37249A

SPM-D21
Synchronizing Unit

Manual
from Version 6.2430

Manual 37249A

WARNING

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

The engine, turbine, or other type of prime mover should be equipped with an overspeed (overtemperature, or overpressure, where applicable) shutdown unit(s), that operates totally independently of the prime mover control unit(s) to protect against runaway or damage to the engine, turbine, or other type of prime mover with possible personal injury or loss of life should the mechanical-hydraulic governor(s) or electric control(s), the actuator(s), fuel control(s), the driving mechanism(s), the linkage(s), or the controlled unit(s) fail.

DANGER

To prevent damage to a control system that uses an alternator or battery-charging unit, make sure the charging unit is turned off before disconnecting the battery from the system.

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive units.**

Important Definitions

WARNING

Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury. Appropriate precautions have to be taken.

CAUTION

Indicates a potentially hazardous situation that, if not avoided, could result in damage to equipment. This 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.

Revision History

Rev.	Date	Editor	Changes
NEW	04-05-27	Tr	Release
A	06-03-28	TP	Changed screens for voltage monitoring from V6.2430; Package harmonization

Contents

Illustrations and Tables

Illustrations

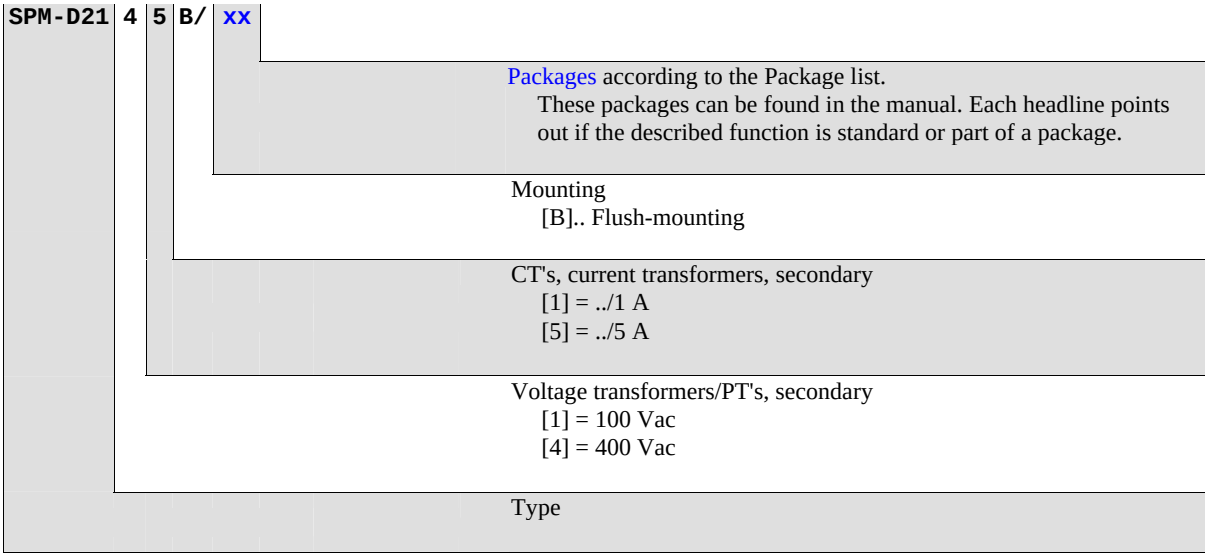
Tables

Chapter 1.
General Information

The SPM-D21 is a synchronizing unit. Through appropriate using of the discrete inputs the following functions can be realized:

- Synchronization (GCB and MCB)
- Synch-check (GCB and MCB)
- Dead bus start (GCB and MCB)
- Idle operation
- Isolated operation
- Operation in parallel with the mains

The SPM-D starts as a standard unit that may have additional functions added with each package. The model of the SPM-D is designated as follows:



Example:

- SPM-D2145B/PSV (PSV Package with 400 Vac PT measuring inputs and 5 A CT measuring input)

Intended Use The unit may only be operated for the uses described in this 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.

NOTE

This manual has been developed for an 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.

The present manual has been prepared to enable the installation and commissioning of the unit. 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.

Chapter 2.
Electrostatic Discharge Awareness

All electronic equipment is static-sensitive, some components more than others. To protect these components from static damage, you must take special precautions to minimize or eliminate electrostatic discharges.

Follow these precautions when working with or near the control.

1. Before doing maintenance on the electronic control, discharge the static electricity on your body to ground by touching and holding a grounded metal object (pipes, cabinets, equipment, etc.).

2. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.

3. Keep plastic, vinyl, and Styrofoam materials (such as plastic or Styrofoam cups, cup holders, cigarette packages, cellophane wrappers, vinyl books or folders, plastic bottles, and plastic ash trays) away from the control, the modules, and the work area as much as possible.

4. **With the opening of the unit the guarantee expires!**
   Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you have to remove the PCB from the control cabinet, follow these precautions:

   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive units or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

WARNING

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.*

Chapter 3.
Installation

CAUTION

A circuit breaker must be provided near to the unit 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

Inductivities connected (such as coils of operating current or undervoltage tripping units, or auxiliary or power contacts) must be connected to a suitable interference suppressor.

WARNING

All technical data and ratings indicated in this chapter are not definite! Only the values indicated in Fehler! Verweisquelle konnte nicht gefunden werden.**:** Fehler! Verweisquelle konnte nicht gefunden werden. **on page 80 are valid!**

The following chart may be used to convert square millimeters [mm²] to AWG and vice versa:

AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²	AWG	mm²
30	0.05	21	0.38	14	2.5	4	25	3/0	95	600MCM	300
28	0.08	20	0.5	12	4	2	35	4/0	120	750MCM	400
26	0.14	18	0.75	10	6	1	50	300MCM	150	1000MCM	500
24	0.25	17	1.0	8	10	1/0	55	350MCM	185		
22	0.34	16	1.5	6	16	2/0	70	500MCM	240		

Table 3-1: Conversion chart - wire size

Wiring Diagrams

SPM-D21/PSV

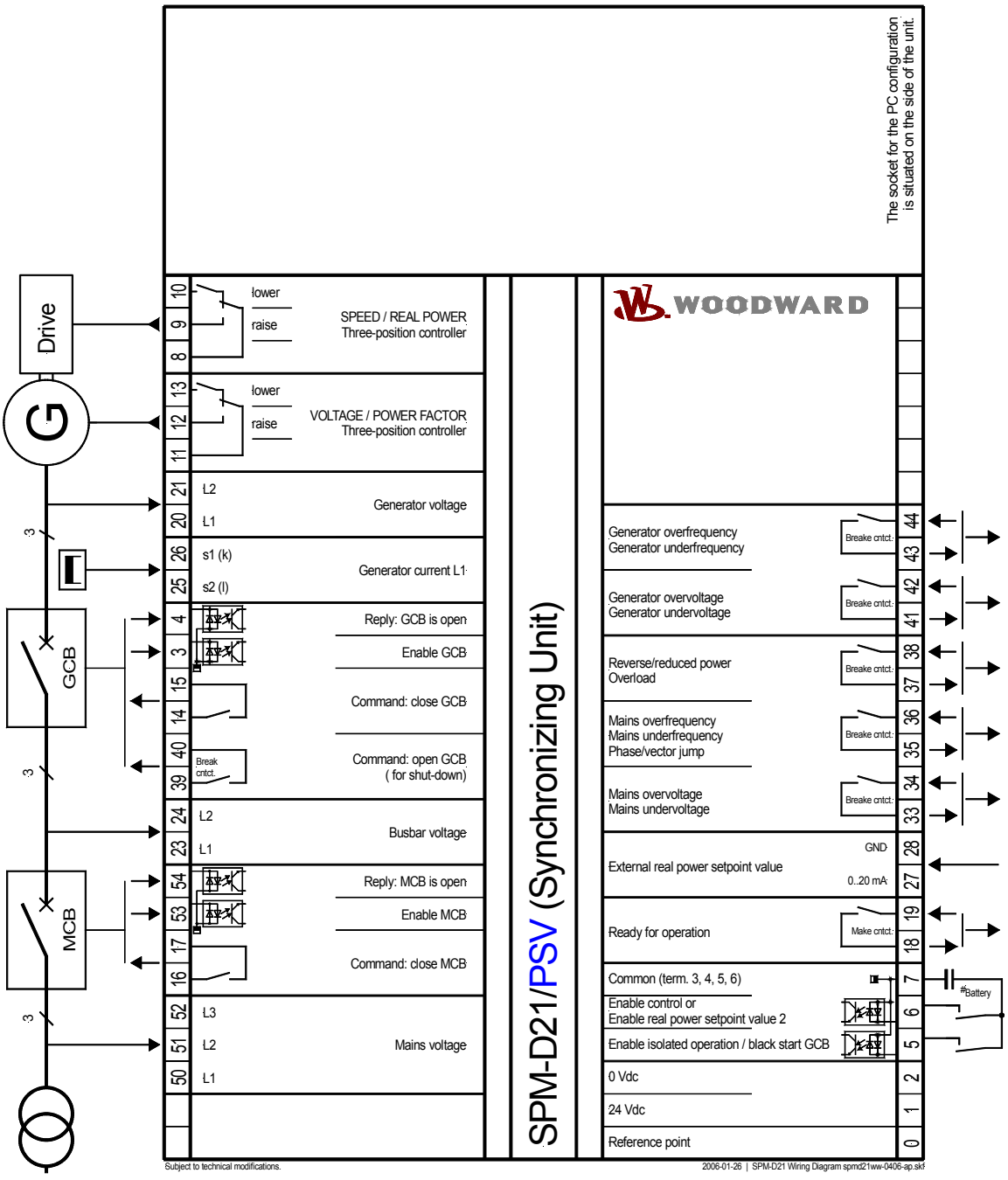


Figure 3-1: Wiring diagram SPM-D21/PSV

SPM-D21/PSVX

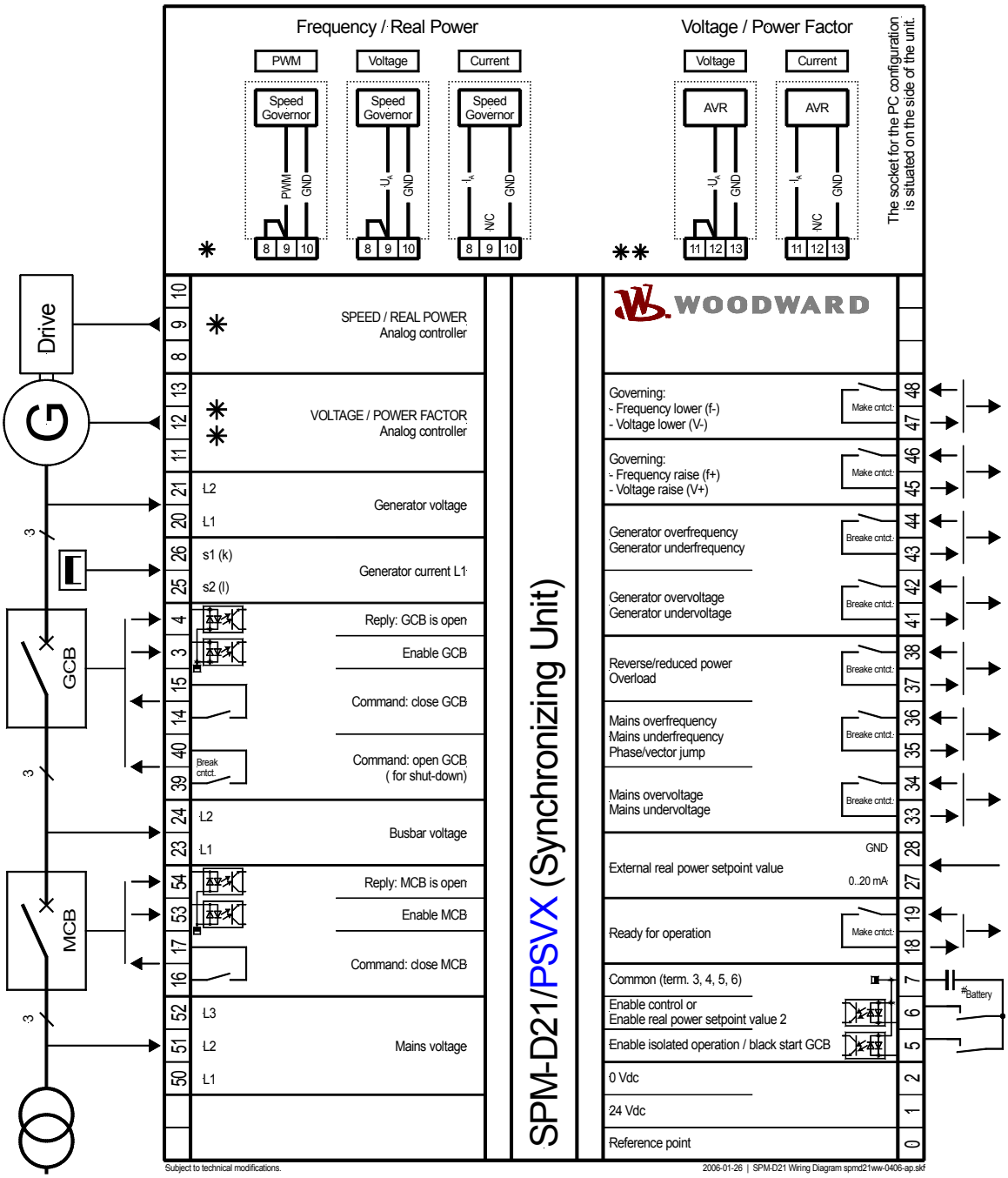


Figure 3-2: Wiring diagram SPM-D21/PSVX

Reference Point

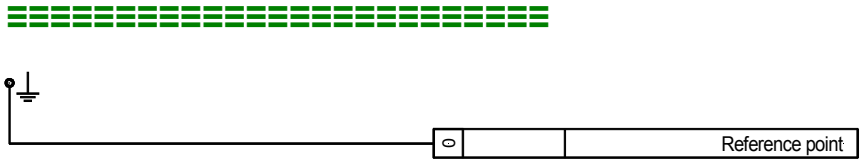


Figure 3-3: Reference point

Terminal	Description	A_{max}
0	Reference point: 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

Power Supply

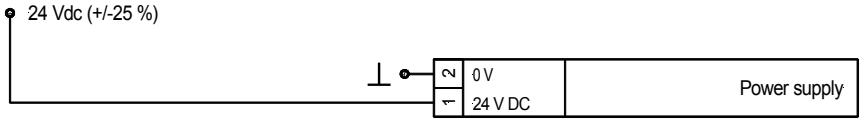


Figure 3-4: Power supply (24 Vdc)

Terminal	Description	A_{max}
Standard		
1	+24 Vdc, 10 W	2.5 mm²
2	0 V	2.5 mm²

Measuring Inputs

NOTE

The three-phase system must have a clockwise field (right-handed rotary field). If the unit is used with a counter-clockwise field (left-handed rotary field), the power factor measurement will not be correct.

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).

Generator

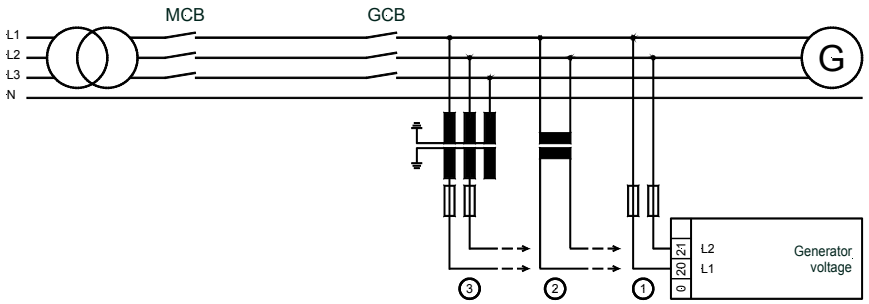


Figure 3-5: Measuring inputs - generator voltage

Note: Connection corresponding to the mains configuration (see wiring diagram).

Terminal	Measurement	Description	A_{max}
Connection to the measuring circuit voltage corresponding to the variant ①, ② or ③			
20	direct or via transformer ../100 V	Generator voltage L1	2.5 mm²
21		Generator voltage L2	2.5 mm²
0		Reference point: N-terminal of the low voltage system or star point of the voltage transducer (measuring reference point); → do not connect in three wire installations	Sold. lug

Busbar

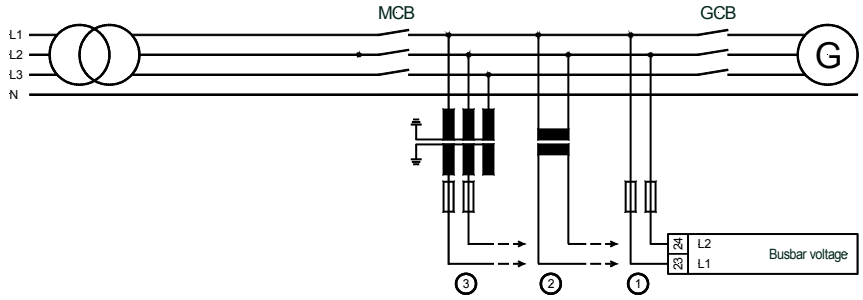


Figure 3-6: Measuring inputs - Busbar voltage

Note: Connection corresponding to the mains configuration (see wiring diagram).

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

Mains

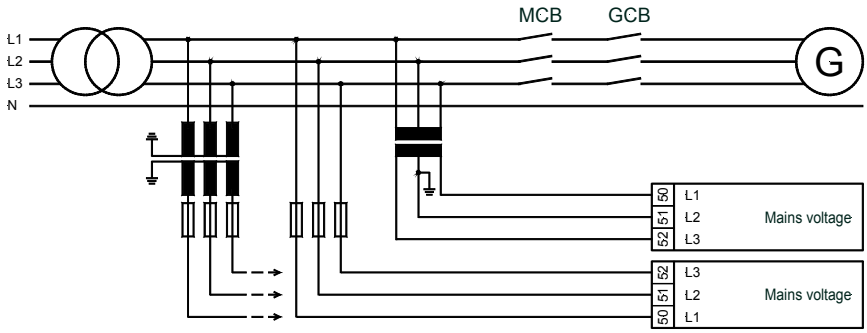


Figure 3-7: Measuring inputs - mains voltage

Note: Connection corresponding to the mains configuration (see wiring diagram).

Terminal	Measurement	Description	A_{max}
50	direct or measurement transducer ../100 V	Mains voltage L1	2.5 mm²
51		Mains voltage L2	2.5 mm²
52		Mains voltage L3	2.5 mm²
0		Neutral point of three-phase system / measurement transducer	2.5 mm²

Current

WARNING

Before disconnecting the secondary terminals of the transformer or the connection of the transformer at the unit make sure that the transformer is short circuited.

NOTE

Current transducers are generally to be earthed on one side secondarily.

