this function are not displayed.

```
Synchronizing
df offs.= 0,00Hz
```

Offset frequency **0.00..0.25 Hz**

During synchronization the setpoint value of the frequency of the system 2 is calculated out of the frequency of system 1 added by this offset. This offset should be at least 0.1 Hz smaller or half the value of dfmax (next parameter). Please also note the setting of the insensitivity of the controller, too.

```
Synchronization
 df max = 0.00Hz
```

Max. perm. differential frequency for synchron. (pos. slip) **0.02..0.49 Hz**

The prerequisite of a connect command's being output is negative deviation from this set differential frequency. This value specifies the upper frequency (positive value corresponds to positive slip).
→ frequency of system 2 is larger than frequency of system 1.

```
Synchronization
 df min = 0.00Hz
```

Max. perm. differential frequency for synchron. (neg. slip) **0.00..-0.49 Hz**

The prerequisite of a connect command's being output is negative deviation from this set differential frequency. This value specifies the lower frequency (negative value corresponds to negative slip).
→ frequency of system 2 is smaller than frequency of system 1.

```
Synchronization
 dU max  = 00.0%
```

Max. perm. differential voltage for synchronization **0.1..15.0 %**

The dead band given in % is related to the voltage transformer rated value of the voltage system 2.

To ensure that a connect command will be issued, the actual value must fall below the entered differential voltage.

```
Synchronization
Time pulse>0.00s
```

Min. pulse duration of connect relay for synchronization **0.04..0.50 s**

The duration of the connect impulse can be adjusted to the subordinate switching unit.

```
Closing time
CB       =000ms
```

Inherent delay of the CB for synchronization **40..300 ms**

The inherent switching time of the circuit breaker corresponds to the lead time of the connect command. The connect command will be issued at the entered time before the synchronization point.

4.3.5 Black start

```
Circuit breaker
Dead bus op. ON
```

Black start of circuit breaker **ON/OFF**

ON .....Release black start function. To switch on the circuit breaker onto the voltage-free system 2 additionally more conditions have to be fulfilled (see chapter 2.6.3 “Black Start” after page 9). The subsequent screens of this function are displayed.

OFF .....No black start is carried out, and the subsequent screens of this function are not displayed.

```
Dead bus op.
 df max = 0.00Hz
```

Maximum differential frequency for black start **0.05..5.00 Hz**

The prerequisite of the output of the connect command is that the frequency of system 2 may, at most, deviate from the setpoint by the set value.

```
Dead bus op.
 dU max =  00.0%
```

Maximum differential voltage black start **0.1..20.0 %**

The differential voltage given in % is related to the voltage transformer rated value of the voltage system 2.

The prerequisite of the output of the connect command is that the voltage of system 2 may, at most, deviate from the setpoint by the set value.

4.3.6 Synchronization time monitoring

```
Sync.time contr.
             ON
```

Synchronization time monitoring **ON/OFF**

ON .....A time monitoring of the synchronization is carried out. Starting the synchronization process simultaneous the time counter is started. If, following the expiry of the set time, the circuit breaker was not closed, a warning message "Connect time CB" is displayed. The synchronization process will be cancelled and the relay "Ready for operation" drops out. Resetting the watchdog occurs by pressing the button "Clear" for at least 3 s. The subsequent screens of this function are displayed.

OFF .....The synchronization will not be monitored. The subsequent screens of this function are not displayed.

```
Sync.time contr.
Delay time 000s
```

Final value for synchronization time monitoring **10..999 s**

Please note above described parameter.

4.3.7 Change passwords

```
Define level 1
code         0000
```

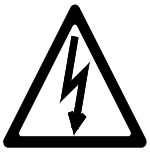
Code level 1 (customer) **0..9999**

This screen appears only in code level 2. Here the code number is defined, which must be set on the item to get into code level 1 (customer). More information about password protection see on page 15.

```
Define level 2
code         0000
```

Code level 2 (commissioner) **0..9999**

This screen mask only appears in code level 2. Here the code number is defined which must be set on the item to get into code level 2 (commissioner). More information about password protection see on page 15.



