Positioning Unit with Parallel Sequence Control

WP-311

Compact Unit
without Power Controller

Doc. no. 212.951/DGB

Ident. no.: 00441108300

Edition: c041 05.02

Software version: 03.0XX

Safety requirements

Please read the following safety requirements prior to installation, operation, maintenance and repair of the device.

- The intended use of the device is described under “Purpose” and must be observed.
- Installation, maintenance and repair of the device shall be performed by a qualified electrician. National regulations concerning
  – accident prevention
  – installation of electrical and mechanical systems
  – radio interference suppression
  shall be observed.
- The technical data of the device, particularly the ambient conditions, shall be observed.
- The device shall only be operated by trained personnel.
- The warranty is invalidated in case of unauthorized modification or opening of the device.
- Please ask your BERGER LAHR technical consultant prior to installing accessories not listed in the chapter “Description of accessories”.
- The safety symbols and notes on the device and in the manual shall be observed.

Explanation of symbols

ATTENTION
Reference to a danger for the device or components, possibly resulting in the endangering of human life.
DANGER
Reference to a direct endangering of human life.

DANGER
High voltage at component, do not touch.

DANGER
High temperature at component, do not touch.

ATTENTION
Warning against electrostatic discharge (ESD).
Only touch the PC board or component in an electrostatically protected environment.

NOTE
Important or additional information concerning the device or the manual.

	Proposals **Improvements**
Berger Lahr GmbH & Co. KG Breslauer Str. 7 Postfach 1180 D-77901 Lahr	**WP-311** Edition: c041 05.02 Doc. no. 212.951/DGB
Sender: Name: Company/department: Address: Telephone no.:	Please inform us, using this form, if you have discovered any errors when reading this document. We should also appreciate any new ideas and proposals.

Proposal and/or improvements:

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1 General description

1.1 Structure and characteristics

The WP-311 positioning unit is used for controlling a stepping motor power controller (e.g. WD3-008). The unit has been designed for wall mounting in a control cabinet.
The WP-311 is available in two housing variants:

– WP-311 in 3-phase housing (fig. 1-1), matching the 3-phase stepping motor product family
– WP-311 in 5-phase housing (fig. 1-2), matching the 5-phase stepping motor product family

Inputs/outputs The unit features 20 freely assignable inputs (inputs I 16 to I 20 are pre-assigned) and 10 freely assignable outputs. The optional RS 485 HS interface can be used for addressing up to ten additional MP 926 input/output cards with 16 inputs and 16 outputs each.

Options A variety of extension options are available, e.g. an additional serial or analog interface and an additional encoder connection for an electronic gear or a field bus interface (e.g. Interbus-S or Profibus-DP).

Programmable controller The unit has the characteristics of a programmable controller with integral movement programming. Sequence programming is possible in the same way as with NC controllers.

IEC 1131-3 Programming is effected in accordance with IEC 1131-3 using a PC as the programming device and the BPRO3 programming system or with the ProOED3 programming interface if the OED3 software is installed on the unit.

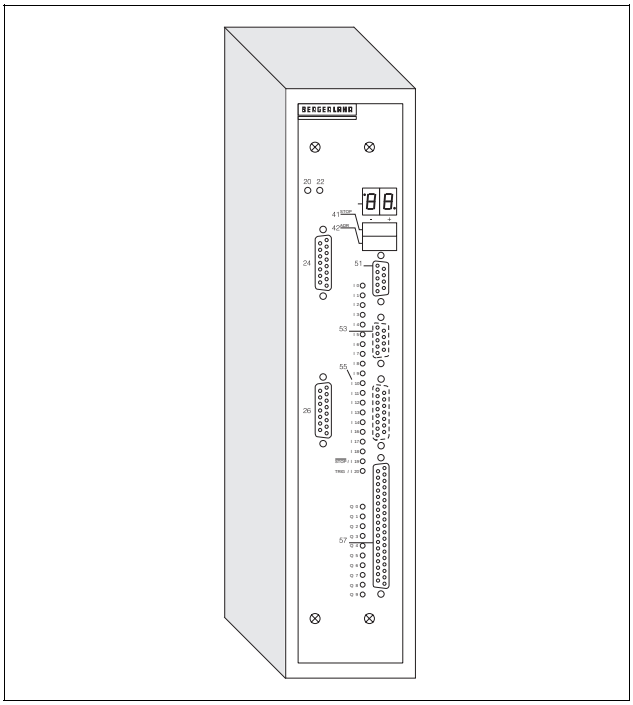


Fig. 1-1 WP-311 in 3-phase housing

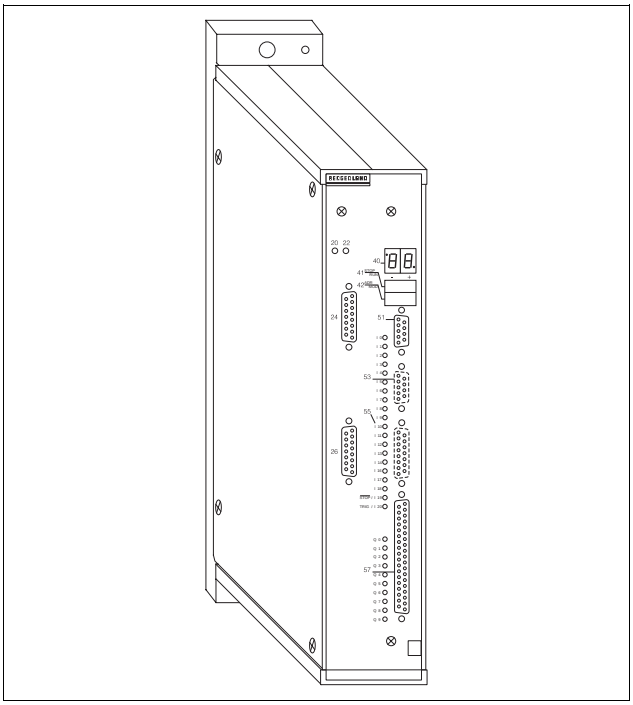


Fig. 1-2 WP-311 in 5-phase housing

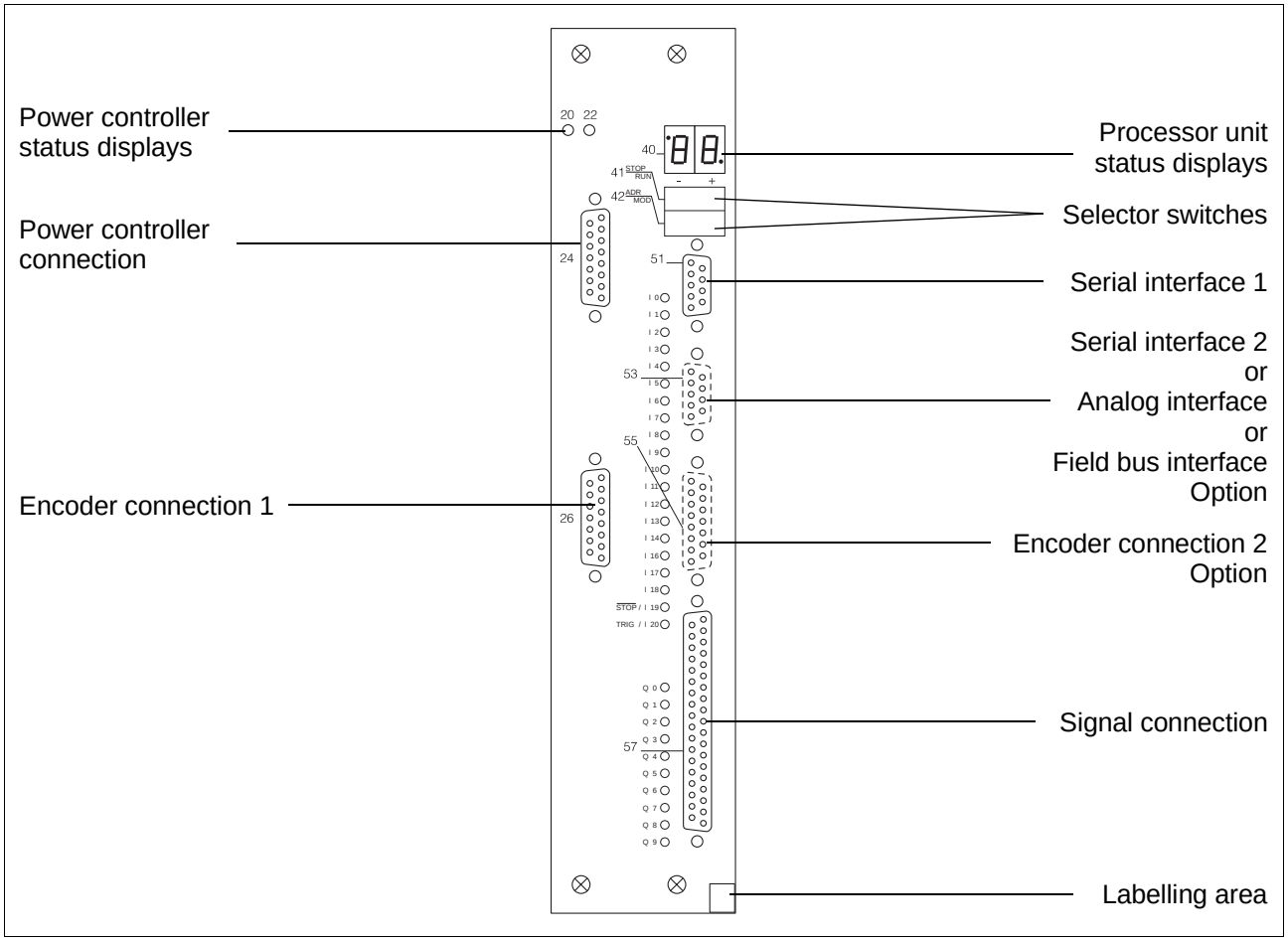


Fig. 1-3 WP-311 front panel

The following controls, indicators and connectors are arranged on the front panel (fig. 1-3):

20 and 22
Power controller status indicators
indicate readiness (item 20) and enable (item 22) of the power controller

24 Power controller connection
for controlling the power controller

26 Encoder connection 1
e.g. for rotation monitoring or electronic gear

40 Processor unit status displays
two seven-segment displays for operating status and malfunction indication

41 Selector switch
In application mode:
STOP (position –) or RUN (position +) the application program
In manual mode:
CCW rotation (position –) or CW rotation (position +) of a motor

42 Selector switch
for setting the ADR network address and the MOD operating mode; in the central position, operating states and malfunctions are indicated;
for error message acknowledgement

51 Serial interface 1, RS 232 or RS 485 LS,
for programming or communication

53 Serial interface 2 (option) as an

RS 232 or RS 485 LS	for communication
RS 485 HS	for the MP 926 input/output card for the Lauer operating panel

or

53 Field bus interface (option) as

CAN	CAN bus interface for network integration
IBS	Interbus-S slave interface for network integration
PBDP	Profibus-DP interface for network integration
RS 485 HS	SUCONET interface

or

53 Analog interface (option)
for input and output of analog values

55 Encoder connection 2 (option)
e.g. for rotation monitoring or electronic gear

57 Signal connection
for signal inputs/outputs and processor unit voltage supply

I 0 to I 20
Status indicators for the inputs

Q 0 to Q 9
Status indicators for the outputs

Labelling area
for the mounting location number

NOTE
The interfaces installed in the unit are indicated on the type plate as follows:

ANOZ	*Analog interface*
CAN	*CAN bus interface*
IBS	*Interbus-S interface*
PBDP	*Profibus-DP interface*
RS 232	*RS 232 serial interface*
LRS 422-IN	*RS 422 encoder interface*
RS 485 LS	*RS 485 serial interface*
RS 485 HS	*Serial interface for MP 926 input/output card, Lauer operating panel or SUCONET (without OED3)*

1.2 Purpose

The WP-311 positioning unit is used for controlling an external power controller, e.g. WD3-008 or WD5-008.

The unit can be used in conjunction with an external power controller as a drive unit for a variety of applications.

The unit has been designed for wall mounting in a control cabinet.