Generator

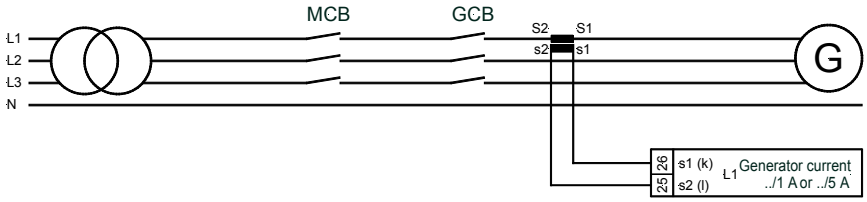


Figure 3-8: Measuring inputs - Generator current

Terminal	Measurement	Description	A_{max}
25	Converter ../1A	Generator current L1; transducer terminal s2(l)	2,5 mm²
26	or ../5A	Generator current L1; transducer terminal s1(k)	2,5 mm²

Discrete Inputs

CAUTION

Please note that the maximum voltages which may be applied at the discrete inputs are defined as follows. Voltages higher than those specified destroy the hardware!

- **Maximum input range: $^{+}/_{-}$18 to 250 Vac/dc.**

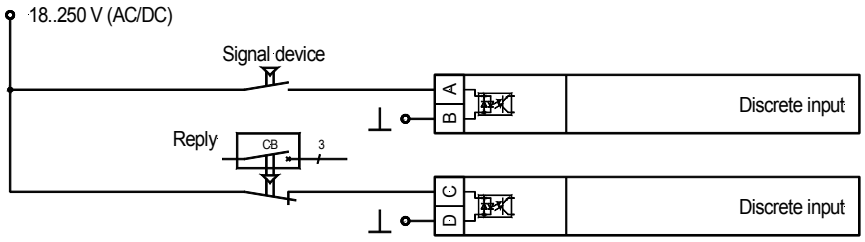


Figure 3-9: Discrete inputs

Terminal	Associated zero-terminal	Description (acc. DIN 40 719 part 3, 5.8.3)	A_{max}
Make contact			
A	***B***		
3	7	Enable GCB	2.5 mm²
5		Enable isolated operation / dead bus start GCB	2.5 mm²
6		Enable control or Switching power setpoint value 1/2[1]	2.5 mm²
53		Release MCB	2.5 mm²
Normally closed contact			
C	***D***		
4	7	Reply: GCB is open	2.5 mm²
54		Reply: MCB is open	2.5 mm²

[1] siehe Parameter "Klemme 6" auf Seite **Fehler! Textmarke nicht definiert.**

Analog Input

WARNING

The analog inputs of the SPM-D are not isolated. When using an isolation monitor, we recommend to use two-pole, isolated transmitters.

The analog inputs for active transmitters (0 to 20 mA, 0 to 10V) should only be operated with two-pole, isolated transmitters.

NOTE

This analog input is not isolated galvanically. If different devices are controlled with the same signal, a buffer amplifier must be installed before each device.

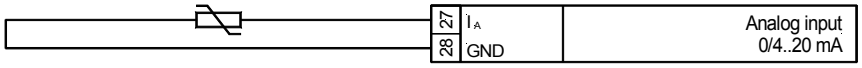


Figure 3-10: Analog input

Terminal	Associated zero-terminal	Description (acc. DIN 40 719 part 3, 5.8.3)	A_{max}
27	28	Setpoint value power	2,5 mm²

Auxiliary And Control Outputs

Circuit Breaker Actions

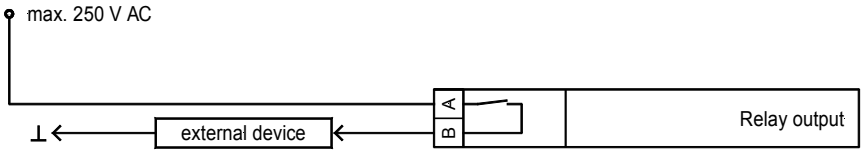


Figure 3-11: Relay outputs - control outputs I (CB control)

Root ***A***	Switched ***B***	Description	A_{max}
14	15	Synchronizing pulse, Command: close GCB	2.5 mm²
16	17	Synchronizing pulse, Command: close MCB	2.5 mm²
39	40	Command: open GCB for shut down	2.5 mm²

NOTE

The relay "Open GCB for shutdown" is used to open the GCB, after the power was reduced automatically (see also chapter 6 Configuration - Configure Controller). This relay is not triggered from watchdogs.

Other Actions

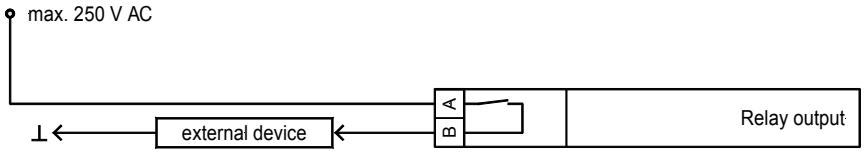


Figure 3-12: Relay outputs - control outputs II (messages)

Monitoring relay Break-contact

Root ***A***	Switched ***B***	Description **Note:** The relays release in case of error.	A_{max}
33	34	Mains over/under voltage	2.5 mm²
35	36	Mains over-/underfrequency, phase jump	2.5 mm²
37	38	Reverse/reduced power, overload	2.5 mm²
41	42	Generator over/under voltage	2.5 mm²
43	44	Generator over/under frequency	2.5 mm²

Signal relay Make-contact

Root ***A***	Switched ***B***	Description **Note:** The relays pick up in case of error.	A_{max}
18	19	Readiness for operation	2,5 mm²

Controller Outputs

The SPM-D21/PSV is equipped with two three-position controllers for voltage and frequency (made of a form C and form A relay). With the version SPM-D21/PSVX different controller output signals can be selected by configuration, which are connected in different ways.

SPM-D21/PSV

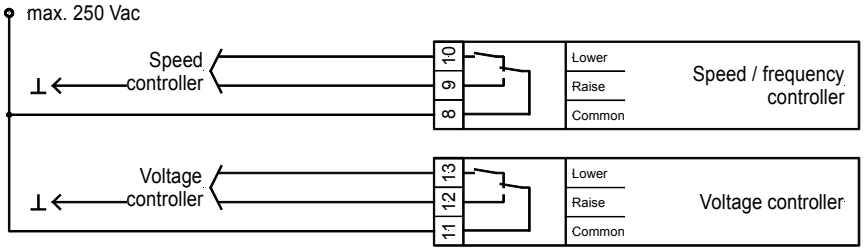


Figure 3-13: Controller - SPM-D21/PSV - three position controller

Terminal		Description	A_{max}
8	common	Speed/frequency controller	2.5 mm²
9	higher		2.5 mm²
10	lower		2.5 mm²
11	common	Voltage controller	2.5 mm²
12	higher		2.5 mm²
13	lower		2.5 mm²

SPM-D21/PSVX

The SPM-D21/PSVX has controller outputs for the following signals which can be changed by configuration as well as over an external bridge.

Versions

NOTE

Only one controller output may be configured as three-step controller.

- **Three-position controller** via relay manager
  - Control of n/f: Parameter "**f-controller type**" = THREESTEP
    n+/f+ = Relay connected to terminals 45/46
    n-/f- = Relay connected to terminals 47/48
  - Control of V: parameter "**v-controller type**" = THREESTEP
    V+ = Relay connected to terminals 45/46
    V- = Relay connected to terminals 47/48

- **Analog controller output**
  - Control of n/f: Parameter "**f-controller type**" = ANALOG
    Current output (mA) = no external bridge/jumper necessary
    Voltage output (V) = external bridge/jumper between 8/9
    Connect the Controller to terminals 9/10
  - Control of V: Parameter "**v-controller type**" = ANALOG
    Current output (mA) = no external bridge/jumper necessary
    Voltage output (V) = external bridge/jumper between 11/12
    Connect the controller to terminals 12/13

- **PWM controller output**
  - Control of n/f: Parameter "**f-controller type**" = PWM
    PWM output = external bridge/jumper between 8/9
    Connect the controller to terminals 9/10

Connection Of The Controllers

Setting: 'THREESTEP' (three-position controller)

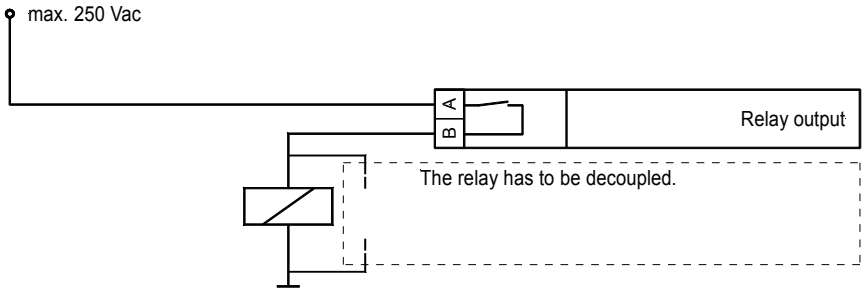


Figure 3-14: Controller - SPM-D21/PSVX - three position controller

Terminal		Description	A_{max}
45 / 46	raise	Speed / Frequency controller or	2.5 mm²
47 / 48	lower	Voltage controller	2.5 mm²

Setting: 'ANALOG' And 'PWM' (Analog Controller) - Frequency Controller

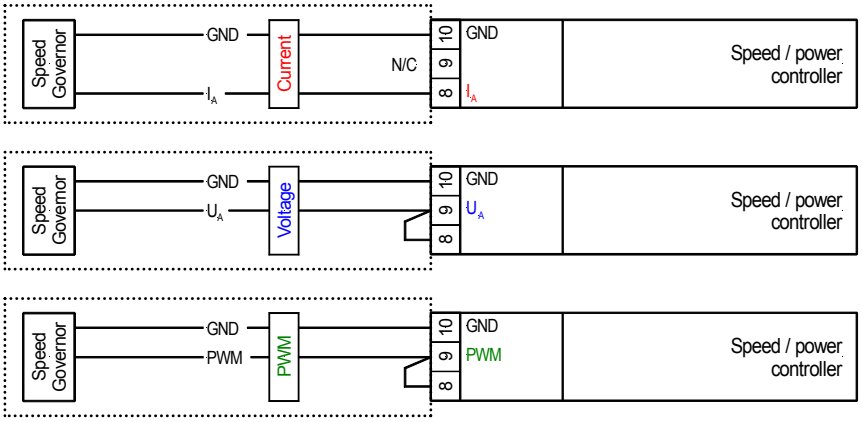


Figure 3-15: Controller - SPM-D21/PSVX - analog controller output - speed/frequency

Type	Terminal		Description	A_{max}
I Current	8	I_A	Speed controller / Frequency controller	2,5 mm²
	9			2,5 mm²
	10	GND		2,5 mm²
U Voltage	8			2,5 mm²
	9	U_A		2,5 mm²
	10	GND		2,5 mm²
PWM	8			2,5 mm²
	9	PWM		2,5 mm²
	10	GND		2,5 mm²

Setting: 'ANALOG' (Analog Controller) - Voltage Controller

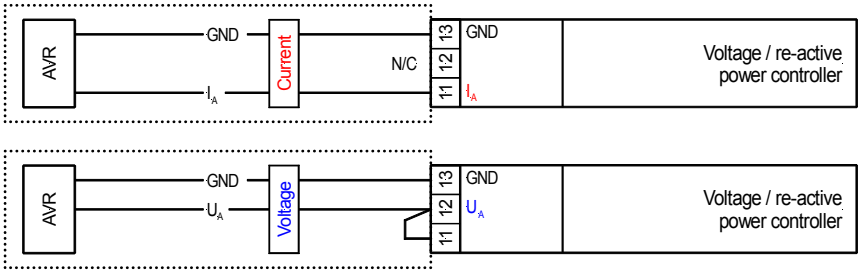


Figure 3-16: Controller - SPM-D21/PSVX - analog controller output - voltage

Type	Terminal		Description	A_{max}
I Current	11	I_A	Voltage controller	2.5 mm²
	12			2.5 mm²
	13	GND		2.5 mm²
U Voltage	11			2.5 mm²
	12	U_A		2.5 mm²
	13	GND		2.5 mm²

Chapter 4.
Functional Description

Functionality

Function Table For Terminal 6 = "Enable Control"

The unit can be used like a SPM-A with this setting.

The status of the discrete inputs "Reply: GCB is open" and "Enable GCB" is displayed using the LEDs "Gen CB - ON" und "Gen CB free" on the operation panel. The status of the discrete inputs "MCB is open" and ""Enable MCB" is also displayed using the LEDs "Bus CB - ON" und "Bus CB free" on the operation panel.
Additionally to the input signals, the conditions in Table 4-9: Operating conditions - terms must be observed.

To get a better overview, the total of all conditions is described in four detailed tables.

Both CBs are open (LED "Gen CB On" is off, LED "Bus CB On" is off)

Input signal				Operating conditions	Condition	Relay "Close MCB"	Relay "Close GCB"	Operating modes SPM-A
LED on front foil : "Bus CB free"	LED on front foil : "Gen CB free"	Digital input : "Isol. oper. / dead bus start GCB"	Digital input : "Release control"					
0	0	x	0	Off or Autom. idle running	- C1	Off Off	Off Off	OFF (GCB)
0	0	x	1	Idle running or Synchronizing GCB	C A	Off Off	Off Off	CHECK (GCB)
1	0	x	0	Off or Autom. idle running dead bus start MCB	- C1 E	Off Off dead bus start	Off Off Off	-
1	0	x	1	Idle running or Synchronizing GCB dead bus start MCB	C A E	Off Off dead bus start	Off Off Off	CHECK (GCB)
0	1	1	1	Idle running or Synchron. GCB or dead bus start GCB	C A B	Off Off Off	Off Slip/phase matching dead bus start	RUN (GCB) (extended)
0	1	1	0	Off	A	Off	Synchro-Check	-
0	1	0	1	Idle running or Synchronizing GCB	C A	Off Off	Off Slip/phase matching	RUN (GCB)
0	1	0	0	Off	A	Off	Slip/phase matching	PERMISSIVE (GCB)
1	1	1	1	Idle running or Synchron. GCB or dead bus start GCB or dead bus start MCB	C A B E	Off Off Off dead bus start	Off Slip/phase matching dead bus start Off	-
1	1	x	0	Off dead bus start MCB	A E	Off dead bus start	Slip/phase matching Off	-
1	1	0	1	Idle running or Synchron. GCB or dead bus start MCB	C A E	Off Off dead bus start	Off Slip/phase matching Off	-

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

Table 4-1: Operating conditions - terminal 6 = "Enable control"

GCB is open, MCB is closed (LED "Gen CB On" is off, LED "Bus CB On" is on)

Input signal				Operating conditions	Condition	Relay "Close MCB"	Relay "Close GCB"	Operating modes SPM-A
LED on front foil : "Bus CB free"	LED on front foil : "Gen CB free"	Digital input : "Isol. oper. / dead bus start GCB"	Digital input : "Release control"					
x	0	x	1	Idle running or Synchronizing GCB	C A	Off Off	Off Off	-
x	0	x	0	Off or Autom. idle running	- C1	Off Off	Off Off	(OFF)
x	1	x	1	Idle running or Synchronizing GCB	C A	Off Off	Off Slip/phase matching	-
0	1	1	0	Off	A	Off	Synchrocheck	-
0	1	0	0	Off	A	Off	Slip/phase matching	PERMISSIVE (GCB)
1	1	x	0	Off	A	Off	Slip/phase matching	-

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

Table 4-2: Operating conditions - Terminal 6 = "Enable control"

GCB is closed, MCB is open (LED "Gen CB On" is on, LED "Bus CB On" is off)

Input signal				Operating conditions	Condition	Relay "Close MCB"	Relay "Close GCB"	Operating modes SPM-A
LED on front foil : "Bus CB free"	LED on front foil : "Gen CB free"	Digital input : "Isol. oper. / dead bus start GCB"	Digital input : "Release control"					
1	x	0	1	Off	F	Slip/phase matching	Off	PERMISSIVE (MCB)
0	x	0	x	Off	-	Off	Off	(OFF)
1	x	0	0	Off	F	Slip/phase matching	Off	PERMISSIVE (MCB)
0	x	1	1	Isolated operation or Synchronizing MCB	D F	Off Off	Off Off	CHECK (MCB)
0	x	1	0	Off	-	Off	Off	(OFF)
1	x	1	1	Isolated operation or Synchronizing MCB	D F	Off Slip/phase matching	Off Off	RUN (MCB)
1	x	1	0	Off	F	Synchro-Check	Off	-

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

Notice: Two conditions are possible "PERMISSIVE (MCB)" because the controller can be blocked either by removing the discrete input "Enable isolated operation/Dead bus start GCB" or by removing the discrete input "Enable control".

Table 4-3: Operating conditions - Terminal 6 = "Enable control"

Both CBs are closed (LED "Gen CB On" is on, LED "Bus CB On" is on)

Input signal				Operating conditions	Conditions	Relay "Close MCB"	Relay "Close GCB"	Operating modes SPM-A
LED on front foil : "Bus CB free"	LED on front foil : "Gen CB free"	Digital input : "Isol. oper. / dead bus start GCB"	Digital input : "Release control"					
x	0	x	1	power / power factor control or shutdown	- G	OFF OFF	OFF OFF	-
x	1	x	1	power / power factor control	-	OFF	OFF	-
x	x	x	0	Off	-	OFF	OFF	OFF

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

Table 4-4: Operating conditions - Terminal 6 = "Enable control"

Functional Table For Terminal 6 = "Release Power Control Setpoint 2"

The unit can be used as a ASG 421+ with this setting.

The status of the discrete inputs "Reply: GCB open" and "Enable GCB" is displayed using the LEDs "Gen CB - ON" und "Gen CB free" on the operation panel. Equally the status of the discrete inputs "MCB is open" and "Enable MCB" is displayed using the LEDs "Bus CB ON" and "Bus CB free" on the operation panel.
Additionally to the input signals the conditions in Table 4-9: Operating conditions - terms must be noticed.

To get a better overview, the total of all conditions is described in four detailed tables.

