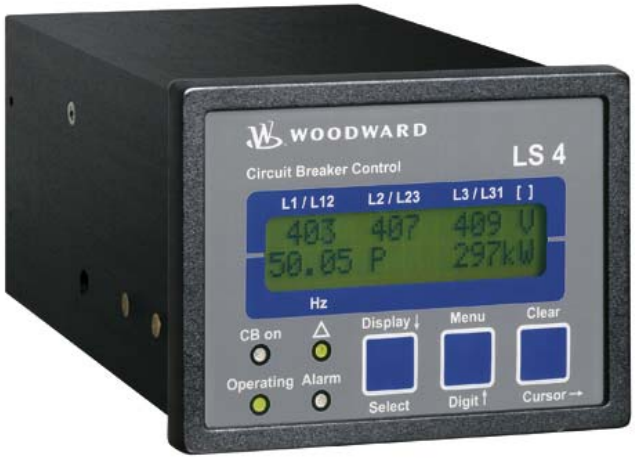
37105C

LS 4
Circuit Breaker Control



Manual
Software Version 3.2xxx

Manual 37105C

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 device(s), that operates totally independently of the prime mover control device(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 device(s) fail.

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

CAUTION

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device 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 devices.**

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Important definitions

WARNING

Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

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

NOTE

Provides other helpful information that does not fall under the warning or caution categories.

Revision History

Rev.	Date	Editor	Changes
NEW	04-01-01	Tr	Release
A	04-05-14	TP	Minor corrections
B	06-04-19	TP	Technical review
C	08-11-26	TE	Minor corrections

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Chapter 1.
General Information

The LS 4 is an intelligent synchronizer and protection device capable of measuring voltage and current though integrated measuring inputs. It can calculate set point values using internal software routines (i.e. for synchronization) and can transfer these set point values to a lower level GCP control unit using the integrated CAN bus (Guidance Level). The LS 4 is also capable of closing the connected breaker at the synchronous point. Additionally the measured/calculated values may be monitored for exceeding/falling below a predefined set point resulting in an automatic opening of the connected circuit breaker.

The detailed model description for the LS 4 reads as follows:

LS4 15 B	
	Mounting [B]=Flush-mounting
	Current transformer, secondary [1] = ../1 A [5] = ../5 A
	Voltage transformer, secondary [1] = 100 Vac [4] = 400 Vac
	Type

Table 1-1: Reading LS 4 part numbers

Example:
LS 415B (flush mounted, standard unit with 100 Vac PT and ../5 A CT inputs)

Intended Use: This control must 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 item fitted with all available options. Inputs/outputs, functions, configuration screens and other details described which do not exist on your item may be ignored.

The present manual has been prepared to enable the installation and commissioning of the item. Due to the large variety of parameter settings it is not possible to cover every possible combination. This manual is 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 easily as synthetics.

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

4.) **Opening the control cover may void the unit warranty.**
Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:

- Ensure that the device is completely voltage-free (all connectors have to be disconnected).
- Do not touch any part of the PCB except the edges.
- Do not touch the electrical conductors, connectors, or components with conductive devices or with bare 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.

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.*

Chapter 3.
Installation

CAUTION

A circuit breaker must be located 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

Inductive devices connected to the system (such as operating current coils, undervoltage tripping units, or auxiliary/power contacts) must be connected to a suitable interference suppressor.

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 Diagram

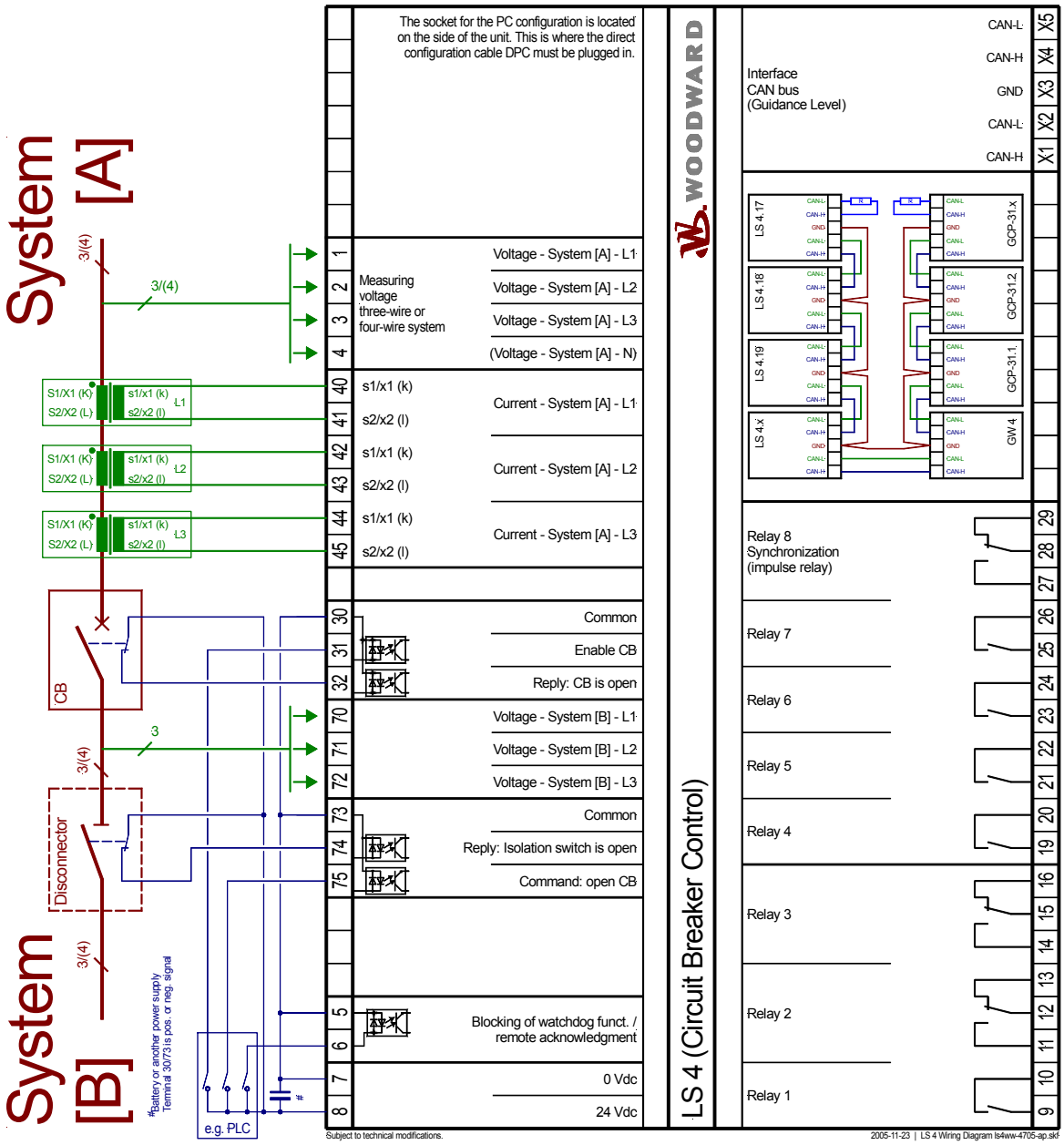


Figure 3-1: Wiring diagram

Power Supply

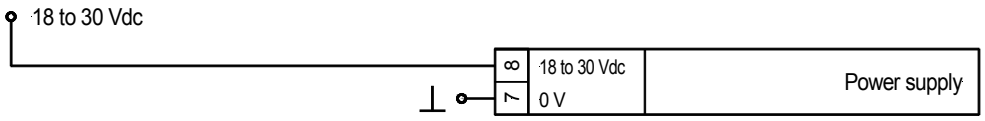


Figure 3-2: Power supply

Terminal	Description	Amax
Standard		
8	18 to 30 Vdc, max. 10 W	2.5 mm²
7	0 Vdc reference point	2.5 mm²

Measuring Inputs

Voltage - System [A]

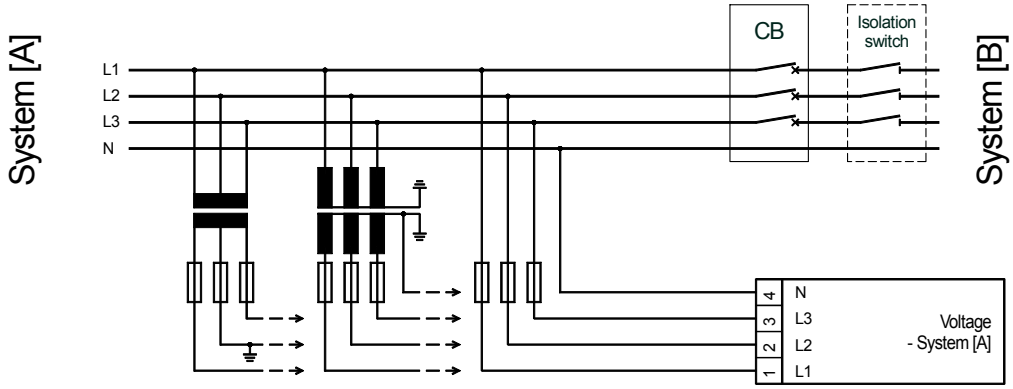


Figure 3-3: Measuring inputs - voltage - system [A]

Terminal	Measuring	Description	A_{max}
1	400 Vac direct or via 100 Vac transformer	Voltage - system [A] - L1	2.5 mm²
2		Voltage - system [A] - L2	2.5 mm²
3		Voltage - system [A] - L3	2.5 mm²
4		Neutral point of the 3-phase system/transformer	2.5 mm²

Voltage - System [B]

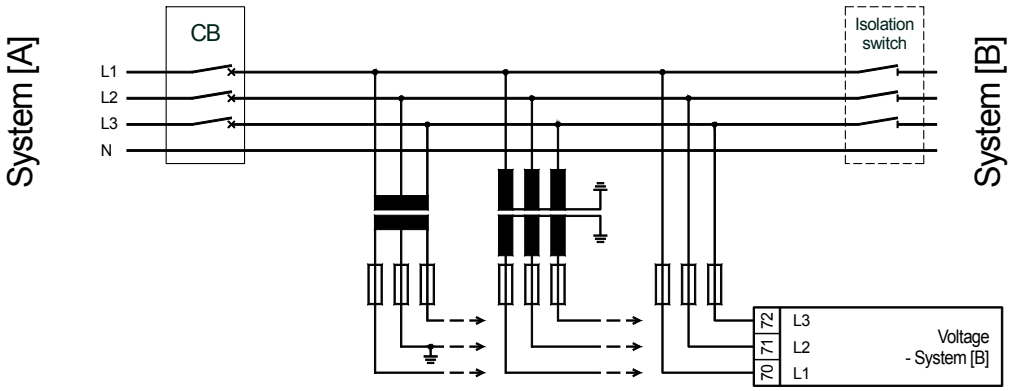


Figure 3-4: Measuring inputs - voltage - system [B]

Terminal	Measuring	Description	A_{max}
70	400 Vac direct or via 100 Vac transformer	Voltage - system [B] - L1	2.5 mm²
71		Voltage - system [B] - L2	2.5 mm²
72		Voltage - system [B] - L3	2.5 mm²

Current - System [A]

CAUTION

Before disconnecting the secondary current transformer connections or the connections of the current transformer at the device, ensure that the current transformer is short-circuited.

NOTE

Grounding of the secondary of a current transformer must always be single-sided.

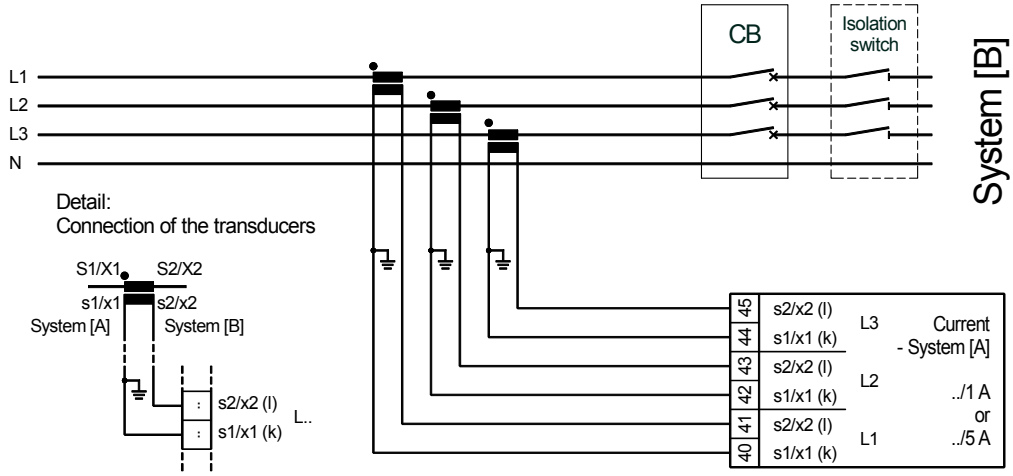


Figure 3-5: Measuring inputs - current - system [A]

Terminal	Measuring	Description	A_{max}
40	Transformer ../1 A or ../5 A	Current - System [A] - L1, transformer term. s1/x1 (k)	4.0 mm²
41		Current - System [A] - L1, transformer term. s2/x2 (l)	4.0 mm²
42		Current - System [A] - L2, transformer term. s1/x1 (k)	4.0 mm²
43		Current - System [A] - L2, transformer term. s2/x2 (l)	4.0 mm²
44		Current - System [A] - L3, transformer term. s1/x1 (k)	4.0 mm²
45		Current - System [A] - L3, transformer term. s2/x2 (l)	4.0 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 will destroy the hardware!

- **Maximum input range: +/-18 to 250 Vac.**

The discrete inputs may be either connected in a positive or a negative logic circuit:

- positive logic The discrete input is connected with +/-18 to 250 Vac.
- negative logic The discrete input is connected with GND.

Positive Logic

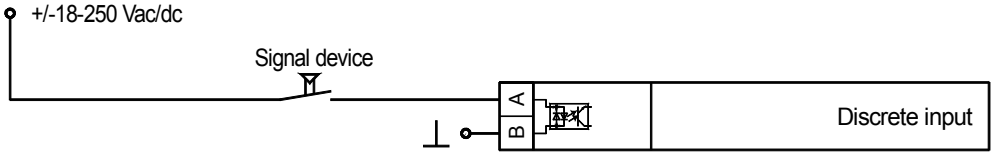


Figure 3-6: Discrete inputs - positive logic

Terminal	Associated common	Description (according to DIN 40 719, part 3, 5.8.3)	A_{max}
A	***B***		
5	6	Blocking of protective functions / remote acknowledgment	2.5 mm²
31	30	Enable CB	2.5 mm²
32		Reply: CB is open	2.5 mm²
74	73	Reply: Isolation switch is open	2.5 mm²
75		Command: open CB	2.5 mm²

Negative Logic

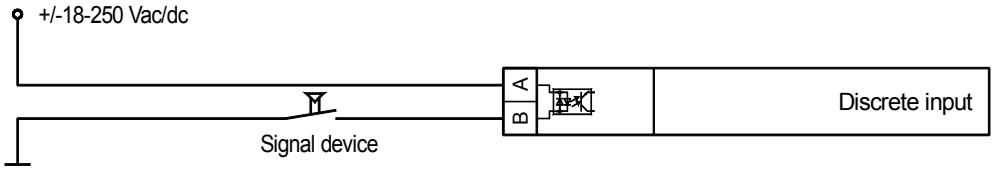


Figure 3-7: Discrete input - negative logic

Associated common	Terminal	Description (according to DIN 40 719, part 3, 5.8.3)	A_{max}
A	***B***		
6	5	Blocking of protective functions / remote acknowledgment	2.5 mm²
30	31	Enable CB	2.5 mm²
	32	Reply: CB is open	2.5 mm²
73	74	Reply: Isolation switch is open	2.5 mm²
	75	Command: open CB	2.5 mm²

Relay Outputs

CAUTION

The function "Command: open CB" must be assigned to one of the freely configurable relays using the relay manager (see Parameter 98).

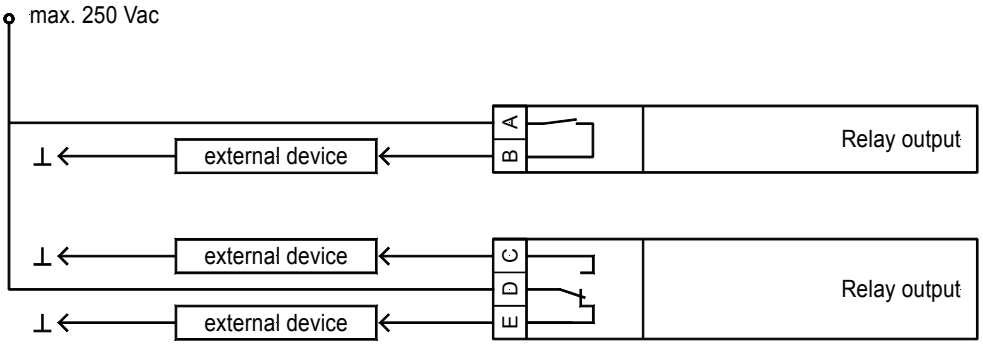


Figure 3-8: Relay outputs

			Description	A_{max}
Make contact				
Root ***A***	Switched ***B [NO]***			
9	10		Relay 1 (ready for operation; NC)	2.5 mm²
19	20		Relay 4	2.5 mm²
21	22		Relay 5	2.5 mm²
23	24		Relay 6	2.5 mm²
25	26		Relay 7	2.5 mm²
Change-over contact				
Swtchd ***C [NO]***	Root ***D***	Opened ***E [NC]***		
11	12	13	Relay 2	2.5 mm²
14	15	16	Relay 3	2.5 mm²
27	28	29	Synchronization (pulse relays)	2.5 mm²

Interface

Interface Connection

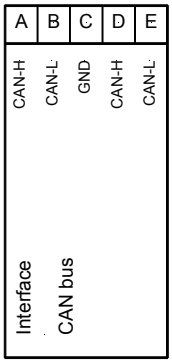


Figure 3-9: Interface - terminals

Terminal					Description
A (X1)	B (X2)	C (X3)	D (X4)	E (X5)	
[1]	[1]	GND	CAN-H	CAN-L	CAN bus

[1] may be used to loop CAN bus and/or to connect termination resistance.

CAN Bus Shielding

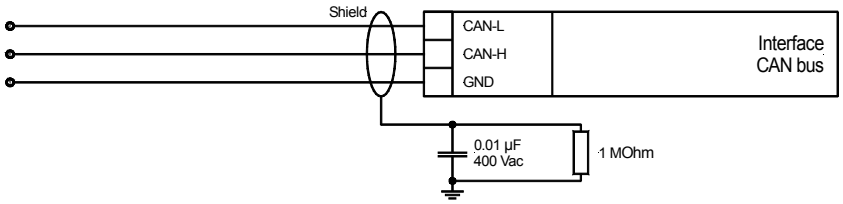


Figure 3-10: Interface - CAN bus shielding

CAN Bus Topology

NOTE

Please note that the CAN bus must be terminated with an impedance which corresponds to the wave impedance of the cable (e.g. 120 Ω). The CAN bus is terminated between CAN-H and CAN-L.