1.2.1 System environment

An IBM PC/AT (or compatible computer) with the BERGER LAHR BPRO3 programming system installed is used as the programming device (fig. 1-3); for more information, refer to the BPRO3 documentation. If the OED3 software is installed on the controller, its programming interface ProOED3 is used for programming.

Up to 62 BERGER LAHR Series 300 controllers (e.g. WP-311) can be programmed and operated via two serial PC interfaces. Each serial interface can be used for programming 31 controllers.

Programming features

The WP-311 positioning unit has the following programming features:

– Parallel processing of PLC and movement functions
– Direct or indirect control of parallel inputs and outputs
– Individual programming of the serial interfaces

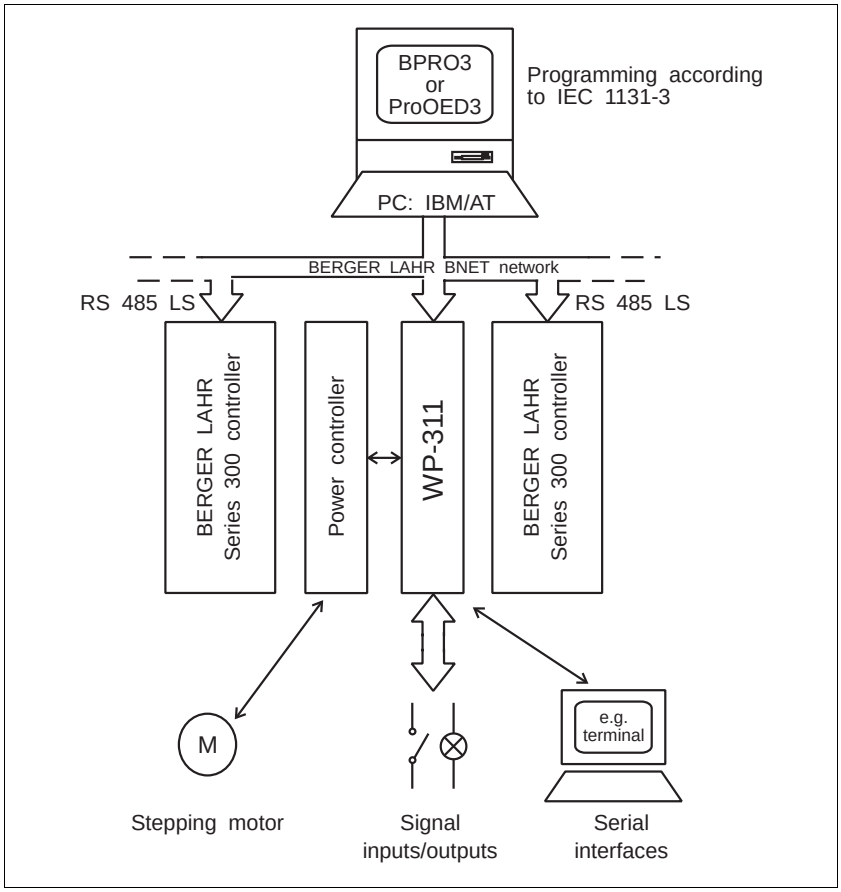


Fig. 1-4 System environment

1.2.2 Connection diagram

Figure 1-5 illustrates the connection diagram of the positioning controller with the available interfaces.
Communication between PC and positioning controller is effected either through the RS 232 or RS 485 LS serial interface or the field bus interface (e.g. Interbus-S), depending on the actual interface configuration.

NOTE
If the controller is provided with an RS 485 LS interface and the PC with an RS 232 interface, an interface converter (e.g. MP 923, see chapter 6.2.2) must be used.

NOTE
With an RS 485 LS interface, the MP 924 interface distributor can be used for implementing a network (see chapter 6.2.3).

NOTE
With an RS 232 interface, networking is not possible.

NOTE
With an Interbus-S interface, the MP 927 Interbus-S interface adapter must be used (see separate Interbus-S documentation).

NOTE
With a Profibus-DP interface, e.g. a bus terminal must be used.

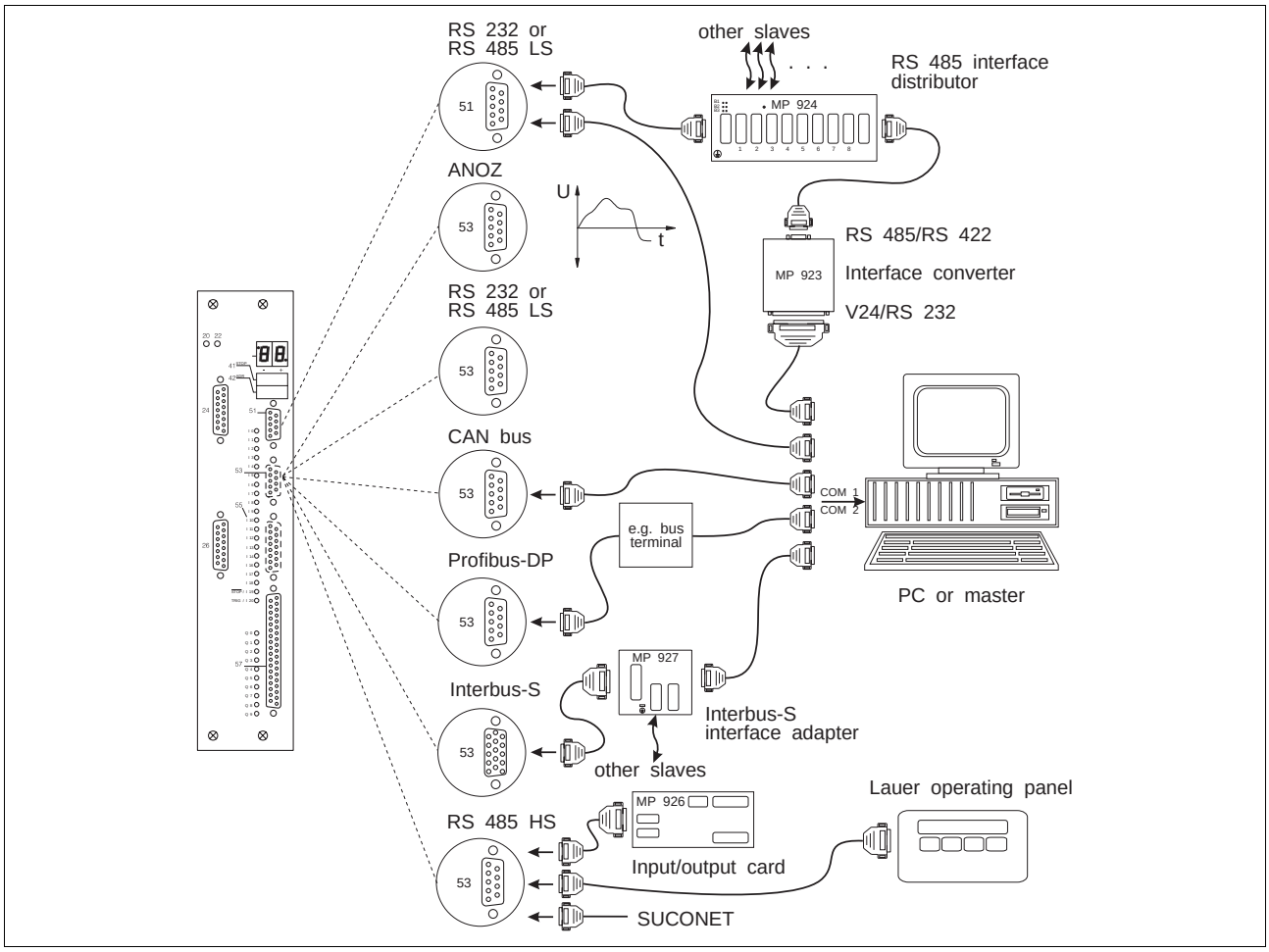


Fig. 1-5 Connection diagram

1.3 Function

1.3.1 Hardware components

Two printed circuit boards of Eurocard format with type size 6 HU are installed in the unit for accommodating the separator card and the microprocessor control. The most important function blocks of the unit are evident in the block diagram (fig. 1-6).

Signal interface

Optocouplers at the signal interface are used for isolating the input and output signals between the external controller and the internal electronic circuits.

DC/DC power supply unit

A DC/DC power supply unit generates various voltage levels for supplying the internal electronic circuits.

NOTE
The electronic circuitry of the processor unit consists of PELV circuits according to DIN VDE 0160.

Serial interface 1, 2

The serial interfaces can be used for establishing links to external programming and control units or operating terminals.

Analog interface

The analog interface can be used for processing analog values from application programs. The analog interface has five ±10 V inputs and one 10 V output.

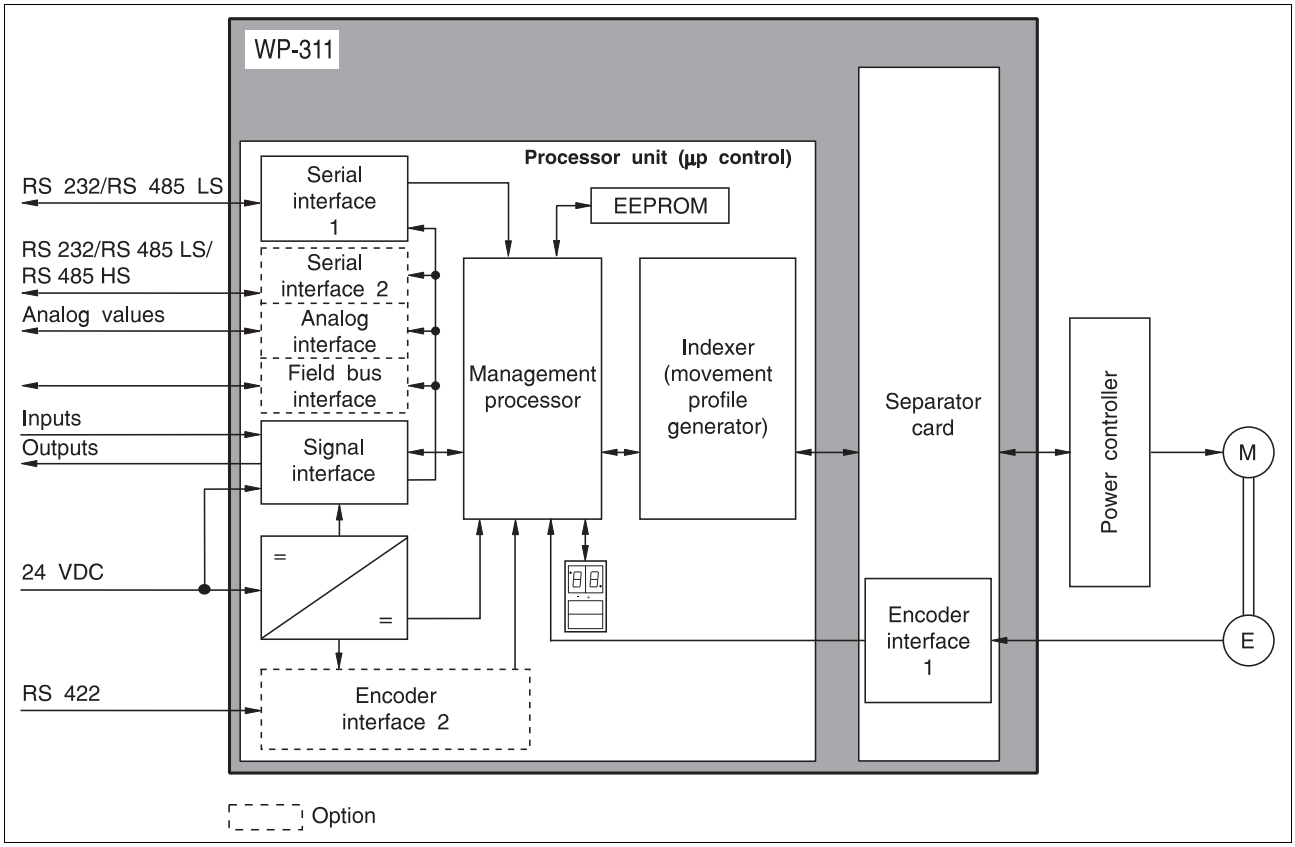


Fig. 1-6 Block diagram

Field bus interface The controller can be equipped with a standardized field bus interface (e.g. Interbus-S or Profibus-DP). This enables the controller to receive and execute commands from a master unit.