DANGER !!!

When commissioning the unit, please observe the five safety rules that apply to the handling of live equipment. Make sure that you know how to provide first aid in current-related accidents and that you know where the first-aid kit and the nearest telephone are. Never touch any live components of the system or on the back of the system:

L I F E T H R E A T E N I N G

WARNING !

The unit may only be commissioned by a qualified technician. The "EMERGENCY-SHUTOFF" function must function safely before the commissioning and must not depend on the particular machine.

CAUTION !

1. Prior to commissioning, check that all measuring voltages are correctly connected with regard to phases. The rotating field must be measured. Any lack or incorrect connection of measuring voltages or other signals may lead to incorrect functions and damage the unit as well as engines and components connected to the unit.

Procedure

2. Disconnection of the connection commands directly on the circuit breaker.

3. The supply voltage (24 V_{DC}) must be applied following a check to ensure that all measuring voltages have been connected in the correct phase relation.

4. By simultaneously pressing the two buttons "Digit" and "Cursor" you change into configuration and test mode.

5. Enter all operating data in the sequence of the different screens. The setting limits can derived from both the screen description (to the right next to the screens) and also the parameter list at the end of the manual.

6. If all releases are lacking, you have to check whether the measured voltage corresponds to the displayed value. **The absence of a measuring voltage can lead to an asynchronous switching command when the black start is active**.

7. Checking the signal "Enable CB": After applying the "Enable CB" the LED "Enable" on the pressure-sensitive front membrane lights up.

8. Synchronization of the circuit breaker:
   a) Separate the connection to the circuit breaker;
   b) the voltage at which synchronization is to occur must be within the permissible range;
   c) apply the signal "Enable CB";
   d) if the voltage is 50 % more than the set rated value, the frequency controller begins to control. The control parameter should be set so that the set value is optimally adjusted.
   e) Before inserting the circuit breaker it is absolutely necessary to check whether the measuring voltages are attached correctly. It must also be checked whether the synchronous conditions are fulfilled in the moment when the SPM-D10B/PSY4 issues an add-on pulse. This check can easily occur in measuring the difference voltage directly at the appropriate circuit breaker.

9. Black start
   The output of the command for connecting to a de-energized busbar can be simulated in input/test mode. The illumination of the LED "Connect" indicates, that at this moment, an add-on order would be output for the corresponding switch if automatic mode was selected.

10. By simultaneously pressing the two buttons "Digit" and "Cursor" automatic mode is activated.

11. After successfully connecting the circuit breaker, the LED "Closed" must light up.

6.1 Technical data

Measuring values
- Measuring voltages .. Rated voltage (Vn): ..... 230/400 Vac
  Measuring range: ..... 50..400 Vac
- Rated frequency ..... 40.0..70.0 Hz
- Accuracy ..... Class 1

Environmental variables
- Power supply ..... 24 Vdc (±25 %)
- Intrinsic consumption ..... max. 10 W
- Ambient temperature ..... -20..70 °C
- Ambient humidity ..... 95 %, non-condensing

Measuring inputs
- **Voltage** ..... Resistances 0.1 %
- Linear measuring range up to ..... $1.3 \times U_N$
- Input resistance ..... 0.696 MΩ
- Max. power consumption per path ..... 0.15 W

Discrete inputs
- electrically isolated
- Input range ($U_{Cont, digital input}$) ..... 18..250 Vac/dc
- Input resistance ..... 68 kΩ