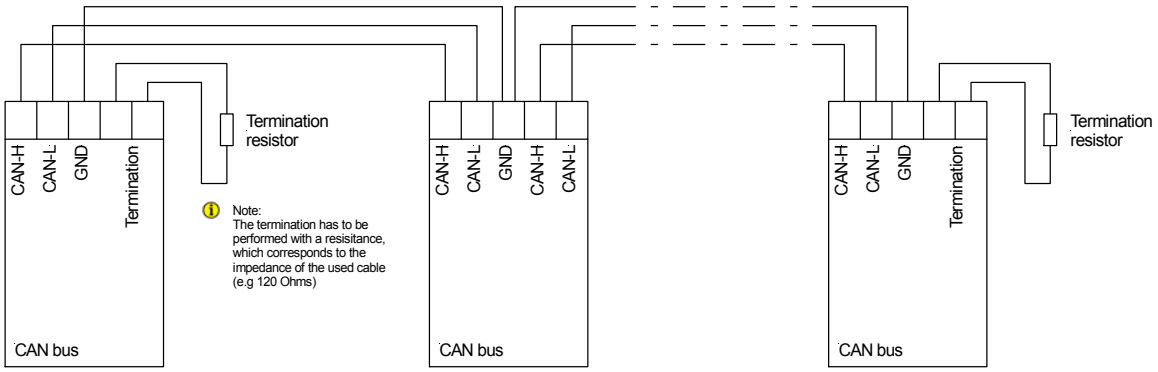


Figure 3-11: Interfaces - CAN bus topology

Possible CAN Bus Problems

If no data is transmitted on the CAN bus, check the following for common CAN bus communication problems:

- T structure bus is utilized (stub-end feeders or branch lines are not recommended)
- CAN-L and CAN-H are interchanged
- Not all devices on the bus are using identical Baud rates
- Terminating resistor(s) is/are missing
- Incorrect baud rate (too high) for length of CAN bus

Maximum CAN Bus Length

The maximum length of the communication bus wiring is dependent on the configured Baud rate. Refer to Table 3-2 for the maximum bus length (Source: CANopen; Holger Zeltwanger (Hrsg.); 2001 VDE VERLAG GMBH, Berlin und Offenbach; ISBN 3-8007-2448-0).

Baud rate	Max. length
1000 kbit/s	25 m
800 kbit/s	50 m
500 kbit/s	100 m
125 kbit/s	250 m
50 kbits/s	1000 m
20 kbit/s	2500 m

Table 3-2: Maximum CAN bus length

The maximum specified length for the communication bus wiring might not be achieved if poor quality wire is utilized, there is high contact resistance, or other conditions exist. Reducing the baud rate may overcome these issues.

DPC - Direct Configuration Interface

NOTE

To configure via the configuration interface (direct configuration), you need the configuration cable (part number 5417-557), the program LeoPC1 (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 program and its setup.

If Parameter 5 "Direct para" is enabled on the control, communication via the CAN bus interface on terminals X1/X5 is disabled.

Chapter 4.
Functional Description

Introduction

Measuring Values

- **Voltage**
  Three-phase measurement of the rms values of the phase-to-neutral and phase-to-phase voltages of two systems (system [A] and [B]; system [B] only phase-to-phase). This unit can be delivered with the following measuring voltage ranges (rated values). Selection of type during ordering (see page 75 "Technical Data"):
  - 66/115 Vac
  - 230/400 Vac
- **Frequency**
  Time measurement from the digitally filtered measuring voltages. The measurement of the frequency is three-phased if all voltages are greater than 15 % of the rated value (100 Vac or 400 Vac). This guarantees a fast and precise measurement of the frequency. However the frequency is still measured correctly even if voltage is only applied to one phase.
- **Current**
  Three-phase rms values.
- **Real power**
  Single-phase measuring calculated from apparent power and power factor cosphi (power factor).
- **Re-active power**
  Single-phase measurement calculated from apparent power and power factor sinphi.
- **Power factor cosphi**
  Time measurement between the filtered measuring values of the voltage V_{L12} and the conductor current I_{L1}.

General Functions

- 1 freely configurable relay output (NO) as ready for operation relay
- 4 freely configurable relay outputs (NO)
- 2 freely configurable relay outputs (change-over)
- 1 relay output (change-over) for synchronization (pulse relay)
- Discrete input for alarm blocking or acknowledgment
- Password system
- CAN bus interface
- 4 discrete control inputs

Protection Functions

CAUTION

The function "Command: open CB" must be assigned to one of the freely configurable relays using the relay manager (see Parameter 98).

Function	Monitoring	System monitored
• Three-phase over-/undervoltage (2 levels)	V>/V<	only system [A]
• Over-/underfrequency	f>/f<	only system [A]
• Voltage asymmetry	Vas>	only system [A]
• dφ/dt phase/vector jump	dφ/dt	only system [A]
• df/dt (ROCOF)	df/dt	only system [A]

Control/Synchronization Functions

- Transmission of set point values via CAN bus to a lower level control unit (i.e. GCP-31) for synchronization of one circuit breaker with voltage and frequency adjustment
- Transmission of actual values via the CAN bus to a control unit (i.e. GCP-31) for real power control
- Closing of the CB onto a dead (de-energized) bus bar

Direction of Power

If the unit's current transformers are wired according to the pin diagram shown below, the following values are indicated:

Positive real power System [A] supplies real power.
Inductive cos φ System [A] is over-excited and supplies inductive re-active power. It works like an over-excited generator/alternator.

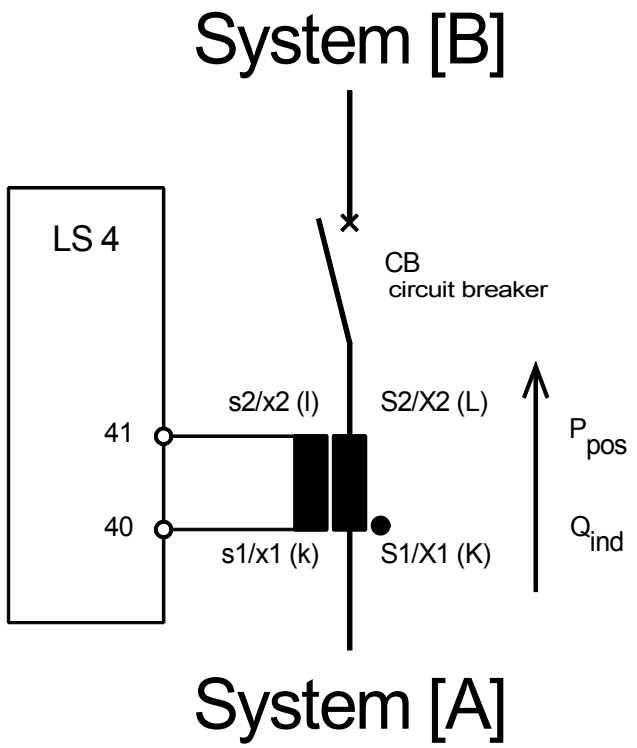


Figure 4-1: Direction of power

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

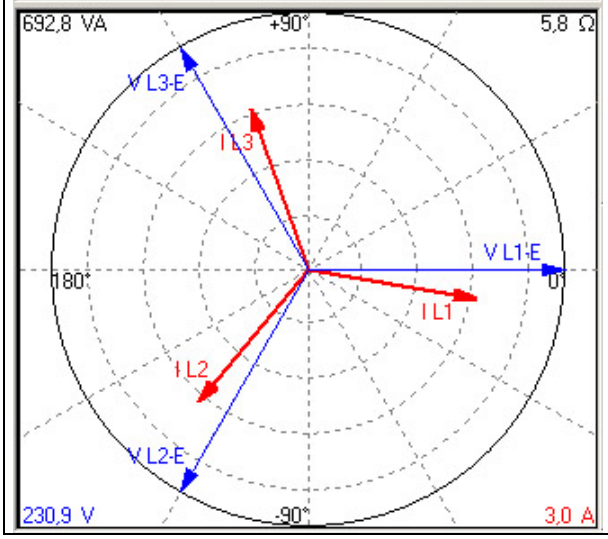
Control: If the control unit is equipped with a power factor controller

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

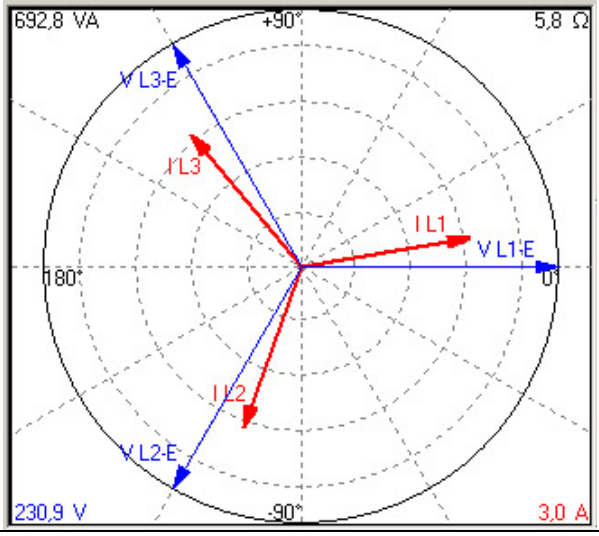
Phasor diagram:

inductive	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	-130,00 °	-1,286 A	-1,532 A
I L3	2,000 A	110,00 °	-684,0 mA	1,879 A



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



Function

Synchronizing

The variable system is synchronized to the fixed system (variable and fixed system can be configured) for voltage and frequency. This is done by sending set point values through the CAN bus to the lower level GCP control that are electrically connected with the configured variable system. The LS 4 calculates the correct synchronous point to issue a CB close command using the switching time of the CB (Parameter 37). Synchronizing/closing of the CB is done if the following conditions are fulfilled simultaneously:

- The unit is in automatic mode.
- The synchronizing function is enabled (Parameter 31).
- Voltage and frequency of both systems [A] and [B] are within the configured range (for both systems this range is adjustable by changing the settings for the voltage monitoring functions of system [A] if this protection is enabled; Parameter 57, Parameter 63, Parameter 73, and Parameter 79):

Monitoring	Voltage	Frequency
ON	Watchdog settings	Watchdog settings
OFF	$V_{System\ [A/B]} < 75\ \%\ V_{Rated}$ $V_{System\ [A/B]} > 112.5\ \%\ V_{Rated}$	$f_{System\ [A/B]} < 88.5\ \%\ f_{Rated}$ $f_{System\ [A/B]} > 112.5\ \%\ f_{Rated}$

Table 4-1: Permissible range for synchronization

- The discrete input "Enable CB" is set.
- The discrete input "Reply: CB is open" is set.
- The synchronizing time monitoring is disabled or is not reached (Parameter 52).
- No alarm is triggered if parameter "Blocking at synchronizing alarm" is configured to ON (Parameter 39).
- No GCP is trying to carry out a dead bus start.
- No higher prioritized LS 4 is trying to close its breaker.

Dead Bus Start

A close CB command without synchronization may be issued if the following conditions are fulfilled simultaneously:

- Dead bus start function is configured to ON (Parameter 43).
- Discrete input "Enable CB" is set.
- Discrete input "Reply: CB is open" is set.
- One of the three possible black start functions is enabled
  1.) Parameter 46 ($V_{system\ A}=V_n/V_{system\ B}=0$)
  $V_{system\ A}$ is equal with V_n (using the configured rated voltage difference dV |V-V_n|) and $V_{system\ B}$ is zero (using the configured zero voltage difference dV |V-0|).
  2.) Parameter 45 ($V_{system\ A}=0/V_{system\ B}=V_n$)
  $V_{system\ A}$ is zero (using the configured zero voltage difference Vd |V-0|) and $V_{system\ B}$ is equal with V_n (using the configured rated voltage difference dV |V-V_n|).
  3.) Parameter 44 ($V_{system\ A}=0/V_{system\ B}=0$)
  VA is zero and VB is zero (using the configured zero voltage difference dV |V-0|).
- No alarm is triggered if parameter "Blocking at dead start alarm" is configured to ON (Parameter 51).
- No GCP is trying to carry out a dead bus start.
- No higher prioritized LS 4 is trying to close its breaker.

In conditions 1 and 2 the frequency of systems [A] or [B] must be within the configured range.

Configuration Methods

Following configuration methods may be utilized . Configuration may be performed via:

- CAN bus using a CAN bus card in the PC and the PC program LeoPC1,
- The configuration plug using the direct configuration cable DPC and the PC program LeoPC1, or
- Via front touch pad-buttons and the LC display.

Chapter 5.
Display and Operation Components

The pressure-sensitive membrane of the front panel consists of a plastic coating. All keys have been designed as touch-sensitive membrane switch elements. The display is a LC-display, consisting of 2 rows of 16 characters each, with indirect green lighting. The contrast of the display can be infinitely adjusted via a rotary potentiometer positioned on the left side of the control. The configuration plug is located on the left side of the unit as well. Please connect the direct configuration cable there (DPC).

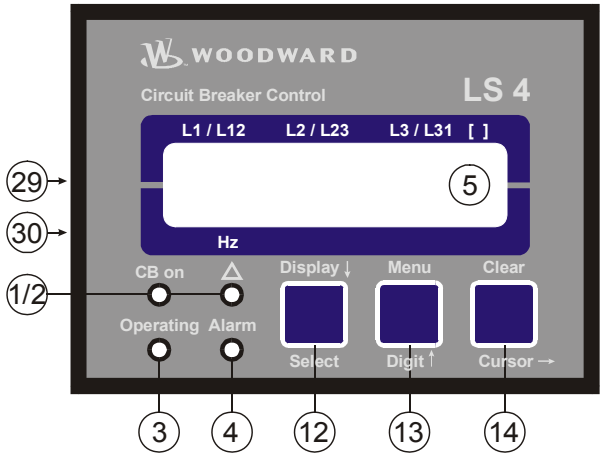


Figure 5-1: Front panel

Short Description of LED and Push Buttons

LEDs

No.	Description	Function
1	CB on	Reply: CB is closed
2	Delta	Display of phase-phase or phase-neutral voltages
3	Operation	Automatic mode
4	Alarm	Alarm occurred

Push Buttons

No.	Description	Function
12	Display↓	Advance to next screen
12	Select	Confirm selection
13	Menu	Select menu
13	Digit↑	Increase the digit
14	Clear	Acknowledgement of alarm messages
14	Cursor→	Move cursor one position to the right

Miscellaneous

No.	Description	Function
5	LC display	Display all text messages and readings
29	DPC plug	Configuration plug
30	Potentiometer	Adjust LCD contrast

LEDs

NOTE

If the "Delta" LED not illuminated and an "A" is visible in the field "[ ]" of the LC display, the conductor currents may be read in the first line of the LC display.

1 **CB on**
Color: Yellow

CB is closed

If this LED is illuminated the connected CB is closed.

2 **Delta**
Color: Yellow

Display of line-to-line/line-neutral voltages

ON .....The displayed values are phase-phase (delta) voltages.
OFF .....The displayed values are phase-neutral (wye) voltages.

3 **Operation**
Color: Green

Operation

This LED is illuminated constantly when the LS 4 is in the Automatic mode. If this LED is flashing, the LS 4 is in the configuration mode.

4 **Alarm**
Color: Red

Alarm

This LED flashes as long as a set point limit is exceeded. When all measuring values are below the configured set point limit again and "Auto clearing display" is configured "OFF", this LED will change to steady illumination.

Push Buttons

In order to facilitate the setting of the parameters the buttons are equipped with an "AUTOSCROLL" function while the controller is in the configuration mode. It permits the user to rapidly advance to the next setting and configuration screens, the digits, or the cursor position. The "AUTOSCROLL" function will only be enabled when the user presses and holds the corresponding buttons.

12 **Display↓ / Select**
Color: Blue

Display↓ / Select

Automatic mode: Display↓ - By pressing this button, the user advances through the display of operating (wye voltages, delta voltages, wire currents) and alarm messages. The "Delta" LED is illuminated accordingly.
Configuration: Select - By pressing this button, the user advances 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 the button again, the user causes the system to advance to the next configuration screen.

13 **Menu / Digit↑**
Color: Blue

Menu / Digit↑

Automatic mode: Menu - By pressing this button, the user advances through the messages displayed on the second line of the display. (Various measured values and any alarm messages that have not been cleared are indicated.)
Configuration: Digit↑ - By pressing this button, the digit at which the cursor is presently located is increased by one digit. The increase is restricted by the permissible limits (see list of parameters included in Appendix A). If the highest permissible number has been reached, the number automatically returns to the lowest permissible number.

14 **Clear / Cursor→**
Color: Blue

Clear / Cursor→

Automatic mode: Clear - Individual alarm messages are deleted by pressing this button provided the fault is no longer present.
Configuration: Cursor→ - This button moves the cursor one position to the right. When the cursor reaches the extreme right position it may be returned to the extreme left position by pressing the Cursor→ button again.

Display

5 LC display **LC display**

Performance values can be monitored from the two-line display, provided that the control is in automatic mode. In configuration mode, the individual parameters are displayed.

Automatic Mode (Upper Line of the Display: Measured Values)

NOTE

The user can scroll through the upper display line with the "Display ↓" button.

"Delta" = off
→ Phase-neutral voltages

```
230 230 230 V
---------------
```

"Delta" = on
→ Phase-phase voltages

```
400 400 400 V
---------------
```

"Delta" = off
→ Conductor currents

```
314 314 314 A
---------------
```

Upper line of display when in automatic mode: measured values System [A]

The following measured values of system [A] are displayed (depending if the "Delta" LED is or is not illuminated):

- The "Delta" LED is not illuminated (Delta=off) and the letter "V" is displayed to the right of the numerical values.
  The line-neutral voltages of system [A] (V_{L1-N}, V_{L2-N}, and V_{L3-N}) of the wye or four-conductor system will be displayed. If the available system is a Delta or three-conductor system, the Parameter 6 "Volt. measuring" must be set to "Phase-to-phase". As a result the line-neutral display does not appear.
- The "Delta" LED is illuminated (Delta=on) and the "V" is displayed to the right of the numerical values.
  The line-to-line voltages of system [A] (V_{L1-L2}, V_{L2-L3}, and V_{L3-L1}) of the three/four conductor system are displayed.
- The "Delta" LED is not illuminated (Delta=off) and the letter "A" is displayed to the right of the numerical values. The conductor currents (I_{L1}, I_{L2}, and I_{L3}) of system [A] are visible.

Automatic Mode (Bottom Line of the Display: Measured Values)

NOTE

The "Menu" button may be used to scroll through the messages shown on the bottom line of the display.

```
---------------
00.00 xxxxxxxxxx
```

Display in automatic mode, bottom line: measured values

The frequency is always indicated in [Hz].
Instead of "**xxxxxxxxxx**" the following measuring values are indicated:

System [A]	**Engineering unit of measure**
• Real power P	kW / MW
• cosphi	no units
• Re-active power Q	kvar / Mvar
• Apparent power S	kVA / MVA
• Synchronizing angle	degrees [°]

System [B]	**Engineering unit of measure**
• Synchr. voltage VB_{L1-L2}	V / kV
• Synchr. voltage VB_{L2-L3}	V / kV
• Synchr. voltage VB_{L3-L1}	V / kV
• Synchr. frequency fB	Hz

Automatic Mode (Bottom Line of the Display: Alarm Messages)

NOTE

The user may scroll through the alarm messages that have occurred with the "Menu" button.

```
----------------
00.00 yyyyyyyyyy
```

Display in automatic mode, bottom line: alarm messages

Alarm messages are shown on the bottom line of the unit display. Table contains a list of all alarm messages that the control may monitor for depending on how the unit is configured.

Type of alarm	yyyyyyyyyy
System [A]	
Overvoltage, level 1 / level 2	Overvolt.1 / 2
Undervoltage, level 1 / level 2	Undervlt.1 / 2
Asymmetry	Asymmetry
Overfrequency, level 1 / level 2	Overfreq.1 / 2
Underfrequency, level 1 / level 2	Underfrq.1 / 2
Phase/vector jump	Phase shift
df/dt	Fault df
Phase rotation alarm	Rot.field
Connecting time exceeded	Connect t.
Interface fault	Interface

Table 5-1: Messages and alarms in the LC display

Interfaces

The LS 4 is equipped with two interfaces that work at the following baud rates:

- Direct configuration 9,600 Baud (8 Bit, no parity, 1 Stop bit)
- CAN bus (CiA) 125, 250 or 500 kBaud configurable via serial interface.

Direct Configuration (DPC)

The unit may be directly configured utilizing a DPC configuration cable, the configuration interface port, and a PC/laptop computer with the LeoPC1 program. The proper configuration file must be opened using LeoPC1 (file name: "xxxx-xxxx-yyy-zz.asm" ["xxxx-xxxx" is the product number or P/N, "yyy" is the revision number, and "zz" is the language code]). The parameters in the "Configuration" chapter may be modified using this file.

Chapter 6.
Configuration

Configuration may be performed by manually inputting the desired set points utilizing the touch pad buttons and the LC display. Alternately, the unit may also be configured using a PC/laptop computer and the program LeoPC1 via the serial interface or through the CAN bus. The following baud rates are usable if the unit is configured through Leo PC1:

- Configuration via direct configuration plug = 9,600 Baud
- CAN bus configuration: The Baud rate is equal to the Baud rate of transmitting and receiving Baud rates. This Baud rate may be configured using the direct configuration cable (125, 250, 500 kBaud according to CiA; standard setting = 125 kBaud).