Management processor The management processor runs the application program and passes movement commands to the indexer. The application program is stored in a battery-buffered RAM. The application program can be stored in an EEPROM in addition.

Status displays and selector switches The selector switches can be used for setting the operating mode, the network address as well as the interface parameters. The seven-segment displays indicate operating states and malfunctions.

Indexer The indexer (movement profile generator) generates pulse/direction signals for controlling the external power controller from the movement command parameters (travel, speed, acceleration).

Encoder interface 1 The encoder interface 1 is freely available for implementing, for example, rotation monitoring or an electronic gear.

Encoder interface 2 The encoder interface 2 is an option which can be used for rotation monitoring or an electronic gear.

Separator card The separator card provides the link between the indexer and the external power controller. Two LEDs are provided for power controller readiness and enable indication.

1.3.2 Operating modes

1.3.2.1 Application mode

In application mode, a program can be loaded into the WP-311 positioning unit and executed.

Programming may be effected either with a PC with the BPRO3 programming software installed or with the ProOED3 programming interface (if the OED3 software is installed on the controller).

Programming is possible without being linked to the WP-311 positioning unit, i.e. off-line. The programming device can be used for directly programming and testing the controller.

1.3.2.2 Manual mode

Manual mode is an auxiliary mode for setting up and testing the system.

In manual mode, the selector switch (item 41) on the unit front panel can be used for moving the stepping motor in a clockwise (CW) or counterclockwise (CCW) direction.

The limit switches and the STOP input must be wired.

1.3.2.3 On-line command processing

The on-line command processing mode is active if the controller is provided with a serial interface and MODE is set to 60 or 70, or if the controller is provided with a field bus interface. In this mode, single movement commands and other commands are transmitted to the controller and executed immediately. A comprehensive command set for programming is available for on-line command processing. This operating mode is described in a separate documentation for each appropriate interface.

RS 485 LS network

Several controllers with RS 485 LS interfaces can be operated from a single master controller or from a PC. The controller's network address is set by MODE 61 or 71 on the front panel. The master controller must use a polling command to specify the unit with which it wants to communicate (see separate documentation).

Communication via field bus network

A standardized field bus interface, e.g. Interbus-S (see fig. 1-7) or Profibus-DP, can be used for transmitting movement and other commands from a master unit to the controller for execution; see on-line command processing.
Communication via a field bus interface is described in a separate documentation for each appropriate interface.

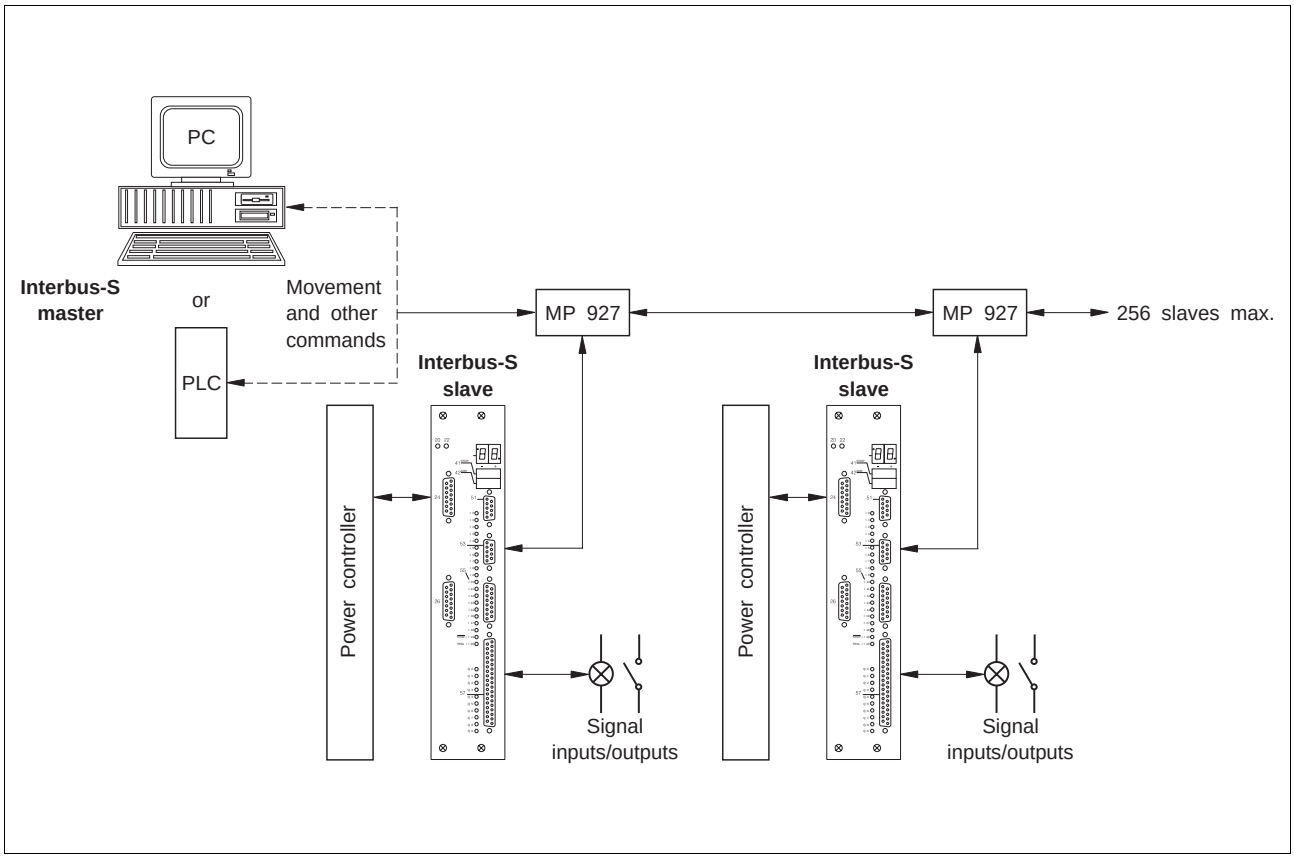


Fig. 1-7 Interbus-S network operating

1.4 Technical data

1.4.1 General data

Application program memory	128 kb battery-buffered RAM and EEPROM
Storage space	for approx. 12,000 BPRO3 instructions
with OED3 vers. 1.XX	for approx. 1500 OED3 instructions
with OED3 vers. 2.XX	for approx. 3000 OED3 instructions
Time for a logic instruction	
with BPRO3	approx. 1.5 µs
with OED3 version 1.XX	approx. 2.0 ms
with OED3 version 2.XX	approx. 0.5 ms
Max. number of BPRO3 user blocks	150
Max. number of BPRO3 data block types	100

1.4.2 Electrical data

1.4.2.1 Supply voltage

Processor unit

Supply voltage	24 VDC
Min. operating voltage (on unit)	20 VDC
Max. operating voltage (on unit)	30 VDC
Power consumption	1.2 A max.
Ripple voltage	<2 V_{ss}

NOTE
The 24 V voltage supply must fulfil the requirements of DIN VDE 0160 concerning protected extra low voltages (PELV).

1.4.2.2 Analog interface

Internal leakage resistance towards ground	1 Mohm

Electrical characteristics of the inputs

Five signal inputs, opto-isolated	±10 V
Precision	±0.25%, ±25 mV
A/D converter resolution	minimum of 3700 steps
Input resistance	>10 Kohms

Electrical characteristics of the outputs

One signal output, opto-isolated, short-circuit protected	10 V (max. 30 mA)
Precision	±0.5%, ±50 mV
D/A converter resolution	minimum of 200 steps

1.4.2.3 Serial interfaces

RS 232 interface

Internal leakage resistance towards ground	1 Mohm

RS 485 LS four-wire interface (option)

Supply voltage output	12 VDC (9 VDC min., 18 VDC max.)
Short-circuit protected	150 mA max.
Internal leakage resistance towards ground	1 Mohm

RS 485 HS interface for MP 926 input/output card (option)

Two-line remote bus	
Maximum number of input/output cards	10
Maximum cable length	400 m
Compatible with BPRO3 programming system	from version 3.11
Compatible with ProOED3 programming interface	from OED3 version 1.05

1.4.2.4 Field bus interfaces

All field bus interfaces are opto-isolated and have an internal leakage resistance towards ground of 1 Mohm.

Interbus-S slave interface (option IBS)

Two-line remote bus	
4 data words	
Transmission rate	500 kbauds
Distance to adjacent station	400 m max.

Profibus-DP slave interface (option PBDP)

The transmission rate is set by the master (12 Mbauds max.).

Line length	see Profibus-DP specifications

CAN bus interface (option CAN)

Transmission rate	10 kbauds to 500 kbauds
Line length	
at 10 kbauds	7000 m max.
at 125 kbauds	570 m max.
at 500 kbauds	80 m max.

SUCONET slave interface (RS 485 HS option, on controllers without OED3)

Bus interface	RS 485 HS
Bus cable	Shielded twisted-pair cable
Transmission speed	187.5 kbauds and 375 kbauds

1.4.2.5 Power controller connection

Opto-isolated

Inputs

Turn-on voltage	0 V to +2 V, 8 mA max.
Turn-off voltage	4.5 V or open input
Transmission frequency	1 kHz max.
Outputs, short-circuit protected	Push-pull acc. to RS 422A
Pulses	500 kHz max.
Shield connection	On both ends

1.4.2.6 Encoder connections

RS 422 IN signal level

Short-circuit protected	
Maximum cable length	100 m
Wire cross-section	0.25 mm^2 for signals 0.5 mm^2 for supply
Shield connection	On both ends
Voltage output	5 V ±5% (300 mA max.)
Optionally for encoder connection 2	12 VDC (9 VDC min., 18 VDC max., 200 mA max.)
Internal leakage resistance towards ground	1 Mohm

1.4.2.7 Signal connection

Shield connection	On both ends
Internal leakage resistance towards ground	1 Mohm

Electrical characteristics of the inputs

Opto-isolated, polarity reversal protection, hardware debounce

Typical signal voltage level	24 V
Maximum input voltage	30 V
Typical input current at 24 V	7 mA
Turn-on voltage	>15 V
Turn-off voltage	<5 V
Settling time t_E	
Inputs I 0 to I 19	1.0 to 1.5 ms
Trigger input I 20	0.1 to 0.15 ms

Electrical characteristics of the outputs

Opto-isolated, inductive loadability, short-circuit protected

Maximum voltage	30 V
Maximum switching current	400 mA
Voltage drop at 400 mA	<2 V

DANGER
The signal inputs and the 24 VDC supply voltages at the signal connection must be definitely isolated from mains. The maximum voltage towards ground must not exceed 60 VDC or 25 VAC.