Both CBs are open (LED "Gen CB On" is off, LED "Bus CB On" is off)

Input signal				**Operating conditions**	**Condition**	**Relay "Close MCB"**	**Relay "Close GCB"**
LED on front foil : "Bus CB free"	LED on front foil : "Gen CB free"	Digital input : "Isol. oper. / dead bus start GCB"	Digital input : "Power control setpoint 2				
0	0	x	x	Off or Automatic idle running	- C1	- Off	- Off
1	0	x	x	dead bus start MCB	E	dead bus start	Off
0	1	1	x	Idle running or Synchronizing GCB or dead bus start GCB	C A B	Off Off Off	Off Slip or phase matching dead bus start
0	1	0	x	Idle running or Synchronizing GCB	C A	Off Off	Off Slip or phase matching
1	1	1	x	Idle running or Synchronizing GCB or dead bus start GCB or dead bus start MCB	C A B E	Off Off Off dead bus start	Off Slip or phase matching dead bus start Off
1	1	0	x	Idle running or Synchronizing GCB or dead bus start MCB	C A E	Off Off dead bus start	Off Slip or phase matching Off

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

Table 4-5: Operating conditions - Terminal 6 = "Enable control"

GCB is open, MCB is closed (LED "Gen CB On" is off, LED "Bus CB On" is on)

Input signal				Operating conditions			
LED on front foil : "Bus CB free"	LED on front foil : "Gen CB free"	Digital input : "Isol. oper. / dead bus start GCB"	Digital input : "Power control setpoint 2		Condition	Relay "Close MCB"	Relay "Close GCB"
x	0	x	x	Idle running	C	Off	Off
x	1	x	x	Idle running or Synchronizing GCB	C A	Off Off	Off Slip or phase matching

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

Table 4-6: Operating conditions - Terminal 6 = "Enable control"

GCB is closed, MCB is open (LED "Gen CB On" is on, LED "Bus CB On" is off)

Input signal				Operating conditions			
LED on front foil : "Bus CB free"	LED on front foil : "Gen CB free"	Digital input : "Isol. oper. / dead bus start GCB"	Digital input : "Power control setpoint 2		Condition	Relay "Close MCB"	Relay "Close GCB"
x	x	0	x	Off	-	Off	Off
0	x	1	x	Isolated mode	D	Off	Off
1	x	1	x	Isolated mode or Synchronizing MCB	D F	Off Slip or phase matching	Off

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

Table 4-7: Operating conditions - Terminal 6 = "Enable control"

Both CBs are closed (LED "Gen CB On" is on, LED "Bus CB On" is on)

Input signal				Operating conditions			
LED on front foil : "Bus CB free"	LED on front foil : "Gen CB free"	Digital input : "Isol. oper. / dead bus start GCB"	Digital input : "Power control setpoint 2		Condition	Relay "Close MCB"	Relay "Close GCB"
x	0	x	0/1	power / power factor control setpoint 1/2 or shutdown	- G	Off Off	Off Off
x	1	x	0/1	power / power factor control setpoint 1/2	-	Off	Off

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

Table 4-8: Operating conditions - terminal 6 = "OFF"

Additional Conditions

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

Condition		
A	Synchronization Generator circuit breaker	The systems to be synchronized have to be inside the following limits: 50 % < V < 125 % of rated voltage V_N 80 % f < 110 % of rated frequency f_N (after the synchronization time alarm has responded the synchronization will be stopped)
B	Dead bus start Generator circuit breaker	Parameter "GCB dead bus operation ON" Busbar voltage has to be less than 5 % of rated voltage Voltage and frequency of the generator have to lie inside the parameterized limits for dead bus operation.
C1	Automatic idle running	Parameter "Automatic idle running ON" for start of frequency control: Generator voltage > 50 % rated voltage V_N for start of voltage control: Generator frequency > 90 % rated frequency f_N
C	Idle running	for start of frequency control: Generator voltage > 50 % rated voltage V_N for start of voltage control: Generator frequency > 90 % rated frequency f_N
D	Isolated operation	for start of frequency control: Generator voltage > 50 % rated voltage V_N Parameter "Frequency control isolated operation ON" for start of voltage control: Generator frequency > 90 % rated frequency f_N Parameter "Voltage control isolated operation ON"
E	Dead bus start MCB	Parameter "MCB dead bus operation ON" Busbar voltage has to be less than 5 % of rated voltage Voltage and frequency of the mains have to lie inside certain limits.
F	Synchronizing MCB	The systems to be synchronized have to lie inside the following limits: 50 % < V < 125 % of rated voltage V_N 80 % f < 110 % of rated frequency f_N (after the synchronization time alarm has responded the synchronization will be stopped)
G	Shutdown	Parameter "Shutdown ON"

Table 4-9: Operating conditions - terms

Control Inputs

Release GCB
Terminal 3

- Terminal 6 = "Enable control"
  If this discrete input is set, the operation of the GCB is released. For tests during commissioning, zero volt can be applied to this input. Thus, a switching of the GCB can be prevented, even if the control functions are enabled. If both circuit breakers are closed and the parameter "Shut-down" is set ON, thus initiates by reset of this input, that the genset is shut down.
- Terminal 6 = "Release Power Setpoint value"
  If this discrete input is set, the operation of the GCB and the control functions are enabled at the same time, if this input is set. If both circuit breakers are closed and the parameter "Shutdown" is set ON, thus initiates by reset of this input, that the genset is shut down.

Release MCB
Terminal 53

- Terminal 6 = "Release Control"
  If this input is set, the operation of the MCB is enabled. For tests during commissioning, zero volt can be applied to this input and thus switch on of the MCB can be prevented. although if control functions are active. If the MCB is closed, this input has no effect.
- Terminal 6 = "Release Power Setpoint Value"
  If this input is set, the operation of the MCB is enabled and controlling is released, if all other conditions for isolated operation are fulfilled. If the MCB is closed, this input has no effect.

Reply: GCB is open
Terminal 4

The status of the GCB must be transmitted to this unit through this input. The input must be set if the GCB is open. (The status of this input is checked for its plausibility and is signaled with the LED "Gen CB - ON".)

Reply: MCB is open
Terminal 54

The status of the MCB must be transmitted to this unit through this input. The input must be set if the MCB is open. (The status of this input is checked for its plausibility and is signaled with the LED "Bus CB - ON".)

Enable: Isolated operation/dead bus start GCB
Terminal 5

With an opened GCB a dead bus start is enabled, by setting this input. With a closed GCB the frequency and voltage controllers are enabled for isolated operation, by setting this input.

CAUTION

If several generators feed one busbar, it has to be ensured with external interlocking that only one of the generators is released for dead bus start at a time. If several generators are released for dead bus start at the same time, it may happen that the generator circuit breakers close at the same time, which might cause serious damage to the generators!

Enable control or switching power setpoint value
Terminal 6

Terminal 6 = "Enable control"
If "terminal 6 = Enable control" is set, the frequency and voltage controllers are enabled, when setting this input. For tests during commissioning, zero volt can be applied to this input and thus, the control functions can be switched off.
Terminal 6 = " Release Power Setpoint Value"
If "terminal6 = power setpoint value" is set, the setpoint value for the real power is selected. If this input is set, setpoint value 2 is used for control or the setpoint value of the mA-input. otherwise setpoint value 1 is used.

Operating Conditions

Idle Control

The generator voltage and generator frequency are adjusted to the configured setpoint values. The generator circuit breaker is open.

Synchronizing GCB

Synchronization With Slip

The generator voltage will be corrected to the amplitude and frequency of the busbar voltage. In consideration of the inherent delay the connect command for the GCB will be issued. The synchronization is done under the following conditions (see also tables in chapter "Function" at page 22):

- The unit is in the automatic mode (LED "Automatic" lights up).
- The synchronization is switched on.
- The voltages and frequencies are within a certain range.
- The input "Enable GCB" is set (if terminal 6 = Power setpoint value).
- The input "Enable GCB" is set, to enable the connection command and the input "Enable control" is set, to enable the control functions (if terminal 6 = Enable control).
- The input "Reply: GCB is open" is set and
- the synchronization time monitoring is not switched on or has not tripped.

Synchronization With Zero Phase Control

The generator voltage will be corrected to the amplitude of the busbar voltage by the voltage controller. The frequency controller is operating in two possible stages:

- Frequency correction: - As long as the difference of the frequency between generator and busbar does not fall below the configured value "df start", the generator is corrected to the frequency of the busbar.
- Phase angle correction: - If the frequency difference between generator and busbar is less than the value "df start", the frequency controller adjusts the phase angle of the generator to that of the busbar, in view of turning the phase difference to zero. The control of the phase angle is stopped only, when the frequency difference between the generator and the busbar is getting greater then the value "df start" plus a firmly deposited hysteresis of 0.8 Hz.

The connect command for the power circuit breaker is done under the following conditions:

- The configured limits for voltage and frequency are met.
- The phase angle between the systems is less then the maximum permissible angle for at least the configurable time
- The input "Enable GCB" is set (if terminal 6 = Power setpoint value)
- The input "Enable GCB" is set, to enable the connect command and the input "Enable control" is set, to enable the controls (if terminal 6 = Enable control)
- The input "Reply GCB is open" is set

The connection is done without consideration of the inherent delay. In the phase-angle-zero-control mode the analog input should be selected for the frequency controller.

Synchronizing MCB

Synchronization With Slip

The busbar voltage will be corrected to the amplitude and frequency of the mains voltage. In consideration of the inherent delay the connect command for the MCB will be issued. The synchronization is done under the following conditions (see also tables in chapter "Function" at page 22):

- The unit is in the automatic mode (LED "Automatic" lights up).
- The synchronization is switched on.
- The voltages and frequencies are within a certain range.
- The input "Enable MCB" is set (if terminal 6 = Power setpoint value).
- The input "Enable MCB" is set, to enable the connection command and the input "Enable control" is set, to enable the control functions (if terminal 6 = Enable control).
- The input "Enable isolated operation/dead bus start GCB" is set to enable control functions,
- The input "Reply: GCB is open" is not set,
- The input "Reply: MCB is open" is set and
- the synchronization time monitoring is not switched on or has not tripped.

Synchronization With Zero Phase Control

The busbar voltage will be corrected to the amplitude of the mains voltage by the voltage controller. The frequency controller is operating in two possible steps:

- Frequency correction: - As long as the difference of the frequency between busbar and mains does not fall below the configured value "df start", the busbar is corrected to the frequency of the mains.
- Phase angle correction: - If the frequency difference between busbar and mains is less than the value "df start", the frequency controller adjusts the phase angle of the busbar to that of the mains, in view of turning the phase difference to zero. The control of the phase angle is stopped only, when the frequency difference between the busbar and the mains is getting greater then the value "df start" plus a firmly deposited hysteresis of 0.8 Hz.

The connect command for the power circuit breaker is done under the following conditions:

- The configured limits for voltage and frequency are met.
- The phase angle between the systems is less then the maximal permissible angle for at least the configurable time
- The input "Enable MCB" is set (if terminal 6 = Power setpoint value)
- The input "Enable MCB" is set, to enable the connect command and the input "Enable control" is set, to enable the controls (if terminal 6 = Enable control)
- The input "Enable isolated operation/dead bus start GCB" is set to enable control functions,
- The input "Reply: GCB is open" is not set,
- The input "Reply: MCB is open" is set.

The connection is done without consideration of the inherent delay. In the phase-angle-zero-control mode the analog input should be selected for the frequency controller.

Synch-Check GCB

In this condition, the unit can be used as a synchronization control. No control is carried out. The relay "GCB close" remains picked up, as long as the following conditions are met:

- The configured limit for the voltage difference is met (screen "synchronization dV_{max}")
- The configured limits for the frequency difference are met (screens "synchronization df_{max} and df_{min}")
- The configured limit for the phase angle is met (screen "slip synchron. phi_{max}")
- The input "Reply: GCB is open" is set
- The parameter "Terminal 6" is configured to "Enable control",
- the terminal 6 is not set (the control is disabled),
- the input "Enable isolated operation / dead bus start GCB" is set and
- the input "Enable GCB" is set.

The synchronization time monitoring is disabled.

Synch-Check MCB

In this condition, the unit can be used as a synchronization control. No control is carried out. The relay "MCB close" remains picked up, as long as the following conditions are met:

- The configured limit for the voltage difference is met (screen "synchronization dV_{max}")
- The configured limits for the frequency difference are met (screens "synchronization df_{max} and df_{min}")
- The configured limit for the phase angle is met (screen "slip synchron. phi_{max}")
- The input "Reply: GCB is open" is not set
- The parameter "Terminal 6" is configured to "Enable control",
- the terminal 6 is not set (the control is disabled),
- the input "Enable isolated operation / dead bus start GCB" is set and
- the input "Enable MCB" is set.
- the input "Reply: MCB is open" is set.

The synchronization time monitoring is disabled.

Isolated Operation

The generator voltage and frequency will be adjusted to the configurable setpoint values. The generator breaker is closed. To activate the voltage controller, the parameter "voltage controller in isolated operation" must be set to "ON". To activate the frequency controller, the parameter "frequency controller in isolated operation" must be set to "ON". More over, isolated operation is only possible, if the discrete input "Release isolated operation / dead bus start" is set.

Closing The GCB Without Synchronization (Dead Bus start GCB)

Output of a connect command for the GCB without synchronization if the following conditions are met:

- The unit is in the automatic mode (LED "Automatic" lights up),
- the parameter "**Gen. switch black start**" has been set to "**ON**",
- the busbar is not energized (V_{SS} < 5 % V_N),
- the generator voltage and frequency are within the configured limits,
- the input "Enable isolated operation / dead bus start GCB" is set,
- the input "Enable GCB" is set and
- the input "Reply: GCB is open" is set
- the input "Reply: MCB is open" is set.
- terminal 6 is set (if "Terminal 6 Enable Control").

If at the same time the conditions for a dead bus start MCB are fulfilled, the dead bus start MCB has priority.

Closing The MCB Without Synchronization (Dead Bus start MCB)

Output of a connect command for the MCB without synchronization if the following conditions are met:

- The unit is in the automatic mode (LED "Automatic" lights up),
- the parameter "**Mains switch black start**" has been set to "**ON**",
- the busbar is not energized (V_{SS} < 5 % V_N),
- The mains voltage deviates from the rated voltage less than three-times of the parameter "Synchronizing dV max".
- The mains frequency deviates from the rated frequency less than four times of the parameter "Synchronizing df max".
- the input "Enable MCB" is set,
- the input "Reply: MCB is open" is set and
- the input "Reply: GCB is open" is set.

If at the same time the conditions for a dead bus start GCB are fulfilled, the dead bus start MCB has priority.

Operation In Parallel With The Mains

In operation in parallel with the mains both circuit breakers are closed and the real power and the power factor cos phi are controlled to the configured setpoint values, preconditioned that the controllers are activated in the configuration. If "terminal 6 = Enable control" is adjusted, terminal 6 must be set additionally, so that the controller operates.

Selection Of The Power Setpoint Value

- If the generator is connected in parallel with the mains over the GCB, initially a part load lead is carried out.
- If "Terminal 6 = Enable control" is adjusted, the following is valid:
  - Set value 2, if "setpoint value 2 external" is configured "OFF" or
  - the set value predetermined over the mA-signal, if "power setpoint value 2 external" is configured "ON".
- If "Terminal 6 = Power setpoint value" is adjusted, the following is valid:
  - Set value 1, if terminal 6 is not set or
  - set value 2, if terminal 6 is set and "Setpoint value external" is configured "OFF" or
  - the set value predetermined over the mA-signal, if terminal 6 is set and "Setpoint value external" is configured "ON"
  - the power setpoint is always routed over a setpoint ramp, whose increase is adjustable.
  - the power setpoint is upwards limited to the configured value "P max"
  - the power setpoint is downwards limited to the configured value "P min".

Shutdown

If "Shutdown" is configured "ON", the installation can be shutdown over the input "Enable GCB", that means:
- With the resetting of the input "Enable GCB" shutdown starts and
- the power will be reduced.
- If the real power falls below 10 % of the rated power, the relay "open GCB for shutdown" will be opened.

LED "Gen CB - ON" Flashes

LED "Gen CB - ON" flashes: Incorrect signal state of the "Reply: GCB is open" on terminal 4.
Possible faults:
- Reply present on (= 0 V)
  generator and busbar voltage not synchronous

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

LED "Bus CB - ON" Flashes

LED "Bus CB - ON" flashes: Incorrect signal state of the "Reply: MCB is open" on terminal 54.
Possible faults:
- Reply present on (= 0 V)
  busbar and mains voltage not synchronous

If the LED flashes, one must check to see whether the input on terminal 54 is correctly wired. For the wiring to be correct, there must be **0 V** applied to the input when the **power circuit breaker is closed**.

Control Outputs

Synchronization pulse: Command: Close GCB
Terminals 14/15

By setting this relay the GCB will be closed. The relay drops out after the pulse is output. Exception: Operation mode Synch-check.

Synchronization pulse: Command: Close MCB
Terminals 16/17

By setting this relay the MCB will be closed. The relay drops out after the pulse is output. Exception: Operation mode Synch-check.

Readiness for operation
Terminals 18/19

The contact assembly is closed when the unit is ready for operation. The relay will drop out if the following occurs:

a) The internal self-monitoring system stated an alarm. In this case a trouble-free function of the unit cannot be guaranteed and other appropriate measures have to be taken into account, if necessary.
b) The synchronization time monitoring system is enabled and has responded.

Command: open GCB for shutdown
Terminal 39/40

The relay can be used for shutdown of the installation. It is assigned for shutdown and works independent of the watchdogs (see also chapter "Operation In Parallel With The Mains" after page 35).

Isolation Of The Power Supply From The Discrete Inputs

By means of an appropriate external wiring, the common reference point of the discrete inputs (terminal 7) can be metallically separated from the supply voltage (0 V, terminal 2) . This is for instance necessary, if the discrete inputs are not to be controlled with +24 Vdc and a metallic separation of the control voltage (e. g. 220 Vdc, 220 Vac) from the supply voltage has to be ensured.

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 (supply voltage)
  Terminal 7: 0 V or N (control voltage)

Analog Controller Outputs

The analog PID controller forms a closed-loop control loop together with the controlled system (usually a first-order lag element). The parameters of the PID controller (proportional-action coefficient K_P, derivative-action time T_V and reset time T_n) can be modified individually.

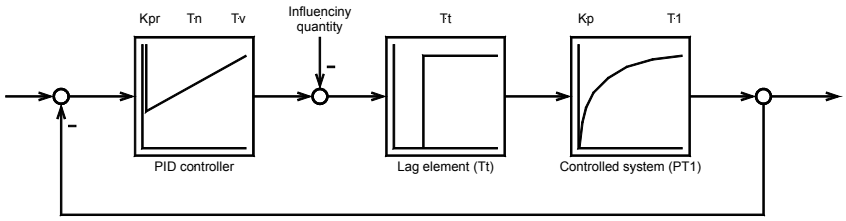


Figure 4-1: Control loop

If an abrupt disturbance variable is applied to the control loop, the reaction of the controlled system can be recorded at the output as a function of time (step response).

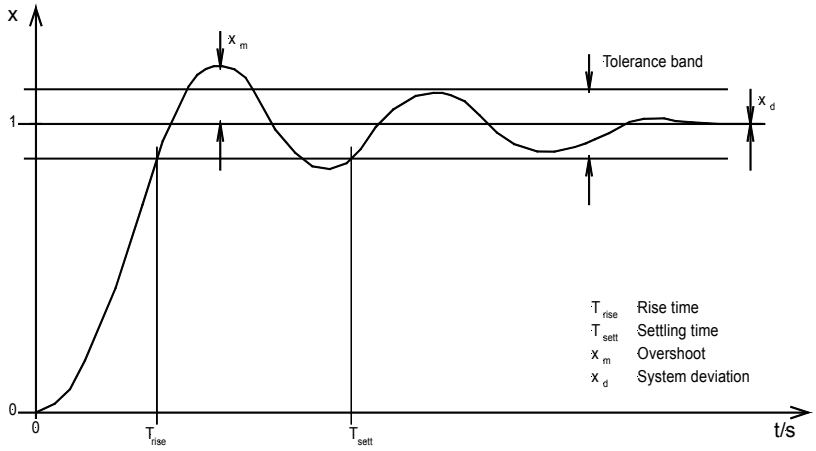


Figure 4-2: Step response (example)

Various values can be obtained from the step response; these are required for adjusting the controller to its optimum setting:

Rise time T_{an}: Period starting when the value of the control variable leaves a predefined tolerance range for the control variable following a jump in the disturbance variable or reference input variable and ending the first time the value re-enters this range.

Setting time T_{aus}: Period starting when the value of the control variable leaves a predefined tolerance range for the control variable following a step in the disturbance variable or reference input variable and ending when the value re-enters this range permanently.