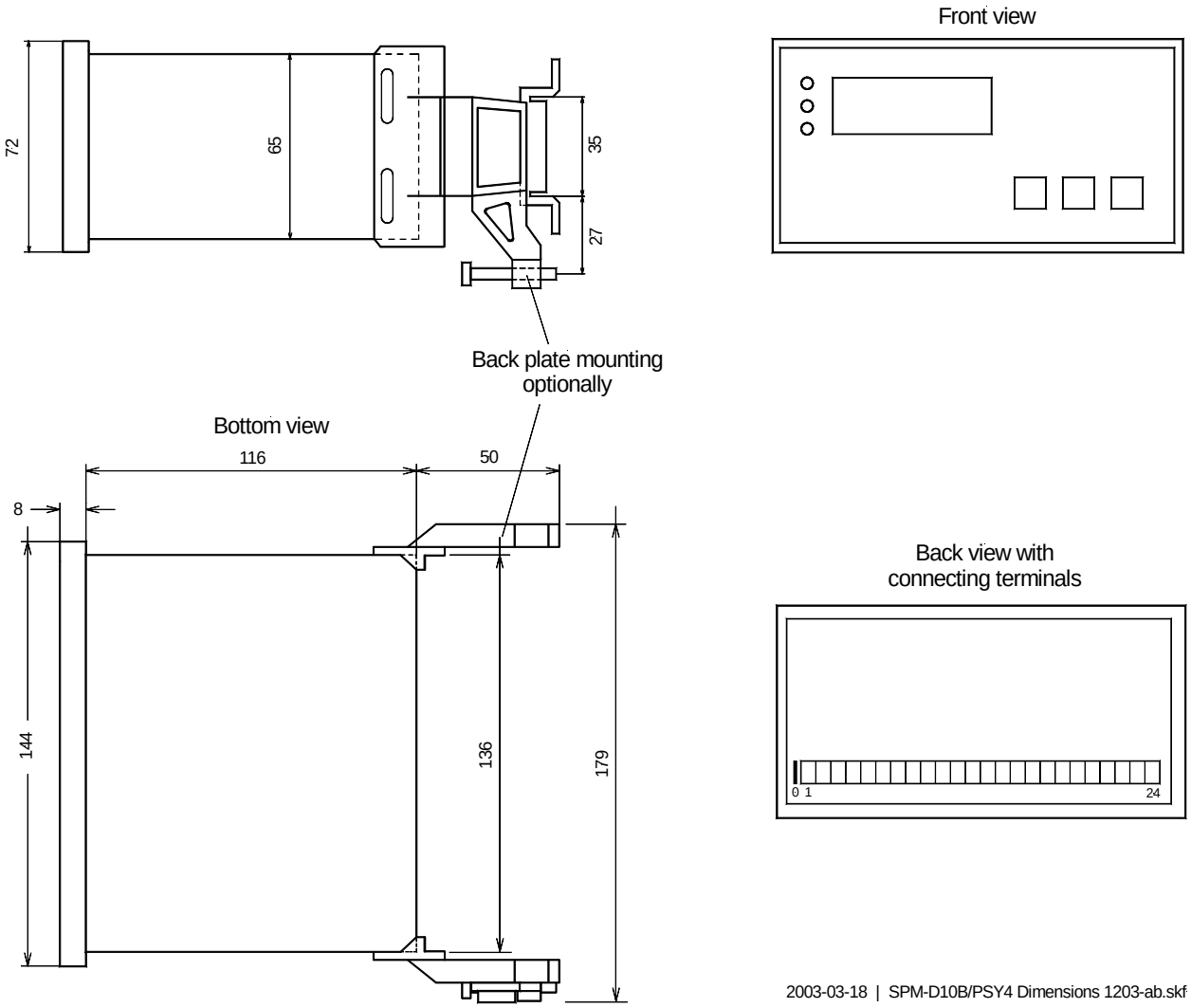
Potential-free outputs
- isolated ..... potential-free make-contact
- Contact material ..... AgCdO
- General purpose (GP) ($U_{Cont, relay output}$) AC ..... 2.00 Aac@250 Vac
  DC ..... 2.00 Adc@24 Vdc
  0.36 Adc@125 Vdc
  0.18 Adc@250 Vdc
- Pilot duty (PD) ($U_{Cont, relay output}$) AC B300
  DC ..... 1.00 Adc@24 Vdc
  0.22 Adc@125 Vdc
  0.10 Adc@250 Vdc