CAUTION

Please note that configuration only should be done while the system is not in operation.

NOTE

A list of all parameters may be found in Appendix B of this manual.

You can advance through the individual parameter screens if you are in configuration mode (simultaneously pressing of "Digit↑" and "Cursor→" push buttons permits access to the configuration mode) by using the "Select" button. If you press and hold the "Select" push button, the scroll function will be activated, allowing for the parameter screens to be advanced through more rapidly. The control unit will permit the operator to reverse up to four previous screens (exception: it is not possible to reverse from the first parameter to the last parameter or to backup through the service screens). To perform the reverse function through the parameter screens, the "Select" and "Cursor→" push buttons must be pressed and released simultaneously. The control unit will revert to automatic mode if an entry isn't performed, a change made, or any other action performed for 120 seconds.

NOTE

There are two different hardware versions described in this operating manual: A 100 V-version [1] and a 400 V-version [4]. The versions vary as far as the configuration screens and the parameter input ranges are concerned. The two types are differentiated by indicating the voltage: ([1] ... or [4] ...).

```
Adjust Settings:
SELECT (ANWAHL)
```

Configuration mode **Button "Select"**

After the configuration mode is enabled, the subsequent screens can be viewed and modified within the preset limits. Please note, that by depressing the "Select" button, the following screens are advanced by one screen each. If a parameter is configured "OFF", the related screens are not displayed or monitored by the control. Pressing the "Select" button will advance the displayed screen to the next parameter.

Basic Data

Parameter 1

```
Software version
      X.xxxx
```

Software version

This screen displays the software version loaded into the control (the last two xx are for software revisions which do not affect the function of the unit).

Parameter 2

```
SPRACHE/LANGUAGE
----------------
```

Language selection **Deutsch/English**

The desired language for the controller to operate in is set by this parameter. The screens (configuration and display screens) can be displayed either in German or English.

Entering the Configuration

Password

The unit is equipped with a three-level code and configuration hierarchy, which allows different user access to the control. A distinction is made between:

Code level CS0 ***(User Level)*** Factory password = none
This code level allows for monitoring of the system and does not permit access to the parameters. Configuration is blocked.

Code level CS1 ***(Basic Service Level)*** Factory password = "**0 0 0 1**"
This code level entitles the user to change selected parameters, like setting Bar/PSI, °C/°F, and clock adjustment. Changing a password is not permitted at this level. This password expires two hours after entering the password and the user is returned to the CS0 level.

Code level CS2 ***(Commissioning Level)*** Factory password = "**0 0 0 2**"
Allows direct access to all parameters (displaying and changing). In addition, the user may also set the password for levels CS1 and CS2. This password expires two hours after entering the password and the user is returned to the CS0 level.

NOTE

Once the code level is entered, access to the configuration menus will be allowed for two hours or until another password is entered into the control. If a user needs to exit a code level, then code level CS0 should be entered. This will block any configuration of the control. A user may return to CS0 by allowing the entered password to expire after two hours or by changing any one digit on the random number generated on the password screen and entering it into the unit.

NOTE

The following configuration screen "Enter code number" only appears if the parameter "Password Protection" is configured "ON" (see below).

Parameter 3

```
Enter code
number      0000
```

Enter code number **0000 to 9999**

Upon enabling the configuration mode, the user is required to enter an access code number, which identifies the various users. The displayed number XXXX is a randomly generated number. If the random number is confirmed by pressing the "Select" button without being changed, the current level of access maintained. Upon entering either a level 1 or level 2 access code, the corresponding level of access is granted. If an incorrect access code is entered the control unit changes to code level 0 and all access is blocked until a code level 1 or 2 access code is entered.

Parameter 4

```
Password
Protection   ON
```

Password protection **ON/OFF**

ON .....Password protection is enabled. Configuration access is enabled by entering the appropriate password (Code level 1/2). If an incorrect code number has been entered, configuration is blocked.
OFF .....Password protection is disabled. Access to configuration screens is permanently set to code level 2 and the code number is not queried. This parameter can only be changed if the code number of code level 2 has been entered.

Basic Settings

WARNING

The incorrect configuration of the unit may lead to faulty measurement of the system and cause damage to the generator or switchgear systems!

Direct Configuration

NOTE

For configuration via the direct configuration plug, a direct configuration cable DPC (P/N 5417-557), the program LeoPC1 (supplied with the cable), and the corresponding configuration files are required. After installing LeoPC1 consult the online help feature for a description of the program and its setup.

CAUTION

If the subsequent parameter "Direct Config." (Parameter 5) is configured to "YES", the communication with the terminals X1 to X5 via the interface is blocked. This setting can lead to malfunctions during operation because there is no connection to the other LS 4/GCP. If the communication via the interface X1 to X5 is to be re-established after the configuration of the unit (i.e. CAN bus link to a GCP or via a Gateway GW 4), the parameter must be set to "NO" (Parameter 5).

NOTE

The following conditions must be fulfilled to enable configuration via DPC:

- **Parameter 5 "Direct parametr." is configured to "YES"**
- **A reply is present that signals that the circuit breaker is open (LED "CB ON" is off, DI at terminal 32 is energized)**
- **A reply is present that signals that the disconnector is open (only if Parameter 17 "Segement number Disconnector" ≠ "0", DI at terminal 74 is energized)**

Parameter 5

```
Direct parametr.
                YES
```

Direct configuration **YES/NO**

YES..... Configuration via the direct configuration port is possible if the CAN bus link that may be established via the terminals X1 to X5 is disabled . The following conditions must exist for direct configuration:
- a connection must be established between the unit and the PC via the direct configuration cable DPC
- the Baud rate of the program LeoPC1 must be set to 9,600 Baud
- the correct configuration file must be used (file name: "xxxx-xxxx-yyy-zz.asm").

NO..... Configuration via the direct configuration port is not possible. The CAN bus link which may be established via the terminals X1 to X5 is activated.

Voltage Measuring

Parameter 6

```
Volt. measuring
---------------
```

This parameter only affects the display. The monitoring screens are defined further below.

Voltage measuring **Phase to phase/Phase-neutral**

This parameter is used to distinguish how the voltage is to be measured. If this parameter is set to "**Phase to phase**", the configuration screen **"Volt.-monitoring"** (Parameter 56) does not appear.

Potential Transformer Configuration

Parameter 7

```
Volt.transformer
sec.[A]     000V
```

Potential transformer secondary, system [A] **[1] 50 to 120 V; [4] 50 to 480 V**

The potential transformer secondary voltage is set here in V. This parameter is utilized to calculate the system voltage in the display. For voltages measured without a potential transformer, secondary and primary voltage must be configured the same.

Parameter 8

```
Volt.transformer
prim[A] 00.000kV
```

Potential transformer primary, system [A] **0.1 to 65.0 kV**

The potential transformer primary voltage is set here in kV. This entry is used to show the system voltage in the display.

Parameter 9

```
Volt.transformer
sec.[B]     000V
```

Potential transformer secondary, system [B] **[1] 50 to 120 V; [4] 50 to 480 V**

The potential transformer secondary voltage is set here in V. This parameter is utilized to calculate the system voltage in the display. For voltages measured without a potential transformer, secondary and primary voltage must be configured the same.

Parameter 10

```
Volt.transformer
prim[B] 00.000kV
```

Potential transformer primary, system [B] **0.1 to 65.0 kV**

The potential transformer primary voltage is set here in kV. This entry is used to show the system voltage in the display.

Example: If a voltage of 400 V is measured without a potential transformer, the secondary transformer voltage must be configured to **400V** and the primary transformer voltage must be configured to **00.400V**.

Current Transformer

Parameter 11

```
Current transf.
          0000/x
```

Current transformer, system [A] **1 to 9,990/{X} A**

The input of the current transformer ratio is necessary for the indication and control of the actual monitored value. The current transformers ratio should be selected so at least 60% of the secondary current rating can be measured when the monitored system is at 100% of operating capacity (i.e. at 100% of system capacity a 5A CT should output 3A). If the current transformers are sized so that the percentage of the output is lower, the loss of resolution may cause inaccuracies in the monitoring and control functions and may affect the functionality of the control.
The control may be ordered with either ../1 A or ../5 A current transformer inputs. The CT inputs will dictate how this parameter is displayed on the control. Information about the current transformers inputs may be found on the unit data plate.

{x} = 1 ..... LS4x**1**B/xxx = Current transformer with ../1 A rated current
{x} = 5 ..... LS4x**5**B/xxx = Current transformer with ../5 A rated current

CAUTION

The settings of the rated voltage in the system must to be equal to the settings in the lower level control unit GCP since the LS 4 only transmits a percentage [%] value via the CAN bus.

Parameter 12

```
Rated voltage
          000V
```

Rated voltage **[1] 50 to 120 V; [4] 50 to 480 V**

Using this parameter the rated value for voltage is defined (percentage parameters of protective functions relate to this value only).

Parameter 13

```
Rated frequency
          00.0Hz
```

Rated frequency **40.0 to 70.0 Hz**

Rated frequency in the system (of the generator or public grid).

NOTE

With a positive real power, a positive real current flows in the "k-l" direction in the current transformer. Positive re-active power means that with a positive effective direction, inductive re-active (lagging) current flow in the effective direction. If the circuit of the current transformer facing the system [A] are connected to "k", the unit shows a positive real power when system [A] supplies real power. This is explained in the section "Direction of Power" on page 21.

CAUTION

The settings of the rated power in the system (Parameter 14) must be equal to the settings in the lower level GCP control unit because the LS 4 only transmits a percentage [%] value via the CAN bus. If the lower level GCP control unit is connected to more than one incoming mains no control of the mains interchange power is possible. The total power evaluated in all LS 4 is displayed in the GCP.

Parameter 14

```
Rated power
          00000kW
```

Rated power **5 to 16,000 kW**

The rated power is configured here. The exact value of the rated power is absolutely vital. Many measurement, control, and monitoring functions refer to this value.

LS 4 Functions

Function

The voltage measuring of the LS 4 is connected three phase. Current measuring is connected three-phase to system [A] if this function is required. The possible functions are:

- Measuring conversion of both systems three-phase measured voltages as well as the three-phase measured current of system [A] (if connected).
- Protection of the measured primary values via comparison of the configured set point values with the true RMS values for over-/under voltage, over-/under frequency, phase/vector jump, df/dt (ROCOF), and voltage asymmetry.
- Calculation of set point values for synchronization that are transmitted via the CAN bus to the lower level GCP control unit). Frequency/voltage are controlled according to these set point values for synchronization in the GCP.
- Operation of the connected breaker.

Segment Number

A segment is defined as a section of the bus, feeder, or interconnection, which cannot electrically be isolated to a smaller section and is connected to a circuit breaker or an isolation switch with is operated or supervised by an LS 4. A transformer is not to be considered as a segment or a point of isolation. Each segment, feeder, or interconnection must be assigned a number that is unique to that segment. The following restrictions apply when assigning segment numbers:

- A busbar must be assigned a number same number as the lowest numbered generator on that bus bar segment.
- The numbers assigned to other generators on the same busbar cannot be used to identify busbar segments.

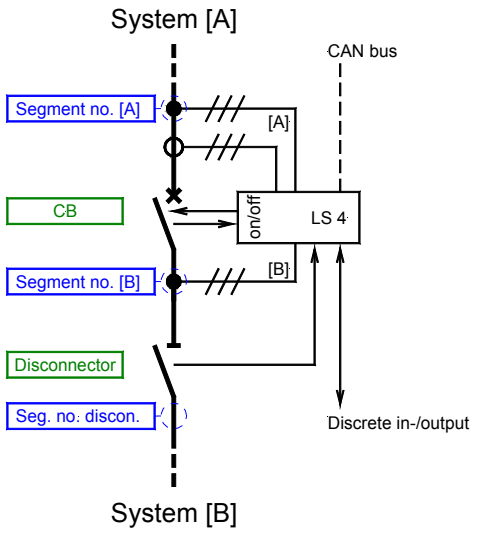
  Example: A system with six generators and two bus bars with a tiebreaker must be numbered in the following manner. Generators 1, 2, and 3 are on busbar one and generators 4, 5, and 6 are on busbar 2. Busbar one is assigned segment number 1 and busbar 2 is assigned segment number 4. The numbers 2, 3, 5, and 6 cannot be used to identify segments of the system.

Otherwise the segment numbers can be assigned freely (see examples A to F).

Each LS 4 may be assigned up to three segment numbers.

NOTE

It is not permissible to connect a load between the breaker and the isolation switch (segment no. [B]).



- Voltage measuring input segment no. [A]
- Voltage measuring input segment no. [B]
- Disconnector/isolation switch segment no.

Figure 6-1: LS 4 principle

CAN Bus Number (Control Number)

To communicate via the CAN bus it is necessary to configure all connected controls with a unique control number. The numbers 1 to 14 are reserved for the GCP (GCP parameter "generator number"), the numbers 17 to 24 are reserved for the LS 4 (Parameter 108: "Device number CAN bus"). The segment number for the generator busbar must be identical to the lowest generator number directly connected to that bus.

Data Communication via the CAN Bus

from the LS 4 to a higher level control system

- Status of the CB (open/closed)
- Status of the disconnector / isolation switch
- Set point value f/V +/-
- Alarms

to the LS 4 from a higher level control system

- Enable closing of the CB
- Open the CB

Priority During Breaker Closure

In an emergency application the simultaneous closing of two circuit breakers is blocked via communications between the LS4 and the GCB. Once a GCP is enabled to for a dead bus connection it has priority over all LS 4s (any CB controlled by an LS 4 cannot be closed).
If multiple LS 4s are enabled to close a circuit breaker at the same time the LS 4 with the lowest CAN identification number receives the master status and transmits the set point signals to the genset control (all other LS 4s are inactive)

Preparation

Please prepare the LS 4 for configuration as follows:

- Draw a one-line diagram that only contains essential equipment. The schematic should consist of a minimum: all used GCPs, all transformers, all breaker elements (such as circuit breakers and isolation switches), all elements to be controlled, and all LS 4s. Assign numbered addresses for each component of the system in accordance with the methods described below.
- Number all GCP control units from 1-14 (order is user-defined and depends on your application). DO NOT CHANGE this number after configuration of the LS 4 has begun. If this number is changed all LS 4s must be reconfigured.
- Number all system LS 4s from 17-24 (order is user-defined and depends on your application). DO NOT CHANGE this number after configuration of the LS 4 has begun. If this number is changed all LS 4s must be reconfigured.
- Number all segments, generators, and mains/feeders in the system. DO NOT CHANGE this number after configuration of the LS 4 has begun. If this number is changed all LS 4s must be reconfigured.
- Define which GCPs are connected to a common busbar.
- Configure all GCPs.

The LS 4s are now ready to be configured via the touch pad buttons or Leo PC.

Configuration Screens in the LS 4

Parameter 15

```
Segment number
System [A]    00
```

Segment number of systems A **1 to 28**

Enter the pre-assigned segment number for system [A] of this LS 4.

Parameter 16

```
Segment number
System [B]    00
```

Segment number of system B **1 to 28**

Enter the pre-assigned segment number for system B of this LS 4.

Parameter 17

```
Segment number
Disconnector  00
```

Segment number of the disconnector/isolation switch **0 to 28**

If a disconnector/isolation switch is connected to one of the two systems A or B, enter the segment number opposite of the disconnector/isolation switch. If no disconnector/isolation switch is utilized enter 00.

NOTE

Do not configure the following system (A or B) as mains connection.

Parameter 18

```
Disconnector at
---------------
```

Voltage system of the disconnector/isolation switch **Voltage A / Voltage B**

Enter which system a disconnector/isolation switch is connected to. If you entered "**`Segment number Disconnector`**" 00 in the prior screen this screen is irrelevant and should be ignored.

Parameter 19

```
Mains power meas
----------------
```

Validity of power measurement **invalid / valid**

invalid..... If the measured power is not to be used for control configure as "invalid".
valid..... If the measured power is to be used for mains interchange real power control configure as "valid".

Parameter 20

```
Mains connection
----------------
```

Mains connection **Voltage A / Voltage B / Disconnector / none**

Fixed networks in the system must be defined as a mains connection. This is used to transfer mains parallel and mains failures for Automatic Mains Failure (AMF) to the lower level GCP.
Voltage A..... System [A] is a fixed mains incoming.
Voltage B..... System [B] is a fixed mains incoming.
Disconnector .. On the opposite side of the disconnector a fixed mains incoming is connected.
none ..... None of the systems is a fixed mains incoming and is not used for mains failure detection.

Parameter 21

```
Variable system
----------------
```

Select variable system **Voltage A / Voltage B**

One of the systems must be defined as a variable system. A variable system is defined as a system that can change in frequency and voltage due to changes in frequency and voltage of the GCP control unit. In normal applications this is the frequency/voltage that is situated opposite the mains voltage of the MCB. The opposite side of the CB is therefore either constant (mains voltage) or a controlled stable (bus coupler) system. If one of the systems is configured as mains connection the other system is automatically assumed as variable.

Parameter 22

Busbar generator 1-8

```
Busb. y 12345678
Gen.    00000000
```

[y = 1 to 3]

Parameter 23

Busbar generator 9-14

```
Busb. y   9ABCDE
Gen.      000000
```

[y = 1 to 3]

Select bus bars **Y/N**

With this parameter all generators connected to the same (generator) busbar are defined (each generator controlled through one GCP) as connected to the same bus bar. In the upper line the generator (control) number of the GCP are shown (A = 10, B = 11, ..., E = 14). Enter a Y if the generator supplies to the selected busbar). This parameter is necessary for a correct function (i.e. for load/var sharing used with paralleled generators). Three [y = 1 to 3] bus bars per system are possible. Parameters for three busbars must be configured. The busbar number is represented by “y” in the sample display screen to the left. All generators connected to the same busbar are defined by this parameter. The top line of the display represents the individual generators. For generators 10 and above, hexidecimal is used to represent the individual units (i.e. 10=A, 11=B, etc).

Note: All LS 4s must be configured identically with this parameter.

Example: Generators 1, 2 and 4 are connected to the same bus bar
→ configure as "**YYNYNNNN**".

Parameter 24

```
Measuring CB ON
---------------
```

Measuring system for closing the CB **one-phase / three-phase**

one-phase ..... For synchronization of the CB only one phase of voltage V_{L12} for both systems A and B is used.

three-phase .... For synchronization of the CB all three phases of voltage V_{L123} for both systems A and B are used (three-phase synchronization). Additionally the direction of field rotation for both systems is monitored and an alarm is issued if the directions do not match.

Parameter 25

```
Command open CB
not delayed  YES
```

Command to immediately open CB **YES/NO**

YES .....The command to open the CB (DI at terminal 75) is carried out immediately, regardless if there is a request for power reduction, synchronization, or opening of a CB by another LS 4/GCP. The following screens of this function will not be displayed.

NO .....The command to open the CB (DI at terminal 75) is carried out following the verification that no other LS 4/GCP is requesting a power reduction, synchronization, or opening of a CB. The following screens of this function are displayed.

Parameter 26

```
Command open CB
Pow. reduct. NO
```

Visible only if Parameter 25 has been configured to NO

Power reduction prior to "Command: open CB" **YES/NO**

YES .....The "Command: open CB" would be issued following a power reduction after reaching the following configured level (see Table).

NO .....The "Command: open CB" would be issued after the comparison of other LS 4/GCP with the discrete input "Command: open CB"(terminal 75). A power reduction is not carried out.

Type of rigid system	Type of variable system	Open CB
Mains	Generator	with power reduction
Mains	Mains	without power reduction
Feeder	Mains	without power reduction
Feeder	Generator	without power reduction
Generator	Generator	with power reduction
Generator	Feeder	without power reduction
Feeder	Feeder	without power reduction
Mains	Feeder	without power reduction

Table 6-1: Power reduction

Parameter 27

```
Command open CB
Open at     000%
```

Visible only if Parameter 25 has been configured to NO

"Command: open CB" at **0 to 100 %**

If the prior screen is configured to YES the "Command: open CB" is issued to the configured relay following a power reduction and reaching or falling below this level.