Overshoot x_m: Highest transient setpoint value deviation during the transition from one steady-state condition to a new steady-state condition following modification of the disturbance variable or reference input variable ($x_{m\ Optimal} \leq 10$ %).

Permanent control deviation x_d: The present deviation between setpoint value and control variable in the steady-state condition (PID controller: $x_d = 0$).

From these values, the values K_P, T_n and T_V can be determined by various calculations. Moreover, it is possible, by performing various calculations, to determine the optimal controller settings, e. g. by calculating compensation or adjustment of the time constants, T-sum rule, or symmetric optimum. Other setting procedures and information may be obtained from current literature.

CAUTION

The following must be observed regarding the controller setting:

- **Ensure that the emergency shutdown system is ready for use.**
- **While determining the critical frequency, pay attention to the amplitude and frequency.**
- **If the two values change uncontrollably:**

➔ EMERGENCY SHUTDOWN ←

Initial state: The start position of the controller is determined using the initial state of the controller. If the controller is switched off, the initial state can be used to output a fixed controller position. Even when the analog controller is switched off, the initial state can be freely adjusted (e.g. the speed controller can be controlled in a statically manner).

```
Controller output
Initial state 000%
```

Initial state **0 to 100 %**

Analog controller output setting with controller switched off.

General settings: The setting rule described below only serves as an example. Whether this method is suitable for setting your particular controlled system has not been and cannot be taken into account as each controlled system behaves uniquely.

There are various methods of setting a controller. The setting rules of Ziegler and Nichols are explained below (determination for abrupt disturbances on the system input); this setting method assumes a pure lag element connected in series with a first-order lag system.

1. Controller operated as a P-only controller
   (where $T_n = \infty$ [screen setting: T_n =0], $T_V = 0$).
2. Increase gain K_P (P gain) until the control loop oscillates continuously at $K_P = K_{Pcrit}$.

CAUTION

If the unit starts to oscillate uncontrollably, carry out an emergency shutdown and alter the screen setting accordingly.

3. Measuring of the cycle duration T_{crit}
4. Set the parameters:

PID controller

$K_P = 0{,}6 \times K_{Pkrit}$
$T_n = 0{,}5 \times T_{krit}$
$T_V = 0{,}125 \times T_{krit}$

PI controller

$K_P = 0{,}45 \times K_{Pkrit}$
$T_n = 0{,}83 \times T_{krit}$

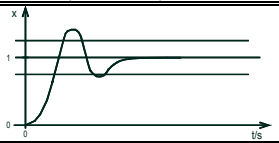
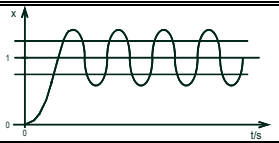
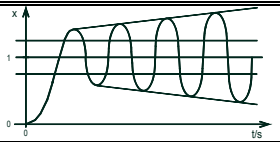
Step response		
Controller setting Optimum ($x_m \leq 10$ %)	Controller setting T_{krit}	Controller setting Incorrect
		

Figure 4-3: Step response - controller set-up

P gain (K_{PR}) Proportional-action coefficient **1 to 240**

```
Pr.-sensitivity
        Kp=000
```

The proportional-action coefficient K_P indicates the closed-loop control system gain. The variable to be controlled is achieved more rapidly by increasing the P-gain.

Reset time (T_n) **0.2 to 60.0 s**

```
Reset time
      Tn = 00,0s
```

The reset time T_n belongs to the I-part of the PID controller. The I-component results in permanent control deviation being eliminated in the controlled state.

Derivative-action time (T_V) **0.00 to 6.00 s**

```
Derivative act.
time    Tv=0.00s
```

The derivative-action time T_V belongs to the D-part of the PID controller. An increase in the phase reserve (stability) and the attenuation results from increasing this parameter.

Chapter 5.
Display And Operating Elements

The cover foil of the front plate is made of coated plastics. All keys have been designed as touch-sensitive membrane switch elements. The display is a LC-display, consisting of 2 × 16 characters, which are indirectly illuminated in red. The contrast of the display is infinitely variable by a rotary potentiometer at the left side.

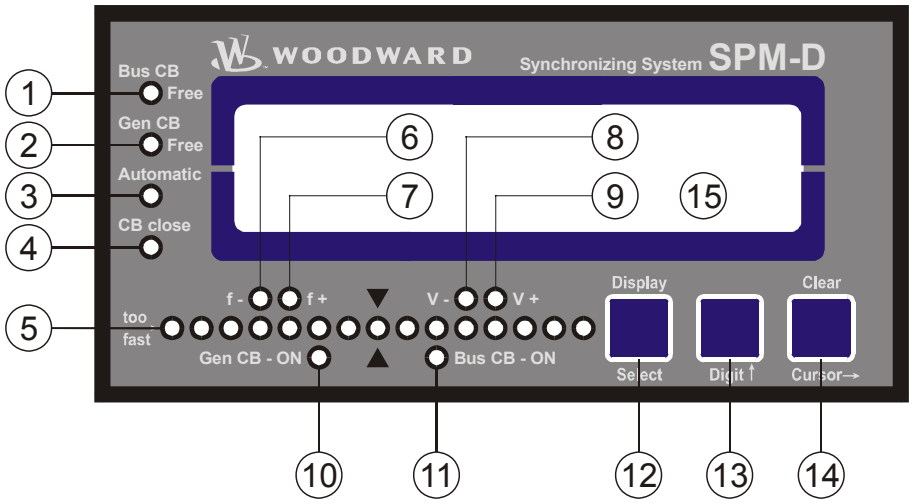


Figure 5-1: Front foil

Brief Explanation Of The LEDs And Push-Buttons

LEDs

No	Description	Function
1	Bus CB Free	Enable MCB
2	Gen CB Free	Enable GCB
3	Automatic	Automatic mode
4	CB close	Close command to the CB issued
5	Synchroscope	Display of phase position
6	f-	Governor output: frequency lower (reduce speed)
7	f+	Governor output: frequency raise (increase speed)
8	V-	Governor output: voltage lower (reduce excitation)
9	V+	Governor output: voltage raise (increase excitation)
10	Gen CB - ON	Reply: GCB is closed
11	Bus CB - ON	Reply: MCB is closed

Buttons

No	Description	Function
12	Display↓	Advance display
12	Select	Confirm selection
13	Digit↑	Increase digit
14	Clear	Acknowledge alarm
14	Cursor→	Shift input position one digit to the right

Others

No	Description	Function
15	LC-Display	LC-Display
	Potentiometer	Adjust LCD contrast

LEDs

1 **Bus CB Free**
Color: green

Enable mains circuit breaker

The LED "Bus CB Free" indicates that the MCB breaker has been enabled for operation. The status of the LED corresponds to the status of the discrete input "Enable MCB".

2 **Gen CB Free**
Color: green

Enable generator circuit breaker

The LED "Gen CB Free" indicates that the GCB has been enabled for operation. The status of the LED corresponds to the status of the discrete input "Enable GCB".

3 **Automatic**
Color: green

Automatic mode

The LED "automatic" lights up when the unit is in automatic mode. It will extinguish as soon as you switch to the configuration mode.

4 **CB close**
Color: green

CB close

Die LED "CB close" lights up when the unit outputs an add-on order to one of the power circuit breakers. The status of the LED corresponds to the status of the relay "close GCB resp. close MCB".

5 LED-row: **too fast→**
Color: red/yellow/green

Phase position / synchroscope

The row of LEDs indicates the current phase position between the two voltages indicated on the display. The green LED in the middle of the 15 LEDs indicates that the measured phase angle between the voltage systems is less than 12 ° electrical. The phase position is only displayed in the automatic mode and only, if the difference between the frequency values is smaller than 2 Hz and both voltages are within the specified permissible ranges. These ranges are defined as follows:

Frequency ranges	80 to 110 % f_N
Voltage ranges	50 to 125 % U_N

There are two different directions of rotation:

left → right..If the LEDs run from left to right, the generator frequency is too high, i.e., the generator or the variable mains turn too rapidly;

right → left..If the LEDs run from right to left, the generator frequency is too low, i.e., the generator respectively the variable mains turn too slowly.

6 **f-** Color: yellow — **Governor output decrease frequency**

Three position controller The LED "f-" indicates if the unit outputs a pulse to decrease the frequency. The status of the LED corresponds to the status of the relay "speed lower".

Analog controller If the actuating signal of the controller is changing to reduce the frequency, the LED illuminates.

7 **f+** Color: yellow — **Governor output increase frequency**

Three position controller r The LED "f+" indicates if the unit outputs a pulse to increase the frequency. The status of the LED corresponds to the status of the relay "speed raise".

Analog controller If the actuating signal of the controller is changing to increase the frequency, the LED illuminates.

8 **V-** Color: yellow — **Governor output reduce voltage**

Three-position controller The LED "V-" indicates if the unit outputs a pulse to decrease voltage. The status of the LED corresponds to the status of the relay "voltage lower".

Analog controller If the actuating signal of the controller is changing to reduce the voltage, the LED illuminates.

9 **V+** Color: yellow — **Governor output increase voltage**

Three-position controller r The LED "V+" indicates if the unit outputs a pulse to increase voltage. The status of the LED corresponds to the status of the relay "voltage raise".

Analog controller r If the actuating signal of the controller is changing to increase the voltage, the LED illuminates.

10 **Gen CB - ON** Color: green — **Generator power circuit breaker ON**

The LED "Gen CB - ON" signals the response of the GCB. The LED lights up if the discrete input "Reply: GCB is open" is not set and will extinguish as soon as the discrete input is set. (see also chapter "LED "Gen CB - ON" Flashes" on page 35).

11 **Bus CB – ON** Color: green — **Mains power circuit breaker ON**

The LED "Bus CB - ON" signals the response of the MCB. The LED lights up if the discrete input "Reply: MCB is open" is not set and will extinguish as soon as the discrete input is set. (see also chapter "LED "Gen CB - ON" Flashes" on page 35).

Push-Buttons

In order to facilitate the setting of the parameters the buttons are equipped with a "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 enabled when the user depresses the corresponding keys for a certain period of time.

12 Display / Select **Display / Select**

Automatic mode: Display - By pressing this button, one navigates through the display of operating and alarm messages.

Configuration: Select - A jump is made to the next configuration screen. If the value originally displayed has been changed via the "Digit↑" or "Cursor→" push-buttons the newly set value is saved by pressing the "Select" push-button once. By pressing this push-button again, the user causes the system to display the next configuration screen.

13 Digit↑ **Digit ↑**

Automatic mode: Digit↓ - no function

Configuration: Digit↑ - With this push-button, the number at which the cursor is currently located is increased by one digit. The increase is restricted by the admissible limits (see list of parameters included in the appendix). In case the maximum number is reached which can be set, the number automatically returns to the lowest admissible number.

14 Clear / Cursor → **Clear / Cursor→**

Automatic mode: Clear - By pressing this button, all alarm messages are deleted, provided that they are no longer detected.

Configuration: Cursor→ - This push-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.

LC Display

15 LC-Display **LC-Display**

Performance quantities can be retrieved from the two-lines display, provided that the unit is in automatic mode. With the push button "Display" you can switch between the different operating modes and alarm messages. In configuration mode, the individual parameters are displayed.

Display Monitoring In Automatic Mode: Double Voltage / Frequency Display

NOTE

If the device changes into operating mode synchronization, automatically it will be changed to the respective double display.

LCD type 1 (V configured)

```
B: 000 V 00,00Hz
G: 000 V 00,00Hz
```

Double voltage and double frequency displays, Generator values

The measuring values of generator and busbar (synchronizing GCB) or of busbar and mains (synchronizing MCB) are displayed. The phase angle between the indicated voltages is displayed by the synchroscope (LED strip).

LCD type 2 (kV configured)

```
B:00,0kV 00,00Hz
G:00,0kV 00,00Hz
```

B.....Busbar voltage and frequency
G .....Generator voltage and frequency
M.....Mains voltage and mains frequency

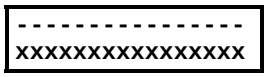
Display Monitoring In Automatic Mode: Generator Values

Generator values

```
Gen.00.0kV i0.95
   0000A  0000kW
```

The following measuring values are monitored:
Voltage, power factor, current, real power.

Display Monitoring In Automatic Mode: Alarm Indication



Alarm indication, bottom line

The indications are displayed according to the following list:

Type of alarm	Displayed text
Mains overvoltage	**Mains overvolt.**
Mains undervoltage	**Mains undervolt.**
Mains overfrequency	**Mains overfreq.**
Mains underfrequency	**Mains underfreq.**
Phase shift	**Phase shift**
Generator underfrequency	**Gen.underfreq.**
Generator overfrequency	**Gen.overfreq.**
Generator undervoltage	**Gen.undervolt.**
Generator overvoltage	**Gen. overvoltage**
Generator overload	**Gen.overload**
Generator reverse/reduced load	**Rev.power/underl**
Synchronization time of the GCB exceeded	**Synchr.time Gen.**
Synchronization time of the MCB exceeded	**Synch.time mains**
Break of the 4-20mA signal for the power setpoint value	**Wirebreak PSet**

Chapter 6.
Configuration

WARNING

Please observe that the configuration may not be performed while the system is in operation.

NOTE

Please note the parameter list at the end of this manual.

While in configuration mode, (simultaneous depression of "Digit↑" and "Cursor→"), the function "Select" causes the input masks to scroll. A long depression of the key "Select" activates the scrolling function, causing a quick scrolling of the indication displays. Please note that a backward scrolling of the last four configuration masks is possible (Exception: Jumping from the first to the last mask is not possible). 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.

Configure Basic Data

SPRACHE/LANGUAGE english	**Language selection** **German/English** The screens (configuration and display screens) can be displayed in either German or English.
Software version x.xxxx	**Software version** Indicates the current software version.

Password Protection

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 (CL0) -** User: Third party
  This code level enables no access whatsoever to the parameters. The configuration is blocked.

- **Code level 1 (CL1) -** User: Plant operator
  This code level entitles the user to change a few selected parameters. Changing a code number is not possible in this case.

- **Code level 2 (CL2) -** User: Commissioner
  With code level 2 the user has direct access to all parameters (displaying and changing). In addition, in this level the user may also set the code number for levels 1 and 2 or switch off the password protection.

```
Enter code
          XXXX
```

Enter code number **0000 to 9999**

On accessing the configuration mode, a code number, which identifies the various users, is requested. The displayed number XXXX is a random number (RN). If the random number has been confirmed with "Select" without being changed, the unit's code level remains. On entering the code number for level 1 respectively level 2, the unit switches into code level CL1 respectively CL2 and the parameters can be changed accordingly. On entering a wrong code number, the unit switches into code level 0.

NOTE

Two hours after entering the code number the code level automatically drops back to CL0!
The default code number for code level 1 (CL1) is "0001"!
The default code number for code level 2 (CL2) is "0002"!
Only in code level 2 the password protection can be switched off!

```
Password
Protection    ON
```

Password protection **ON/OFF**

ON .....Access to configuration is done by entering the relevant code number (code level 1/2). If a wrong code number was entered, the configuration will be blocked.

OFF .....The user has direct access to all parameters, the code number is not requested.

Direct Configuration

NOTE

To configure via the configuration interface (direct configuration) you need the configuration cable (ordering code "DPC"), the program LeoPC1 (is delivered with the cable) and the corresponding configuration files. Please consult the online help installed when the program is installed for a description of the LeoPC1 PC program and its setup.

The parameters of the unit can be read via lateral plug at any time. With the password protection switched off or if the unit is in code level 2, writing of parameters via direct configuration is also possible. If the password protection is switched on and the unit is in code level 0 or 1, the password (code number) of code level 2 must be entered via direct configuration, to modify the parameters. The possibility, to modify parameters via display, is not affected thereby.

```
Direct para.
          YES
```

Configuration via the lateral plug **YES/NO**

YES..... Configuration via lateral plug is possible. The following further conditions for configuration via lateral plug must be met:
- A connection between the unit and the PC via the direct configuration cable must be available,
- the baud rate of the LeoPC1 program must be 9.600 baud and
- one must use the corresponding configuration file (filename: "*.asm", called by *.cfg).

NO..... Configuration via lateral plug cannot be carried out.

Configure Basic Settings

Parameter 1

```
Configure
measuring    YES
```

Configuration of basic settings **YES / NO**

For a better overview the multitude of parameters is classified in several groups. With the setting in the mask it is selected if the parameter group of the basic setting is monitored on the display. The function mode of the device is not affected.

YES .....The following parameter of the basic settings are monitored. They can be noted and changed, as described below.
NO .....The parameter of the basic settings are not monitored.

WARNING

An incorrect input may lead to wrong measuring values and destroy the generator!

Parameter 2

```
Rated Frequency
     fn = 00,0Hz
```

Rated generator frequency **48.0 to 62.0 Hz**

Enter the rated frequency of the generator (or the public mains) which in most cases is 50 Hz or 60 Hz.

Parameter 3

```
Generator freq.
Setpoint= 00,0Hz
```

Generator setpoint frequency **48.0 to 62.0 Hz**

The setpoint frequency of the generator is to be entered in this mask. It will be needed for the frequency controller while in idle operation.

Parameter 4

```
Gen. voltage
secondary  000V
```

Secondary generator voltage (measuring transducer) **[1] 50 to 125 V, [4] 50 to 440 V**

The secondary generator voltage 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.

Parameter 5

```
Busbar voltage
secondary  000V
```

Secondary busbar voltage (measuring transducer) **[1] 50 to 125 V, [4] 50 to 440 V**

The secondary busbar voltage 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.

Parameter 6

```
Mains voltage
secondary  000V
```

Secondary mains voltage (measuring transducer) **[1] 50 to 125 V, [4] 50 to 440 V**

Secondary mains voltage (busbar voltage) 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.

Parameter 7

```
Gen. voltage
primary 00.000kV
```

Primary generator voltage (measuring transducer) **0.1 to 65.0 kV**

The primary generator voltage 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.

Parameter 8

```
Busbar voltage
primary 00.000kV
```

Primary busbar voltage (measuring transducer) **0.1 to 65.0 kV**

The primary busbar voltage 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.

Parameter 9

```
Mains voltage
primary 00.000kV
```

Primary mains voltage (measuring transducer) **0.1 to 65.0 kV**

The primary mains voltage 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.

Parameter 10

```
Rated voltage
......Vn = 000V
```

Rated voltage **[1] 50 to 125 V, [4] 70 to 420 V**

This value is used, among other things, to determine the permissible range for the synchronization.

Parameter 11

```
Gen. voltage
Setpoint    000V
```

Generator setpoint voltage **[1] 50 to 125 V, [4] 50 to 440 V**

This value of the voltage specifies the setpoint of the generator voltage for idle and isolated operation.

Parameter 12

```
Current transf.
Generator 0000/0
```

Generator current transformer **10 to 9,990/x A**

The primary transformer rated current of the generator current transformer is to be entered here. The ratio must be selected in such a manner that, at maximum power, at least 40 % of the transformers rated current flows. A lower percentage may lead to incorrect measurements.

{X} / 1 A ..... Secondary rated current = 1 A at primary rated current = {X} A;
{X} / 5 A ..... Secondary rated current = 5 A at primary rated current = {X} A;
{X} ..... e.g. from the main row 10, 15, 20, 30, 50 or 75 A and the decimal fractions and multiples of these or the corresponding secondary series with 12.5, 25, 40 or 60 A.