1.4.2.8 Device protection

Protection and monitoring circuits: Power amplifier overtemperature, short-circuit between motor leads (no ground fault protection), undervoltage and overvoltage

Type of protection IP 20 according to EN 60529: 1991

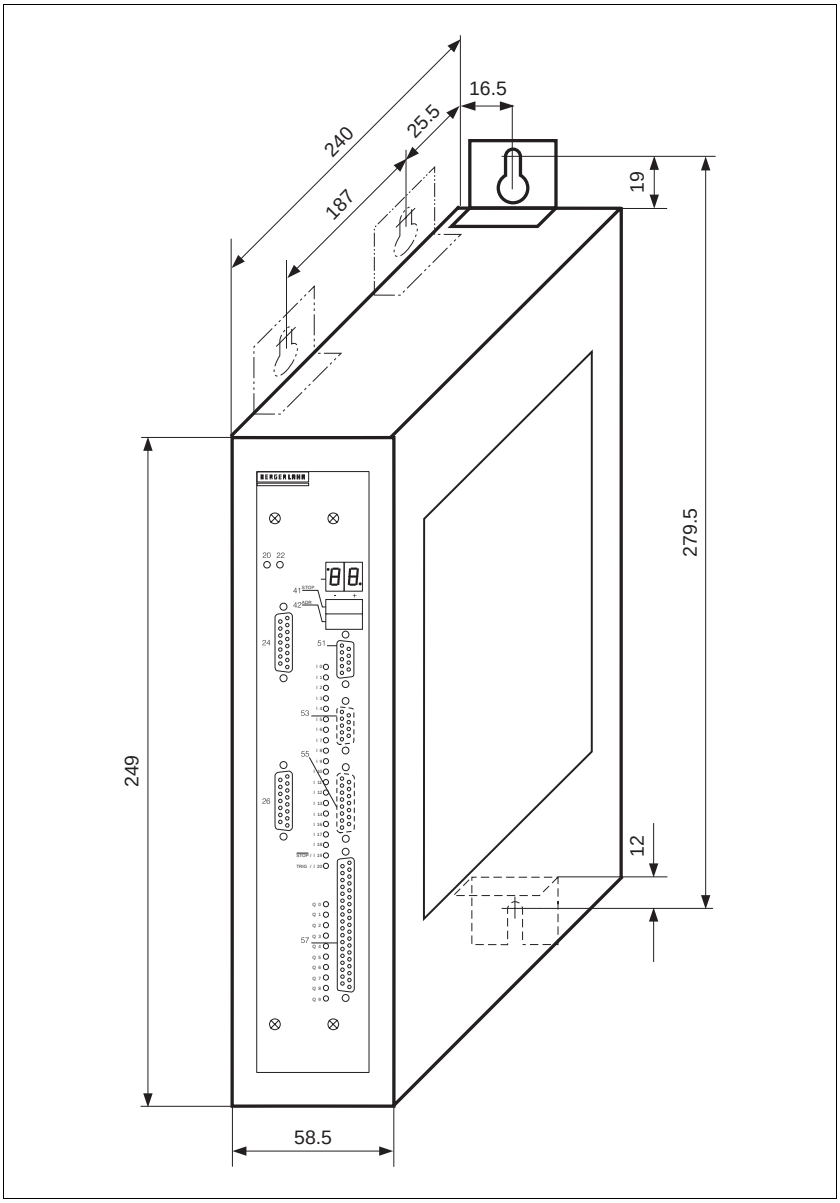


Fig. 1-8 WP-311 dimensions with 3-phase housing

1.4.3 Mechanical data

WP-311 dimensions	
with 3-phase housing	See fig. 1-8
with 5-phase housing	See fig. 1-9
WP-311 weight	
with 3-phase housing	approx. 1.6 kg
with 5-phase housing	approx. 1.8 kg

1.4.4 Ambient conditions

Ambient temperature	0°C to +50°C
Storage temperature	-25°C to +70°C
Noise immunity	
acc. to IEC 801-2	Severity 2
acc. to IEC 801-4	Severity 4
Humidity class, components	F acc. to DIN 40040
Humidity class, tested to IEC 68 part 2-3 at:	
Air temperature	+40°C, +2°C
Relative humidity non-condensing	93%, +2%, -3%

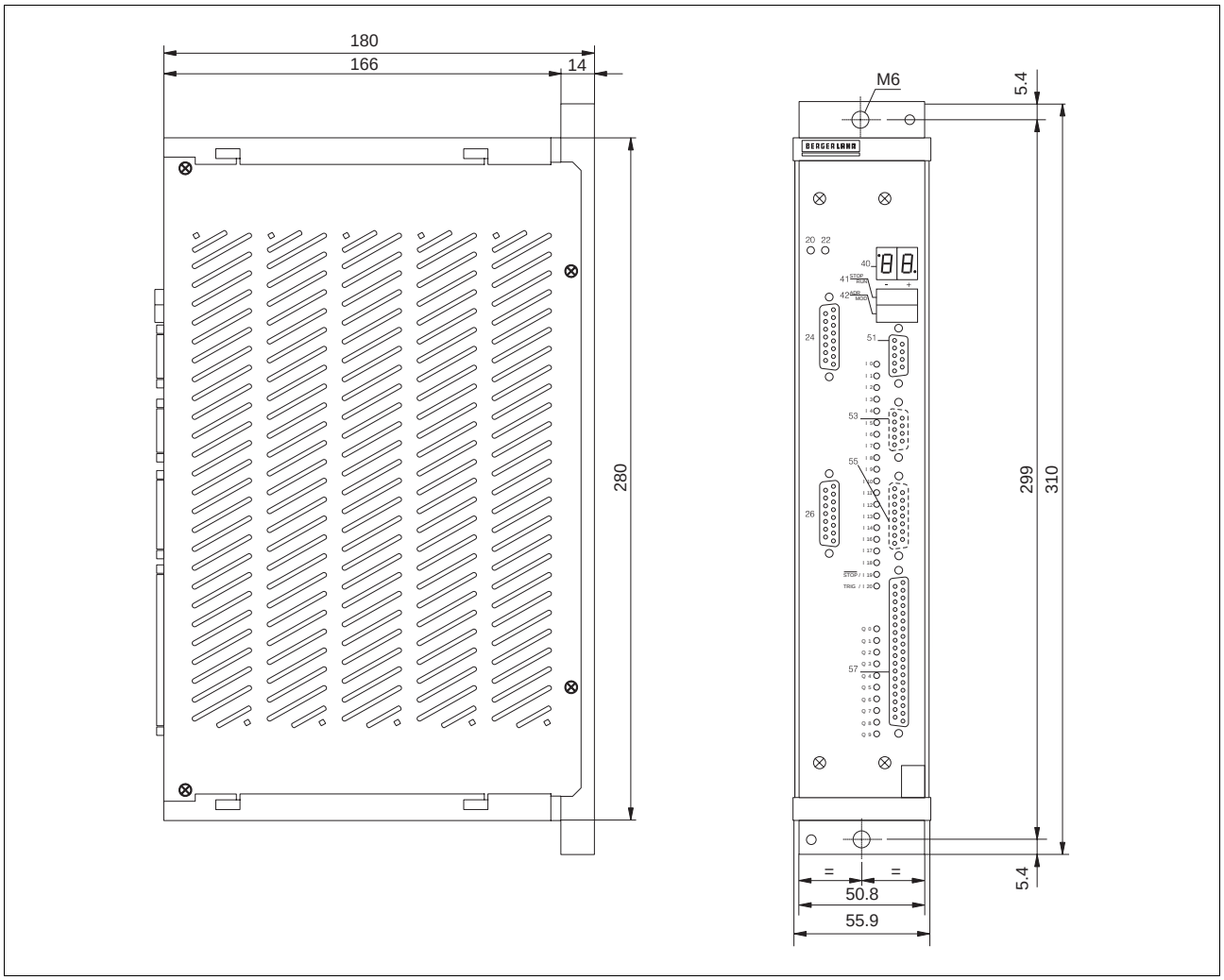


Fig. 1-9 WP-311 dimensions with 5-phase housing

1.4.5 Regulations

Machinery directive

Insofar as the machinery corresponds to the machinery directive 89/392/EEC and the configuration meets the EMC test conditions specified by BERGER LAHR, conformity with the machinery directive is hereby certified.

EMC directive

In a configuration which meets the EMC test conditions specified by BERGER LAHR, conformity with the following standards can be certified in accordance with the EMC directive 89/336/EEC:

Radio interference suppression (when using a mains filter, see Accessories)	according to EN 50081-2: 1993
Static discharge	according to EN 60801-2: 1993, class 3
Burst	according to IEC 801-4: 1988, class 4

BERGER LAHR EMC test requirements

- Use a BERGER LAHR motor lead. Length of motor lead is 10 m.
- Insert a BERGER LAHR mains filter into the mains supply line.
- Install the device into the control cabinet.
- Use BERGER LAHR signal cables and wire them according to the documentation.
- Run signal, mains and motor cables separately (non-parallel) and ensure a large surface area contact between the cable shield and ground on both ends.
- Install the mains filter directly at the device. If this is not possible, use a shielded connection line (1 m max.) between filter and device.
- Ensure a large surface area contact between filter, device and ground (mount on a grounded metal plate or on control cabinet rear panel, or use a ground strap).

Low-voltage equipment directive

Pursuant to the low-voltage equipment directive 73/23/EEC, the products are in conformity with the following standards:

Protection class	1 acc. to prEN 50178: 1994
Overvoltage	Category III acc. to prEN 50178: 1994
Contamination	Grade 2 acc. to prEN 50178: 1994

1.4.6 Approvals

prEN 50178 classification VDE 0160/11.94

EN 60950 classification VDE 0805: 1993 + A2: 1994

UL 508 file no. 153 659

2 Installation

2.1 Scope of supply

The delivery must be checked for completeness.

The scope of supply (fig. 2-1) comprises:

Qty.	Designation
1	WP-311 positioning unit
1	WP-311 documentation
4	Mounting bracket (for 3-phase housing)
1	Ground strap (for 3-phase housing)
1*	On-line Command Processing via CAN Bus documentation or On-line Command Processing via Interbus-S documentation or On-line Command Processing via Profibus-DP documentation
1*	Diskette with device master file for setup with Profibus-DP interface

* If the appropriate interface is installed.

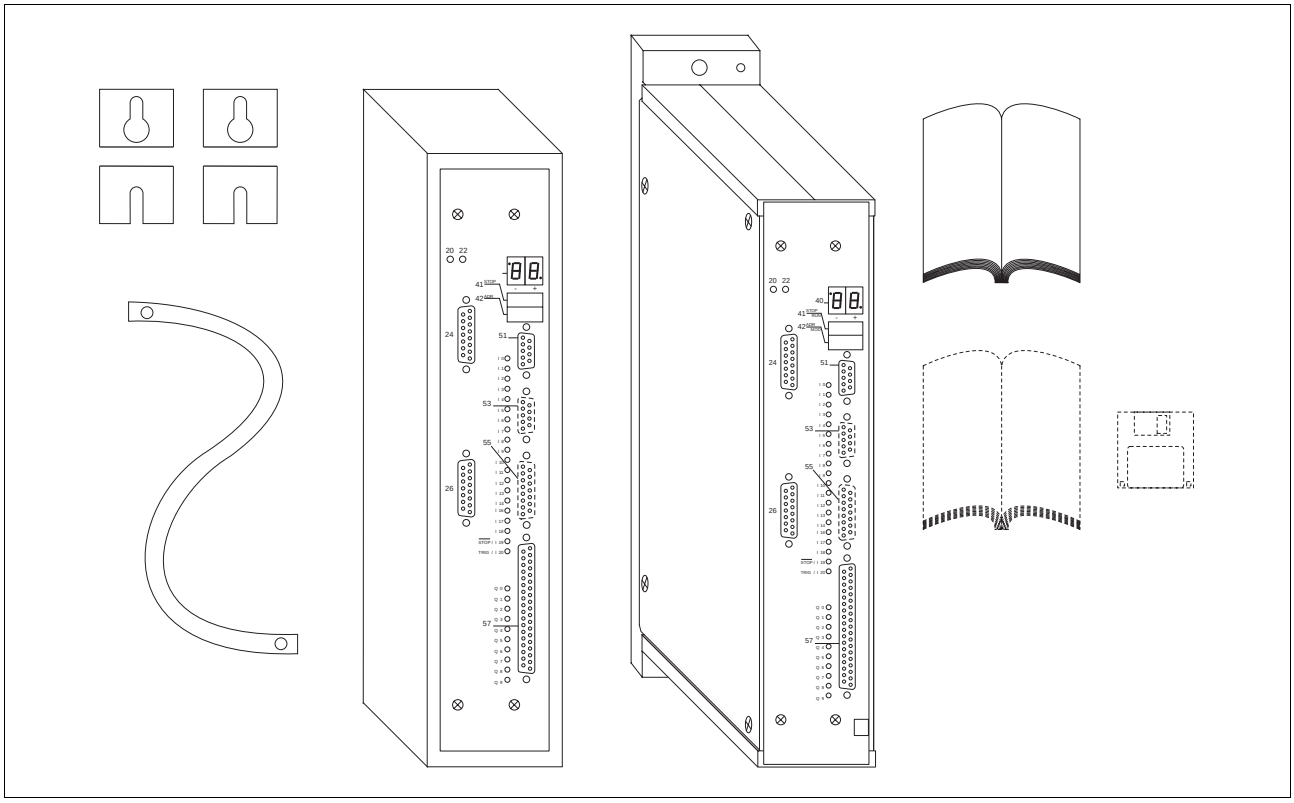


Fig. 2-1 Scope of supply

2.2 Accessories

The following accessories are available and must be ordered separately (for a description of accessories, see chapter 6.2):

- Battery for wall mounting units
- FT 2000 operating terminal
- On-line Command Processing via Serial Interface documentation (Doc. no. 212.986)
- MP 926 input/output card (16 inputs/16 outputs)
- MP 927 Interbus-S interface adapter
- Power controller, e.g. WD3-008 or WD5-008
- BPRO3 programming system
  or
  ProOED3 programming interface for device variant with OED3 operating system software
  (appropriate documentation and diskettes)
- MP 923 interface converter (RS 485 LS/RS 232)
- MP 924 interface distributor
- WP-311 set of connectors (all sub-D connectors)
- Crossover adapter for master/slave operation via RS 485 LS interface
- Encoder cable
- Interbus-S/MP 927 signal cable
- Electronic gear cable
- RS 485 LS interface cable, male/female
- RS 485 LS interface cable, male/male
- Signal cable
- Signal cable for power controller

NOTE
Refer to the sales documentation of the WP-311 positioning unit for the accessory order numbers.