Configuration Screens in the GCP Control Unit

NOTE

This section describes the configuration screens in the GCP control unit which work together with the LS 4. Please also note the settings for the emergency power and the mains settling time.

Parameter 28

```
LS 4 modus
              ON
```

LS 4 mode **ON/OFF**

ON..... The GCP is operating in LS 4. The control unit CAN bus messages from the LS 4 and reacts accordingly. Additionally the control unit transmits messages to the LS 4.

OFF..... The control unit operates without LS 4 functionality as a normal genset control.

Parameter 29

```
Rated power
system   00000kW
```

Rated power in the system **0 to 16,000 kW**

The LS 4 transmits the actual mains real power in percent related to the rated power in the system to the GCP control unit .

Note

This configuration is valid only if Parameter 28 is configured to ON.

ATTENTION

Due to the LS 4 only transmitting a percentage value related to the rated value it is mandatory to configure the rated power in all units (GCPs and LS 4s) to the same value.

Parameter 30

```
Mains decoupling
via    ---------
```

Mains decoupling through **GCB/external**

GCB..... If a mains failure occurs (see mains protection) the GCB would be opened. (A mains failure would be detected using the mains voltage on terminals 50/51/52.)

external..... The GCP control unit reacts as follows to a mains failure: a mains decoupling order is issued by closing the relay "Mains failure external" in the GCP. This command must be evaluated externally (i.e. open the mains circuit breaker).

Note

"Mains decouple through external" is valid only if Parameter 28 is configured to ON.

In the LS 4 mode the following is valid:

- The value "Mains current" is not visible.
- The service display "Mains frequency and voltage" is not visible.
- Instead of the display "Mains power factor" and "Mains power" the power measured in the LS 4 would be displayed: "**MN LS 4: B/L00000kW**". If the unit is not in parallel to the mains, the value "0000" is displayed.
- Instead of the display "Mains voltage" the display "**M-decoupl:0000kV**" occurs (the displayed voltage is the voltage measured through the terminals 50/51/52).
- Mains voltage:
  The GCP mains voltage measuring inputs (terminals 50/51/52) must be connected to the busbar together with the busbar voltage inputs (terminals 23/24).
- The "Enable MCB" input (terminal 53) has no function in the LS 4 mode. If this discrete input is set a mains settling time is displayed.
- The "Reply MCB" input (terminal 54) has no function in the LS 4 mode.
- To evaluate and carry out an emergency power operation (i.e. AMF) in the GCP a missing mains voltage message will be issued from the LS 4 to the GCP.
- Emergency power operation is evaluated by the LS 4. Precondition for this is a mains failure or no connection of the generator busbar with the mains. This means that the GCP control unit performs emergency operation if mains voltage is present, but the mains circuit breaker or a possibly existing disconnector is open.
- The voltage connected to the mains measuring inputs (terminals 50/51/52), is only used for mains disconnection in mains parallel operation.

Examples for Configuration

Example A - H-Connection with two gensets per bus bar

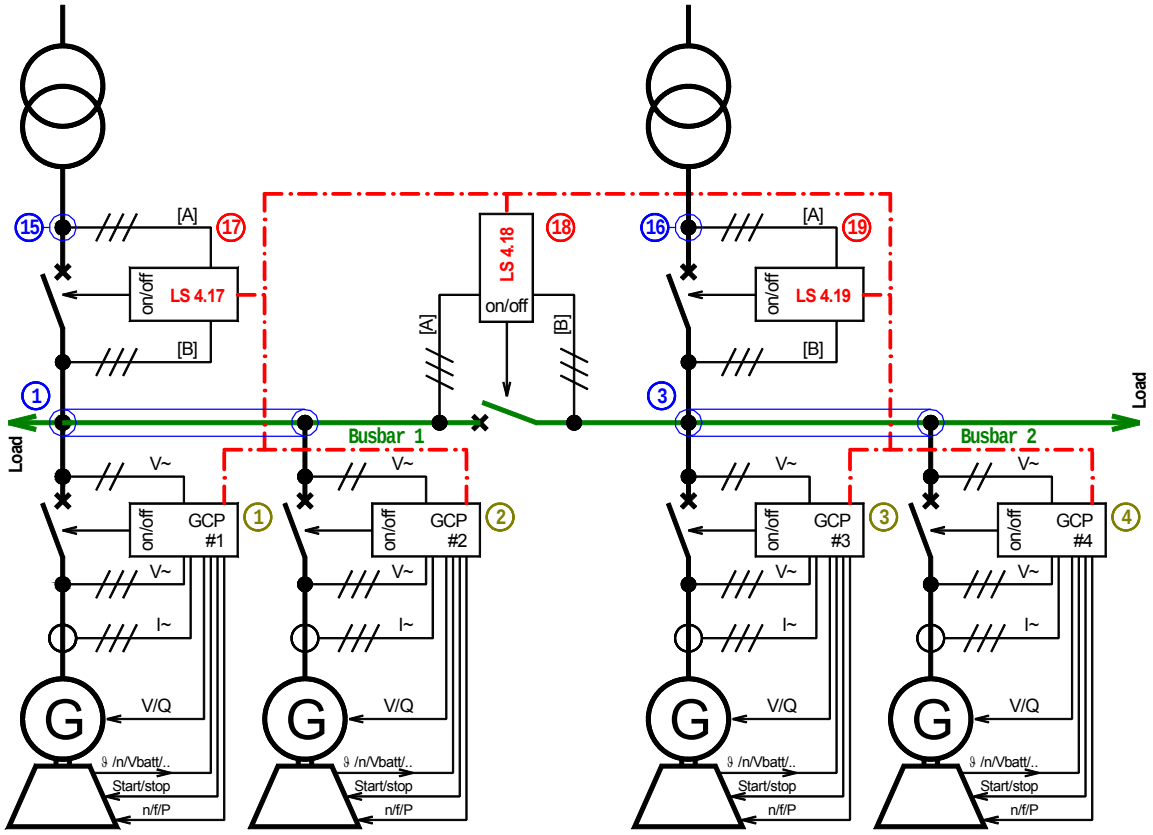


Figure 6-2: Example A - H-Connection with two gensets per bus bar

Parameter	LS 4.17	LS 4.18	LS 4.19
Segment no. syst.[A]	15	1	16
Segment no. syst.[B]	1	3	3
Segment no. disconn.	0	0	0
Disconnector at	irrelevant		
Mains power meas	invalid		
Mains connection	System A	none	System A
Variable system	System B	System A	System B
Busb. 1 12345678 Gen.	YYNNNNNN		
Busb. 1 9ABCDE Gen.	NNNNNN		
Busb. 2 12345678 Gen.	NNYYNNNN		
Busb. 2 9ABCDE Gen.	NNNNNN		
Busb. 3 12345678 Gen.	NNNNNNNN		
Busb. 3 9ABCDE Gen.	NNNNNN		

Table 6-2: Example A - H-Connection with two gensets per bus bar

Example B - Double-H-connection with two gensets per bus bar

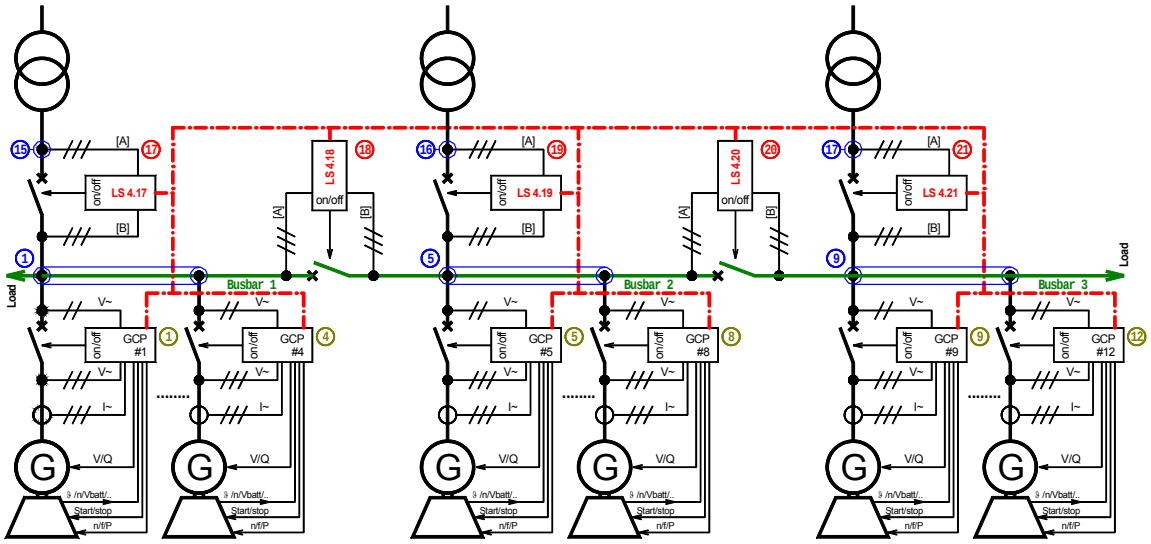


Figure 6-3: Example B - Double-H-connection with two gensets per bus bar

Parameter	LS 4.17	LS 4.18	LS 4.19	LS 4.20	LS 4.21
Segment no. syst.[A]	15	1	16	5	17
Segment no. syst.[B]	1	5	5	9	9
Segment no. disconn.	0	0	0	0	0
Disconnector at	irrelevant				
Mains power meas	invalid				
Mains connection	System A	none	System A	none	System A
Variable system	System B	System A	System B	System B	System B
Busb. 1 12345678 Gen.	YYYYNNNN				
Busb. 1 9ABCDE Gen.	NNNNNN				
Busb. 2 12345678 Gen.	NNNNYYYY				
Busb. 2 9ABCDE Gen.	NNNNNN				
Busb. 3 12345678 Gen.	NNNNNNNN				
Busb. 3 9ABCDE Gen.	YYYYNN				

Table 6-3: Example B - Double-H-connection with two gensets per bus bar

Example C - Emergency power application with 1× generator and 1× feeder bus bar

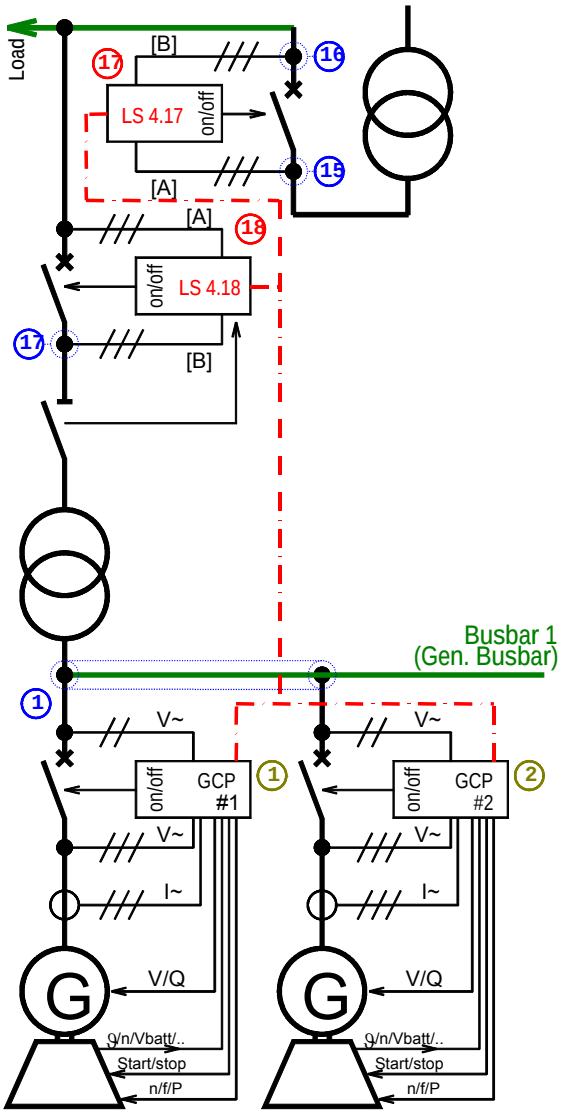


Figure 6-4: Example C - Emergency power application with 1× generator and 1× feeder bus bar

Parameter	LS 4.17	LS 4.18
Segment no. syst.[A]	**15**	**16**
Segment no. syst.[B]	**16**	**17**
Segment no. disconn.	**0**	**1**
Disconnector at	**irrelevant**	**System B**
Mains power meas	**invalid**	
Mains connection	**System A**	**none**
Variable system	**System B**	**System B**
Busb. 1 12345678 Gen.	**YYNNNNNN**	
Busb. 1 9ABCDE Gen.	**NNNNNN**	
Busb. 2 12345678 Gen.	**NNNNNNNN**	
Busb. 2 9ABCDE Gen.	**NNNNNN**	
Busb. 3 12345678 Gen.	**NNNNNNNN**	
Busb. 3 9ABCDE Gen.	**NNNNNN**	

Table 6-4: Example C - Emergency power application with 1× generator and 1× feeder bus bar

Example D - Emergency power application with 1× generator and 2× feeder bus bars

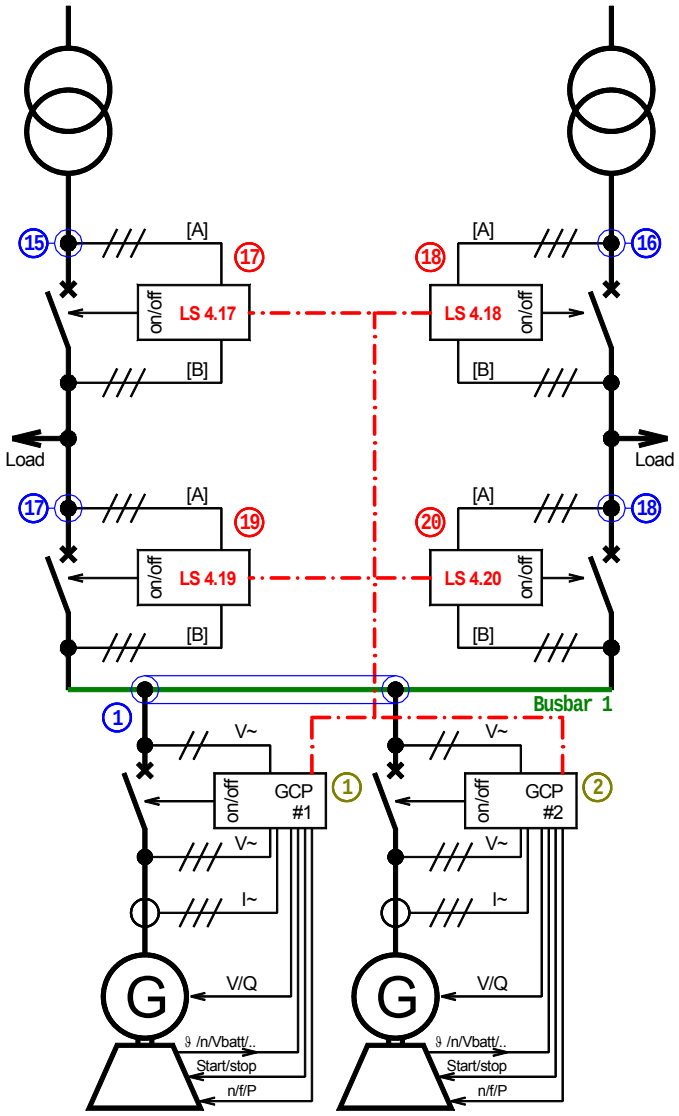


Figure 6-5: Example D - Emergency power application with 1× generator and 2× feeder bus bars

Parameter	LS 4.17	LS 4.18	LS 4.19	LS 4.20
Segment no. syst.[A]	15	16	17	18
Segment no. syst.[B]	17	18	1	1
Segment no. disconn.	0	0	0	0
Disconnector at	irrelevant			
Mains power meas	invalid			
Mains connection	System A	System A	none	none
Variable system	System B	System B	System B	System B
Busb. 1 12345678 Gen.	YYNNNNNN			
Busb. 1 9ABCDE Gen.	NNNNNN			
Busb. 2 12345678 Gen.	NNNNNNNN			
Busb. 2 9ABCDE Gen.	NNNNNN			
Busb. 3 12345678 Gen.	NNNNNNNN			
Busb. 3 9ABCDE Gen.	NNNNNN			

Table 6-5: Example D - Emergency power application with 1× generator and 2× feeder bus bars

Example E - Multiple mains incomings to one common bus bar (no emergency power)

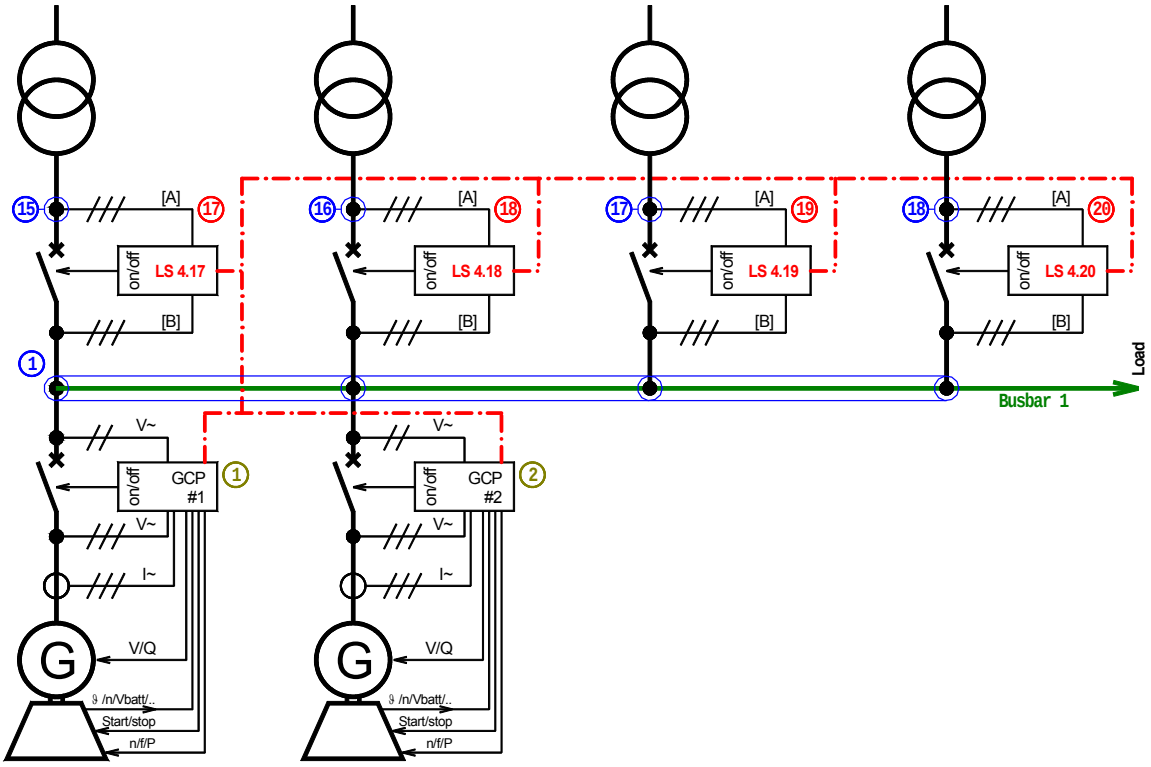


Figure 6-6: Example E - Multiple mains incomings to one common bus bar (no emergency power)

Parameter	LS 4.17	LS 4.18	LS 4.19	LS 4.20
Segment no. syst.[A]	15	16	17	18
Segment no. syst.[B]	1	1	1	1
Segment no. disconn.	0	0	0	0
Disconnector at	irrelevant			
Mains power meas	invalid			
Mains connection	System A	System A	System A	System A
Variable system	System B	System B	System B	System B
Busb. 1 12345678 Gen.	YYNNNNNN			
Busb. 1 9ABCDE Gen.	NNNNNN			
Busb. 2 12345678 Gen.	NNNNNNNN			
Busb. 2 9ABCDE Gen.	NNNNNN			
Busb. 3 12345678 Gen.	NNNNNNNN			
Busb. 3 9ABCDE Gen.	NNNNNN			

Table 6-6: Example E - Multiple mains incomings to one common bus bar (no emergency power)