Housing
- Type ..... APRANORM DIN 43700
- Dimensions ..... 144 × 72 × 122 mm
- Front cutout ..... 138 [+1.0] × 68 [+0.7] mm
- Connection ..... Screw-type terminals 2.5 mm²
  use 60/75 °C copper wire only
  use class 1 wire only or equivalent
- Weight ..... depending on model, approx. 800 g

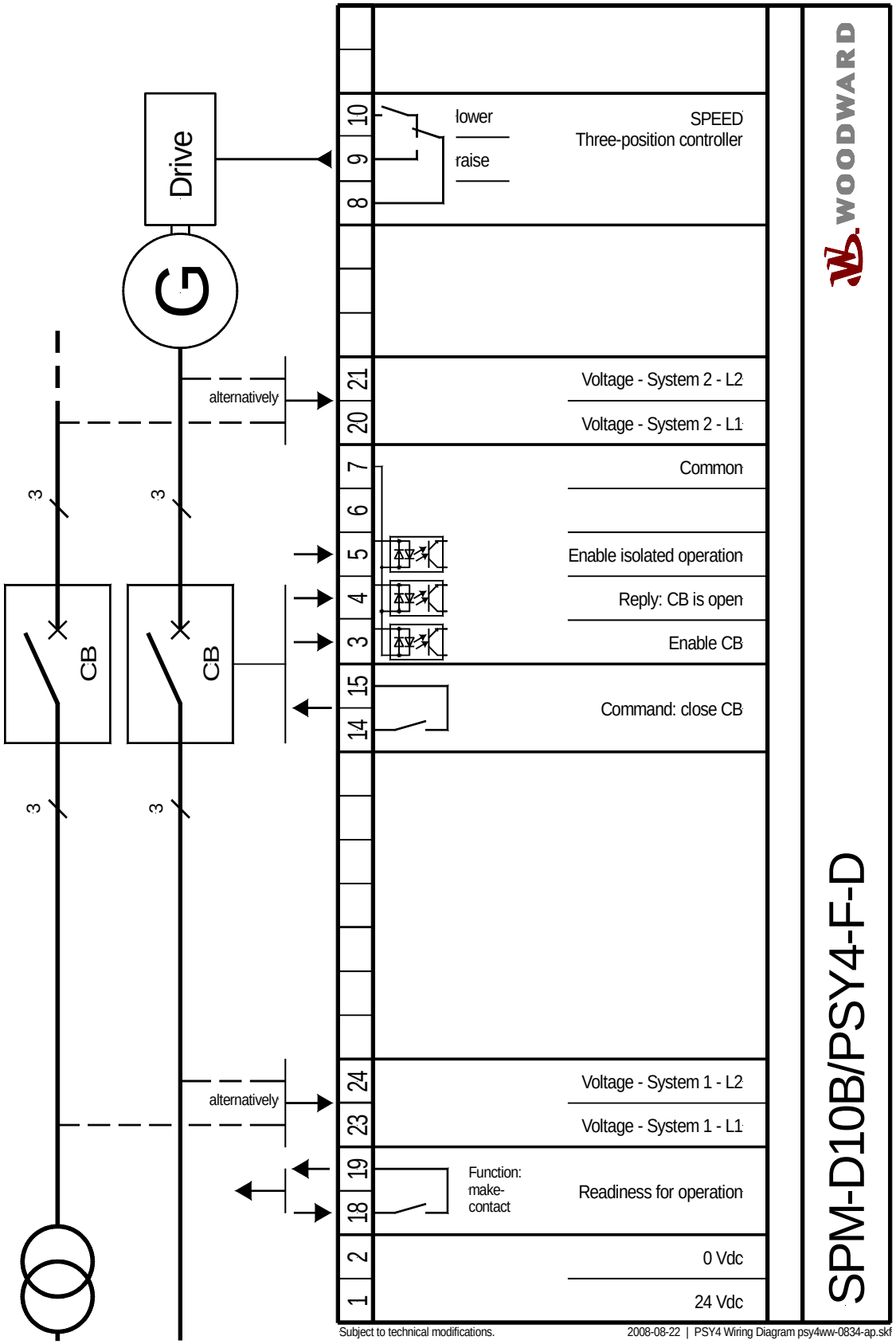
Protection
- Degree of protection ..... IP21; from front IP42
- Pressure-sensitive front membrane ..... isolating surface
- Disturbance test (EC) ..... Tested according to valid EN codes of practice