Parameter 13

```
Rated power
   Gen. = 0000kW
```

Generator rated power **[1] 100 to 9,999 kW; [4] 5 to 9,999 kW**

The rated real power of the generator is to be entered here.

Configure Controller

Parameter 14

```
Configure
Controller   YES
```

Configuration of the controller settings **YES / NO**

For a better overview the multitude of parameters is classified in several groups. With the setting in the mask it is selected if the parameter group of the basic setting is monitored on the display. The function mode of the device is not affected.

YES .....The following parameter of the controller settings are monitored. They can be noted and changed, as described below.
NO .....The parameter of the controller settings are not monitored.

CAUTION

An incorrect entry may lead to uncontrolled actions of the governor and may destroy the automatically regulated generator!

Idle Control

Parameter 15

```
Automatic idle
Running      ON
```

Automatic idle control **ON/OFF**

ON .....With the generator power circuit breaker open, frequency and voltage are controlled to the adjusted setpoint values in spite of missing the enable of the controllers (see also chapter "Function" on page 22)
OFF .....Idle control is carried out only with controllers released (see also chapter "Function" on page 22).

Parameter 16

```
Terminal 6
        xxxxxxx
```

Function terminal 6 **Enable control / Power setpoint value**

Enable control: The controllers are enabled via the discrete input on terminal 6. The power circuit breaker is enabled separately via terminal 3 (Enable CB). With this setting the unit can be used like a SPM-A.
Power setpoint value: The controllers are enabled simultaneously with the power circuit breaker via terminal 3 (Enable CB). Power setpoint value 1 and power setpoint value 2 can be selected over the discrete input at terminal 6 (see also chapter Operation In Parallel With The Mains on page 35). With this setting the unit can be used like a ASG410+.

Frequency Controller

The SPM-D21/PSV is equipped with a three-position controller for frequency and does not contain the following masks. Furthermore only the masks for setting the three-position controller are existing. With the extended version SPM-D21/PSVX, several controller output signals can be selected via the following screen. In case of the extended version, depending on the selected type of controller, the appropriate screens appear subsequently.

Parameter 17

```
f control type
       xxxxxxx
```

only PSVX Package

Frequency controller type **THREESTEP/ANALOG/PWM**

THREESTEP The frequency controller operates as a three-position controller and outputs higher (f+) and lower pulses (f-) via the according relays. Only one of the two controllers (the frequency or the voltage controller) can be used at a time for the output via the relays.

ANALOG .... The frequency controller operates as a continuous controller with an analog output signal (mA or V).

PWM ..... The frequency controller operates as a continuous controller with a pulse-width-modulated output signal and constant level.

Note: The controller setting and the following screens are different, in a way which type of controller will be selected here.

Three-Position Controller (SPM-D21/PSV and SPM-D21/PSVX: Setting 'THREESTEP')

Parameter 18

```
Freq. controller
             ON
```

PSVX Package:
with 'THREESTEP' setting

Frequency controller **ON/OFF**

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

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

Parameter 19

```
Freq. controller
Isol. oper.  ON
```

PSVX Package:
with 'THREESTEP' setting

Isolated operation frequency controller **ON/OFF**

ON..... In isolated operation the frequency controller is enabled.

OFF..... In isolated operation the frequency controller is disabled.

Parameter 20

```
Freq. Controller
Ramp..=.00.0Hz/s
```

PSVX Package:
with 'THREESTEP' setting

Frequency controller setpoint ramp **0.1 to 99.9 Hz/s**

A 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.

Parameter 21

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

PSVX Package: only with 'THREESTEP' setting

Frequency controller insensitivity **0.02 to 1.00 Hz**

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

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

Parameter 22

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

PSVX Package: only with 'THREESTEP' setting

Minimum frequency controller ON period **10 to 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.

Parameter 23

```
Freq. controller
Gain Kp     00.0
```

PSVX Package: only with 'THREESTEP' setting

Frequency controller gain **0.1 to 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.

Analog Controller Outputs (Only SPM-D21/PSVX: Settings 'ANALOG' And 'PWM')

Parameter 24

```
f control output
        xxxxxxx
```

only PSVX Package with 'ANALOG' setting

Controller output signal **see table**

This configuration screen only appears, if the frequency controller is configured as ANALOG type! The range of the analog output signal is adjusted here. To choose between a current signal in mA or a voltage signal in V, one has to connect appropriate jumpers to the output terminals. (see chapter "Controller Outputs on page 19). The following output signals are possible:

Type	Setting in above configuration screen	Jumper between terminal 8/9	Adjustment range	Adjustment range min.	Adjustment range max.
Current	+/-20mA (+/-10V)	no	+/-20mA	-20 mA	+20 mA
	+/-10mA (+/-5V)		+/-10mA	-10 mA	+10 mA
	0 to 10mA (0 to 5V)		0 to 10mA	0 mA	10 mA
	0 to 20mA (0 to 10V)		0 to 20mA	0 mA	20 mA
	4 to 20mA		4 to 20mA	4 mA	20 mA
	10 to 0mA (5 to 0V)		10 to 0mA	10 mA	0 mA
	20 to 0mA (10 to 0V)		20 to 0mA	20 mA	0 mA
	20 to 4mA		20 to 4mA	20 mA	4 mA
Voltage	+/-20mA (+/-10V)	yes	+/-10V	-10 Vdc	+10 Vdc
	+/-10mA (+/-5V)		+/-5V	-5 Vdc	+5 Vdc
	+/-3V		+/-3V	-3 Vdc	+3 Vdc
	+/-2.5V		+/-2.5V	-2.5Vdc	+2.5 Vdc
	+/-1V		+/-1V	-1 Vdc	+1 Vdc
	0 to 10mA (0 to 5V)		0 to 5V	0 Vdc	5 Vdc
	0.5V to 4.5V		0.5 to 4.5V	0.5 Vdc	4.5 Vdc
	0 to -20mA (0 to 10V)		0 to 10V	0 Vdc	10 Vdc
	10 to 0mA (5 to 0V)		5 to 0V	5 Vdc	0 Vdc
	4.5V to 0.5V		4.5 to 0.5V	4.5 Vdc	0.5 Vdc
	20 to 0mA (10 to 0V)		10 to 0V	10 Vdc	0 Vdc

Parameter 25

```
f control output
Level PWM 00.0V
```

only PSVX Package with 'PWM' setting

Level PWM signal **3.0 to 10.0 V**

These configuration screen only appears, if the frequency controller is configured as PWM type! The voltage level of the PWM signal is adjusted here.

Parameter 26

```
PWM-signal
Logic  positive
```

only PSVX Package with 'PWM' setting

Logic PWM signal **positive / negative**

These configuration screen only appears, if the frequency controller is configured as PWM type!

positive ..... If the controller output signal accounts for 100 %, the adjusted PWM level is output permanently, at 0 % the output signal accounts for 0 V.

negative ..... If the controller output signal accounts for 100 %, 0 V is output permanently, at 0 % the output signal corresponds to the adjusted PWM level.

Parameter 27

```
f control output
Init.state  000%
```

only PSVX Package with 'ANALOG' or 'PWM' setting

Initial frequency controller state **0 to 100 %**

Controller output setting with controller switched off. The setting value in percent relates to the range between the minimal value and the maximal value of the output signal (see below).

Parameter 28

```
Freq. controller
           ON
```

PSVX Package
with 'ANALOG' or 'PWM' setting

Frequency controller **ON/OFF**

ON .....The generator frequency is controlled. The generator frequency is controlled in various manners depending on the task (idle / isolated operation / synchronization). The subsequent screens of this function are displayed.
OFF .....Control is not carried out and the subsequent screens of this function are not displayed.

Parameter 29

```
Freq. controller
Isol. oper.   ON
```

PSVX Package
with 'ANALOG' or 'PWM' setting

Isolated operation frequency controller **ON/OFF**

ON .....In isolated operation the frequency controller is enabled.
OFF .....In isolated operation the frequency controller is disabled.

Parameter 30

```
Freq. controller
Ramp....00.0Hz/s
```

PSVX Package
with 'ANALOG' or 'PWM' setting

Frequency controller setpoint ramp **0.1 to 99.9 Hz/s**

A 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.

Parameter 31

```
f control output
(max.)      000%
```

only PSVX Package
with 'ANALOG' or 'PWM' setting

Maximal value frequency controller **0 to 100%**

Upper limit of the analog controller output.

Parameter 32

```
f control output
(min.)      000%
```

only PSVX Package
with 'ANALOG' or 'PWM' setting

Minimal value frequency controller **0 to 100%**

Lower limit of the analog controller output.

Parameter 33

```
Freq. controller
Gain Kp      000
```

only PSVX Package
with 'ANALOG' or 'PWM' setting

P gain of the frequency controller **1 to 240**

The proportional coefficient specifies the gain (see chapter, "Analog Controller Outputs" from page 37).

Parameter 34

```
Freq. controller
Reset Tn   00.0s
```

only PSVX Package
with 'ANALOG' or 'PWM' setting

Reset time load frequency controller **0.0 to 60.0 s**

The reset time T_n belongs to the I part of the PID controller (see chapter "Analog Controller Outputs" from page 37).With the setting T_n=0.00 s the Ipart is switched off.

Parameter 35

```
Freq. controller
Derivat.Tv 0.00s
```

only PSVX Package
with 'ANALOG' or 'PWM' setting

Derivative-action time frequency controller **0.00 to 6.00 s**

The derivative action time T_V belongs to the D part of the PID controller (see chapter "Analog Controller Outputs" from page 37)) With the setting T_V=0.00 s the D-part is switched off.

Voltage Controller

The SPM-D21/PSV is equipped with a three-position controller for voltage and does not contain the following screen. Furthermore only screens for the setting of the three-position controller are existing. With the extended version SPM-D21/PSVX, several controller output signals can be selected via the following screen. In case of the extended version, depending on the selected type of controller, the appropriate screens appear subsequently.

Parameter 36

```
V contr. type
       xxxxxxx
```

only PSVX Package

Voltage controller type **THREESTEP/ANALOG**

THREESTEP The voltage controller operates as a three-position controller and outputs higher (V+) and lower pulses (V-) via the according relays. Only one of the two controllers (the frequency or the voltage controller) can be used at a time for the output via the relays.

ANALOG .... The voltage controller operates as a continuous controller with an analog output signal (mA or V).

Note: The controller setting and the following screens are different, in a way which type of controller will be selected here.

Three-Position Controller (SPM-D21/PSV And SPM-D21/PSVX: Setting 'THREESTEP')

Parameter 37

```
Volt. controller
              ON
```

PSVX Package:
with 'THREESTEP' setting

Voltage controller **ON/OFF**

ON..... Generator voltage control is carried out. The generator voltage is controlled in various manners depending on the task (idle / isolated operation / synchronization). The subsequent screens of this function are displayed.

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

Parameter 38

```
Volt. controller
Isol. oper.  ON
```

PSVX Package:
with 'THREESTEP' setting

Voltage controller isolated mode **ON/OFF**

ON..... In isolated operation the voltage controller is enabled.

OFF..... In isolated operation the voltage controller is disabled.

Parameter 39

```
Volt. controller
Ramp     = 00V/s
```

PSVX Package:
with 'THREESTEP' setting

Voltage controller setpoint ramp **1 to 99 V/s**

A 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.

Parameter 40

```
Volt. controller
Dead band 00.0V
```

PSVX Package: only with 'THREESTEP' setting

Voltage controller insensitivity **[1] 0,1 to 15,0 V, [4] 0,5 to 60,0 V**

Idle/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.

Parameter 41

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

PSVX Package: only with 'THREESTEP' setting

Minimum voltage controller ON period **20 to 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.

Parameter 42

```
Volt. controller
Gain Kp     00.0
```

PSVX Package: only with 'THREESTEP' setting

Voltage controller gain factor **0.1 to 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.

Analog Controller Outputs (Only SPM-D21PSV/PSVX: Setting 'ANALOG')

Parameter 43

```
V control output
        xxxxxxx
```

only PSVX Package with 'ANALOG' setting

Controller output signal **see table**

This configuration screen only appears, if the voltage controller is configured as ANALOG type!
The range of the analog output signal is adjusted here. To choose between a current signal in mA or a voltage signal in V, one has to connect appropriate jumpers to the output terminals. (see chapter Auxiliary And Control Outputs on page 17).
The following output signals are possible:

Type	Setting in above configuration screen	Jumper between terminal 11/12	Adjustment range	Adjustment range min.	Adjustment range max.
Current	+/-20mA (+/-10V)	no	+/-20mA	-20 mA	+20 mA
	+/-10mA (+/-5V)		+/-10mA	-10 mA	+10 mA
	0 to 10mA (0 to 5V)		0 to 10mA	0 mA	10 mA
	0 to 20mA (0 to 10V)		0 to 20mA	0 mA	20 mA
	4 to 20mA		4 to 20mA	4 mA	20 mA
	10 to 0mA (5 to 0V)		10 to 0mA	10 mA	0 mA
	20 to 0mA (10 to 0V)		20 to 0mA	20 mA	0 mA
	20 to 4mA		20 to 4mA	20 mA	4 mA
Voltage	+/-20mA (+/-10V)	yes	+/-10V	-10 Vdc	+10 Vdc
	+/-10mA (+/-5V)		+/-5V	-5 Vdc	+5 Vdc
	+/-3V		+/-3V	-3 Vdc	+3 Vdc
	+/-2.5V		+/-2.5V	-2.5Vdc	+2.5 Vdc
	+/-1V		+/-1V	-1 Vdc	+1 Vdc
	0 to 10mA (0 to 5V)		0 to 5V	0 Vdc	5 Vdc
	0.5V to 4.5V		0.5 to 4.5V	0.5 Vdc	4.5 Vdc
	0 to 20mA (0 to 10V)		0 to 10V	0 Vdc	10 Vdc
	10 to 0mA (5 to 0V)		5 to 0V	5 Vdc	0 Vdc
	4.5V to 0.5V		4.5 to 0.5V	4.5 Vdc	0.5 Vdc
	20 to 0mA (10 to 0V)		10 to 0V	10 Vdc	0 Vdc

Parameter 44

```
V control output
Init.state  000%
```

only PSVX Package with 'ANALOG' setting

Initial voltage controller state **0 to 100%**

Controller output setting with controller switched off. The setting value in percent relates to the range between the minimal value and the maximal value of the output signal (see below).

Parameter 45

```
Volt. controller
           ON
```

PSVX Package with 'ANALOG' setting

Voltage controller **ON/OFF**

ON..... Generator voltage control is carried out. The generator voltage is controlled in various manners depending on the task (idle / isolated operation / synchronization). The subsequent screens of this function are displayed.
OFF..... Control is not carried out, and the subsequent screens of this function are not displayed.

Parameter 46

```
Volt. controller
Isol. oper.  ON
```

PSVX Package with 'ANALOG' setting

Voltage controller isolated mode **ON/OFF**

ON..... In isolated operation the voltage controller is enabled.
OFF..... In isolated operation the voltage controller is disabled.

Parameter 47

```
Volt. Controller
Ramp     = 00V/s
```

PSVX Package with 'ANALOG' setting

Voltage controller setpoint ramp **1 to 99 V/s**

A 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.

Parameter 48

```
V control output
(max.)      000%
```

only PSVX Package with 'ANALOG' setting

Maximal value voltage controller **0 to 100 %**

Upper limit of the analog controller output.

Parameter 49

```
V control output
(min.)      000%
```

only PSVX Package with 'ANALOG' setting

Minimal value voltage controller **0 to 100 %**

Lower limit of the analog controller output.

Parameter 50

```
Volt. controller
Gain Kp      000
```

only PSVX Package with 'ANALOG' setting

P-gain voltage controller **1 to 240**

The proportional coefficient specifies the gain (see chapter, "Analog Controller Outputs" from page 37").

Parameter 51

```
Volt. controller
Reset Tn   00.0s
```

only PSVX Package with 'ANALOG' setting

Voltage controller reset time **0.0 to 60.0 s**

The reset time T_n belongs to the I part of the PID controller (see chapter "Analog Controller Outputs" from page 37). With the setting T_n=0.00 s the I part is switched off.

Parameter 52

```
Volt. controller
Derivat.Tv=0.00s
```

only PSVX Package with 'ANALOG' setting

Derivative-action time voltage controller **0.00 to 6.00 s**

The derivative-action time T_V belongs to the D part of the PID controller (see chapter "Analog Controller Outputs" from page 37). With the setting T_v=0.00 s the D-part is switched off.

Power Factor Control

NOTE

Refer to the appendix Power Factor Definition on page 85 for this.

Parameter 53 **Power φ factor controller** **ON / OFF**

```
Pow.fact.control
          ON
```

ON .....A load-independent, automatic control of the power φ factor will be carried out in the operation in parallel to the mains. On currents (smaller than 5 % of the transducer rated current) the power factor can be measured only very inaccurately and the controller is automatically locked. The subsequent screen masks of this option will be displayed.

OFF .....The frequency will not be controlled, and the (otherwise) subsequent screen masks of this option will not be displayed.

Parameter 54 **Power φ factor controller setpoint** **i0.70 to 1.00 to k0.70**

```
Pow.fact.control
Setpoint = 0.00
```

The amount of the reactive load in operation in parallel with the mains is controlled in such a way, that the given power φ factor is used. The letters "i" and "c" stand for "inductive = lagging" (overexcited generator) and "capacitive = leading" (underexcited generator) reactive load.

Parameter 55 **Setpoint ramp of the power φ factor controller** **0.01 to 0.30 /s**

```
Pow.fact.control
Ramp =0.00/s
```

A 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.

Three-position controller (SPM-D21/PSV And SPM-D21/PSVX: Setting 'THREESTEP')

Parameter 56 **Insensitiveness of power φ factor controller** **0.5 to 25.0 %**

```
Pow.fact.control
Dead band 00.0%
```

PSVX Package:
only with 'THREESTEP' setting

The unit internally automatically calculates the amount of reactive load which corresponds to the power $\varphi_{\text{factor setpoint}}$. In operation in parallel with the mains, the reactive load is controlled in such a manner that - in its controlled state - the actual value deviates from the internally calculated setpoint by no more than the set percentage of insensitivity. In this case, the percentage value refers to the generator nominal power.

Parameter 57 **Gain of power φ factor controller** **0.1 to 99.9**

```
Pow.fact.control
Gain   Kp=00.0
```

PSVX Package:
only with 'THREESTEP' setting

The gain K_p affects the operating time of the relays. By increasing this value, the operating time can be increased in case of a certain system deviation.

Setting 'Analog' (Only SPM-D21PSV/PSVX: ANALOG)

These configuration screens only appear, if the frequency controller is configured as ANALOG!

Parameter 58

```
Pow.fact.control
Gain Kp     000
```

only PSVX Package with 'ANALOG' setting

P gain of power φ factor controller **1 to 240**

The gain is indicated by the proportional coefficient.

Parameter 59

```
Pow.fact.control
Reset Tn   00.0s
```

only PSVX Package with 'ANALOG' setting

Reset time of power φ factor controller **0.0 to 60.0 s**

The reset time T_n belongs to the I part of the PID controller. (With this setting T_n=00,0s the I-part is switched off).