Example F - Multiple mains/generator application

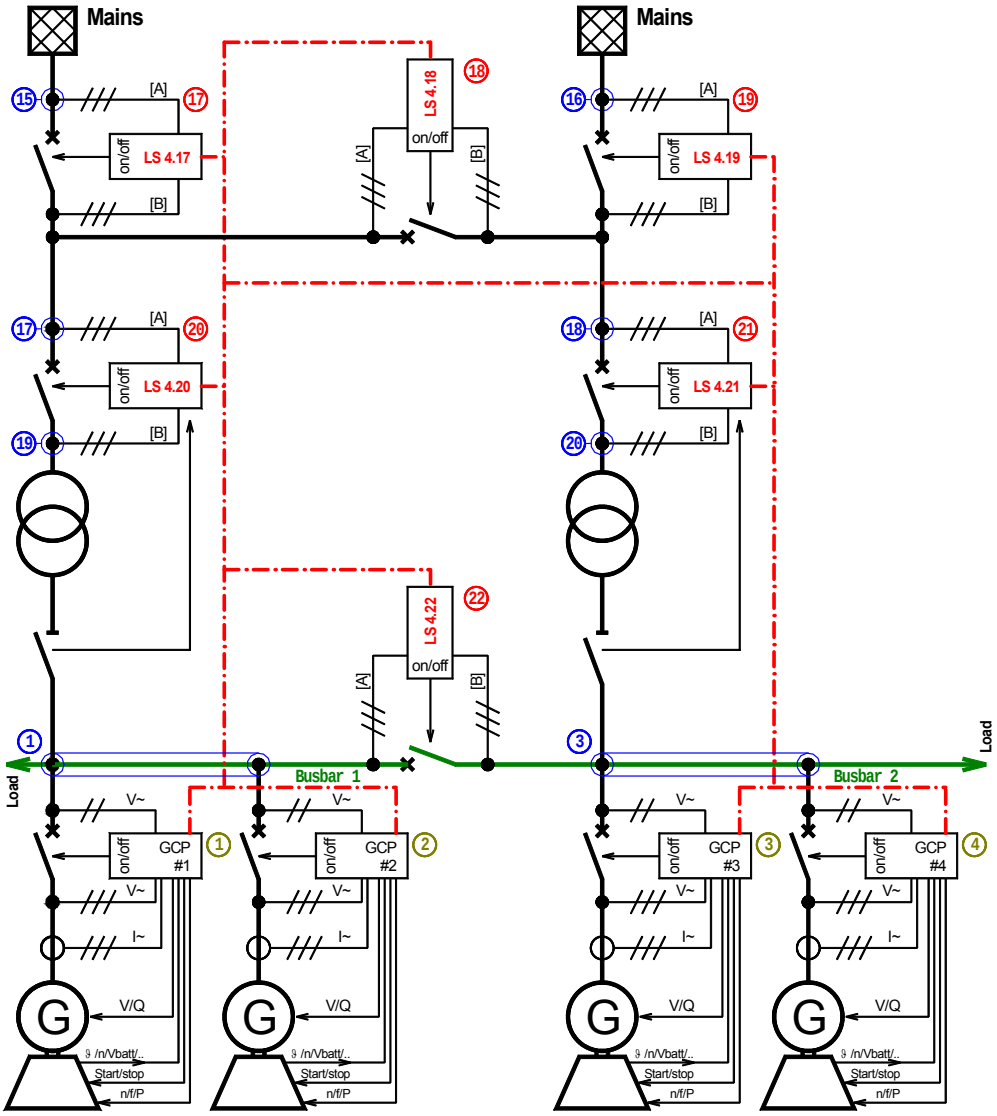


Figure 6-7: Example F - Multiple mains/generator application

Parameter	LS 4.17	LS 4.18	LS 4.19	LS 4.20	LS 4.21	LS 4.22
Segment no. syst.[A]	15	17	16	17	18	1
Segment no. syst.[B]	17	18	18	19	20	3
Segment no. disconn.	0	0	0	1	3	0
Disconnector at	irrelev.	irrelev.	irrelev.	System B	System B	irrelev.
Mains power meas	invalid					
Mains connection	System A	none	System A	none	none	none
Variable system	System B	System B	System B	System B	System B	System B
Busb. 1 12345678 Gen.	YYNNNNNN					
Busb. 1 9ABCDE Gen.	NNNNNN					
Busb. 2 12345678 Gen.	NNYYNNNN					
Busb. 2 9ABCDE Gen.	NNNNNN					
Busb. 3 12345678 Gen.	NNNNNNNN					
Busb. 3 9ABCDE Gen.	NNNNNN					

Table 6-7: Example F - Multiple mains/generator application

Control Functions

Synchronizing Functions

Function: "Synchronization"
The control unit calculates internally the electrical angle of advance to issue the circuit breaker closure command. The corresponding lead-time remains constant due to the inherent delay of the breaker regardless of the frequency differential of the two systems. If the voltage and frequency differential of the two systems are within permissible limits, the breaker closure command may be issued under the following conditions:

- The momentary voltage effective values of the two systems must each be greater than 75 % and less than 112.5 % of the configured set point voltage. (With activation of the voltage protection these values apply as valid; Parameter 57 and Parameter 63)
- The set point for the maximum permissible differential voltage between the two systems is not exceeded (Parameter 34).
- The set point for the maximum permissible differential frequency between the two systems is not exceeded (Parameter 32 and Parameter 33).
- The electrical angle between two equal phases must be less than the permissible phase-displacement angle (slip-dependent) set point (Parameter 35).

Synchronizing Functions

Parameter 31

```
Synchronizing
functions    ON
```

Synchronizing functions **ON/OFF**

ON..... The synchronization functions are enabled, and the following screens of this function are displayed.
OFF..... The synchronization functions are disabled, and the subsequent screens of this function are not indicated.

Parameter 32

```
Synchronization
df max    0.00Hz
```

Max. admissible positive differential frequency **0.02 to 0.49 Hz**

The prerequisite for the issuing of a close CB command is that the differential frequency is lower than the configured positive limit. This value indicates the upper limit frequency (positive value corresponding to positive slip → frequency) of the variable system is greater than the frequency of the fixed system during synchronization of the CB.

Parameter 33

```
Synchronization
df min   -0.00Hz
```

Max. admissible negative differential frequency **0.00 to -0.49 Hz**

The prerequisite for the issuing of a close CB command is that the differential frequency has fallen below the configured negative limit. This value indicates the lower frequency (a negative value represents negative slip) of the variable system lower than the frequency of the fixed system during synchronization of the CB.

Parameter 34

```
Synchronization
dV max      00.0%
```

Max. admissible differential voltage **0.1 to 15.0 %**

The set percentage refers to the configured secondary voltage. To ensure that a connect command will be issued, the actual value must fall below the entered differential voltage percentage.

Parameter 35

```
Synchronization
s opt       0.00%
```

Optimum slip **+/-0.04 to +/-0.50 %**

This value allows for adjustment of the synchronization frequency in relationship to the system being synchronized with. It is possible to set slip in the positive and negative directions. The LS 4 transfers this difference as a set point value to the GCP. The GCP then controls the frequency according to the value set in this screen.

Parameter 36

```
Synchronization
Time pulse>000ms
```

Pulse duration for switching **50 to 250 ms**

The duration of the breaker closure command is defined by this parameter. The length of the pulse can be adjusted to the requirements of the individual breaker. The configured value defines the minimum on time of the pulse.

Parameter 37

```
Synchronization
Closing t. 000ms
```

Switcher time delay circuit breaker **40 to 300 ms**

The inherent switching time of the power circuit breaker corresponds to the lead-time of the close CB order. This set point is the amount of time that the close CB command is issued prior to the generator reaching the synchronous time, irrespective of the differential frequency.

Phase Angle Deviation (Phase Shift)

WARNING

Ensure the following parameters are configured correctly to prevent erroneous synchronization settings. Incorrect wiring of the system cannot be compensated for with this parameter!

Parameter 38

```
Synchronization
Phase diff.±000°
```

Phase angle deviation **-180 to 0 to +180 °**

This parameter compensates for phase angle deviations, which can be caused by transformers (i.e. a delta to wye transformer) located within the electrical system. Ensure the following parameters are configured correctly to prevent erroneous synchronization settings. Incorrect wiring of the system cannot be compensated for with this parameter!

Please act as follows: If a transformer is not located between systems [A] and [B] or if the transformer has a vector group without a phase angle deviation, then a phase angle deviation of 0° should be configured in this parameter.

a) Interconnection of the mains voltage possible

With a phase angle deviation of 0° and the generator not running and the mains energized, close the GCB. This will result in system [A] and system [B] being at the same voltage potential. The phase angle deviation will now be displayed on the LS 4 screen (synchronization angle phi). Enter the displayed value into this parameter.

CAUTION

The correct setting must be validated in every control unit with a differential voltage measurement (see chapter "Commissioning")!

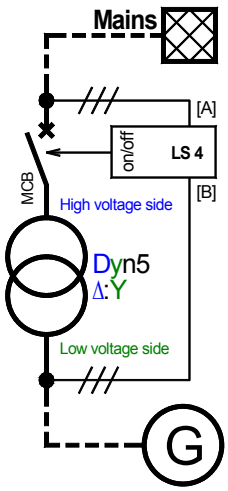
b) Interconnection of the mains voltage not possible but the vector group of the transformer is known

The vector group of the transformer is known and states the phase angle deviation in multiplies of 30°. Out of the vector group the phase angle deviation can be calculated as an angle from 0° to 360°. **For this value the voltage of the low voltage side is behind the voltage of the high voltage side ⇨ phase angle deviation α! When calculating the resulting value, the low voltage side of the transformer always lags behind the high voltage side (phase angle deviation α).**

The phase difference is to be calculated as follows:

	High voltage side = System [A]	High voltage side = System [B]
α < 180 °	α	-α
α > 180 °	-360 ° + α	360 ° - α

Table 6-8: Calculation of the phase angle deviation

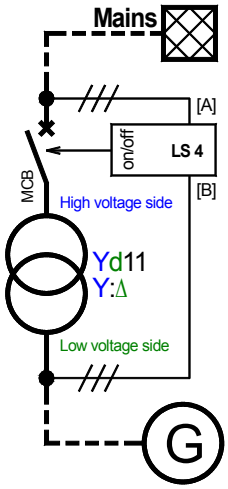


Example 1

System [B] is connected to the generator. The generator voltage is connected to the low voltage side of a transformer with the vector group ***Dyn5***. The MCB is connected to the high voltage side, which connects the transformer to the mains. System [A] is connected to the mains. Because of the transformer the phase angles at the breaker differ between the measuring voltages of system [A] and system [B]. A phase angle deviation exists which can be compensated with the LS 4.

Using the vector group 5 (Dyn**5**) it counts $\alpha = 5 \times 30\,° = 150\,°$. Because $150\,° < 180\,°$ and system [A] is connected to the high voltage side this results into α to be used as phase difference. Enter **150 °** into as parameter for the phase difference.

```
Synchronization
Phase diff. 150°
```



Example 2

Data identical with example 1, but the vector group is ***Yd11***.

Using the vector group 11 (Yd**11**) it counts $\alpha = 11 \times 30\,° = 330\,°$. Because $330\,° > 180\,°$ and system [A] is connected to the high voltage side this results into $(-360\,° + \alpha)$ to be used as phase difference. Enter **-30 °** into as parameter for the phase difference.

```
Synchronization
Phase diff.-030°
```

CAUTION

The correct setting must be validated in every control unit with a differential voltage measurement (see chapter "Commissioning")!

Blocking of Synchronization at Alarms

Parameter 39

```
Synchronization
block.alarm  ON
```

Blocking of synchronization at alarm	ON/OFF

ON .....Synchronization is not permitted if an alarm is present.
OFF .....Synchronization is permitted if an alarm is present.

Synchronous Networks

Parameter 40

```
Parallel mains
---------------
```

Parallel mains **blocked / available**

available ..... Closing of the CB onto synchronous networks is enabled. The following screens of this function are visible.
blocked ..... Closing of the CB onto synchronous networks is disabled. The following screens of this function are not visible.

Parameter 41

```
Parallel mains
phi max      00°
```

Max. admissible angle between both voltage systems **0 to 20 °**

The prerequisite for the issuing of a close CB order is that the differential angle is below the configured limit.

Parameter 42

```
Parallel mains
phi max      00s
```

Min. time "Angle phi max" to issue a close CB command **0 to 99 s**

For a close CB order to be issued, the differential angle between the both voltage systems must be lower than the "Synchr. networks phi max" (Parameter 41) continuously for the time specified with this parameter.

Dead Bus Start Functions

Function: "Dead bus start"
Closing the circuit breaker may be performed even if synchronization voltage is not present. The close CB command is issued while taking into account that input "Enable CB" (terminal 31) is connected and input "Reply: CB is closed" (terminal 32) signals an open circuit breaker (reference Figure 3-1: Wiring diagram)

CAUTION

The measuring voltages are normally protected. A blown fuse may lead to the unit executing a dead bus start. In this case the unit would, among other things, switch to an asynchronous voltage, which can lead to substantial damage to the system. Therefore, the release of the dead bus start function must be locked via external safety measures if a blown fuse is detected (Removal of the "Enable CB" signal).

Parameter 43

```
Dead bus op. CB
               ON
```

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

ON .....Dead bus start function is enabled. The prerequisite for this is the detection of an operating condition that corresponds to the specifications. The subsequent screens of this function are displayed.
OFF .....No dead bus start is carried out, and the subsequent screens of this function are not displayed.

Parameter 44

```
Dead bus op. CB
VA=0/VB=0      ON
```

Dead bus start function 1: VA = VB = 0 **ON/OFF**

Enabling dead bus start function 1: This application requires the voltage in both systems to fall below an adjustable threshold value in order to enable the output of a close CB order (dead system A - dead system B).

Parameter 45

```
Dead bus op. CB
VA=0/VB=Vn     ON
```

Dead bus start function 2: VA = 0, VB = Vn **ON/OFF**

Enabling dead bus start function 2; This application dictates the approximate value of the voltage of system VA must be zero and the voltage of system VB must be applied (dead system A - live system B).

Parameter 46

```
Dead bus op. CB
VA=Vn/VB=0     ON
```

Dead bus start function 3: VA = Vn, VB = 0 **ON/OFF**

Enabling dead bus start function 3: This application dictates the approximate value of the voltage of system VB must be zero and the voltage of system VA must be applied (live system A - dead system B).

Parameter 47

```
Dead bus op. CB
      Tmin > 00s
```

Min. monitoring time of the dead bus start conditions **0 to 20 s**

Before a dead bus start may be initiated, all conditions for the closing of the circuit breaker must be maintained for the preset time.

Parameter 48

```
Dead bus op. CB
dV |V-O| <   00%
```

Max. adm. zero voltage diff. for switching to the dead busbar **3 to 50 %**

To ensure that the value of a voltage is detected as "approximate zero" the maximum deviation from zero must not exceed the preset value (referring to the rated voltage).

Parameter 49

```
Dead bus op. CB
dV |V-Vn| <  00%
```

Min. rated voltage diff. for switching to the dead busbar **1 to 20 %**

To ensure that a voltage is detected as "applied", the deviation from the rated voltage must not exceed the preset value.

Parameter 50

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

Max. rated frequency diff. for switching to the dead busbar **0.05 to 5.00 Hz**

To ensure that a circuit breaker may be closed, the deviation of the frequency of the voltage-carrying system from the rated frequency must not exceed the differential frequency preset.

Parameter 51

```
Dead bus op. CB
block.alarm  ON
```

Blocking of dead bus start at alarm **ON/OFF**

ON..... The dead bus start function is not permitted if an alarm is present.
OFF..... The dead bus start function is permitted if an alarm is present.

Switching Time Monitoring

Parameter 52

```
CB timeout
             ON
```

Switching time monitoring **ON/OFF**

ON..... Connection time is monitored. The subsequent screens of this function is displayed.
OFF..... Unsuccessful connection is not monitored, and a closing operation of the circuit breaker is carried out until the breaker is closed. The subsequent screens of this function are not displayed.

Parameter 53

```
CB timeout
Delay       000s
```

Timeout of closing time monitoring **0 to 999 s**

As soon as the closing operation of the CB is initiated, a timer is started simultaneously. If the circuit breaker is not closed after the preset time, an alarm is triggered. Resetting of this alarm may be done by depressing the "Clear" button after the release delay has expired (Parameter 54).

Parameter 54

```
CB timeout
Release del.000s
```

Release delay **0 to 999 s**

The alarm remains active for the time designated in this screen. During this time a breaker with a lower priority may be synchronized/closed. Deleting the "Release CB" (terminal 31) resets this alarm immediately.

Parameter 55

```
CB syn.ti. fault
to relay    0000
```

Output of the alarm "Connection time alarm" to relay **0 to 7**

This relay outputs that the time to close the breaker has been expired (description: see Parameter 101).

Monitoring Functions

CAUTION

The function "Command: open CB" must be assigned to one of the freely configurable relays using the relay manager (see Parameter 98).

Monitoring Type Configuration

NOTE

Parameter 56 does not appear if a "Phase to phase" measurement (Parameter 6) has been configured in the configuration screen "Volt. measuring".

Parameter 56

```
Volt.-monitoring
----------------
```

Monitoring for ... Phase to phase / Phase-neutral

The unit can monitor either the phase-neutral voltages (four-wire wye system) or the phase-to-phase voltages (three-wire delta system). Typically, the phase-neutral voltages are monitored in the low voltage system (400 Vac version; parameter text: **(Phase-N)**), and the phase-to-phase voltages are monitored in the mid-tap voltage system (100 Vac version; parameter text: **(ph-ph)**). A monitoring of phase-to-phase voltage is primarily utilized if a triggering of the voltage watchdog for a ground fault condition is not desired in an isolated or compensated system. Parameter 6 "**Volt. measuring**" must be configured "Phase to phase" to obtain this effect. The settings of this parameter have the following effect on the configuration screens:

Phase-neutral The voltage on terminals 1 through 4 is measured as a four-wire wye system and all subsequent screens regarding voltage monitoring are related to the phase-neutral voltage (VA_{L-N}). In the configuration screens, this is indicated by the supplement "**(Phase-N)**".

Phase to phase If the voltage system connected to terminal 1 through 4 is a three-wire delta system, this setting must be chosen. The measurement screen and all subsequent screens regarding voltage monitoring are related to the phase-to-phase voltage (VA_{L-L}). In the configuration screens, this is indicated by the supplement "**(ph-ph)**".

Overvoltage Monitoring

Function: "Voltage not within permissible limits"
The monitored voltage in at least one phase is not within the configured permissible limits for overvoltage. The alarm message "**Overvolt.1**" or "**Overvolt.2**" will be displayed. This message **cannot** be suppressed with the discrete input "Blocking of protective functions / remote acknowledgement".

Parameter 57

```
Overvoltage
Monitoring   ON
```

Overvoltage monitoring **ON/OFF**

ON..... Overvoltage monitoring is enabled. The subsequent screens of this function are displayed.
OFF..... Overvoltage monitoring is disabled. The subsequent screens of this function are not displayed.

Parameter 58

Parameter "Phase to phase":

```
Overvoltage 1
V(ph-ph) > 000V
```

Parameter "Phase-neutral":

```
Overvoltage 1
(Phase-N)  >000V
```

Threshold overvoltage level 1 **(Phase-phase) [1] 20 to 150 V; [4] 20 to 520 V**
(Phase-neutral) [1] 10 to 87 V; [4] 10 to 300 V

Overvoltage (level 1) is defined by this parameter. If this limit is reached or exceeded, the unit outputs the message "**Overvolt.1**". If a relay was assigned to this function in the relay manager (Parameter 101), that relay will be energized.

Parameter 59

```
Overvoltage 1
Delay     00.00s
```

Delay for level 1 **0.02 to 99.98 s**

In order to initiate an overvoltage (level 1) alarm, the measured voltage must exceed and remain above the configured threshold (Parameter 58) without interruption for at least the period of time specified in this screen.