6.2 Dimensions

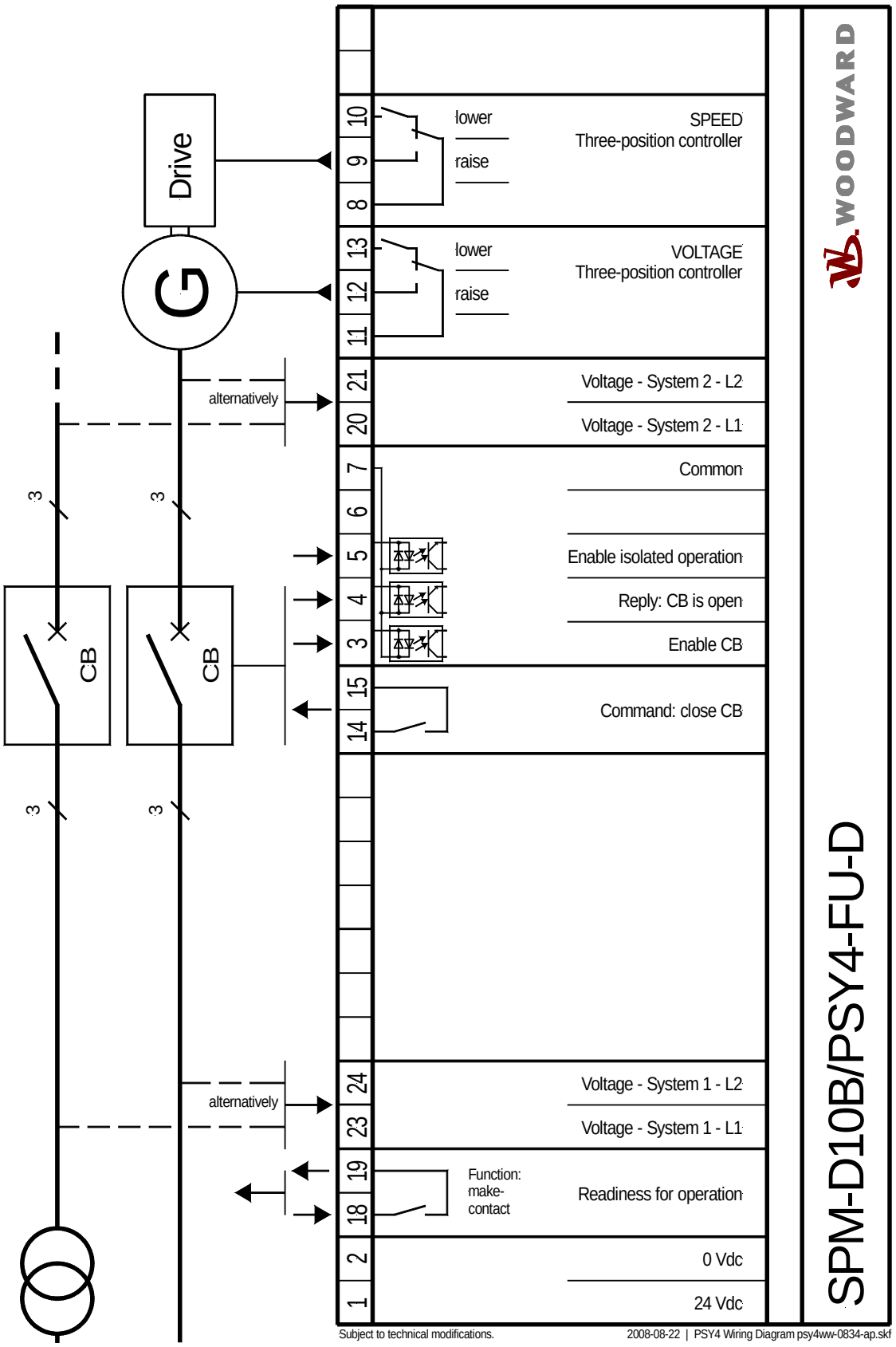
Housing	Type APRANORM DIN 43700
Dimensions	144 × 72 × 122 mm
Front section	138 [+1.0] × 68 [+0.7] mm
Connection	1.5 mm² or 2.5 mm² screw terminals depending on the plug connector
Degree of protection	IP 21, front IP 42
Weight	depending on model, approx. 800 g