Parameter 60

```
Pow.fact.control
Derivat.Tv 0.00s
```

only PSVX Package with 'ANALOG' setting

Derivative action time of the power φ factor controller **0,0 to 6,0 s**

The derivative-action time T_V identifies the D part of the PID controller (With this setting T_v=0,00s the D-part is switched off).

Real Power Controller

Parameter 61

```
Power controller
          ON
```

Active load controller **ON / OFF**

ON .....During the operation in parallel with the mains the real power is controlled to the pre-selected setpoint value. The subsequent screen masks of this option will be displayed.

OFF .....The power will not be controlled, and the subsequent screen masks of this option will not be displayed.

Parameter 62

```
Power controller
P max.=    000 %
```

Maximum power limitation **10 to 120 %**

The setpoint value of the real power controller is internally limited to this value, so that no higher value can be adjusted. The percentage value refers to the generator nominal power.

Parameter 63

```
Power controller
P min.=    000 %
```

Minimum power limitation **0 to 50 %**

The setpoint value of the real power controller is internally limited to this value, so that no smaller value can be adjusted. The percentage value refers to the generator nominal power.

Partial Load Lead

Parameter 64

```
Warm up load
Setpoint = 000 %
```

Limit value part load lead **5 to 110 %**

If the unit requires a warming-up period a lower fixed power setpoint value can be specified after synchronizing to the operation in parallel with the mains. The limit value of part load lead refers to the generator rated power.

Parameter 65

```
Warm up load
time       000s
```

Period of part load lead **0 to 600 s**

Entry of the period during which the part load lead will be kept (after the first closing of the generator power circuit breaker when the unit is operated in parallel to the mains). If a part load lead is not desired enter "0" for this parameter.

Shut Down

Parameter 66

```
Shutdown and
open GCB     ON
```

Shut down **ON / OFF**

ON .....In operation in parallel with the mains the generator set will shut down if the input "release GCB" is taken away (see also chapter "Operation In Parallel With The Mains" on page 35).

OFF .....In operation in parallel with the mains the status of the input "release GCB" has no importance.

Parameter 67

```
Power controller
P set1  = 0000kW
```

Setpoint value 1 generator real power **0 to 9999 kW**

To select the setpoint value for the real power control, please see chapter 4 Function al Description – Operating Conditions – Operating In Parallel With The Mains on page 36.

Parameter 68

```
Power controller
P set2  = 0000kW
```

Setpoint value 2 generator real power **0 to 9999 kW**

To select the setpoint value for the real power control, please see chapter 4 Function al Description – Operating Conditions – Operating In Parallel With The Mains on page 36.

Setpoint Specification Via Analog Input 0/4 to 20 mA

Parameter 69

```
Power setpoint
external   ON
```

Real-power controller external setpoint specification **ON / OFF**

ON..... The real load setpoint can be preset via an external signal 0/4 to 20 mA. The following masks of this option are monitored. (see also chapter "Operation In Parallel With The Mains" on page 35).

OFF..... No external setpoint value specification can be carried out via the 0/4 to 20 mA input. The following to masks of this option are not monitored.

Parameter 70

```
Analog input
      0/4-20mA
```

Setpoint value specification analog input **0-20 / 4-20 mA**

The analog input of the real power controller (terminals 27/28) can be switched over here between 0 to 20 mA and 4 to 20 mA.

0-20 mA..... Minimum value of the setpoint at 0 mA; maximum value at 20 mA.

4-20 mA..... Minimum value of the setpoint at 4 mA; maximum value at 20 mA. A wire break control is carried out. If the signal falls under the value of 2 mA the message "Wirebreak" is monitored on the display.

Parameter 71

```
External setp.
0/4mA =  00000kW
```

Scaling the minimum value **0 to 9999 kW**

The minimum value of the setpoint is defined here.

Parameter 72

```
External setp.
20mA =   00000kW
```

Scaling the maximum value **0 to 9999 kW**

The maximum value of the setpoint is defined here.

Parameter 73

```
Power controller
Ramp = 000 kW/s
```

Active load controller setpoint ramp **1 to 999 kW/s**

A 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.

Three-Position Controller (SPM-D21/PSV And SPM-D21/PSVX: Setting 'THREESTEP')

For the SPM-D21/PSVX is valid: These configuration screens only appear, if the frequency controller is configured as THREESTEP!

Parameter 74

```
Power controller
Dead band= 00.0%
```

PSVX Package: only with 'THREESTEP' setting

Insensitivity of active load controller **0.1 to 25.0 %**

When the unit operates in parallel with the mains the active load will be controlled in such a way that the actual value in the adjusted state differs no more from the activated power setpoint than by the amount of the entered insensitivity. This percentage is based on the generator nominal power.

Parameter 75

```
Power controller
Gain   Kp  00.0
```

PSVX Package: only with 'THREESTEP' setting

Gain of active load controller **0.1 to 99.9**

The gain K_p affects the operating time of the relays. By increasing this value, the operating time can be increased in case of a certain system deviation.

Parameter 76

```
Power controller
Sens.red.   *0,0
```

PSVX Package: only with 'THREESTEP' setting

Reduction of insensitivity for active load controller **1.0 to 9.9**

If no actuating pulse was issued for at least 5 seconds the insensitivity will be reduced by the entered factor.
Example: In case of an insensitivity of 2.5 % and a factor 2.0 the insensitivity will be increased to 5.0 % after 5 seconds. If the system deviation afterwards exceeds 5.0 % the original insensitivity (2.5 %) of the controller will be set automatically. Using this entry the frequent actuation processes which are not necessary can be avoided thus extending the life of the actuating device.

Analog Controller Outputs

These configuration screens only appear, if the frequency controller is configured as ANALOG or PWM!

Parameter 77

```
Power controller
Gain Kp    000
```

only PSVX Package with 'ANALOG' or 'PWM' setting

P gain of the active load controller **1 to 240**

The gain is indicated by the proportional coefficient.

Parameter 78

```
Power controller
Reset Tn  00,0s
```

only PSVX Package with 'ANALOG' or 'PWM' setting

Reset time of the active load controller **0.0 to 60.0 s**

The reset time T_n belongs to the I part of the PID controller. With this setting T_n=00,0s the I-part is switched off.

Parameter 79

```
Power controller
Derivat.Tv 0,00s
```

only PSVX Package with 'ANALOG' or 'PWM' setting

Derivative action time of the active load controller **0.0 to 6.0 s**

The derivative-action time T_V identifies the D part of the PID controller. With this setting T_v=0,00s the D-part is switched off.

Synchronization

Configure Synchronization

CAUTION

Please consider that the unit does not have an internal rotating field monitoring.

The unit assumes always a clockwise phase rotation direction of all voltage systems, which are measured.

A rotating field monitoring must be provided by the customer in order to avoid a CB closure with a counter-clockwise rotating field.

Parameter 80

```
Configure
breaker      YES
```

Configuration of synchronization functions **YES / NO**

For a better overview the multitude of parameters is classified in several groups. With this setting in the mask; it is selected if the parameter group of the synchronization functions, synchronization time monitoring and dead bus start is monitored on the display. The function mode of the device is not affected.

YES..... The following parameter of the synchronization functions, synchronization time monitoring and dead bus start are monitored. They can be noted and changed, as described below.

NO..... The parameter of the synchronization functions, synchronization time monitoring and dead bus start are not monitored.

Parameter 81

```
Synchronizing
functions   ON
```

Synchronization functions **ON/OFF**

ON..... An adaptation of the generator frequency and voltage to the busbar values (respectively busbar frequency and busbar voltage to the mains values) is carried out and a connect command is output. The subsequent screens of this function are displayed.

OFF..... No synchronization occurs, but idle control if necessary. No connect command is output. The subsequent screens of this function are not displayed.

Parameter 82

```
Synchronization
 df max = 0,00Hz
```

Max. perm. differential frequency (pos. slip) **0.02 to 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 → generator frequency is greater than the busbar frequency).

Parameter 83

```
Synchronization
 df min =-0,00Hz
```

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

The prerequisite of a connect command's being output is positive deviation from this set differential frequency. This value specifies the lower frequency (negative value corresponds to negative slip → generator frequency is less than the busbar frequency).

Parameter 84

```
Synchronization
 dV max  =  00V
```

Max. perm. differential voltage **[1] 1 to 20 V, [4] 1 to 60 V**

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

Parameter 85

```
Synchronization
Brk.hold T>0.00s
```

Min. pulse duration of connect relay **0.04 to 0.50 s**

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

Parameter 86

```
Phase matching
           ON
```

Phase-angle-zero-control **ON / OFF**

ON.....The synchronization is carried out with phase-angle-zero-control and the switching of the power circuit breaker is done dependent of the phase angle [see chapter "Operating conditions"]. In the following, the screens for adjusting the phase-angle-zero-control appear.

OFF.....The synchronization is carried out on frequency and voltage of bus-bar/mains and closing the contacts of the power circuit breaker is done in the synchronous point [see chapter " Operating conditions "]. In the following, the screens for adjusting the slip synchronization appear.

Parameter 87

```
Phase matching
Max phase < 00°
```

Zero phase control = OFF

Max. perm. differential angle **0 to 60°**

This configuration screen only appears, if the phase-angle-zero-control is switched off! The prerequisite of a connect command's being output is negative deviation from this set differential angle.

Synchronization with slip - In the operation mode "synchronization with slip" this angle is only used as an additional criterion. If this criterion shall not take effect, one has to set the angle to 60° here.

In the operation

Synch-check - In the operation mode "Synch-check" the negative deviation from this angle is obligatory for picking up the relay "Switch GCB" or "Switch MCB".

Parameter 88

```
Slip synchroniz.
TClose GCB=000ms
```

Zero phase control = OFF

Inherent delay of GCB **40 to 00 ms**

This configuration screen only appears, if the phase-angle-zero-control is configured OFF! The closing time of the GCB corresponds to the lead time of the connect command. The connect command will be issued at the entered time before the synchronization point.

Parameter 89

```
Slip synchroniz.
TClose MCB=000ms
```

Zero phase control = OFF

Inherent delay of MCB **40 to 300 ms**

This configuration screen only appears, if the phase-angle-zero-control is configured OFF! The closing time of the MCB corresponds to the lead time of the connect command. The connect command will be issued at the entered time before the synchronization point.

Parameter 90

```
Phase matching
Dwell time 00.0s
```

Zero phase control = ON

Dwell time for switching in case of phase-angle-zero-control **0.2 to 10.0 s**

This configuration screen only appears, if the phase-angle-zero-control is switched on!

When the maximal permitted differential angle is undershot, a time counter is started and only after the expiry of the dwell time a connection pulse is output. The time counter will be reset, if one of the conditions, which are necessary for the switching, should not be met.

Parameter 91

```
Phase matching
Gain          00
```

Zero phase control = ON

Phase-angle-zero-control gain **1 to 36**

This configuration screen only appears, if the phase-angle-zero-control is switched on!
When phase-angle-zero-control is enabled, this gain determines, how much the output signal is changed depending on phase difference. It must be pointed out, that the frequency controller is also enabled during a phase-angle-zero-control and has to be adjusted accurately first, before this gain is adapted.

Parameter 92

```
Phase matching
df start  0.00Hz
```

Zero phase control = ON

Differential frequency for starting phase-angle-zero-control **0.02 to 0.25 Hz**

This configuration screen only appears, if the phase-angle-zero-control is switched on!
The phase-angle-zero-control is enabled, when the differential frequency between generator and busbar or busbar and mains undershoots the value adjusted here.

Synchronization Time Monitoring

Parameter 93

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

Synchronization time monitoring **ON/OFF**

ON..... This setting ensures that the synchronization time of the GCB and the MCB will be monitored. A time counter starts simultaneously with the beginning of the synchronization. If, following the expiry of the set time, the power circuit breaker has not been enabled, a warning message "Synchronization time GCB" or "Synchronization time MCB" is output. Moreover, the synchronization procedure will be cancelled and the relay "readiness for operation" drops out. By pressing the button "Clear" for at least 3 seconds or by removing one of the conditions, which are necessary for the synchronization (e.g. terminal 3 "Release CB"), the watchdog is reset. The subsequent screens of this function are displayed.

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

Parameter 94

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

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

Please refer to the above description of the configuration screen.

Dead Bus Start

If the busbar is in its voltage-free state, the direct connection (dead bus start) of the GCB or the MCB may be carried out.

Parameter 95

```
Gen. circ.break.
Dead bus op. ON
```

Dead bus start of GCB **ON/OFF**

ON .....Release of the dead bus start function for the GCB. Furthermore conditions [see chapter "Closing The GCB Without Synchronization (Dead Bus start GCB)" starting on page 34] have to be met to switch the GCB to the voltage-free busbar. The subsequent screens of this function are displayed.

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

Parameter 96

```
Dead bus op. GCB
 df max = 0,00Hz
```

Maximum differential frequency for GCB dead bus start **0.05 to 5.00 Hz**

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

Parameter 97

```
Dead bus op. GCB
 dV max =   00V
```

Maximum differential voltage for GCB dead bus start **[1] 1 to 20 V, [4] 1 to 60 V**

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

Parameter 98

```
Mains circ.break
Dead bus op. ON
```

Dead bus start of MCB **ON/OFF**

ON .....Release of the dead bus start function for the MCB. Furthermore conditions [see chapter "Closing The GCB Without Synchronization (Dead Bus start GCB)" starting on page 34] have to be met to switch the MCB to the voltage-free busbar. The subsequent screens of this function are displayed.

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

Monitoring Configuration

Parameter 99 **Configuration of protection** **YES / NO**

```
Configure
monitoring   YES
```

For a better overview the multitude of parameters is classified in several groups. With this setting in the mask; it is selected whether the parameter group of watchdogs is monitored on the display. The function mode of the device is not affected.

YES..... The following parameters of the watchdogs are monitored. They can be noted and changed, as described below.
NO..... The parameters of the watchdogs are not monitored

Generator Reverse/Reduced Power Monitoring

The generator real power is monitored with regard to its falling below the set triggering value.
The watchdog is assigned to the relay on the terminals 37/38. In regular status the relay is picked up, that means the contact is closed. If the watchdog has triggered, the relay drops out, that means the contact opens and the message "Reverse/reduced power" appears on the display. If the tripping criteria is present for less than 1 second, the relay returns into regular status automatically. The message on the display can be cleared automatically or by pressing the button "Clear" (see also chapter "Auto Acknowledge Messages" on page 76).

Parameter 100 **Reverse/minimum load monitoring** **ON / OFF**

```
Reverse/min.pow.
Monitoring  ON
```

ON..... A reverse or reduced load monitoring of the generator real power is carried out. The subsequent screens of this function are displayed.
OFF..... There is no monitoring, and the subsequent masks of this function are not displayed

Parameter 101 **Reverse/reduced power monitoring threshold value** **-99 to 0 to +99 %**

```
Reverse/min.pow.
Threshold = 00%
```

The threshold value refers to the input rated power of the generator.
Reduced power monitoring: Tripping, if the real load falls below the (positive) limiting value**.**
Reverse load monitoring: Triggering, if the direction of the real power is reversed and the (negative) limit value is fallen below.

Parameter 102 **Delay of reverse/minimum load monitoring** **0.1 to 99.9 s**

```
Reverse/min.pow.
Delay     00.0s
```

In order for tripping to occur, negative deviation from the threshold value must occur without interruption for at least the period of time specified in this screen.

Generator Overload Monitoring

The generator real power is monitored for exceeding the set pickup value.
The watchdog is assigned to the relay on the terminals 37/38. In regular status the relay is picked up, that means the contact is closed. If the watchdog has triggered, the relay drops out, that means the contact opens and the message "Gen. overload" appears on the display. If the tripping criteria is present for less than 1 second, the relay returns into regular status automatically. The message on the display can be cleared automatically or by pressing the button "Clear" (see also chapter "Auto Acknowledge Messages" on page 76).

Parameter 103

```
Gen. overload
Monitoring  ON
```

Overload monitoring **ON / OFF**

ON .....Generator real power overload monitoring is carried out. The subsequent screens of this function are displayed.
OFF .....There is no monitoring, and the subsequent masks of this function are not displayed.

Parameter 104

```
Gen. overload
Threshold =000%
```

Threshold value generator overload monitoring **0 to 120 %**

The threshold value refers to the generator rated power.

Parameter 105

```
Gen. overload
Delay time = 00
```

Generator overload monitoring delay **0 to 99 s**

In order to trip monitoring, the threshold value must be exceeded without interruption for at least the period of time specified in this screen.
In this setting the tripping delay is about 80 ms.

Generator Frequency Monitoring

The generator frequency is monitored with regard to exceeding or falling below the set threshold value.
The watchdog is assigned to the relay on the terminals 43/44. In regular status the relay is picked up, that means the contact is closed. If the watchdog has triggered, the relay drops out, that means the contact opens and the message "Gen. overfreq." resp. "Gen. underfreq." appears on the display. If the tripping criteria is present for less than 1 second, the relay returns into regular status automatically. The message on the display can be cleared automatically or by pressing the button "Clear" (see also chapter "Auto Acknowledge Messages" on page 76).

Parameter 106

```
Gen.frequency.
Monitoring  ON
```

Generator frequency monitoring **ON/OFF**

ON..... The generator frequency is monitored. The generator frequency is monitored as regards overfrequency and underfrequency. The subsequent screens of this function are displayed.
OFF..... There is no monitoring, and the subsequent masks of this function are not displayed.

Parameter 107

```
Gen. overfreq.
     f > 00.00Hz
```

Threshold value: Generator overfrequency **40.0 to 70.0 Hz**

If the value of the generator frequency exceeds that value set here, there is a triggering.

Parameter 108

```
Gen. overfreq.
Delay time=0.00s
```

Generator overfrequency threshold delay **0.04 to 9.98 s**

In order to trip monitoring, the threshold value must be exceeded without interruption for at least the period of time specified in this screen.

Parameter 109

```
Gen. underfreq.
     f < 00,00Hz
```

Threshold value: Generator underfrequency **40.0 to 70.0 Hz**

If the value of the generator frequency falls below the value set here, there is a triggering.

Parameter 110

```
Gen. underfreq.
Delay time=0.00s
```

Generator underfrequency threshold delay **0.04 to 9.98 s**

In order for tripping to occur, negative deviation from the threshold value must occur without interruption for at least the period of time specified in this screen.

Generator Voltage Monitoring

The external conductor voltages U_{L1}/U_{L2} of the generator are monitored for exceeding or falling below the set threshold value. The watchdog is assigned to the relay on the terminals 41/42. In regular status the relay is picked up, that means the contact is closed. If the watchdog has triggered, the relay drops out, that means the contact opens and the message "Gen. overvoltage" resp. "Gen. undervoltage" appears on the display. If the tripping criteria is present for less than 1 second, the relay returns into regular status automatically. The message on the display can be cleared automatically or by pressing the button "Clear" (see also chapter "Auto Acknowledge Messages" on page 76).

Parameter 111

```
Gen.voltage
Monitoring  ON
```

Generator voltage monitoring **ON / OFF**

ON .....The generator voltage is monitored. The generator voltage is monitored with regard to overvoltage and undervoltage. The subsequent screens of this function are displayed.

OFF .....There is no monitoring, and the subsequent masks of this function are not displayed.