2.3 Mounting

DANGER
The supply voltage must be disconnected whenever assembly work is carried out.

The unit must be installed in a control cabinet.

ATTENTION
Clean air supply must be ensured in the control cabinet.

Mounting the WP-311 with 5-phase housing

A fork wrench is required for installing the WP-311 with 5-phase housing; special tools are not required.

1. Drill two holes into the mounting panel; see fig. 1-9 for the dimensions.

2. Fasten the unit with two M6 screws.

NOTE
For unit combinations, observe the units' central axis distances; see table (dimensions given in mm).

Central axis distances (in mm) for unit combinations	WD5-008	WDP5-118	WDP5-228	WDP5-318	WP-311
WD5-008	87	87	87	87	74
WDP5-118	87	87	87	87	74
WDP5-228	87	87	87	87	74
WDP5-318	87	87	87	87	74
WP-311	74	74	74	74	61

Mounting the WP-311 with 3-phase housing

You can use the mounting brackets to install the WP-311 with 3-phase housing on the rear or on the left (fig. 1-8).

NOTE
When installing the unit, a minimum clearance of 10 cm must be ensured above and below the unit or to the adjacent unit. Leave 15 cm free in front of the unit to give room for fitting the cable connections.

Fasten the ground strap supplied at the bottom front of the unit with screws and connect it to a grounded part of the control cabinet.

2.4 Wiring

DANGER
Whenever wiring work is carried out, the mains connector must be disconnected.

ATTENTION
Wiring work may only be carried out in accordance with VDE 0105 by trained personnel.

NOTE
See chapter 1.4 for the technical data of the individual connections and interfaces.

NOTE
The ground connections of the interfaces in adapter slots 51, 53 and 55 are internally connected.

NOTE
Shield connection on both ends ensures optimum protection against interference for digital systems. However, it must be noted that differential potentials (in particular in case of supply from different sources) may cause inadmissible currents in the shields. Such interfering currents can be avoided by using suitable bonding conductors. The following cross-sections should be used for bonding lines:
16 mm^2 Cu for bonding lines up to 200 m
25 mm^2 Cu for bonding lines exceeding 200 m

2.4.1 Power controller connection

1. Solder the litz wires to the connector as illustrated in fig. 2-2.
2. Push the shield back and fix with a cable tie.
3. Insert two hexagon head bolts (fig. 2-3) into the connector shell.
4. Place the connector into the connector shell.
5. Fasten the cable and the shield to the connector shell with screws, providing for strain relief.

ATTENTION
Ensure good electrical contact between the shield and the connector shell on both cable ends.

6. Insert two caps into the unused cable entries.
7. Assemble the two parts of the connector shell with two screws.
8. Fasten the connector to the front panel (item 24) with screws.
9. Establish the connection on the power controller end; see fig. 2-4.

Pin	Abbreviation	Assignment	
1	PULSE	Pulse	→
2	DIR	Direction	→
3	ENABLE	Power controller enable	→
4	PWM	Current control	→
5	GND	Ground	→
6	–	Spare	
7	TEMP_MOT	Motor temperature prewarning, line interruption	←
8	$\overline{\text{READY}}$	Power controller ready	←
9	$\overline{\text{PULSE}}$	Inverted pulse	→
10	$\overline{\text{DIR}}$	Inverted direction	→
11	$\overline{\text{ENABLE}}$	Inverted power controller enable	→
12	$\overline{\text{PWM}}$	Inverted current control	→
13	RM_FAULT	Rotation monitoring error	←
14	TEMP_INT	External power controller temperature prewarning	←
15	GND	Ground	→

$\overline{\text{active low}}$ signal ← Input → Output

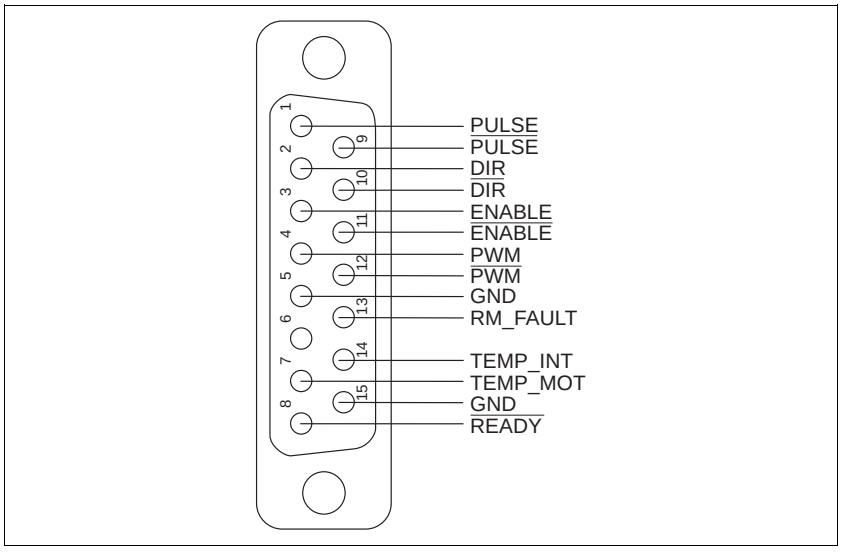


Fig. 2-2 Power controller connection - device end

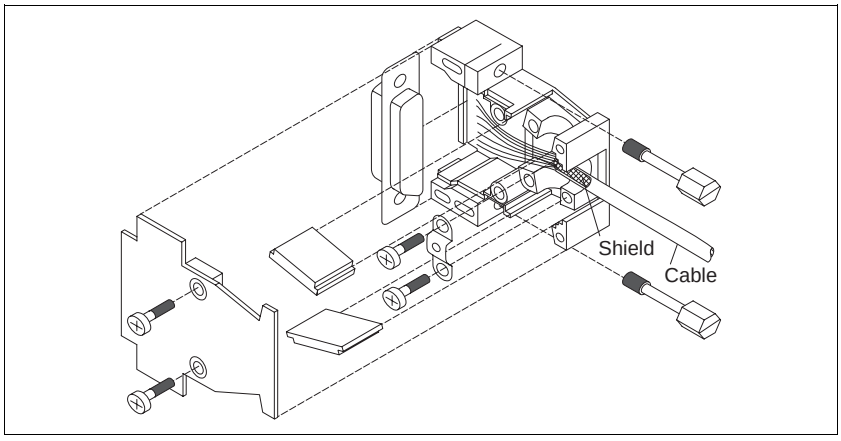


Fig. 2-3 Power controller connector assembly

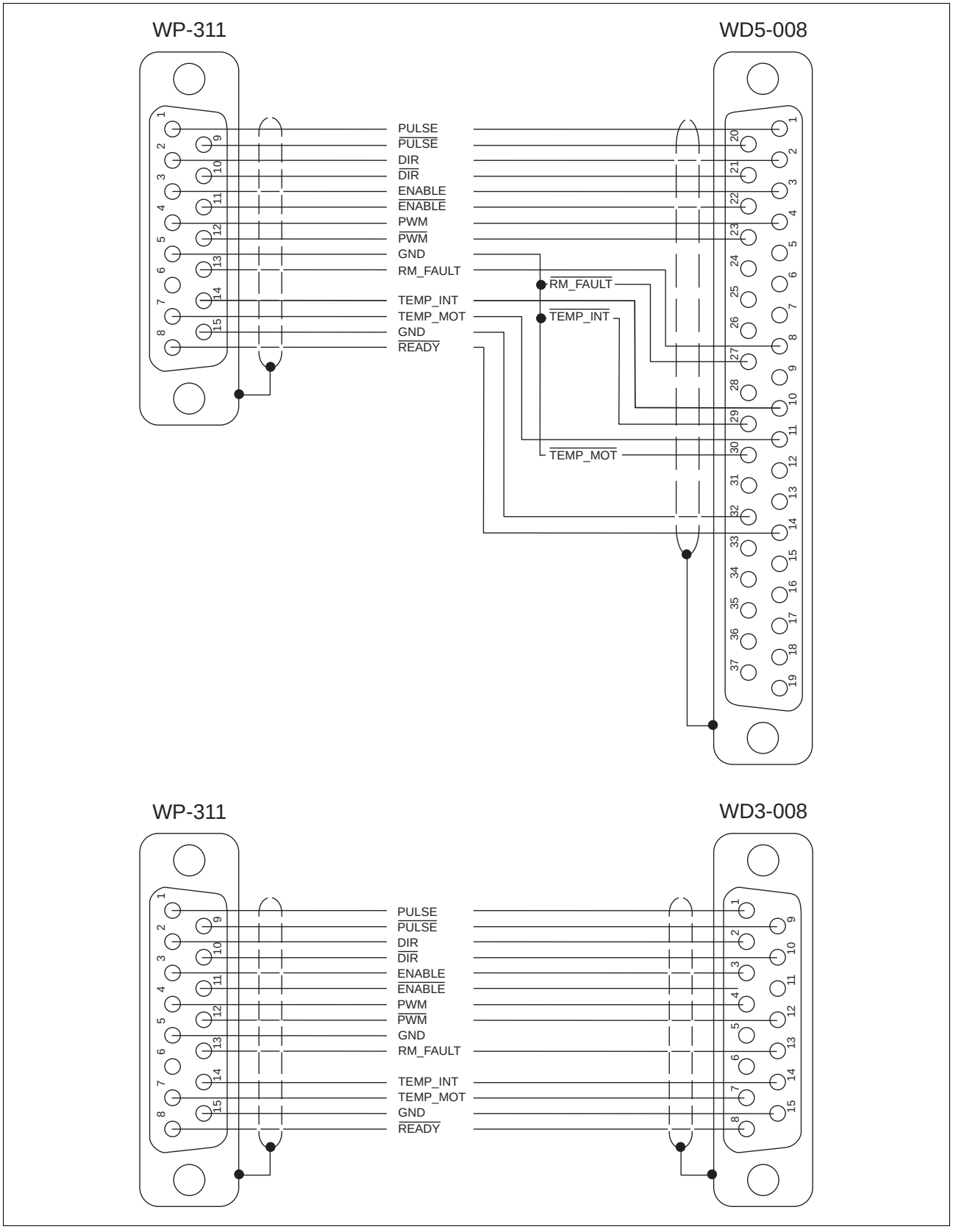


Fig. 2-4 Wiring example

Pulse and direction signals

The indexer must generate pulses in order to set the drive shaft of the stepping motor into rotation. These pulses are output to the power controller with the pulse signal (fig. 2-5). Each positive pulse edge initiates one stepping motor step. The direction of the step is determined by the direction signal.