6.3.1 SPM-D10B/PSY4-F-D



6.3.2 SPM-D10B/PSY4-FU-D



SPM-D10B/PSY4 Synchronizing system
Parameter list

Version _____

Project _____

Device number _____ Date _____

Option	Parameter Line 1 - Text - Line 2	Setting range	Default setting	Customer settings	
	Sprache/Language	German/English	English	☐ G ☐ E	☐ G ☐ E
	Software version		1.1xxx		
	Enter Code number	0..9999			
	Password Protection	ON/OFF		☐ ON ☐ OFF	☐ ON ☐ OFF
	Rated frequency fn=	48.0..62.0 Hz	50.0 Hz		
	Generator freq. fset =	48.0..62.0 Hz			
	Voltage System 1 secondary	50..440 V	400 V		
	Voltage System 2 secondary	50..440 V	400 V		
	Voltage System 1 primary	0.1..65.0 kV	0.4. kV		
	Voltage System 2 primary	0.1..65.0 kV	0.4. kV		
	Rated voltage Un =	70..420 V	400 V		
FU-D only	Voltage System 2 setpoint	50..440 V	400 V		
	Automatic idle Running	ON/OFF	ON	☐ ON ☐ OFF	☐ ON ☐ OFF
	Freq. controller	ON/OFF	ON	☐ ON ☐ OFF	☐ ON ☐ OFF
	Freq. controller Ramp	0.1..99.9 Hz/s			
	Freq. controller Dead band=	0.02..1.00 Hz	0.10 Hz		
	Freq. controller Time pulse>	10.. 250 ms	80 ms		
	Freq. controller Gain Kp=	0.1..99.9	15.0		
FU-D only	Volt. controller	ON/OFF	ON	☐ ON ☐ OFF	☐ ON ☐ OFF
..	Volt. controller Isolated op.	ON/OFF	ON	☐ ON ☐ OFF	☐ ON ☐ OFF
..	Volt. controller dead band	0.1..25.0 %	1.0 %		
..	Volt. controller time pulse>	20..250 ms	80 ms		
FU-D only	Volt. controller gain Kp	0.1..99.9	15.0		
	Synchronizing functions	ON/OFF	ON	☐ ON ☐ OFF	☐ ON ☐ OFF
	Synchronizing df offs.	0.00..0.25 Hz			
	Synchronization df max =	0.02..0.49 Hz	0.18 Hz		
	Synchronization df min =	0.00..-0.49 Hz	-0.10 Hz		
	Synchronization dU max =	0.1..15.0 %	6.0 %		
	Synchronization Time pulse>	0.04..0.50 s	200 ms		
	Closing time CB=	40.. 300 ms	80 ms		
	Circuit breaker Dead bus op.	ON/OFF	OFF	☐ ON ☐ OFF	☐ ON ☐ OFF
	Dead bus op. df max	0.05..5.00 Hz	0.25 Hz		
	Dead bus op. dU max	0.1..20.0 %	10.0 %		
	Sync.time contr.	ON/OFF	ON	☐ ON ☐ OFF	☐ ON ☐ OFF
	Sync.time contr. Delay time	10..999 s	120 s		
	Define level 1 Code	0000..9999	0001		
	Define level 2 Code	0000..9999	0002		