Parameter 112

```
Gen.overvoltage
       U > 000V
```

Threshold value: Gen. overvoltage **[1] 20 to 150 V; [4] 20 to 520 V**

If the value of the generator voltage exceeds the value set here, there is a triggering.

Parameter 113

```
Gen.overvoltage
Delay time=0.00s
```

Generator overvoltage threshold delay **0.04 to 9.98 s**

In order to trip monitoring, the threshold value must be exceeded without interruption for at least the period of time specified in this screen.

Parameter 114

```
Gen.undervoltage
       U < 000V
```

Threshold value: Gen. undervoltage **[1] 20 to 150 V; [4] 20 to 520 V**

If the value of the generator voltage falls below the value set here, there is a triggering.

Parameter 115

```
Gen.undervoltage
Delay time=0.00s
```

Generator undervoltage threshold delay **0.04 to 9.98 s**

In order for tripping to occur, negative deviation from the threshold value must occur without interruption for at least the period of time specified in this screen.

Mains Frequency Monitoring

The monitoring of mains frequency is absolutely necessary if a generator is operated within a public network. In case of a mains failure (e.g. short interruption of power supply) the generator working mains parallel must be automatically disconnected from the mains. The mains frequency is monitored with regard to exceeding or falling below the set threshold value. The watchdog is assigned to the relay on the terminals 35/36. In regular status the relay is picked up, that means the contact is closed. If the watchdog has triggered, the relay drops out, that means the contact opens and the message "Mains overfreq." resp. "Mains underfreq." appears on the display. If the tripping criteria is present for less than 1 second, the relay returns into regular status automatically. The message on the display can be cleared automatically or by pressing the button "Clear" (see also chapter "Auto Acknowledge Messages" on page 76).

Parameter 116

```
Mains frequency
Monitoring  ON
```

Mains frequency monitoring **ON / OFF**

ON..... The mains frequency is monitored. The mains frequency is monitored as regards overfrequency and underfrequency. The subsequent screens of this function are displayed.

OFF..... There is no monitoring, and the subsequent masks of this function are not displayed.

Parameter 117

```
Mains overfreq.
     f > 00.00Hz
```

Threshold value: Mains overfrequency **40.0 to 70.0 Hz**

If the value of the mains frequency exceeds the value set here, triggering occurs.

Parameter 118

```
Mains overfreq.
Delay time=0.00s
```

Mains overfrequency threshold delay **0.02 to 9.98 s**

In order to trip monitoring, the threshold value must be exceeded without interruption for at least the period of time specified in this screen.

Parameter 119

```
Mains underfreq.
     f < 00.00Hz
```

Threshold value: Mains underfrequency **40.0 to 70.0 Hz**

If the value of the mains frequency falls below the value set here, triggering occurs.

Parameter 120

```
Mains underfreq.
Delay time=0.00s
```

Mains underfrequency threshold delay **0.02 to 9.98 s**

In order for tripping to occur, negative deviation from the threshold value must occur without interruption for at least the period of time specified in this screen.

Mains Voltage Monitoring

Monitoring the mains voltage is absolutely necessary if a generator is operated within a public network. In case of a mains failure (e.g. short interruption of power supply) the generator working mains parallel must be automatically disconnected from the mains. All phase-phase or phase-neutral voltages of the mains are monitored with regard to exceeding or falling below that set threshold value. The watchdog is assigned to the relay on the terminals 33/34. In regular status the relay is picked up, that means the contact is closed. If the watchdog has triggered, the relay drops out, that means the contact opens and the message "Mains overvoltage" resp. "Mains undervoltage" appears on the display. If the tripping criteria is present for less than 1 second, the relay returns into regular status automatically. The message on the display can be cleared automatically or by pressing the button "Clear" (see also chapter "Auto Acknowledge Messages" on page 76).

Parameter 121

```
Mains voltage
monitoring    ON
```

Mains voltage monitoring **ON/OFF**

ON .....The mains voltage is monitored. The mains voltage is monitored with regard to overvoltage and undervoltage. The subsequent screens of this function are displayed.
OFF .....There is no monitoring, and the subsequent masks of this function are not displayed.

Parameter 122

```
Mains volt.monit
   phase-neutral
```

Mains voltage monitoring **phase-phase/phase-neutral**

phase-phase .The mains voltage monitoring monitors the phase-phase voltage.
phase-neutral The mains voltage monitoring monitors the phase-neutral voltage.

Parameter 123

```
Mains overvolt.
U Ph.-Ph >  000V
```

Mains overvoltage threshold value Ph-Ph **[1] 20 to 150 V; [4] 20 to 520 V**

If the phase-phase voltage exceeds the value configured here, the watchdog triggers. This setting is only effective if the mains voltage monitoring is configured to phase-phase.

Parameter 124

```
Mains overvolt.
U Ph.-N >  000V
```

Mains overvoltage threshold value Ph-N **[1] 20 to 180 V; [4] 20 to 300 V**

If the phase-neutral voltage exceeds the value configured here, the watchdog triggers. This setting is only effective if the mains voltage monitoring is configured to phase-neutral.

Parameter 125

```
Mains overvolt.
Delay time=0.00s
```

Mains overvoltage threshold delay **0.02 to 9.98 s**

In order to trip monitoring, the threshold value must be exceeded without interruption for at least the period of time specified in this screen.

Parameter 126

```
Mains undervolt.
U Ph.-Ph <  000V
```

Mains undervoltage threshold value Ph-Ph **[1] 20 to 150 V; [4] 20 to 520 V**

If the phase-phase voltage falls below the value configured here, the watchdog triggers. This setting is only effective if the mains voltage monitoring is configured to phase-phase.

Parameter 127

```
Mains undervolt.
U Ph.-N <  000V
```

Mains undervoltage threshold value Ph-N **[1] 20 to 180 V; [4] 20 to 300 V**

If the phase-neutral voltage falls below the value configured here, the watchdog triggers. This setting is only effective if the mains voltage monitoring is configured to phase-neutral.

Parameter 128

```
Mains undervolt.
Delay time=0.00s
```

Mains undervoltage threshold delay **0.02 to 9.98 s**

In order for tripping to occur, negative deviation from the threshold value must occur without interruption for at least the period of time specified in this screen.

Phase Shift Monitoring

A phase shift is a sudden change in the voltage curve, which may be caused by a major load change. In this case, the unit detects a change in the cycle duration once. This change in the cycle duration is compared with a calculated mean value from previous measurements. The monitoring is carried out in three phases or, alternatively, even in one phase. The phase jump monitor is only active if the mains voltage is larger than 50 % of the converter rated voltage. The watchdog is assigned to the relay on the terminals 35/36. In regular status the relay is picked up, that means the contact is closed. If the watchdog has triggered, the relay drops out, that means the contact opens and the message "Phase jump" appears on the display (tripping delay is about 60 ms). If the tripping criteria is present for less than 1 second, the relay returns into regular status automatically. The message on the display can be cleared automatically or by pressing the button "Clear" (see also chapter "Auto Acknowledge Messages" on page 76).

Parameter 129

```
Phase shift
Monitoring  ON
```

Phase shift monitoring **ON/OFF**

ON..... The mains frequency is monitored, and a phase shift is registered within the defined range. The subsequent screens of this function are displayed.

OFF..... There is no monitoring, and the subsequent masks of this function are not displayed.

Parameter 130

```
Phase shift mon.
one/three phase
```

Phase shift monitoring **one/three-phase / three-phase only**

one/three-phase: During single-phase voltage phase shift monitoring, tripping occurs if the phase shift exceeds the specified threshold value in at least one of the three phases. **Note:** If a phase shift occurs in one or two phases, the single-phase threshold is considered; if a phase shift occurs in all three phases, the three-phase threshold is considered; This type of monitoring is very sensitive, and may lead to false tripping if the selected phase angle settings are too small.

three-phase only: During three-phase voltage phase shift monitoring, tripping occurs only if the phase shift exceeds the specified threshold value in all three phases within 2 cycles.

Parameter 131

```
Phase shift thr.
One phase 00°
```

This screen is only visible if the monitoring is set to "one/three-phase"..

Maximum phase difference **3 to 90 °**

Tripping occurs if the electrical angle of the voltage curve shifts in at least one phase by more than the specified angle.

Parameter 132

```
Phase shift thr.
 3-phase   00°
```

Maximum phase difference **3 to 90 °**

Tripping occurs if the electrical angle of the voltage curve shifts in all three phases by more than the specified angle.

Auto Acknowledge Messages

Parameter 133

```
Auto-acknowledge
Messages     ON
```

Messages auto acknowledgment **ON/OFF**

ON .....After the error conditions are no longer detected and the revert delay "Messages" are expired, the corresponding message is automatically deleted.

OFF .....After the error conditions are no longer detected, the messages remain in the display. They can be cleared by pressing the button "Clear" for at least 3 seconds. The following mask is not displayed.

Parameter 134

```
Acknowledge
Message aft. 00s
```

Drop-out delay messages **1 to 99 s**

This screen only appears if the screen "Messages auto-acknowledgement" is set to ON. Clearing the messages occurs after the specified time.

Password Configuration

NOTE

Once the code level is set, this is not changed, even if the configuration mode is accessed steady. If an incorrect code number is input, the code level is set to CL0, and the item is thereby blocked for third parties.

If the supply voltage is present and not interrupted for 2 hours, code level 0 is set automatically.

--

Parameter 135

```
Define level 1
code         0000
```

Code level 1 (Customer) **0000 to 9999**

This screen first appears in code level 2 (password protection enabled). Following the input of digits in this screen, the code level for level 1 (Customer) is set. More information to password protection see on page 48.

Parameter 136

```
Define level 2
code         0000
```

Code level 2 (Commissioner) **0000 to 9999**

This screen first appears in code level 2 (password protection enabled). Following the input of digits in this screen, the code level for level 2 (mechanic) is set. More information to password protection see on page 48.

Chapter 7.
Commissioning

DANGER - HIGH VOLTAGE

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:

LIFE THREATENING

WARNING

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

CAUTION

Prior to commissioning, check that all measuring voltages are correctly connected with regard to phases. The connect commands for the power circuit breakers must be disconnected at the power circuit breakers. 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!

CAUTION

Please consider that the unit does not have an internal rotating field monitoring.

The unit assumes always a clockwise phase rotation direction of all voltage systems, which are measured.

A rotating field monitoring must be provided by the customer in order to avoid a CB closure with a counter-clockwise rotating field.

Procedure

1. Disconnect the add-on orders directly at the power circuit breakers.

2. After checking if all measuring voltages are connected in-phase, the power supply has to be applied (24 Vdc) .

3. By simultaneous depression of the two buttons "Digit↑" and "Cursor→" you enter into configuration mode. Before changing into the configuration mode, make sure to reset the discrete input "configuration locked" (connect to 0 V or disconnect). The LED "automatic" will be extinguished.

4. Enter the parameters following the sequence of the different masks. The setting limits can be either read from the description of the masks or from the list of parameters at the end of the operating manual.

5. Do not enable any function (breaker or control) and ensure that all displayed values are correct (are the same as measured with an separate measuring device). **If a measuring voltage has been wired incorrect or not at all, this may lead to an asynchronous add-on order in case of an active dead bus start!**

6. Check the status of all control and auxiliary inputs and the appropriate LEDs on the front foil of the unit. Check the status of all control and auxiliary outputs as well as the setting of the controller outputs.

7. Check the watchdog functions for generator and mains.

8. Synchronizing the power circuit breaker (GCB or MCB):
   a) Disconnect the connection to the power circuit breaker;
   b) the voltage to which the system has to synchronize to, must be within the admissible range;
   c) the signal "Enable CB" has to be applied.
   e) If the generator voltage is 50 % lower that the rated value the frequency controllers starts to operate. Set parameters of the controller in that way that the setpoint value is controlled at an optimum.
   f) Prior to the automatic closing of the circuit breaker ensure that all measuring values have been wired and applied correct. In the synchronous point check weather the synchronizing functions have been configured correctly. This test is best done using a differential voltage meter direct at the power circuit breaker.

9. Dead bus start (GCB or MCB):
   a) Disconnect the connection to the power circuit breaker.
   b) Check all conditions and measuring voltages and test the add-on command.
   c) Automatically switching of the power circuit breaker.

10. After successful closing of the power circuit breaker the LED "Gen CB - ON" has to light up.

11. After successful closing of the mains circuit breaker LED "Bus CB ON" has to light up.

Appendix A.
Dimensions

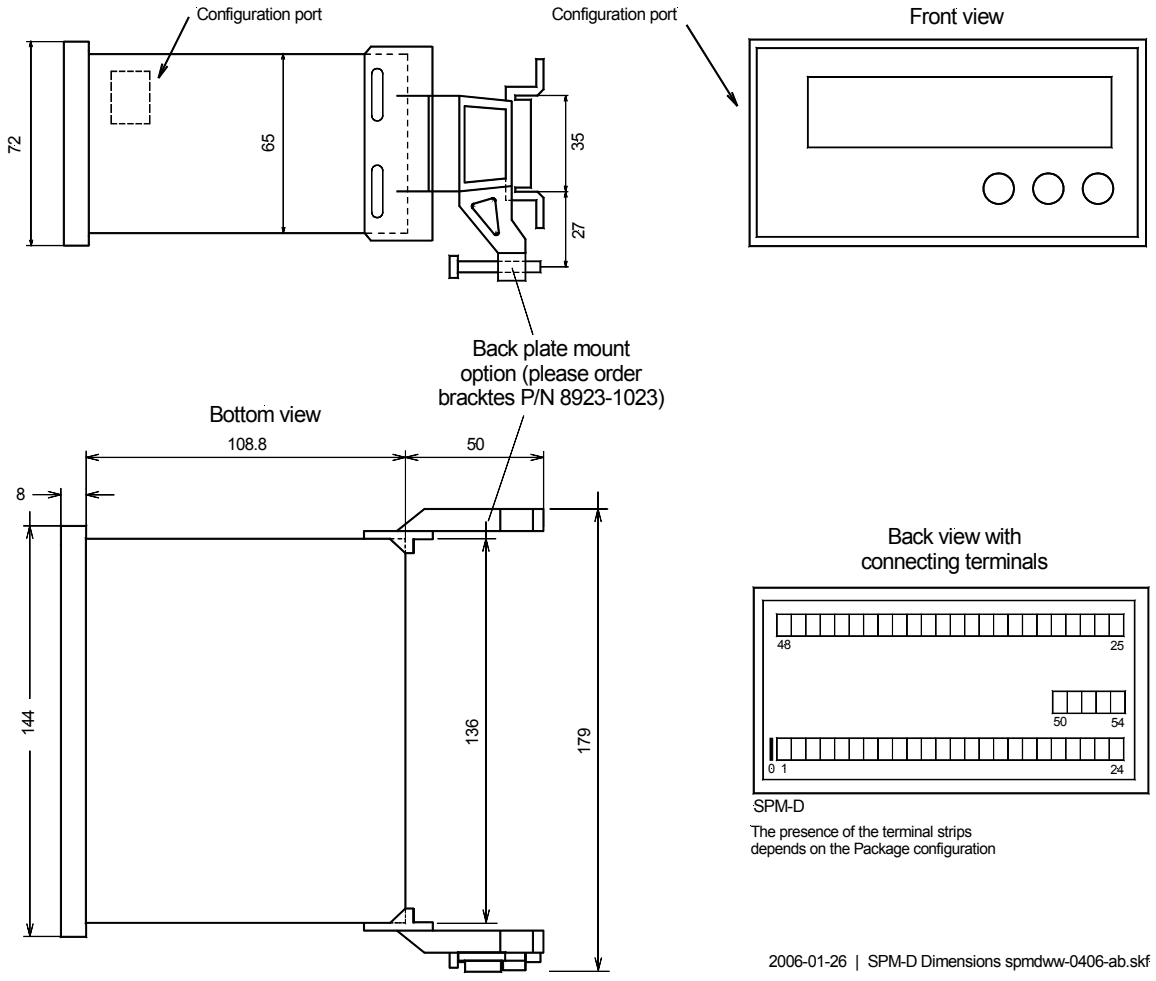


Figure 7-1: Dimensions

Appendix B.
Technical Data

Measuring voltage ----------

- Measuring voltage — Rated value (V_{rated}) ⅄/Δ ..... [1] 66/115 Vac; [4] 230/400 Vac
  Maximum value V_{Ph-Ph} (UL/cUL) ..... [1] max. 150 Vac; [4] max. 300 Vac
  Rated voltage $V_{Ph-ground}$ ..... [1] 150 Vac; [4] 300 Vac
  Rated surge voltage ..... [1] 2.5 kV; [4] 4.0 kV
- Measuring frequency ..... 40.0 to 70.0 Hz
- Accuracy ..... Class 1
- Linear measuring range up to ..... 1.3 × V_{rated}
- Input resistance ..... [1] 0.21 MΩ, [4] 0.696 MΩ
- Maximum power consumption per path ..... 0.15 W

Measuring, current ---------- **isolated**

- Measuring current (I_{rated}) ..../1 A, ../5 A
- Accuracy ..... Class 1
- Linear measuring range up to ..... 3.0 × I_{rated}
- Maximum power consumption per path ..... < 0.15 VA
- Rated short-time current (1 s) ..... [../1 A] 50.0 × I_{rated}, [../5 A] 10.0 × I_{rated}

Ambient variables ----------

Power supply — Standard ..... 24 Vdc (18 to 32 Vdc)
Intrinsic consumption — Standard ..... max. 15 W

- Ambient temperature ..... -20 to +70 °C
- Ambient humidity ..... 95 %, not condensing

Discrete inputs ---------- **isolated**

- Input range ($U_{Cont, digital input}$) ..... 18 to 250 Vac/dc
- Input resistance ..... ca. 68 kΩ

Relay outputs ---------- **isolated**

- Make contact ..... potential free
- 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 .....
  DC ..... 1.00 Adc@24 Vdc
  ..... 0.22 Adc@125 Vdc
  ..... 0.10 Adc@250 Vdc

Analoginputs ---------- **freely scaleable**

- Resolution ..... 10 Bit
- 0/4-20 mA input ..... Load 250 Ω

Housing ----------

- Type ..... APRANORM DIN 43 700
- Dimensions (W × H × D) ..... 144 × 72 × 122 mm
- Front cutout (W×H) ..... 138 [+1.0] × 67 [+0.7] mm

- Wiring ..... Screw-type terminals depending on plug connector 1.5 mm² or 2.5 mm²
- Recommended tightening torque ..... 0.4 Nm or 0.5 Nm
  use 60/75 °C copper wire only
  use class 1 wire only or equivalent
- Weight ..... approx. 800 g

Protection ----------

- Protection system ..... IP42 from front at professional installation
  IP54 from front with gasket (gasket: P/N 8923-1037)
  IP21 from back
- Front foil ..... insulating surface
- EMV test (CE) ..... tested according to applicable EN guidelines
- Listings ..... CE marking; UL listing for ordinary locations
  UL/cUL listed, Ordinary Locations, File No.: E231544