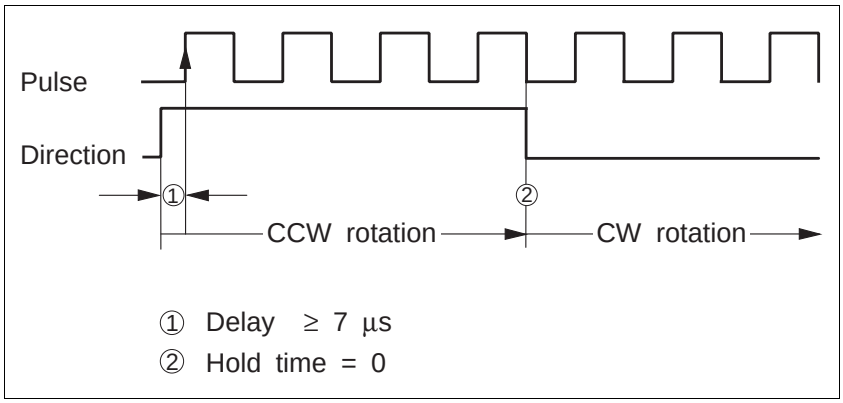


Fig. 2-5 Pulse and direction signals

ENABLE and READY signals

When the processor unit enabled the power controller with the ENABLE signal, the power controller sends READY to indicate readiness (fig. 2-6).

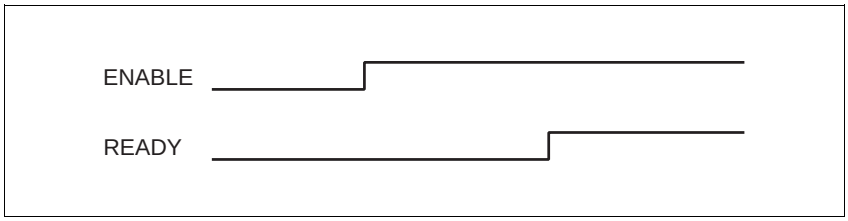


Fig. 2-6 ENABLE and READY signals

PWM signal

The pulse width modulation signal (PWM) can be used for setting the motor current in a range from 0 to 100% (100% = nominal current as set on power controller).

Signal input circuitry

The TEMP_MOT, $\overline{\text{READY}}$, RM_FAULT and TEMP_INT input circuit principle is illustrated in fig. 2-7.

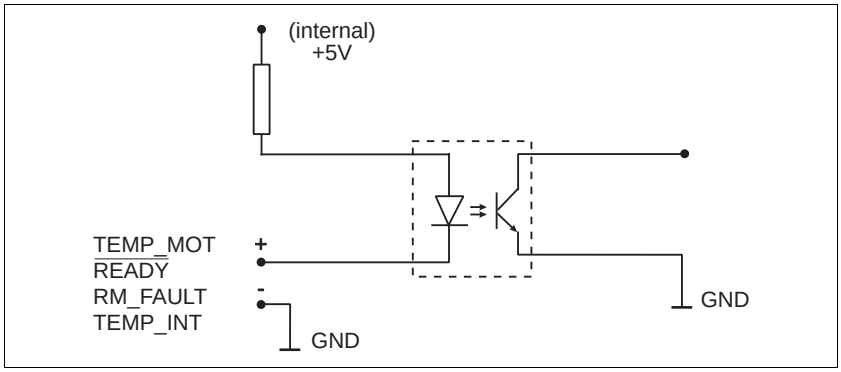


Fig. 2-7 Input circuit principle

2.4.2 Encoder connections

NOTE
The encoder connection 1 is located in slot 26. The encoder connection 2 is located in slot 55; see type plate.

1. Solder the litz wires to the connector as illustrated in fig. 2-8.
2. Push the shield back and fix with a cable tie.
3. Insert two hexagon head bolts (fig. 2-9) into the connector shell.
4. Place the connector into the connector shell.
5. Fasten the cable and the shield to the connector shell with screws, providing for strain relief.

ATTENTION
Ensure good electrical contact between the shield and the connector shell on both cable ends.

6. Insert two caps into the unused cable entries.
7. Assemble the two parts of the connector shell with two screws.
8. Fasten the connector to the front panel (item 26) with screws.
9. Twist the encoder cable wires in pairs as illustrated in fig. 2-10.
10. Establish the connection on the motor end.

ATTENTION
When using 5 V encoders, -SENSE must be connected to 5VGND and +SENSE to 5VDC on the encoder end of the cable.
The 5 VDC encoder supply voltage is only available if the sense lines are properly connected.

NOTE
The encoder connection 1 supply is only available when the power controller is switched on.

NOTE
The encoder connection 2 supply is also ensured with the power controller switched off.

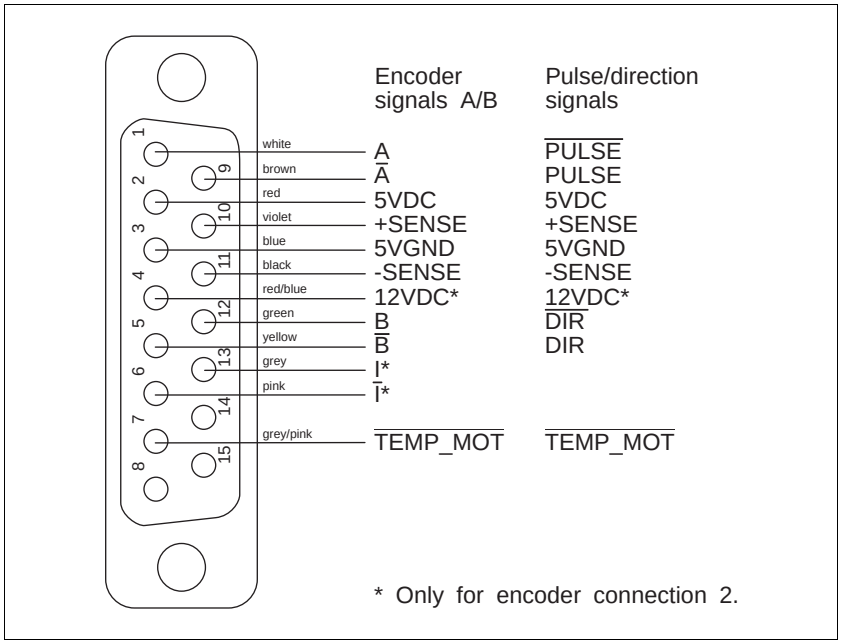


Fig. 2-8 Encoder connector - device end

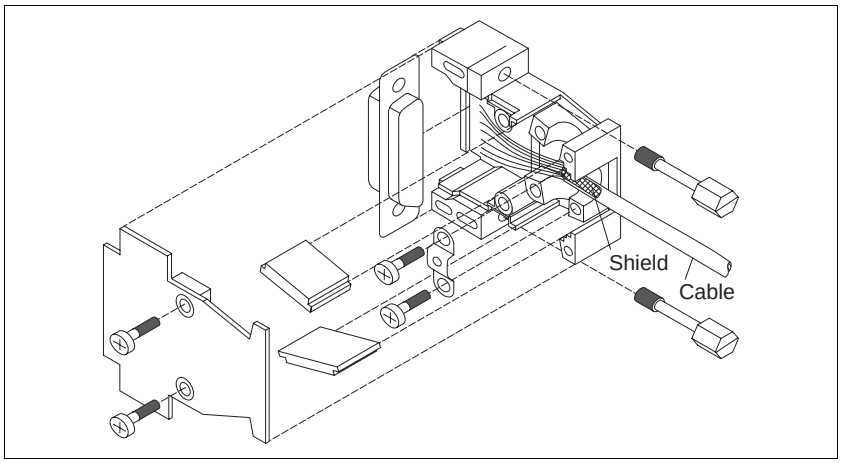


Fig. 2-9 Encoder connector assembly - device end

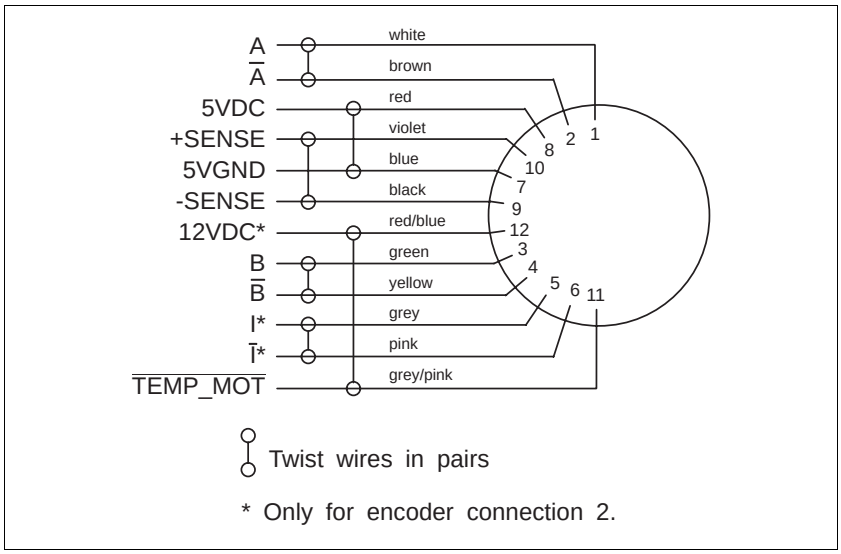


Fig. 2-10 Encoder connector layout - motor end

Encoder signal type A/B

Pin	Abbreviation	Assignment
1	A	Encoder signal A ←
2	5VDC	Sensor supply voltage →
3	5VGND	Sensor supply voltage ground →
4	12VDC*	Sensor supply voltage →
5	$\overline{B}$	$\overline{\text{Encoder signal B}}$ ←
6	$\overline{I}$*	$\overline{\text{Encoder signal I}}$ ←
7	$\overline{\text{TEMP\_MOT}}$	Motor temperature prewarning, line interruption ←
8	–	–
9	$\overline{A}$	$\overline{\text{Encoder signal A}}$ ←
10	+SENSE	Sense regulator 5VDC ←
11	–SENSE	Sense regulator 5VGND ←
12	B	Encoder signal B ←
13	I*	Encoder signal I ←
14	–	–
15	–	–

* Only for encoder connection 2.

$\overline{\text{active low}}$ signal ← Input → Output

ATTENTION
$\overline{\text{TEMP\_MOT}}$ must be connected to 5VDC when using third-party sensors.