Parameter 60

Parameter "Phase to phase":

```
Overvoltage 2
V(ph-ph)   >000V
```

Parameter "Phase-neutral":

```
Overvoltage 2
(Phase-N)  >000V
```

Threshold overvoltage level 2 **(Phase-phase) [1] 20 to 150 V; [4] 20 to 520 V**
(Phase-neutral) [1] 10 to 87 V; [4] 10 to 300 V

Overvoltage (level 2) is defined by this parameter. If this limit is reached or exceeded, the unit outputs the message "**Overvolt.2**". If a relay was assigned to this function in the relay manager (Parameter 101), that relay will be energized.

Parameter 61

```
Overvoltage 2
Delay     00.00s
```

Delay for level 2 **0.02 to 99.98 s**

In order to initiate an overvoltage (level 1) alarm, the measured voltage must exceed and remain above the configured threshold (Parameter 60) without interruption for at least the period of time specified in this screen.

Parameter 62

```
Overvoltage
Hysteresis   00V
```

Hysteresis for overvoltage monitoring **0 to 99 V**

In order to prevent system fluctuations from continually initiating overvoltage alarms (both levels; Parameter 58 and Parameter 60), a lower release point is defined here. If the control monitors the voltage above the permissible limit, the voltage must drop below that threshold and the voltage level defined here for the fault condition to be recognized as no longer existing.
Example: If a 480 V system has an overvoltage limit of 510 V and a hysteresis of 10 V, the monitored voltage for an overvoltage alarm must drop below 500 V to reset the alarm.

Undervoltage Monitoring

Function: "Voltage not within permissible limits"
The monitored voltage in at least one phase is not within the configured permissible limits for undervoltage. The alarm message "**Und.volt.1**" or "**Und.volt.2**" will be displayed. This message can be suppressed with the discrete input "Blocking of protective functions / remote acknowledgement".

Parameter 63

```
Undervoltage
Monitoring  ON
```

Undervoltage monitoring **ON/OFF**

ON .....Undervoltage monitoring is enabled. The subsequent screens of this function are displayed.
OFF .....Undervoltage monitoring is disabled. The subsequent screens of this function are not displayed.

Parameter 64

Parameter "Phase to phase":

```
Undervoltage 1
V(ph-ph)   <000V
```

Parameter "Phase-neutral":

```
Undervoltage 1
(Phase-N)  <000V
```

Threshold undervoltage level 1 **(Phase-phase) [1] 20 to 150 V; [4] 20 to 520 V**
(Phase-neutral) [1] 10 to 87 V; [4] 10 to 300 V

Undervoltage (level 1) is defined by this parameter. If this limit is reached or exceeded, the unit outputs the message " **Und.volt.1**". If a relay was assigned to this function in the relay manager (Parameter 101), that relay will be energized.

Parameter 65

```
Undervoltage 1
Delay     00.00s
```

Delay for level 1 **0.02 to 99.98 s**

In order to initiate an undervoltage (level 1) alarm, the measured voltage must fall below and remain below the configured threshold (Parameter 64) without interruption for at least the period of time specified in this screen.

Parameter 66

Parameter "Phase to phase":

```
Undervoltage 2
V(ph-ph)   <000V
```

Parameter "Phase-neutral":

```
Undervoltage 2
(Phase-N)  <000V
```

Threshold undervoltage level 2 **(Phase-phase) [1] 20 to 150 V; [4] 20 to 520 V**
(Phase-neutral) [1] 10 to 87 V; [4] 10 to 300 V

Undervoltage (level 2) is defined by this parameter. If this limit is reached or exceeded, the unit outputs the message " **Und.volt.2**". If a relay was assigned to this function in the relay manager (Parameter 101), that relay will be energized.

Parameter 67

```
Undervoltage 2
Delay     00.00s
```

Delay for level 2 **0.02 to 99.98 s**

In order to initiate an undervoltage (level 1) alarm, the measured voltage must fall below and remain below the configured threshold (Parameter 66) without interruption for at least the period of time specified in this screen.

Parameter 68

```
Undervoltage
Hysteresis   00V
```

Hysteresis for undervoltage monitoring **0 to 99 V**

In order to prevent system fluctuations from continually initiating undervoltage alarms (both levels; Parameter 64 and Parameter 66), a higher release point is defined here. If the control monitors the voltage below the permissible limit, the voltage must rise above that threshold and the voltage level defined here for the fault condition to be recognized as no longer existing.
Example: If a 480 V system has an undervoltage limit of 440 V and a hysteresis of 10 V, the monitored voltage for an undervoltage alarm must rise above 450 V to reset the alarm.

Voltage Asymmetry Monitoring

The phase-phase voltages are monitored.

Function "Voltage asymmetry not within permissible limits"
The monitored phase-phase voltage differential in the three phases is not within the configured permissible limits for asymmetry (asymmetric voltage vectors; the threshold corresponding to the differential value). The alarm message "**Asymmetry**" will be displayed. This message can be suppressed with the discrete input "Blocking of protective functions / remote acknowledgement".

Parameter 69

```
Asymmetry
Monitoring   ON
```

Asymmetry monitoring **ON/OFF**

ON..... Voltage asymmetry monitoring is enabled. The subsequent screens of this function are displayed.
OFF..... Voltage asymmetry monitoring is disabled. The subsequent screens of this function are not displayed.

Parameter 70

```
Asymmetry
Response v.  00V
```

Maximum permissible voltage asymmetry **0 to 99 V**

The maximum voltage asymmetry is defined by this parameter. If this limit is reached or exceeded, the unit outputs the message "**Asymmetry**". If a relay was assigned to this function in the relay manager (Parameter 101), that relay will be energized.

Parameter 71

```
Asymmetry
Delay     00.00s
```

Pickup delay **0.02 to 99.98 s**

In order to initiate a voltage asymmetry alarm, the measured voltage differential must rise above and remain above the configured threshold (Parameter 70) without interruption for at least the period of time specified in this screen.

Parameter 72

```
Asymmetry
Hysteresis   00V
```

Hysteresis for voltage asymmetry monitoring **0 to 99 V**

In order to prevent system fluctuations from continually initiating a voltage asymmetry fault, a lower release point is defined here. If the control monitors the voltage asymmetry beyond the permissible limit, the voltage differential must fall below that threshold (Parameter 70) plus the voltage level defined here for the fault condition to be recognized as no longer existing.

Overfrequency Monitoring

The frequency monitoring is performed on two levels. The frequency measuring is monitored three-phase if all voltages are greater than 15 % of the rated value (100 V or 400 V). This ensures quick and precise measurement of the frequency. The frequency is still monitored correctly even if voltage is only applied to one phase.

Function "Frequency not within permissible limits"
The monitored frequency is not within the configured permissible limits for overfrequency. The alarm message "**Overfreq.1**" or "**Overfreq.2**" will be displayed. This message **cannot** be suppressed with the discrete input "Blocking of protective functions / remote acknowledgement".

Parameter 73

```
Overfrequency
Monitoring   ON
```

Overfrequency monitoring **ON/OFF**

ON .....Overfrequency monitoring is enabled. The subsequent screens of this function are indicated.
OFF .....Overfrequency monitoring is disabled. The subsequent screens of this function are not displayed.

Parameter 74

```
Overfrequency 1
     f > 00.00Hz
```

Threshold overfrequency, level 1 **40.00 to 80.00 Hz**

Overfrequency (level 1) is defined by this parameter. If this limit is reached or exceeded, the unit outputs the message "**Overfreq.1**". If a relay was assigned to this function in the relay manager (Parameter 101), that relay will be energized.

Parameter 75

```
Overfrequency 1
Delay     00.00s
```

Pickup delay, level 1 **0.02 to 99.98 s**

In order to initiate an overfrequency (level 1) alarm, the measured frequency must exceed and remain above the configured threshold (Parameter 74) without interruption for at least the period of time specified in this screen.

Parameter 76

```
Overfrequency 2
     f > 00.00Hz
```

Threshold overfrequency, level 2 **40.00 to 80.00 Hz**

Overfrequency (level 2) is defined by this parameter. If this limit is reached or exceeded, the unit outputs the message "**Overfreq.2**". If a relay was assigned to this function in the relay manager (Parameter 101), that relay will be energized.

Parameter 77

```
Overfrequency 2
Delay     00.00s
```

Pickup delay, level 2 **0.02 to 99.98 s**

In order to initiate an overfrequency (level 1) alarm, the measured frequency must exceed and remain above the configured threshold (Parameter 76) without interruption for at least the period of time specified in this screen.

Parameter 78

```
Overfrequency
Hysteres. 0.00Hz
```

Hysteresis for overfrequency monitoring, levels 1+2 **0.01 to 9.99 Hz**

In order to prevent system fluctuations from continually initiating overfrequency alarms (both levels; Parameter 74 and Parameter 76), a lower release point is defined here. If the control monitors the frequency above the permissible limit, the frequency must drop below that threshold and the frequency level defined here for the fault condition to be recognized as no longer existing.
Example: If a 60 Hz system has an overfrequency limit of 70 Hz and a hysteresis of 5 Hz, the monitored frequency for an overfrequency alarm must fall below 65 Hz to reset the alarm.

Underfrequency Monitoring

The frequency monitoring is performed on two levels. The frequency measuring is monitored three-phase if all voltages are greater than 15 % of the rated value (100 V or 400 V). This ensures quick and precise measurement of the frequency. The frequency is still monitored correctly even if voltage is only applied to one phase.

Function "Frequency not within permissible limits"
The monitored frequency is not within the configured permissible limits for underfrequency. The alarm message "**Und.freq.1**" or "**Und.freq.2**" will be displayed. This message can be suppressed with the discrete input "Blocking of protective functions / remote acknowledgement".

Parameter 79

```
Underfrequency
Monitoring   ON
```

Underfrequency monitoring **ON/OFF**

ON..... Underfrequency monitoring is enabled. The subsequent screens of this function are indicated.
OFF..... Underfrequency monitoring is disabled. The subsequent screens of this function are not displayed.

Parameter 80

```
Underfrequency 1
     f < 00.00Hz
```

Threshold underfrequency, level 1 **40.00 to 80.00 Hz**

Underfrequency (level 1) is defined by this parameter. If this limit is reached or exceeded, the unit outputs the message "**Und.freq.1**". If a relay was assigned to this function in the relay manager (Parameter 101), that relay will be energized.

Parameter 81

```
Underfrequency 1
Delay     00.00s
```

Pickup delay, level 1 **0.02 to 99.98 s**

In order to initiate an underfrequency (level 1) alarm, the measured frequency must fall below and remain below the configured threshold (Parameter 80) without interruption for at least the period of time specified in this screen.

Parameter 82

```
Underfrequency 2
     f < 00.00Hz
```

Threshold underfrequency, level 2 **40.00 to 80.00 Hz**

Underfrequency (level 2) is defined by this parameter. If this limit is reached or exceeded, the unit outputs the message "**Und.freq.2**". If a relay was assigned to this function in the relay manager (Parameter 101), that relay will be energized.

Parameter 83

```
Underfrequency 2
Delay     00.00s
```

Pickup delay, level 2 **0.02 to 99.98 s**

In order to initiate an underfrequency (level 1) alarm, the measured frequency must fall below and remain below the configured threshold (Parameter 82) without interruption for at least the period of time specified in this screen.

Parameter 84

```
Underfrequency
Hysteres. 0.00Hz
```

Hysteresis for underfrequency monitoring **0.01 to 9.99 Hz**

In order to prevent system fluctuations from continually initiating underfrequency alarms (both levels; Parameter 80and Parameter 82), a higher release point is defined here. If the control monitors the frequency below the permissible limit, the frequency must rise above that threshold and the frequency level defined here for the fault condition to be recognized as no longer existing.
Example: If a 60 Hz system has an underfrequency limit of 50 Hz and a hysteresis of 5 Hz, the monitored frequency for an underfrequency alarm must rise above 55 Hz to reset the alarm.

Phase/Vector Shift Monitoring

A vector/phase shift is defined as the sudden variation of the voltage curve which may be caused by a major generator load change. The control unit measuring circuit detects the change in the cycle duration. This change in the cycle duration is compared with a mean value calculated from previous measurements. The monitoring may be carried out three-phased or one/three-phased. The threshold in degrees indicates the time difference between the mean value and the instantaneous value, referring to the duration of a full cycle. The monitoring can be configured in different ways. The vector/phase shift monitor can also be used as an additional method to decouple from the mains. Vector/phase shift monitoring is only enabled after the monitored voltage exceeds 70% of the PT secondary rated voltage.

Function: "Cycle duration of the voltage not within permissible limits"
The voltage cycle duration is not within the configured vector/phase shift limits. The alarm message "**Ph. shift**" appears. This message can be suppressed with the discrete input "Blocking of protective functions / remote acknowledgement".

Parameter 85

```
Phase shift
Monitoring   ON
```

Phase/vector shift monitoring **ON/OFF**

ON .....Vector/phase shift monitoring is enabled. The voltage/frequency cycle duration is being monitored to ensure it does not exceed the defined limits. The subsequent screens of this function are displayed.
OFF .....Vector/phase shift monitoring is disabled, and the subsequent screens of this function are not displayed.

Parameter 86

```
Phase shift mon.
----------------
```

Phase/vector shift monitoring **one/three phase-3 phase only**

one/three phase An alarm will be issued if the phase angle in any one phase exceeds the configured phase shift phase angle limit. Monitoring of single-phase voltage is exceptionally sensitive and may lead to nuisance tripping if the configured phase angle is to low (Parameter 87 and Parameter 88).
3 phase only.An alarm will be issued if the phase angle in all three phases exceeds the configured phase shift phase angle limit within two waveforms (Parameter 87).

NOTE

If the monitoring is configured as "3 phase only", only Parameter 88 will be displayed. If the monitoring is configured as "one/three-phase", both configuration screens (Parameter 87 and Parameter 88) will be displayed.

Parameter 87

```
Phase shift
(One phase)  00°
```

This screen is visible only if Parameter 86 is configured to one/three phase.

Phase angle of phase/vector shift monitoring, single phase **2 to 30 °**

An alarm will be issued if the phase angle in any one phase exceeds the configured phase shift phase angle limit. If the monitored voltage/frequency reaches or exceeds the phase shift limit, the unit outputs the message "**Ph. shift**". If a relay was assigned to this function in the relay manager (Parameter 101), that relay will be energized.

Parameter 88

```
Phase shift
(3-phase)    00°
```

Phase angle of phase/vector shift monitoring, three phase **2 to 30 °**

An alarm will be issued if the phase angle in any all three phases exceeds the configured phase shift phase angle limit. If the monitored voltage/frequency reaches or exceeds the phase shift limit, the unit outputs the message "**Ph. shift**". If a relay was assigned to this function in the relay manager, that relay will be energized.

df/dt (ROCOF) Monitoring

Function: "Rate Of Change Of Frequency (ROCOF) is not within permissible limits"
Rate of Change Of Frequency (ROCOF) monitoring measures the stability of the frequency. The frequency of a generator will vary due to changing loads and compensation of the fuel system. The rate of these frequency changes due to the load variances is relatively high compared to those of a large network. The control unit calculates the unit of measure per unit of time. The df/dt is measured over 4 sine waves to ensure that it is differentiated from a phase shift. This results in a response time of approximately 100ms. This message can be suppressed with the discrete input "Blocking of protective functions / remote acknowledgement".

Parameter 89

```
df/dt-
Monitoring   ON
```

df/dt (ROCOF) monitoring **ON/OFF**

ON..... Rate Of Change Of Frequency monitoring is enabled. The subsequent screens of this function are displayed.
OFF..... Rate Of Change Of Frequency monitoring is disabled. The subsequent screens of this function are not displayed.

Parameter 90

```
df/dt
Response>0.0Hz/s
```

Threshold for df/dt **1.0 to 9.9 Hz/s**

The Rate Of Change Of Frequency threshold is defined by this parameter. If this limit is reached or exceeded, the unit outputs the message "**Fault df**". If a relay was assigned to this function in the relay manager (Parameter 101), that relay will be energized.

Parameter 91

```
df/dt
Delay    T= 0.0s
```

Pickup delay for df/dt **0.1 to 9.9 s**

In order to initiate a Rate Of Change Of Frequency alarm, the measured df/dt must exceed and remain above the configured threshold (Parameter 90) without interruption for at least the period of time specified in this screen.

Relay Configuration

NOTE

Clearing of faults and fault messages from the control unit will depend on the parameters "External clearing", "Auto-clearing Relays", and "Auto-clearing Display". These three parameters will influence the other depending on how each is configured. This is explained in the following text.

Parameter 92

```
External
Clearing     ON
```

External acknowledgement of the relays via the discrete input "Blocking of protective functions / remote acknowledgement".

Acknowledgement via the discrete input **ON/OFF**

"**Auto-clearing Relays**" configured "**OFF**" (refer to "Auto Acknowledgement of the Relays" on page 64):

OFF .....Alarms that cannot be blocked with discrete input "Blocking of protective functions / remote acknowledgement" will not be reset when the fault condition is no longer present. Pressing the "Clear" button resets the relays.

ON .....All alarms are reset when the discrete input "Blocking of protective functions / remote acknowledgement" (terminals 5/6) is energized. Alarms which cannot be blocked with the discrete input "Blocking of protective functions / remote acknowledgement" are only reset after the fault condition is no longer present.

"**Auto-clearing Relays**" configured "**ON**" (refer to "Auto Acknowledgement of the Relays" on page 64):

OFF .....Pressing the "Clear" button resets the displayed fault messages.

ON .....All displayed fault messages are reset when the discrete input "Blocking of protective functions / remote acknowledgement" (terminals 5/6) is energized. Alarms which cannot be blocked with the discrete input "Blocking of protective functions / remote acknowledgement" are only reset after the fault condition is no longer present.

Auto Acknowledgement of the Relays

Parameter 93

```
Auto-clearing
Relays       ON
```

Auto-clearing relays **ON/OFF**

ON .....Automatic clearing of the relays is enabled. The relays are automatically reset when the fault condition is no longer detected. The alarm message in the display is cleared according to how the parameter "**Auto-clearing Display**" is configured.

OFF .....Automatic clearing of the relays is disabled. Pressing the "Clear" button resets the relays.

The alarm message in the display is cleared according to how the parameter "**Auto-clearing Display**" is configured. The subsequent screens of this function are not indicated.

NOTE

The subsequent screens are only visible if the parameter "Auto-clearing Relays" and the corresponding protective function are enabled and the control unit is equipped with the protective functionality.

Parameter 94

```
Release delay
--------- 00.00s
```

Reset delay for relays **0.02 to 99.98 s**

The individual relays will reset if "Auto-clearing relays" has been enabled and the monitored values have returned to the permissible limits plus / minus the hysteresis (depending on monitoring) without interruption for the time specified in this parameter. If the monitored value exceeds / falls below the threshold limit, the delay timer re-initiates its countdown. The following protective functions may have reset delays configured.

Monitoring for ...	Display instead of "---------"	Note
Overvoltage	Overvolt.	Level 1 and 2
Undervoltage	Und.volt.	Level 1 and 2
Asymmetry	Asymmetry	
Overfrequency	Overfreq.	Level 1 and 2
Underfrequency	Underfrq.	Level 1 and 2
Phase/vector jump	Ph. shift	
df/dt	df/dt	

Table 6-9: Auto-acknowledgment of the relay messages

Auto Acknowledgement of Messages

Parameter 95

```
Auto-clearing
Display   ON
```

Auto-clearing display **ON/OFF**

ON..... After the alarm condition is no longer detected, the message in the display is deleted.

OFF..... The alarm message remains in the display after the fault condition is no longer detected until manually cleared. The subsequent screen of this function is not displayed.

NOTE

The subsequent parameter "Clearing display after " is not visible if "Auto-clearing Relays" is configured to "OFF".

Parameter 96

```
Clearing display
       after 00s
```

Clear displayed message delay **1 to 99 s**

Alarm messages, which have been enabled, will be acknowledged after this configured delay time expires. This delay will initiate once the measure value exceeds/falls below the threshold limit +/- the hysteresis

Changing the Relay Assignment

Parameter 97

```
Change relay-
allocation?  YES
```

Change relay allocation? **YES/NO**

This parameter permits the user to change how the relay outputs are configured. Refer to the list of parameters.

YES .....The relay assignments can be configured and the user may define the relay functionality and assignments. The subsequent screens are displayed.

NO .....The relays are configured with the factory default settings. The subsequent screens are not displayed.