Appendix C.
Parameter List

Product number P/N _____ Rev _____

Version SPM-D21 _____

Project _____

Serial number S/N _____ Date _____

Option	Parameter 100/400V; 1/5 A	Adjustment range	Standard setting	Customer settings	
CONFIGURE GENERAL PARAMETERS					
	SPRACHE/LANGUAGE	German/English	English	☐ G ☐ E	☐ G ☐ E
	Software version		6.1xx		
	Enter code	0000 to 9.999	XXXX		
	Password protection	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Direct para.	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
CONFIGURE BASIC SETTINGS					
	Configure measuring	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	Rated Frequency fn	48.0 to 62.0 Hz	50.0 Hz		
	Generator freq. Setpoint	48.0 to 62.0 Hz	50.0 Hz		
	Gen. voltage secondary	[1] 50 to 125 V [4] 50 to 440 V	[1] 100 V [4] 400 V		
	Busbar voltage secondary	[1] 50 to 125 V [4] 50 to 440 V	[1] 100 V [4] 400 V		
	Mains voltage secondary	[1] 50 to 125 V [4] 50 to 440 V	[1] 100 V [4] 400 V		
	Gen. voltage primary	0.1 to 65.0 kV	0.1 / 0.4 kV		
	Busbar voltage primary	0.1 to 65.0 kV	0.1 / 0.4 kV		
	Mains voltage primary	0.1 to 65.0 kV	0.1 / 0.4 kV		
	Rated voltage Vn	[1] 50 to 125 V [4] 70 to 420 V	[1] 100 V [4] 400 V		
	Gen. voltage Setpoint	[1] 50 to 125 V [4] 50 to 440 V	[1] 100 V [4] 400 V		
	Current transf. Generator	10 to 9,990/x A	1000 A		
	Rated power Gen.	[1] 100 to 9,999 kW; [4] 5 to 9,999 kW	[1] 500 kW [4] 500 kW		
CONFIGURE CONTROLLER					
	Configure controller	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	Automatic idle Running	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Terminal 6	Release control/power set-point value	Release con-trol		
	f control type	THREEP/ANA./PWM	ANALOG		
	Freq. controller	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Freq. controller Isol. oper	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Freq. Controller Ramp	0.1 to 99.9 Hz/s	5.0 Hz/s		
	Freq. controller Dead band	0.02 to 1.00 Hz	0.10 Hz		
	Freq. controllerTime pulse>	10 to 250 ms	80 ms		
	Freq. controller Gain Kp	0.1 to 99.9	15.0		
	f control output	see table	+/-20 mA (+/-10 V)		
	f control output Level PWM	3.0 to 10.0 V	10.0 V		
	PWM-signal Logic	positive/negative	positive		
	f control output Init.state	0 to 100 %	50 %		
	f control output (max.)	0 to 100 %	100 %		
	f control output (min.)	0 to 100 %	0 %		
	Freq. controller Gain Kp	1 to 240	15		
	Freq. controller Reset Tn	0.0 to 60.0 s	2.5 s		
	Freq. controller Derivat.Tv	0.00 to 6.00 s	0.00 s		
	V contr. type	THREESTEP/ANALOG	ANALOG		

Option	Parameter 100/400V; 1/5 A	Adjustment range	Standard setting	Customer settings	
	Volt. controller	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Volt. controllerIsol. oper.	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Volt. controller Ramp	1 to 99 V/s	25 V/s		
	Volt. controller Dead band	[1] 0.1 to 15 V [4] 0.5 to 60 V	[1] 1.0 V [4] 2.0 V		
	Volt. controllerTime pulse>	20 to 250 ms	80 ms		
	Volt. controller Gain Kp	0.1 to 99.9	15.0		
	V control output	see table	+/-20 mA (+/-10 V)		
	V control outputInit.state.	0 to 100 %	50 %		
	V control output (max.)	0 to 100 %	100 %		
	V control output (min.)	0 to 100 %	0 %		
	Volt. controller Gain Kp	1 to 240	15		
	Volt. controller Reset Tn	0.0 to 60.0 s	2.5 s		
	Volt. controller Derivat.Tv	0.00 to 6.00 s	0.00 s		
	Pow.fact.control	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Pow.fact.control Setpoint	i0.70 to 1.00 to k0.70	1.00		
	Pow.fact.control Ramp	0.01 to 0.30 /s	0.01 /s		
	Pow.fact.control Dead band	0.5 to 25.0 %	2.5 %		
	Pow.fact.control Gain Kp	0.1 to 99.9	15		
	Pow.fact.control Gain Kp	1 to 240	15		
	Pow.fact.control Reset Tn	0.0 to 60.0 s	25 s		
	Pow.fact.control Derivat.Tv	0,0 to 6,0 s	0.00 s		
	Power controller	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Power controller P max.	10 to 120 %	100 %		
	Power controller P min.	0 to 50 %	0 %		
	Warm up load Setpoint	5 to 110 %	20 %		
	Warm up load time	0 to 600 s	15 s		
	Shutdown and open GCB	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Power controller P set1	0 to 9999 kW	300 kW		
	Power controller P set1	0 to 9999 kW	500 kW		
	Power setpoint external	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Analog input	0 to 20 / 4 to 20 mA	0-20 mA		
	External setp. 0 mA	0 to 9999 kW	0 kW		
	External setp. 20 mA	0 to 9999 kW	500 kW		
	Power controller Ramp	1 to 999 kW/s	50 kW/s		
	Power controller Dead band	0.1 to 25.0 %	2.5 %		
	Power controller Gain Kp	0.1 to 99.9	15.0		
	Power controller Sens.red.	1.0 to 9.9	2.0		
	Power controller Gain Kp	1 to 240	15		
	Power controller Reset Tn	0.0 to 60.0 s	2.5 s		
	Power controller Derivat.Tv	0.0 to 6.0 s	0.0 s		
CONFIGURE SYNCHRONIZATION					
	Configure breaker	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	Synchronizing functions	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Synchronization df max	0.02 to 0.49 Hz	0.18 Hz		
	Synchronization df min	0.00 to -0.49 Hz	-0.10 Hz		
	Synchronization dV max	[1] 1 to 20 V [4] 1 to 60 V	[1] 6 V [4] 24 V		
	Synchronization Brk.hold T>	0.04 to 0.50 s	0.20 s		
	Phase matching	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Slip synchroniz. Max phase	0 to 60°	7 °		
	Slip synchroniz. TClose GCB	40 to 300 ms	80 ms		
	Slip synchroniz. TClose MCB	40 to 300 ms	80 ms		
	Phase matching Max phase <	0 to 60°	7 °		
	Phase matching Dwell time	0.2 to 10.0 s	10.0 s		
	Phase matching Gain	1 to 36	2		
	Phase matching df start	0.02 to 0.25 Hz	0.20 Hz		
CONFIGURE SYNCH TIME MONITORING					
	Sync.time contr. Alarm	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Sync.time contr. Delay time	10 to 999 s	120 s		

Option	Parameter 100/400V; 1/5 A	Adjustment range	Standard setting	Customer settings	
CONFIGURE DEAD BUS START					
	Gen.circ.break Dead bus op	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Dead bus op. GCB df max	0.05 to 5.00 Hz	0.25 Hz		
	Dead bus op. GCB dV max	[1] 1 to 20 V [4] 1 to 60 V	[1] 10 V [4] 40 V		
	Mains circ.breakDead bus op	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
CONFIGURE MONITORING					
	Configure monitoring	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	Reverse/min.pow. Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Reverse/min.pow. Threshold	-99 to 0 to +99 %	-20 %		
	Reverse/min.pow. Delay	0.1 to 99.9 s	1.0 s		
	Gen. overload Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Gen. overload Threshold	0 to 120 %	120 %		
	Gen. overload Delay time	0 to 99 s	20 s		
	Gen.frequency Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Gen. overfreq. f >	40.0 to 70.0 Hz	55.0 Hz		
	Gen. overfreq. Delay time	0.04 to 9.98 s	3.00 s		
	Gen. underfreq. f <	40.0 to 70.0 Hz	45.0 Hz		
	Gen. underfreq. Delay time	0.04 to 9.98 s	3.00 s		
	Gen.voltage Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Gen.overvoltage U >	[1] 20 to 150 V [4] 20 to 520 V	460 V		
	Gen.overvoltage Delay time	0.04 to 9.98 s	3.00 s		
	Gen.undervoltage U <	[1] 20 to 150 V [4] 20 to 520 V	340 V		
	Gen.undervoltage Delay time	0.04 to 9.98 s	3.00 s		
	Mains frequency monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Mains overfreq. f>	40.0 to 70.0 Hz	50.2 Hz		
	Mains overfreq. Delay time	0.02 to 9.98 s	0.10 s		
..	Mains underfreq. f<	40.0 to 70.0 Hz	48.8 Hz		
..	Mains underfreq. Delay time	0.02 to 9.98 s	0.10 s		
..	Mains voltage monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
..	Mains volt.monit	phase to phase phase to neutral	phase-phase	☐ p-p ☐ p-n	☐ p-p ☐ p-n
..	Mains overvolt. U Ph.-Ph >	[1] 20 to 150 V [4] 20 to 520 V			
..	Mains overvolt. U Ph.-N >	[1] 20 to 150 V [4] 20 to 300 V			
..	Mains overvolt. Delay time	0.02 to 9.98 s	0.10 s		
..	Mains undervolt. U Ph.-Ph <	[1] 20 to 150 V [4] 20 to 520 V			
..	Mains undervolt. U Ph.-N <	[1] 20 to 150 V [4] 20 to 300 V			
..	Mains overvolt. U>	[1] 20 to 150 V [4] 20 to 520 V	440 V		
	Mains overvolt. Delay time	0.02 to 9.98 s	0.10 s		
..	Mains undervolt. U<	[1] 20 to 150 V [4] 20 to 520 V	360 V		
	Mains undervolt Delay time	0.02 to 9.98 s	0.10 s		
	Phase shift Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Phase shift mon.	1/3phase / 3phase	1/3phase	☐ 1/3 ☐ 3	☐ 1/3 ☐ 3
	Phase shift thr. one-phase	3 to 90 °	30 °		
	Phase shift thr.three-phase	3 to 90 °	8 °		
	Auto-acknowledge Messages	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Acknowledge Message aft	1 to 99 s	1 s		
CONFIGURE PASSWORD					
	Define level 1 code	0000 to 9999	0001		
	Define level 2 code	0000 to 9999	0002		

Appendix D.
Power Factor Definition

The phasor diagram is used from the generator's view. This defines the following definitions.

Power Factor is defined as a ratio of the real power to apparent power. In a purely resistive circuit, the voltage and current waveforms are instep resulting in a ratio or power factor of 1.00 (often referred to as unity). In an inductive circuit the current lags behind the voltage waveform resulting in usable power (real power) and unusable power (reactive power). This results in a positive ratio or lagging power factor (i.e. 0.85lagging). In a capacitive circuit the current waveform leads the voltage waveform resulting in usable power (real power) and unusable power (reactive power). This results in a negative ratio or a leading power factor (i.e. 0.85leading).

Inductive: Electrical load whose current waveform lags the voltage waveform thus having a lagging power factor. Some inductive loads such as electric motors have a large startup current requirement resulting in lagging power factors.	Capacitive: Electrical load whose current waveform leads the voltage waveform thus having a leading power factor. Some capacitive loads such as capacitor banks or buried cable result in leading power factors.

Different power factor displays at the unit:

i0.91 (inductive) lg.91 (lagging)	c0.93 (capacitive) ld.93 (leading)

Reactive power display at the unit:

70 kvar (positive)	-60 kvar (negative)

Output at the interface:

+ (positive)	- (negative)

In relation to the voltage, the current is

lagging	leading

The generator is

over excited	under excited

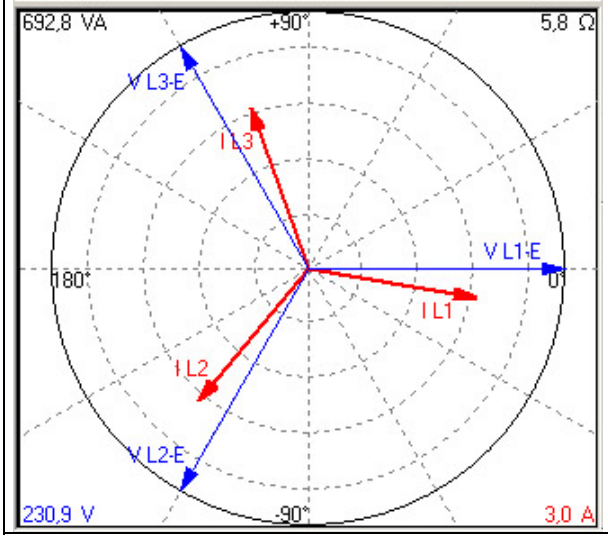
Control: If the control unit is equipped with a power factor controller

A voltage lower "-" signal is output as long as the measured value is "more inductive" than the reference set point Example: measured = i0.91; set point = i0.95	A voltage raise "+" signal is output as long as the measured value is "more capacitive" than the reference set point Example: measured = c0.91; set point = c0.95

Phasor diagram:

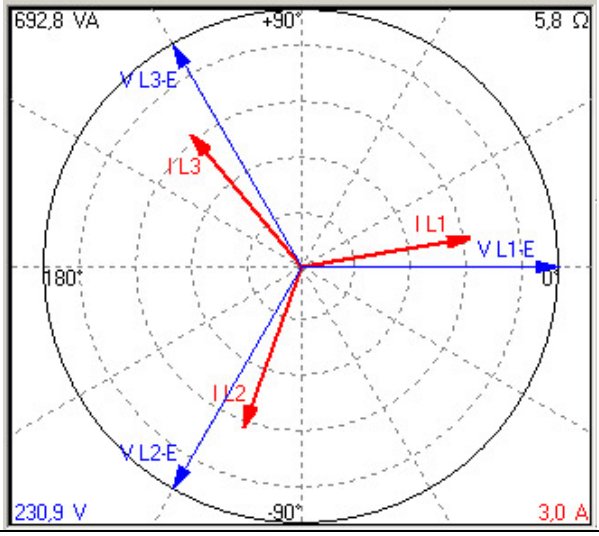
inductive

Signal	Magnitude	Phase	Real	Imaginary
V L1-E	230,9 V	0,00 °	230,9 V	0,000 V
V L2-E	230,9 V	-120,00 °	-115,5 V	-200,0 V
V L3-E	230,9 V	120,00 °	-115,5 V	200,0 V
I L1	2,000 A	-10,00 °	1,970 A	-347,3 mA
I L2	2,000 A	-130,00 °	-1,286 A	-1,532 A
I L3	2,000 A	110,00 °	-684,0 mA	1,879 A



capacitive

Signal	Magnitude	Phase	Real	Imaginary
V L1-E	230,9 V	0,00 °	230,9 V	0,000 V
V L2-E	230,9 V	-120,00 °	-115,5 V	-200,0 V
V L3-E	230,9 V	120,00 °	-115,5 V	200,0 V
I L1	2,000 A	10,00 °	1,970 A	347,3 mA
I L2	2,000 A	-110,00 °	-684,0 mA	-1,879 A
I L3	2,000 A	130,00 °	-1,286 A	1,532 A



Appendix E.
Service Options

Product Service Options

The following factory options are available for servicing Woodward equipment, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is purchased from Woodward or the service is performed. If you are experiencing problems with installation or unsatisfactory performance of an installed system, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact Woodward technical assistance (see "How to Contact Woodward" later in this chapter) and discuss your problem. In most cases, your problem can be resolved over the phone. If not, you can select which course of action you wish to pursue based on the available services listed in this section.

Returning Equipment For Repair

If a control (or any part of an electronic control) is to be returned to Woodward for repair, please contact Woodward in advance to obtain a Return Authorization Number. When shipping the unit(s), attach a tag with the following information:

- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part numbers (P/N) and serial number (S/N);
- description of the problem;
- instructions describing the desired repair.

CAUTION

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules.*

Packing A Control

Use the following materials when returning a complete control:

- protective caps on any connectors;
- antistatic protective bags on all electronic modules;
- packing materials that will not damage the surface of the unit;
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material;
- a packing carton with double walls;
- a strong tape around the outside of the carton for increased strength.

Return Authorization Number RAN

When returning equipment to Woodward, please telephone and ask for the Customer Service Department in Stuttgart [+49 (0) 711 789 54-0]. They will help expedite the processing of your order through our distributors or local service facility. To expedite the repair process, contact Woodward in advance to obtain a Return Authorization Number, and arrange for issue of a purchase order for the unit(s) to be repaired. No work can be started until a purchase order is received.

NOTE

We highly recommend that you make arrangement in advance for return shipments. Contact a Woodward customer service representative at +49 (711) 789 54-0 for instructions and for a Return Authorization Number.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part numbers P/N (XXXX-XXX) that is on the enclosure nameplate;
- the unit serial number S/N, which is also on the nameplate.

How To Contact Woodward

Please contact following address if you have questions or if you want to send a product for repair:

Woodward Governor Company
Leonhard-Reglerbau GmbH
Handwerkstrasse 29
70565 Stuttgart - Germany

Phone: +49 (0) 711 789 54-0 (8:00 – 16:30 German time)
Fax: +49 (0) 711 789 54-100
e-mail: sales-stuttgart@woodward.com

For assistance outside Germany, call one of the following international Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Facility	Phone number
USA	+1 (970) 482 5881
India	+91 (129) 230 7111
Brazil	+55 (19) 3708 4800
Japan	+81 (476) 93 4661
The Netherlands	+31 (23) 566 1111

You can also contact the Woodward Customer Service Department or consult our worldwide directory on Woodward's website (**www.woodward.com**) for the name of your nearest Woodward distributor or service facility. [For worldwide directory information, go to **www.woodward.com/ic/locations**.]

Engineering Services

Woodward Industrial Controls Engineering Services offers the following after-sales support for Woodward products. For these services, you can contact us by telephone, by e-mail, or through the Woodward website.

- Technical support
- Product training
- Field service during commissioning

Technical Support is available through our many worldwide locations, through our authorized distributors, or through GE Global Controls Services, depending on the product. This service can assist you with technical questions or problem solving during normal business hours. Emergency assistance is also available during non-business hours by phoning our toll-free number and stating the urgency of your problem. For technical engineering support, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference technical support.

Product Training is available on-site from several of our worldwide facilities, at your location, or from GE Global Controls Services, depending on the product. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability. For information concerning training, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference ***customer training***.

Field Service engineering on-site support is available, depending on the product and location, from our facility in Colorado, or from one of many worldwide Woodward offices or authorized distributors. Field engineers are experienced on both Woodward products as well as on much of the non-Woodward equipment with which our products interface. For field service engineering assistance, please contact us via our toll-free or local phone numbers, e-mail us, or use our website and reference ***field service***.

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

Contact

Your company _____

Your name _____

Phone number _____

Fax number _____

Control (see name plate)

Unit no. and Revision: P/N: _____ REV: _____

Unit type SPM-D21 _____

Serial number S/N _____

Description of your problem

_____

_____

_____

_____

_____

_____

_____

Please be sure you have a list of all parameters available.

We appreciate your comments about the content of our publications.

Please send comments to: stgt-documentation@woodward.com

Please include the manual number from the front cover of this publication.

Woodward Governor Company
Leonhard-Reglerbau GmbH
Handwerkstrasse 29 - 70565 Stuttgart - Germany
Phone +49 (0)711 / 789 54-0 • Fax +49 (0)711 / 789 54-100
sales-stuttgart@woodward.com

Homepage

http://www.woodward.com/power

Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address/phone/fax/e-mail information for all locations is available on our website (www.woodward.com).

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