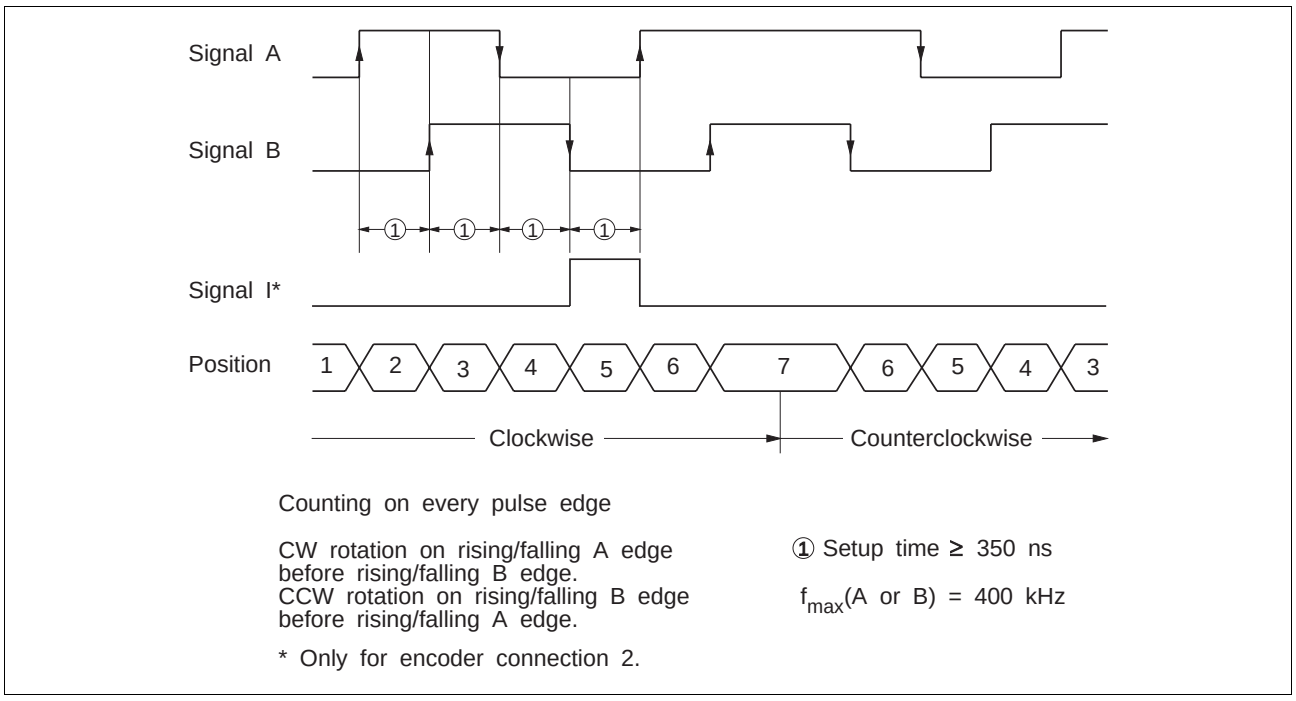


Fig. 2-11 Timing diagram - encoder signals A/B

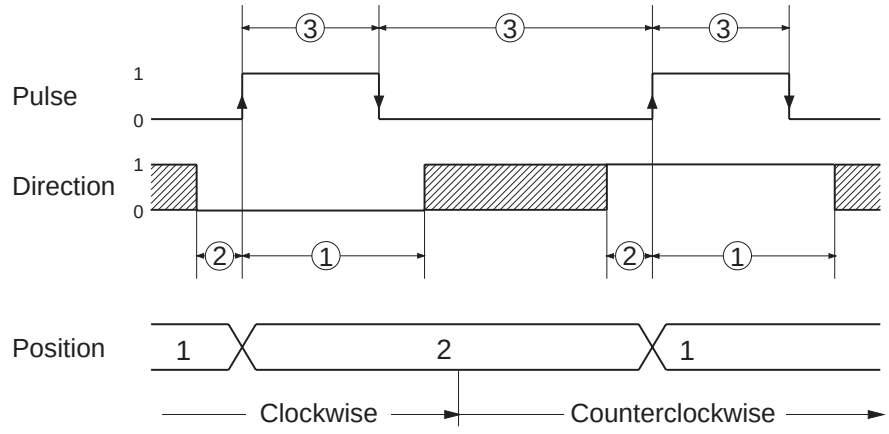
Pulse/direction signal type

Pin	Abbreviation	Assignment
1	$\overline{\text{PULSE}}$	$\overline{\text{Pulse}}$ ←
2	5VDC	Sensor supply voltage →
3	5VGND	Sensor supply voltage ground →
4	12VDC*	Sensor supply voltage →
5	DIR	Direction ←
6	–	–
7	$\overline{\text{TEMP\_MOT}}$	Line interruption ←
8	–	–
9	PULSE	Pulse ←
10	+SENSE	Sense regulator 5VDC ←
11	–SENSE	Sense regulator 5VGND ←
12	$\overline{\text{DIR}}$	Direction ←
13	–	–
14	–	–
15	–	–

* Only for encoder connection 2.

$\overline{\text{active low}}$ signal ← Input → Output

ATTENTION
$\overline{\text{TEMP\_MOT}}$ must be connected to 5VDC.



Counting in case of positive pulse edge

Direction = 0 ⇒ CW rotation of motor
Direction = 1 ⇒ CCW rotation of motor

Undefined area

① Hold time ≥ 300 ns
② Setup time ≥ 100 ns
③ Minimum pulse width ≥ 250 ns

f_{max}(pulse) = 2 MHz

Fig. 2-12 Timing diagram - pulse/direction

2.4.3 Signal connection

The signal inputs and outputs can be freely assigned. The signal inputs I 16 to I 20 are pre-assigned ex works, however, they can also be used freely (see “ensig” control function in BPRO3 programming manual).

1. Solder the litz wires to the connector as required for the desired assignment (see chapter 2.4.3.1).

NOTE
Connect system supply voltage ground to protective ground.

2. Push the shield back and fix with a cable tie.
3. Insert two hexagon head bolts (fig. 2-13) into the connector shell.
4. Place the connector into the connector shell.
5. Fasten the cable and the shield to the connector shell with screws, providing for strain relief.

ATTENTION
Ensure good electrical contact between the shield and the connector shell on both cable ends.

6. Insert two caps into the unused cable entries.
7. Assemble the two parts of the connector shell with two screws.
8. Fasten the connector to the front panel (item 57) with screws.

DANGER
All signal connections must be definitely isolated from mains. The voltage towards ground must not exceed 60 VDC or 25 VAC. All signal circuits are internally grounded via a 1 Mohm bleed resistor.

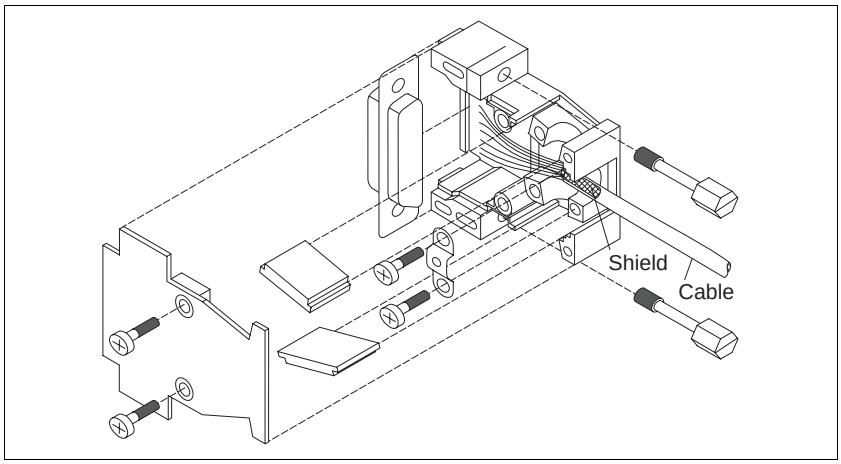


Fig. 2-13 Signal connector assembly - device end

2.4.3.1 Signal connector assignment

The appropriate assignment of the inputs and outputs may be entered into the following table.

NOTE
Input I 15 is not available.

Pin	Abbreviation	Meaning	Assignment
1	I 17: $\overline{\text{LIMN}}$	CCW limit switch	
2	I 20: TRIG	Trigger	
3	I 13		
4	I 11		
5	I 10		
6	I 18: $\overline{\text{REF}}$	Additional reference switch	
7	I 7		
8	I 5		
9	I 3		
10	I 1		
11	Q 9		
12	Q 7		
13	Q 5		
14	Q 3		
15	Q 1		
16	24VDC	System supply voltage	
17	24VDC	System supply voltage	
18	IO24VDC	I/O supply voltage	
19	IO24VDC	I/O supply voltage	
20	I 16: $\overline{\text{LIMP}}$	CW limit switch	
21	I 14		
22	I 12		
23	I 19: $\overline{\text{STOP}}$	Stop	
24	I 9		
25	I 8		
26	I 6		
27	I 4		
28	I 2		
29	I 0		
30	Q 8		
31	Q 6		
32	Q 4		
33	Q 2		
34	Q 0		
35	24VGND	System supply voltage ground	
36	24VGND	System supply voltage ground	
37	IOGND	I/O supply voltage ground	

$\overline{\text{active low}}$ signal I = Input Q = Output

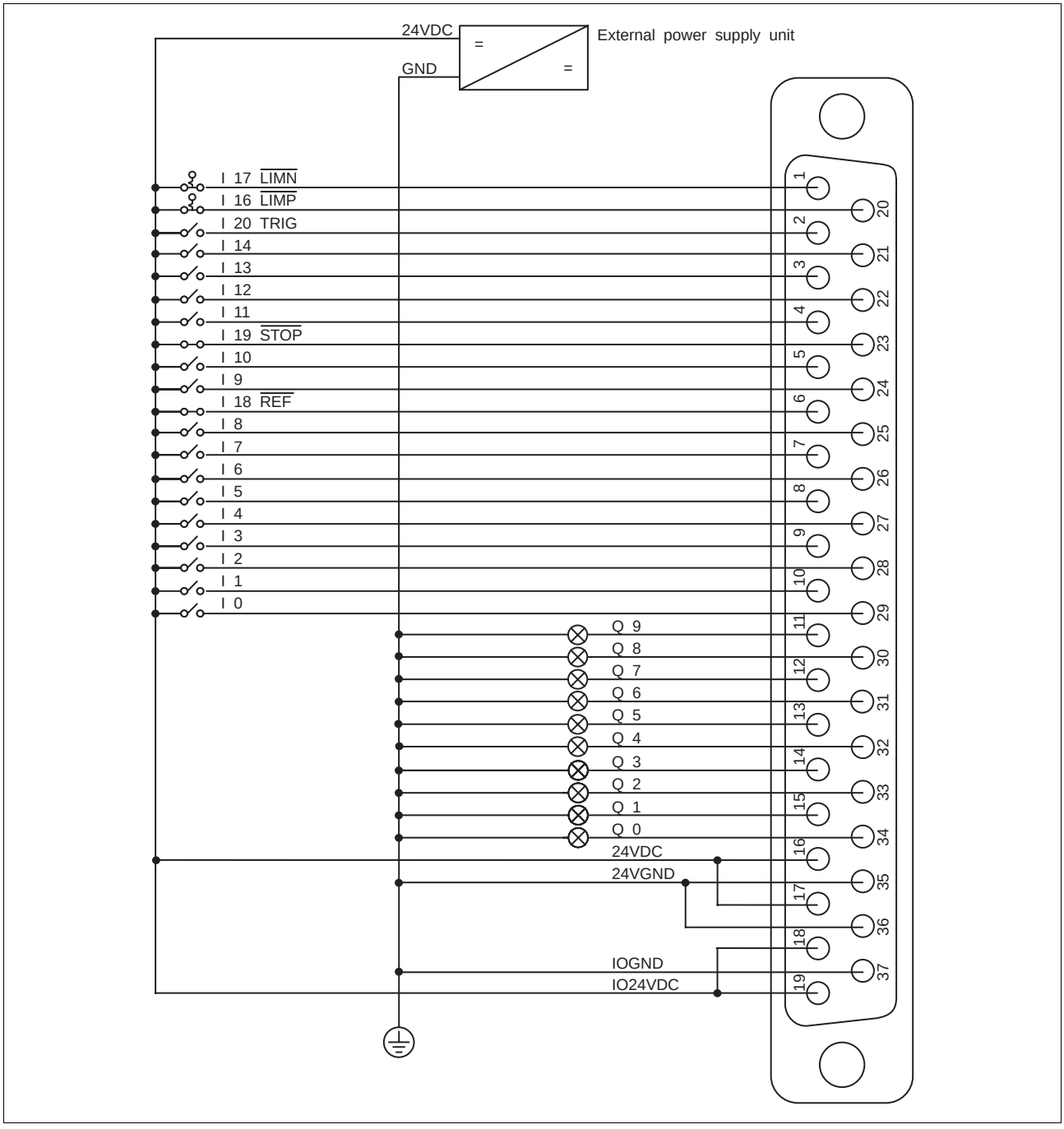


Fig. 2-14 Wiring example

NOTE
With the manufacturer-defined function or the command "brake", any output Qx can be used for controlling a brake; see the documentation on the programming software or on-line command processing via field bus systems (e.g. Interbus-S or Profibus-DP) or via serial interface.

2.4.4 RS 232 serial interface

NOTE
The RS 232 serial interface may be located either in slot 51 or 53; see type plate.

1. Solder the litz wires to the connector as illustrated in fig. 2-15 and fig. 2-16.

Pin	Signal	Meaning
1	–	–
2	RXD	Received data ←
3	TXD	Transmitted data →
4	–	–
5	GND	Ground
6	–	–
7	–	–
8	–	–
9	–	–

← Input → Output

2. Push the shield back and fix with a cable tie.
3. Insert two hexagon head bolts (fig. 2-17) into the connector shell.
4. Place the connector into the connector shell.
5. Fasten the cable and the shield to the connector shell with screws, providing for strain relief.

ATTENTION
Ensure good electrical contact between the shield and the connector shell on both cable ends.
Connect the shield on both ends.