Parameter 98

```
Funct. relay 123
(R=release)  RRR
```

Function of the relays **E/R**

The individual relays may be configured as either E=Energized (Normally Open contacts) or R=Releases (Normally Closed contacts).

Parameter 99

```
Funct. relay  45
(R=release)   RR
```

E .....The relay is configured as normally open (N.O.) contacts. The relay will energize only if the assigned monitoring function has tripped.

R .....The relay is configured as normally closed (N.C.) contacts. The relay is always energized and will only de-energize (release) if the assigned monitoring function has tripped.

Parameter 100

```
Funct. relay  67
(R=release)   RR
```

NOTE.....Relay 1 is configured as R (release/N.C.) and cannot be modified.

NOTE

The following screen(s) will only be displayed if the unit is equipped with the corresponding protective function(s), the protective function is enabled, and the parameter "Change relay allocation" is enabled.

Parameter 101

```
----------------
to relay  0000
```

Assign protective function output to relays **0 to 7**

Each digit in this parameter is used to assign one relay to a protective function. Up to four relay outputs may be assigned to a protective function. The control may be configured as follows:

0..... If the protective function is not assigned to a relay, a "0" must be configured in the display. None of the relay outputs will energize/de-energize when the corresponding protective function trips if all four relay assignments are configured with a "0". A message for the protective function will still be visible in the unit display.

1-7 ..... Relays 1 through 7 are available for assignment to protective function on all units.

Example ..... An LS 4 has a protective function that is required to output a signal to relays 2,4, and 7. That protective function relay assignment should be configured as 2470. The sequence of the numbers has no significance in the functionality or operations.

A relay output may be assigned to more than one protective function. This will cause to relay to issue a signal when any of the configured protective functions trip. If a relay should only issue a signal when a specific protective function trips, then the relay must not be assigned to any other protective function.

Monitoring of ...	Displayed text "----------------"
Overvoltage level 1	**Overvoltage 1**
Overvoltage level 2	**Overvoltage 2**
Undervoltage level 1	**Undervoltage 1**
Undervoltage level 2	**Undervoltage 2**
Asymmetry	**Asymmetry**
Overfrequency level 1	**Overfrequency 1**
Overfrequency level 2	**Overfrequency 2**
Underfrequency level 1	**Underfrequency 1**
Underfrequency level 2	**Underfrequency 2**
Phase/vector jump	**Phase shift**
df/dt	**df/dt**
Centralized alarm (see following page)	**Collect response**
Command: open CB(see following page)	**Command open CB**
Rotary field alarm	**rot. field fault**
Interface error	**Interface fault**

Table 6-10: Relay manager

NOTE

The "ready for operation" function is always assigned to relay 1. However, other protective functions may also be assigned to relay 1 additionally. Relay 1 is always configured as Normally Closed (break contact) and will de-energize if the unit is not ready for operation.

Parameter 102

```
Collect response
to relay  0000
```

Output of the centralized alarm to the relays **0 to 7**

By setting this relay, a centralized alarm is issued. This parameter permits a horn or buzzer to be triggered from this relay. The operator may reset the relay by pressing the "Clear" button for a short period. The relay will be reset in the event another alarm occurs.

Description of the parameters: refer to Table 6-10 on page 67.

Parameter 103

```
Command open CB
to relay  0000
```

Output of the "Command: open CB" to the relays **0 to 7**

By setting this relay the CB will be opened. Following "Reply: CB is open", the relay output is removed.

Description of the parameters: refer to Table 6-10 on page 67.

Interface

General Parameters

Parameter 104

```
Serial control
            ON
```

Control via interface **ON/OFF**

ON..... Control via the serial interface is enabled and control orders received via the interface are processed.
OFF..... Control via the serial interface is disabled and control orders received via the interface are ignored.

NOTE

This functionality is not possible via a Gateway GW 4!

Parameter 105

```
Serial interface
Monitoring   ON
```

Interface monitoring **ON/OFF**

ON..... The interface monitoring is enabled. The control expects to receive bits 2 and 3 to be written to "00" in the control word by the master control within 15 seconds after receiving the last message. If these bits are not read within the prescribed time, and unsuccessful data exchange is detected, and the alarm message "**Interface**" is issued.
OFF..... The interface monitoring is disabled.

NOTE

The communication between the LS 4 and the GCP is always monitored and an interruption of the communication is triggered to the relay configured here.

Parameter 106

```
Inhibit via
Interface  ON
```

Blocking via interface **ON/OFF**

ON..... The protective functions messages (i.e. underfrequency) may be suppress via the interface. This operates in the same manner as terminals 5/6 "Blocking of protective functions / remote acknowledgement".
OFF..... The protective functions messages (i.e. underfrequency) cannot be suppress via the interface.

Parameter 107

```
Interface fault
to relay  0000
```

Message interface alarm to relays **0 to 2**

Relays may be configured to energize when an interface fault is detected. The desired relays that to energize are configured here. The relays will only energize if the parameter "**Serial interface Monitoring**" (Parameter 105) is configured as "**ON**".

CAN Bus Parameter

NOTE

Please note configure IDs must not be duplicated (every ID must be unique in the system). This applies to all CAN bus coupled units. Base ID's must be assigned consecutive numbers when configuring unit addresses.

How to configure transmitting IDs:
All units on the same CAN bus are configured with the same "base ID transmitting" (Parameter 110). With this setting all types of messages are grouped. (Example: All items are configured with "base ID transmitting" = 800. Using the different unit numbers (Parameter 108) on the CAN bus the units are unique; unit number 17: ID = 817; unit number 18: ID = 818, etc.)

Parameter 108

```
Device number
CAN-Bus       00
```

Unit number CAN-Bus **17 to 24**

The unit number must be entered here for CAN bus. The unit number affects the calculation of transmission and control ID's.

Parameter 109

```
Baudrate
       000 kBaud
```

Baudrate CAN bus **125/250/500 kBaud**

Configuration of the Baudrate. If the LS 4 is used with a GCP control unit the Baudrate is to be configured to "125 kBaud".

Parameter 110

```
Base-ID (send)
            0000
```

Base ID transmission **0 to 2.015**

The ID, on which the unit transmits its data is calculated from base ID transmission + unit number CAN bus (Parameter 108). If the LS 4 is used with a GCP control unit, "**0800**" must be configured here.

Parameter 111

```
Base-ID (remote)
            0000
```

Base ID control **0 to 2.015**

The ID, on which the unit receives its data is calculated from base ID control + unit number CAN bus (Parameter 108). If the LS 4 is used with a GCP control unit "**0785**", must be configured here.

Parameter 112

```
ID (parametriz.)
            0000
```

ID for remote configuration **0 to 2.015**

The ID, on which the unit receives its configuration data is entered here. If the unit is configured using a CAN bus card with LeoPC1, "**0831**" must be configured here.

Change Passwords

NOTE

Once the code level is set, it will not be changed even after entering the configuration repeatedly an incorrect code number has been entered, the code level is set to CS0, thus locking the device for external persons.

If for 2 hours uninterruptedly supply voltage is applied, the device automatically switches to code level 0.

Parameter 113

```
Define level 1
code      0000
```

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

This screen appears only when the level 2 password has been entered. After entering the digits into this screen, the code level for level 1 (basic service level) is enabled. After entering this code, the user only has the access rights assigned to this code level.
This code level (CS) is preset to **CS1 = 0 0 0 1**

Parameter 114

```
Define level 2
code      0000
```

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

This screen appears only when the level 2 password has been entered. After entering the digits into this screen, the code level for level 2 (commissioning level) is enabled. After entering the code, the user has the access rights assigned to this code level.
This code level (CS) is preset to **CS2 = 0 0 0 2**

Chapter 7.
Commissioning

DANGER - HIGH VOLTAGE

When commissioning the unit, please observe all safety rules applying to the handling of live equipment. Ensure that you know how to provide first aid in the event of an uncontrolled release of energy and that you know where the first-aid kit and the nearest telephone are. Never touch energized components or the back of the system:

DANGER TO LIFE

CAUTION

Only a qualified technician may commission unit. The "EMERGENCY-OFF" function must be operational prior to commissioning of the system, and must not depend on the unit for its operation.

CAUTION

Prior to commissioning ensure that all measuring devices are connected in correct phase sequence. The connect command for the unit circuit breaker must be disconnected at the unit circuit breaker. The field rotation must be monitored for proper rotation. Any absence of or incorrect connection of voltage measuring devices or other signals may lead to malfunctions and damage the unit, the engine, and/or components connected to the unit!

Commissioning Procedure:

1.) Disable the signal "Command: CB close" (terminal 31).

2.) After wiring the unit and checking whether all voltage-measuring devices are phased correct, apply the control system voltage (i.e. 12/24 Vdc). The "Operation" LED will illuminate.

3.) After applying the measuring variables, the unit will display the measured values. These values should be confirmed with a calibrated measuring instrument.

4.) By simultaneous pressing the two touch pad buttons "Digit↑" and "Cursor→" you will enter into the configuration mode. The unit may now be configured according to the application requirements.

5.) After the unit has been configured properly, exit the configuration mode by simultaneous pressing the two touch pad buttons "Digit↑" and "Cursor→".

CAUTION

Do not proceed to the next step until all previous steps have been accomplished!

6.) Communication with the LS 4
- You may verify whether all LS 4s detect the status of the circuit breaker, which has been installed correctly.
- Simulate closing of the circuit breaker by the LS 4 to verify proper configuration of the LS 4. The CB on" LED" at the LS 4 will illuminate, as soon as the CB is closed.
- The GCP will display the number of units participating in the CAN bus on the "Communicators 00" screen. Prerequisite: The circuit breakers of all LS 4, which are used as tiebreaker and/or bus couplers, are closed. If this is not the case, you may only detect the number of users, who are attached to the opened LS 4 circuit breaker on that part of the CAN bus system to which the GCP are attached, If the displayed number does not correspond to the actual number of participants, check in the LS 4 the parameter "Generator at bus bar" and correct this accordingly if necessary.
- Disable the signal "Command: close CB" (terminal 31).
- By the "Mains parallel" LED " in the GCP you may detect if the circuit breaker reply to the LS 4 is detected correctly. If one of the two systems in the LS 4 was configured as mains potential, the "Mains parallel" LED in the GCP must illuminate accordingly, as soon as the "Reply: CB is open" in the LS 4 is reset (negative logic; at the same time the "CB on" LED of the LS 4 lights up), and the other voltage system of the LS 4 is connected directly with the GCP.
- If a tiebreaker and/or bus coupler exists in the system, this may be checked by simulation of the circuit breaker reply. The number of users in the display of the GCP must increase according to the additional added units. (Example: Before closing the LS 4 (used as tie breaker/bus coupler) there were three GCPs in the first system and two GCP in the second system. After closing the tie breaker/bus coupler CB, there are five GCP participating in the CAN bus.

7.) Test of the synchronization
- Disable the signal "Command: CB close" (terminal 31) to the circuit breaker.
- If the parameter "Synchronization" is configured to 3-phase and if the two voltages of the systems A and B are between 75 % and 112.5 % of the rated voltage (see page 45), the LS 4 outputs a field rotation alarm if it detects that the field rotation is not identical for both systems.
- The voltage of the system [A] must be within the configured limits.
- Apply the signal "Enable CB " to initiate synchronization of the system.
- After applying the signal "Enable CB" the LS 4 transfers the set point values for f and V to the appropriate GCP.
- At the moment of the issuing of a connecting pulse the differential voltage between the appropriate conductors must amount to "zero". This test is to be executed for all three phases, in order to check the correctness of the rotary field.
- After a successful test the signal "Command: close CB" can be enabled again.

8.) Test of the dead bus start functionality
Prior to checking the dead bus start function output of the signal "Command: close CB" must be disabled.

Appendix A. Dimensions

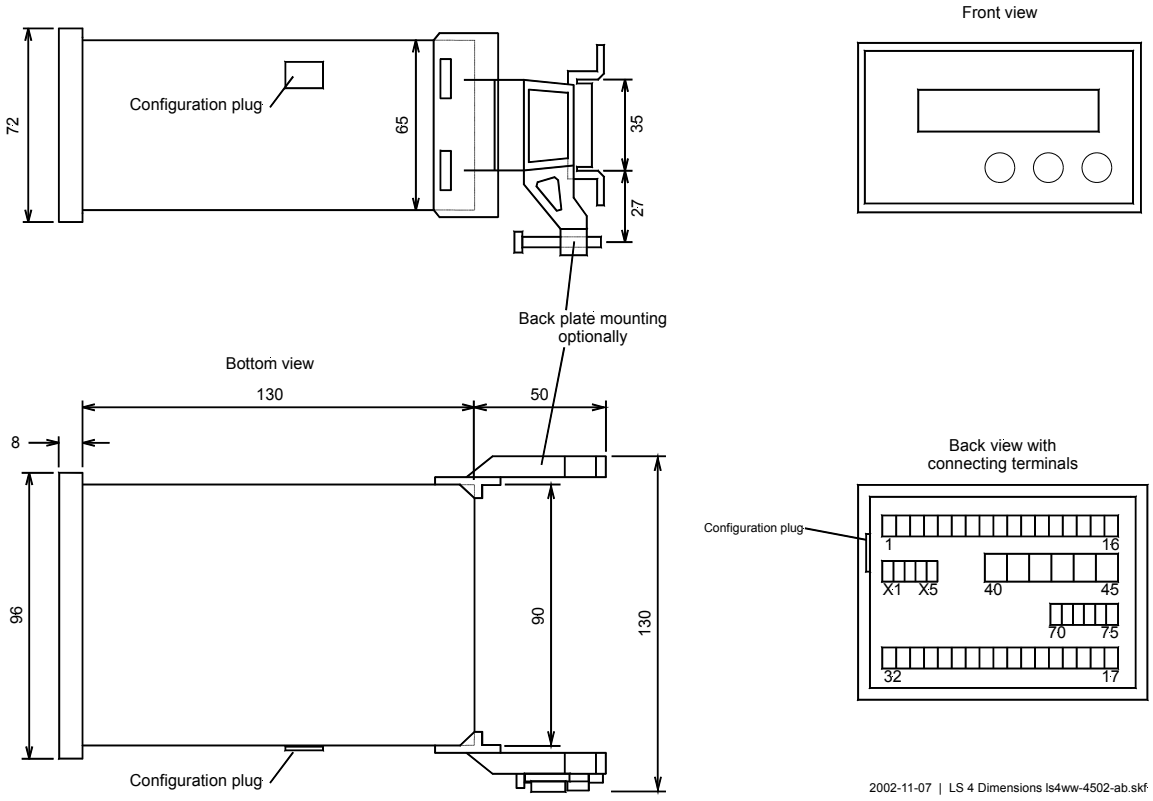


Figure 7-1: Dimensions

Appendix B.
Technical Data

NOTE

Values which does not fit are have to be added to the standard values regarding the UL listing are marked with the amendment "(UL)".

Measuring voltage (U_{meas}) ----------

- 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
- Accuracy .....Class 1
- Linear measuring range up to ..... 1.3 × V_{rated}
- Input resistance .....[1] 0.21 MΩ, or [4] 0.7 MΩ
- Maximum power consumption per path ..... < 0.15 W

Measuring current ($I_{1/gen}$) ---------- **isolated**

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

Measuring frequency ----------

- Rated measuring frequency (f_{rated}) ..... 50/60 Hz (40.0 to 70.0 Hz)

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

- Power supply (U_{aux}).....24 Vdc (18 to 30 Vdc)
- Intrinsic consumption .....max. 12 W
- Ambient temperature .....-20 to 70 °C
- Ambient humidity.....95 %, not condensing

Discrete inputs ($U_{Cont, digital input}$) ---------- **isolated**

- Voltage range ..... 18 to 250 Vac/dc
- Input resistance..... approx. 68 kΩ

Relay outputs ($V_{Cont, relay output}$) ---------- **potential free**

- Contact material ..... AgCdO
- Switching voltage/current (ohmic load) .....max. 250 Vac, 2.00 Aac
- Switching voltage/current (ohmic load) (UL, GP) ..... 24 Vdc, 2.00 Adc
  125 Vdc, 0.36 Adc
  250 Vdc, 0.18 Adc
- Switching voltage/current (inductive load) (UL, PD) B300
  24 Vdc, 1.00 Adc
  125 Vdc, 0.22 Adc
  250 Vdc, 0.10 Adc

Interface ----------isolated

- Insulation voltage ..... min. 500 Vdc
- Version ..... variable

Housing ----------

- Type ..... APRANORM DIN 43 700
- Dimensions (W × H × D) ..... 96 × 72 × 130 mm
- Front cutout (W × H) ..... 91 [+0.8] × 67 [+0.7] mm

- Wiring ..... Screw-plug terminals
  depending on plug connector 1.5 mm², 2.5 mm², or 4 mm²
- Recomm. tightening torque ..... [1.5 mm²] 0.4 Nm / [2.5 mm²] 0.5 Nm / [4.0 mm²] 0.6 Nm
- Connection cable (UL) .....
  use 60/75 °C copper wire only
  use class 1 wire only or equivalent
- Weight ..... approx. 800 g

Protection ----------

- Protection system ..... IP 21
  with external gasket (P/N 8923-1036) and at professional installation IP 54
- Housing (UL) ..... Type 1
  with external gasket (P/N 8923-1036) and at professional installation Type 12
- Front panel ..... insulation surface
- EMC test (CE) ..... tested according to applicable EN guidelines
- Listings ..... UL and cUL Listed, Ordinary Locations, File No.: E231544

Appendix C.
Measured Quantities and Accuracy

Measuring value	Display/range	Accuracy	Note
Frequency			
f_{L1}, f_{L2}, f_{L3}	40.0 to 80.0 Hz	0.05 Hz	
Voltage			
V_{L1}, V_{L2}, V_{L3}, V_{L12}, V_{L23}, V_{L31}	0 to 520 V/0 to 65 kV	1 %	Transformer ratio adjustable
Current			
I_{L1}, I_{L2}, I_{L3}	0 to 9,999 A	1 %	-
Maximum value I_{L1}, I_{L2}, I_{L3}	0 to 9,999 A	1 %	Current slave pointer
Real power			
Total real actual power	-32.0 to 32.0 MW	2 %	-
Re-active power			
Actual value in L1, L2, L3	-32.0 to 32.0 Mvar	2 %	-
Apparent power			
Actual value in L1, L2, L3	0 to 45.0 Mvar	2 %	-
Power factor cos φ			
Actual value cos φ_{L1}	i0.00 to 1.00 to c0.00	1.5 °	-

Reference conditions: The data apply to the following reference conditions:

- Input voltage = sinusoidal rated voltage
- Input current = sinusoidal rated current
- Frequency = rated frequency ± 2 %
- Power supply = rated voltage ± 2 %
- Power factor cos φ = 1
- Ambient temperature 23 °C ± 2 K
- Warm-up period = 20 minutes.

Appendix D.
Interface

Transmission Telegram

The data of the following table can be handled by a Gateway GW 4 or a PLC and can be transferred to other busses. An LS 4 is sending the data via circular CAN messages.

The transmitting rate of this communication is 125 kBaud.

The CAN ID, on which the LS 4 is sending, is calculated as follows:

CAN ID = Base ID Transmit + Unit Number

(The unit number is a parameter adjustable on the LS 4, which influences directly the CAN ID on which the unit sends the visualization message).

A visualization message which is send out of an LS 4 has 8 Bytes and is constructed as follows:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
H‘DD	MUX num-ber	Data word 1 High Byte	Data word 1 Low Byte	Data word 2 High Byte	Data word 2 Low Byte	Data word 3 High Byte	Data word 3 Low Byte

In a visualization message the byte 0 is always used to show the hexadecimal value DD. This one defines the message as a visualization message. As the complete transmission telegram of the LS 4 includes more than three words, byte 1 sends additionally a MUX number starting with 0. Therefore it is theoretically possible to send (256 × 3 = 768) words via the CAN ID. The whole telegram is built up as follows:

Row 1: MUX number 0, data word 1
Row 2: MUX number 0, data word 2
Row 3: MUX number 0, data word 3
Row 4: MUX number 1, data word 1
Row 5: MUX number 1, data word 2
Row 6: MUX number 1, data word 3
.
.
Row(s): MUX number (n-1/3), data word 1
Row (n+1): MUX number (n-1/2), data word 2
Row (n+2): MUX number (n-1/1), data word 3

n depends on the total length of the item special telegram and cannot be larger than H’FF.

MUX	No.	Content (words)	Unit	Note
0/1	1	Protocol number		"1600"
0/2	2	Voltage L_{12}, system [A]	V × $10^{UGNEXPO}$	
0/3	3	Voltage L_{23}, system [A]	V × $10^{UGNEXPO}$	
1/1	4	Voltage L_{31}, system [A]	V × $10^{UGNEXPO}$	
1/2	5	Voltage L_{1N}, system [A]	V × $10^{UGNEXPO}$	
1/3	6	Voltage L_{2N}, system [A]	V × $10^{UGNEXPO}$	
2/1	7	Voltage L_{3N}, system [A]	V × $10^{UGNEXPO}$	
2/2	8	Frequency, system [A]	Hz × 100	
2/3	9	Current in L1, system [A]	A × $10^{IGNEXPO}$	
3/1	10	Current in L2, system [A]	A × $10^{IGNEXPO}$	
3/2	11	Current in L3, system [A]	A × $10^{IGNEXPO}$	
3/3	12	Power factor cos φ	dimensionless	Example: **0064H** cos φ = 1.00 **0063H** cos φ = i 0.99 (inductive) **FF9EH** cos φ = c0.98 (capacitive)
4/1	13	Real power P, system [A]	W × $10^{PGNEXPO}$	
4/2	14	Re-active power Q, system [A]	var × $10^{PGNEXPO}$	positive = inductive; negative = capacitive
4/3	15	Voltage L_{12}, system [B]	V × $10^{UNTEXPO}$	
5/1	16	Voltage L_{23}, system [B]	V × $10^{UNTEXPO}$	
5/2	17	Voltage L_{31}, system [B]	V × $10^{UNTEXPO}$	
5/3	18	Frequency, system [B	Hz × 100	
6/1	19	Exponent		HighByte: UGNEXPO Voltage system [A] LowByte: IGNEXPO Current system [A]
6/2	20	Exponent		HighByte: PGNEXPO Power system [A] LowByte: UNTEXPO Voltage system [B]
6/3	21	Internal alarms 1 Note: 0/1 = Watchdog tripped not 1/0 = Watchdog tripped		Bit 15 = 1 \ Bit 14 = 0 / Overfrequency level 2 Bit 13 = 1 \ Bit 12 = 0 / Underfrequency level 2 Bit 11 = 1 \ Bit 10 = 0 / Overvoltage level 2 Bit 9 = 1 \ Bit 8 = 0 / Undervoltage level 2 Bit 7 = 1 \ Bit 6 = 0 / Internal Bit 5 = 1 \ Bit 4 = 0 / Internal Bit 3 = 1 \ Bit 2 = 0 / Internal Bit 1 = 1 \ Bit 0 = 0 / Internal
7/1	22	Internal alarms 2 Note: 0/1 = Watchdog tripped not 1/0 = Watchdog tripped		Bit 15 = 1 \ Bit 14 = 0 / Overfrequency level 1 Bit 13 = 1 \ Bit 12 = 0 / Underfrequency level 1 Bit 11 = 1 \ Bit 10 = 0 / Overvoltage level 1 Bit 9 = 1 \ Bit 8 = 0 / Undervoltage level 1 Bit 7 = 1 \ Bit 6 = 0 / Internal Bit 5 = 1 \ Bit 4 = 0 / df/dt alarm Bit 3 = 1 \ Bit 2 = 0 / Asymmetry Bit 1 = 1 \ Bit 0 = 0 / dφ/dt phase/vector jump

MUX	No.	Content (words)	Unit	Note
7/2	23	Internal alarms 3		Bit 15 = 1 \ Bit 14 = 0 / Internal
				Bit 13 = 1 \ Bit 12 = 0 / Internal
				Bit 11 = 1 \ Bit 10 = 0 / Internal
				Bit 9 = 1 \ Bit 8 = 0 / Internal
				Bit 7 = 1 \ Bit 6 = 0 / Internal
				Bit 5 = 1 \ Bit 4 = 0 / Internal
		Note:		Bit 3 = 1 \ Bit 2 = 0 / Internal
		0/1 = Watchdog tripped not 1/0 = Watchdog tripped		Bit 1 = 1 \ Bit 0 = 0 / Internal
7/3	24	Internal alarms 4		Bit 15 = 1 \ Bit 14 = 0 / Internal
				Bit 13 = 1 \ Bit 12 = 0 / Internal
				Bit 11 = 1 \ Bit 10 = 0 / Internal
				Bit 9 = 1 \ Bit 8 = 0 / Internal
				Bit 7 = 1 \ Bit 6 = 0 / Internal
				Bit 5 = 1 \ Bit 4 = 0 / Internal
		Note:		Bit 3 = 1 \ Bit 2 = 0 / Internal
		0/1 = Watchdog tripped not 1/0 = Watchdog tripped		Bit 1 = 1 \ Bit 0 = 0 / Internal
8/1	25	Internal alarms 5		Bit 15 = 1 \ Bit 14 = 0 / Internal
				Bit 13 = 1 \ Bit 12 = 0 / Internal
				Bit 11 = 1 \ Bit 10 = 0 / Internal
				Bit 9 = 1 \ Bit 8 = 0 / Internal
				Bit 7 = 1 \ Bit 6 = 0 / Internal
				Bit 5 = 1 \ Bit 4 = 0 / Internal
		Note:		Bit 3 = 1 \ Bit 2 = 0 / Internal
		0/1 = Watchdog tripped not 1/0 = Watchdog tripped		Bit 1 = 1 \ Bit 0 = 0 / Internal
8/2	26	Internal alarms 6		Bit 15 = 1 \ Bit 14 = 0 / Internal
				Bit 13 = 1 \ Bit 12 = 0 / Internal
				Bit 11 = 1 \ Bit 10 = 0 / Internal
				Bit 9 = 1 \ Bit 8 = 0 / Internal
				Bit 7 = 1 \ Bit 6 = 0 / Internal
				Bit 5 = 1 \ Bit 4 = 0 / Internal
		Note:		Bit 3 = 1 \ Bit 2 = 0 / Internal
		0/1 = Watchdog tripped not 1/0 = Watchdog tripped		Bit 1 = 1 \ Bit 0 = 0 / Internal

MUX	No.	Content (words)	Unit	Note
8/3	27	Internal alarms 7 Note: 0/1 = Watchdog tripped not 1/0 = Watchdog tripped		Bit 15 = 1 \ Bit 14 = 0 / Internal Bit 13 = 1 \ Bit 12 = 0 / Wrong rotary field Bit 11 = 1 \ Bit 10 = 0 / Internal Bit 9 = 1 \ Bit 8 = 0 / Internal Bit 7 = 1 \ Bit 6 = 0 / Internal Bit 5 = 1 \ Bit 4 = 0 / Internal Bit 3 = 1 \ Bit 2 = 0 / Internal Bit 1 = 1 \ Bit 0 = 0 / Internal
9/1	28	Internal Diagnosis		Bit 15 = 1 \ Bit 14 = 1 | Bit 13 = 1 | Bit 12 = 1 / 1111 = terminal 32 is set, 0000 = terminal 32 is not set Bit 11 = 1 \ Bit 10 = 1 | Bit 7 = 1 | Bit 6 = 1 / 1111 = terminal 31 is set, 0000 = terminal 31 is not set Bit 7 = 1 \ Bit 6 = 1 | Bit 5 = 1 | Bit 4 = 1 / 1111 = terminal 74 is set, 0000 = terminal 74 is not set Bit 3 = 1 \ Bit 2 = 1 | Bit 1 = 1 | Bit 0 = 1 / 1111 = terminal 75 is set, 0000 = terminal 75 is not set

UGNEXPO Exponent voltage system [A]
IGNEXPO Exponent current system [A]
PGNEXPO Exponent power system [A]
UNTEXPO Exponent voltage system [B]

Receiving Telegram

MUX	No.	Content (words)	Unit	Note
1/1	1	Control word "503"		Bit 15 = 1 Internal
				Bit 14 = 1 Internal
				Bit 13 = 1 Internal
				Bit 12 = 1 Internal
				Bit 11 = 1 Internal
				Bit 10 = 1 Internal
				Bit 9 = 1 Internal
				Bit 8 = 1 Internal
				Bit 7 = 1 Internal
				Bit 6 = 1 Internal
				Bit 5 = 1 Internal
				Bit 4 = 1 Acknowledgment
				Bit 3 = 1 always "0"
				Bit 2 = 1 always "0"
				Bit 1 = 1 Close CB
				Bit 0 = 1 Open CB (high priority)

Format

CAN ID	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x33F	0xEE	Number of the addressed generator [1 bis 8]	Set point value identifier (leading HI Byte)		Value to be sent (leading HI Byte)		Byte 1 XOR Byte 3 XOR Byte 5	Byte 2 XOR Byte 4 XOR Byte 6

Example

CAN ID	Command	Control word
33F	LS 4-17 close command	EE 11 01 F7 00 02 EF E4
33F	LS 4-17 open breaker	EE 11 01 F7 00 01 EF E7
33F	LS 4-17 acknowledgement	EE 11 01 F7 00 10 EF F6

CAN Ids on the Bus

The data flow takes place at the guidance bus (X1/X5). The GCP distribution messages are used originally. (Definition: The device number of the GCP is the node number).

	CAN-ID in [hex]	[decimal]
GCP sends		
Distribution message to other GCPs	180 + GENNO	384 + GENNO
Control message to LS 4 (the GCP with the lowest ID)	311	785
Visualization	320 + GENNO	800 + GENNO
GCP receives		
Distribution message from other GCP	180 + GENNO	384 + GENNO
Control message from an LS 4	300 + GENNO	768 + GENNO
Configuration messages from a higher control	33F	831
LS 4 sends		
Logic message to other LS 4s	180 + LS4NO	384 + LS4NO
Control message to GCP (the LS 4 with the lowest ID)	300 + GENNO	768 + GENNO
LS 4 receives		
Logic message from other LS4	180 + LS4NO	384 + LS4NO
Control message from a GCP	311	785
Configuration messages and configuration messages from a higher control	33F	831

		[hex]	[decimal]
GENNO	=	1 to E	1 to 14
LS4NO	=	11 to 1E	17 to 30

Appendix E.
List of Parameters

Version _____

Project _____

Serial Number _____ Date _____

Option	Parameter	Setting range	Standard setting	Customer settings	
BASIC DATA					
	Software version	-	-		
	Enter code number	0000 to 9999			
	SPRACHE/LANGUAGE	German/English	English	☐ G ☐ E	☐ G ☐ E
	Password protection	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
BASIC SETTINGS					
	Direct parametr.	YES/NO	YES	☐ Y ☐ N	☐ Y ☐ N
	Volt. measuring	Phase to phase / Phase-neutral	P-N		
	Volt.transformer sec.[A]	50 to 120/50 to 480 V	120/400 V		
	Volt.transformer prim[A]	0.100 to 65.000 kV	0.400 V		
	Volt.transformer sec.[B]	50 to 120/50 to 480 V	120/400 V		
	Volt.transformer prim[B]	0.100 to 65.000 kV	0.400 V		
	Current transf.	1 to 9,999/x A	1,000/x A		
	Rated voltage	50 to 120/50 to 480 V	120/400 V		
	Rated frequency	40.0 to 70.0 Hz	50.0 Hz		
	Rated power	5 to 16,000 kW	500 kW		
LS 4 FUNCTIONS					
	Segment number System [A]	1 to 28	1		
	Segment number System [B]	1 to 28	2		
	Segment number Disconnector	0 to 28	0		
	Disconnector at	Voltage A / Voltage B	Voltage A	☐ A ☐ B	☐ A ☐ B
	Mains power meas	valid/invalid	invalid	☐ v ☐ i	☐ v ☐ i
	Mains connection	Voltage A / Voltage B Disconnector / none	none		
	Variable system	Voltage A / Voltage B	Voltage A	☐ A ☐ B	☐ A ☐ B
	Busb. 1 12345678 Gen.	Y/N	NNNNNNNN		
	Busb. 1 9ABCDE Gen.	Y/N	NNNNNN		
	Busb. 2 12345678 Gen.	Y/N	NNNNNNNN		
	Busb. 2 9ABCDE Gen.	Y/N	NNNNNN		
	Busb. 3 12345678 Gen.	Y/N	NNNNNNNN		
	Busb. 3 9ABCDE Gen.	Y/N	NNNNNN		
	Measuring CB ON	one-/three-phase	one-phase	☐ 1 ☐ 3	☐ 1 ☐ 3
	Command open CB not delayed	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	Command open CB Pow.reduct.	YES/NO	NO	☐ Y ☐ N	☐ Y ☐ N
	Command open CB Open at	0 to 100 %	10 %		
SYNCHRONIZATION					
	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	0.1 to 15.0 %	6.0 %		
	Synchronization s opt	+/-0.04 to +/-0.50 %	-0.04 %		
	Synchronization Time pulse>	50 to 250 ms	200 ms		
	Synchronization Closing t.	40 to 300 ms	80 ms		
	Synchronization Phase diff.	-180 to 0 to +180 °	0 °		
	Synchronization block.alarm	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off

Option	Parameter	Setting range	Standard setting	Customer settings	
SYNCHRONOUS NETWORKS					
	Parallel mains	blocked / available	blocked	☐ e ☐ d	☐ e ☐ d
	Parallel mains phi max	0 to 20 °	20 °		
	Parallel mains phi max	0 to 99 s	1 s		
DEAD BUS START					
	Dead bus op. CB	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Dead bus op. CB VA=0/VB=0	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Dead bus op. CB VA=0/VB=Vn	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Dead bus op. CB VA=Vn/VB=0	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Dead bus op. CB Tmin>	0 to 20 s	5 s		
	Dead bus op. CB dV|V-0| <	3 to 50 %	10 %		
	Dead bus op. CB dV|V-Vn| <	1 to 20 %	5 %		
	Dead bus op. CB df max	0.05 to 5.00 Hz	0.25 Hz		
	Dead bus op. CB block.alarm	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
TIME MONITORING					
	CB timeout	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	CB timeout Delay	0 to 999 s	120 s		
	CB timeout Release del.	0 to 999 s	120 s		
	CB syn.ti. fault to relay	0 to 7	0002		
MONITORING FUNCTIONS					
	Volt.-monitoring	Phase to phase / Phase-neutral	P-P	☐ 3 ☐ 4	☐ 3 ☐ 4
	Overvoltage Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Overvoltage 1 V(ph-ph) >	20 to 130/20 to 520 V	110/440 V		
	(Phase-N) >	10 to 75/10 to 300 V	64/254 V		
	Overvoltage 1 Delay	0.02 to 99.98 s	0.10 s		
	Overvoltage 2 V(ph-ph) >	20 to 130/20 to 520 V	120/480 V		
	(Phase-N) >	10 to 75/10 to 300 V	69/277 V		
	Overvoltage 2 Delay	0.02 to 99.98 s	0.04 s		
	Overvoltage Hysteresis	0 to 99 V	8 V		
	Undervoltage Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Undervoltage 1 V(ph-ph) <	20 to 130/20 to 520 V	90/360 V		
	(Phase-N) <	10 to 75/10 to 300 V	51/207 V		
	Undervoltage 1 Delay	0.02 to 99.98 s	0.10 s		
	Undervoltage 2 V(ph-ph) <	20 to 130/20 to 520 V	80/320 V		
	(Phase-N) <	10 to 75/10 to 300 V	46/184 V		
	Undervoltage 2 Delay	0.02 to 99.98 s	0.04 s		
	Undervoltage Hysteresis	0 to 99 V	8 V		
	Asymmetry Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Asymmetry Response v.	0 to 99 V	10/40 V		
	Asymmetry Delay	0.02 to 99.98 s	2.00 s		
	Asymmetry Hysteresis	0 to 99 V	4 V		
	Overfrequency Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Overfrequency 1 f >	40.00 to 80.00 Hz	50.20 Hz		
	Overfrequency 1 Delay	0.02 to 99.98 s	0.10 s		
	Overfrequency 2 f >	40.00 to 80.00 Hz	51.00 Hz		
	Overfrequency 2 Delay	0.02 to 99.98 s	0.04 s		
	Overfrequency Hysteres.	0.01 to 9.99 Hz	0.05 Hz		
	Underfrequency Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Underfrequency 1 f <	40.00 to 80.00 Hz	49.80 Hz		
	Underfrequency 1 Delay	0.02 to 99.98 s	0.10 s		
	Underfrequency 2 f <	40.00 to 80.00 Hz	49.00 Hz		
	Underfrequency 2 Delay	0.02 to 99.98 s	0.04 s		
	Underfrequency Hysteres.	0.01 to 9.99 Hz	0.05 Hz		
	Phase shift Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	Phase shift mon.	one/three phase / 3 phase only	3-phase only	☐ 1-3 ☐ 3	☐ 1-3 ☐ 3
	Phase shift (One phase)	2 to 30 °	30 °		
	Phase shift (3-phase)	2 to 30 °	8 °		
	df/dt- Monitoring	ON/OFF	OFF	☐ on ☐ off	☐ on ☐ off
	df/dt Response>	1.0 to 9.9 Hz/s	2.5 Hz/s		
	df/dt Delay T=	0.1 to 9.9 s	0.1 s		

Option	Parameter	Setting range	Standard setting	Customer settings	
RELAY OUTPUTS					
	External Clearing	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Auto-clearing Relays	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Release delay Overvolt.	0.02 to 99.98 s	0.10 s		
	Release delay Und.volt.	0.02 to 99.98 s	0.10 s		
	Release delay Asymmetry	0.02 to 99.98 s	0.10 s		
	Release delay Overfreq.	0.02 to 99.98 s	0.10 s		
	Release delay Underfrq.	0.02 to 99.98 s	0.10 s		
	Release delay Ph. shift	0.02 to 99.98 s	0.10 s		
	Release delay df/dt	0.02 to 99.98 s	0.10 s		
	Auto-clearing Display	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Clearing display after	1 to 99 s	1 s		
	Change relay- allocation?	YES/NO	YES	☐ Y ☐ N	☐ Y ☐ N
	Funct. relay 123 (R=release)	R/E	RRR		
	Funct. relay 45 (R=release)	R/E	RR		
	Funct. relay 67 (R=release)	R/E	RR		
	Overvoltage 1 to relay	0 to 7	0002		
	Overvoltage 2 to relay	0 to 7	0002		
	Undervoltage 1 to relay	0 to 7	0002		
	Undervoltage 2 to relay	0 to 7	0002		
	Asymmetry to relay	0 to 7	0002		
	Overfrequency 1 to relay	0 to 7	0003		
	Overfrequency 2 to relay	0 to 7	0003		
	Underfrequency 1 to relay	0 to 7	0003		
	Underfrequency 2 to relay	0 to 7	0003		
	Phase shift to relay	0 to 7	0003		
	df/dt to relay	0 to 7	0003		
	Collect response to relay	0 to 7	0000		
	Command open CB to relay	0 to 7	0000		
	rot. field fault to relay	0 to 7	0000		
INTERFACE					
	Serial control	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Serial interface Monitoring	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Inhibit via Interface	ON/OFF	ON	☐ on ☐ off	☐ on ☐ off
	Interface fault to relay	0 to 7	0003		
	Device number CAN-Bus	17 to 24	17		
	Baudrate	125/250/500 kBaud	125 kBaud		
	Base-ID (send)	0 to 2,015	0800		
	Base-ID (remote)	0 to 2,015	0785		
	ID (parameterize.)	0 to 2,015	0831		
PASSWORDS					
	Define level 1 code	0000 to 9999	0001		
	Define level 2 code	0000 to 9999	0002		

Appendix F.
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 shipping 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 (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 GmbH
Handwerkstrasse 29
70565 Stuttgart - Germany

Phone: +49 (711) 789 54-0 (8.00 - 16.30 o'clock)
Fax: +49 (711) 789 54-100
E-mail: stgt-info@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 5811
India	+91 (129) 409 7100
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 LS4 _____

Serial number S/N _____

Description of your problem

_____

_____

_____

_____

_____

_____

Please be sure you have a list of all parameters available. You can print this using LeoPC1. Additionally you can save the complete set of parameters (standard values) and send them to our Service department via e-mail.

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.

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stgt-info@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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