6. Insert two caps into the unused cable entries.
7. Assemble the two parts of the connector shell with two screws.
8. Fasten the connector to the front panel with screws.

ATTENTION
For reasons of noise immunity, the RS 232 cable should be as short as possible (15 m max.)!

NOTE
The attachment screws of the connector shells must have M3 thread on the device end and UNC thread on the PC end.

NOTE
For master/slave operation via the RS 232 interface (e.g. PC as the master, controller as the slave), the transmit and receive lines must be crossed over between the units.

NOTE
With an RS 232 interface, networking is not possible.

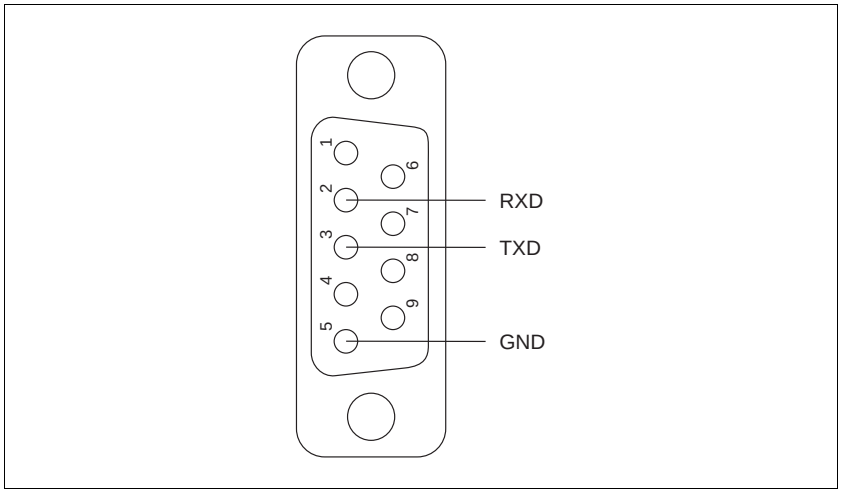


Fig. 2-15 Interface connector - device end

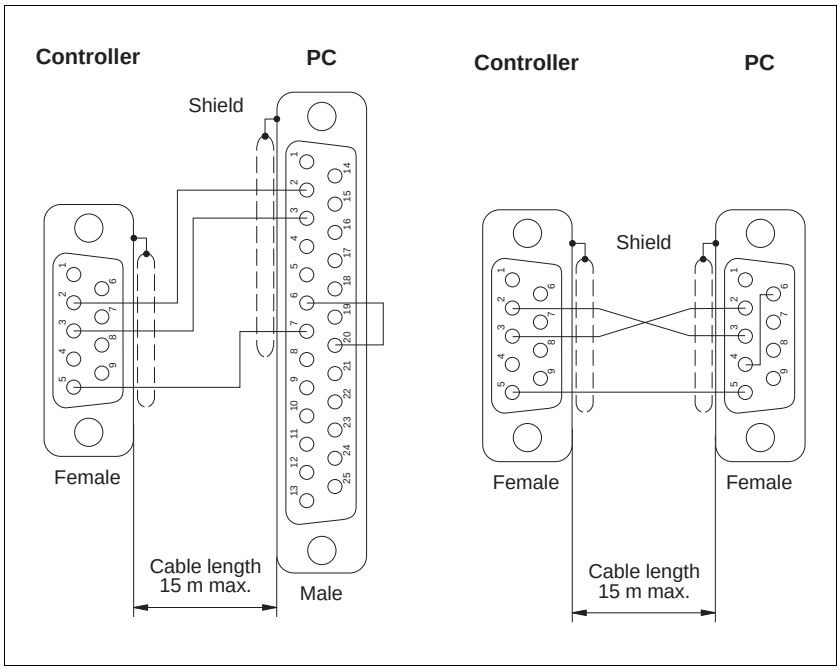


Fig. 2-16 Controller/PC wiring

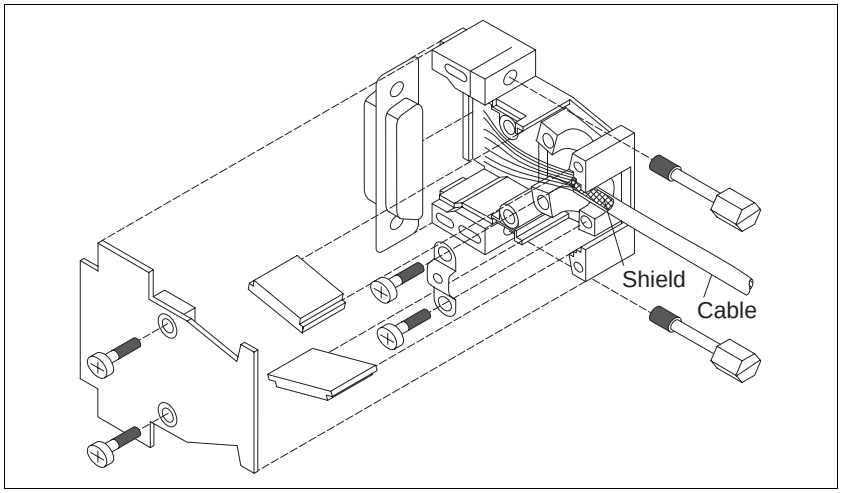


Fig. 2-17 Interface connector assembly

2.4.5 RS 485 LS serial interface

NOTE
The RS 485 LS serial interface may be located either in slot 51 or 53; see type plate.

NOTE
The serial interface is a four-wire interface.

1. Solder the litz wires to the connector as illustrated in fig. 2-18.

Pin	Signal	Meaning	
1, 6	12VDC	MP 923 supply voltage	→
2, 7	GND	MP 923 supply voltage ground	→
3	$\overline{\text{TXD}}$	Inverted transmitted data	→
4	$\overline{\text{RXD}}$	Inverted received data	←
5	SGND	Signal ground	
8	TXD	Transmitted data	→
9	RXD	Received data	←

← Input → Output

2. Push the shield back and fix with a cable tie.
3. Insert two hexagon head bolts (fig. 2-19) into the connector shell.
4. Place the connector into the connector shell.
5. Fasten the cable and the shield to the connector shell with screws, providing for strain relief.

ATTENTION
Ensure good electrical contact between the shield and the connector shell on both cable ends.
Connect the shield on both ends.

6. Insert two caps into the unused cable entries.
7. Assemble the two parts of the connector shell with two screws.
8. Fasten the connector to the front panel with screws.

NOTE
For a computer with an RS 232 interface, the MP 923 interface converter can be used; see chapter 6.2.2.

NOTE
The MP 924 interface distributor can be used for controlling eight units (see chapter 6.2.3).

NOTE
For master/slave operation via the RS 485 LS interface (e.g. controller as the master, operating terminal as the slave), the transmit and receive lines must be crossed over between the units. For this purpose, a crossover adapter can be used; see chapter 6.2.4.

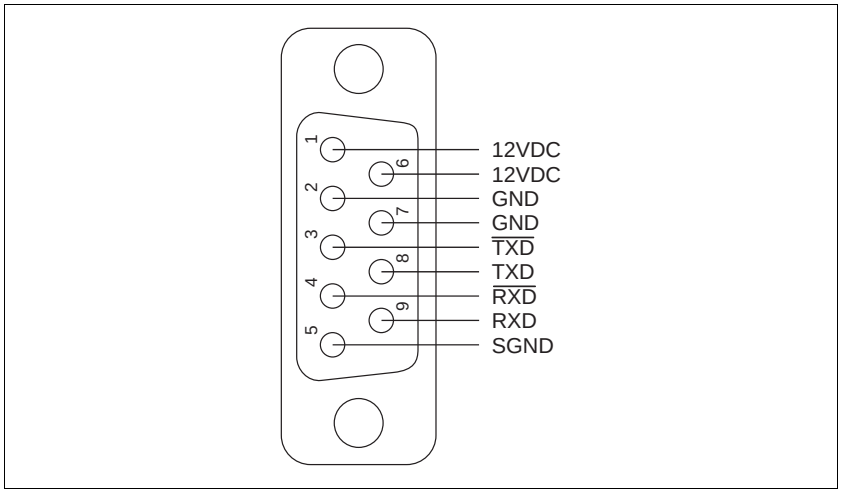


Fig. 2-18 Interface connector - device end

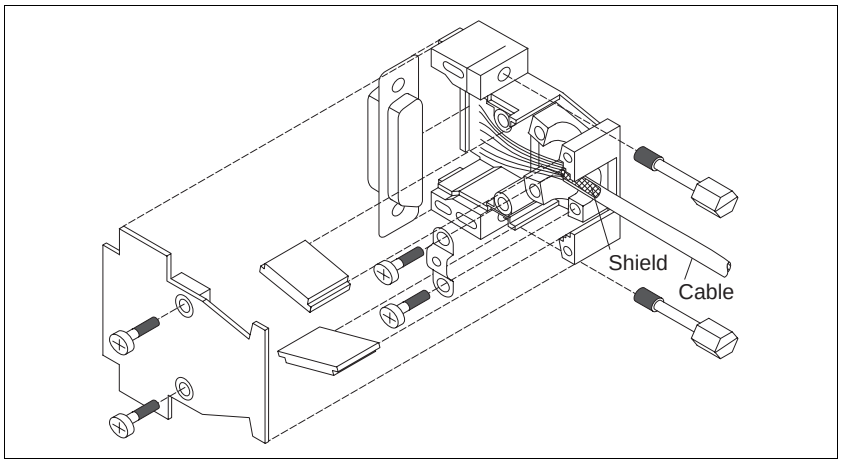


Fig. 2-19 Interface connector assembly

2.4.6 RS 485 HS serial interface

NOTE
The serial interface RS 485 HS is installed in adapter slot 53; see type plate. In controllers without OED3, the RS 485 HS interface can be used as a SUCONET field bus interface. In controllers with OED3, an MP 926 input/output card or a Lauer operating panel can be connected to the RS 485 HS interface.

NOTE
Wiring and setup of the RS 485 HS interface are described in the SUCONET and MP 926 documentation as well as in the ProOED3 documentation (for the Lauer operating panel).

2.4.7 Field bus interface

NOTE
The field bus interface (e.g. Interbus-S or Profibus-DP) is installed in adapter slot 53; see type plate.

NOTE
Wiring and setup of the field bus interface is described in a separate documentation for the respective interface.

2.4.8 Analog interface

NOTE
The analog interface is installed in adapter slot 53; see type plate.

1. Solder the litz wires to the connector as illustrated in fig. 2-20.

Pin	Signal	Meaning	
1	ANA_OUT	Voltage output (0 to 10 V, 30 mA max.)	→
2	ANA_OUT GND	Voltage output ground	→
3	ANA_IN21	Analog input 21 (-10 V to +10 V)	←
4	ANA_IN20	Analog input 20 (-10 V to +10 V)	←
5	ANA_IN2 GND	Ground for analog input 20 and 21	←
6	ANA_IN12	Analog input 12 (-10 V to +10 V)	←
7	ANA_IN1 GND	Ground for analog inputs 10 to 12	←
8	ANA_IN11	Analog input 11 (-10 V to +10 V)	←
9	ANA_IN10	Analog input 10 (-10 V to +10 V)	←

← Input → Output

NOTE
ANA_OUT GND is the internal voltage ground. The reference potential of the ANA_IN1 GND and ANA_IN2 GND inputs must not differ from the ANA_OUT GND reference potential by more than ±0.5 V.

2. Push the shield back and fix with a cable tie.

3. Insert two hexagon head bolts (fig. 2-21) into the connector shell.

4. Place the connector into the connector shell.

5. Fasten the cable and the shield to the connector shell with screws, providing for strain relief.

ATTENTION
Ensure good electrical contact between the shield and the connector shell.
Connect the shield on both ends.

6. Insert two caps into the unused cable entries.

7. Assemble the two parts of the connector shell with two screws.

8. Fasten the connector to the front panel (item 53) with screws.

ATTENTION
The ground connections of the interfaces in adapter slots 51, 53 and 55 are internally connected. In the case of multiple ground connections, this may cause ground loops with resulting interference at the analog inputs. Such interference can be reduced by means of bonding lines.

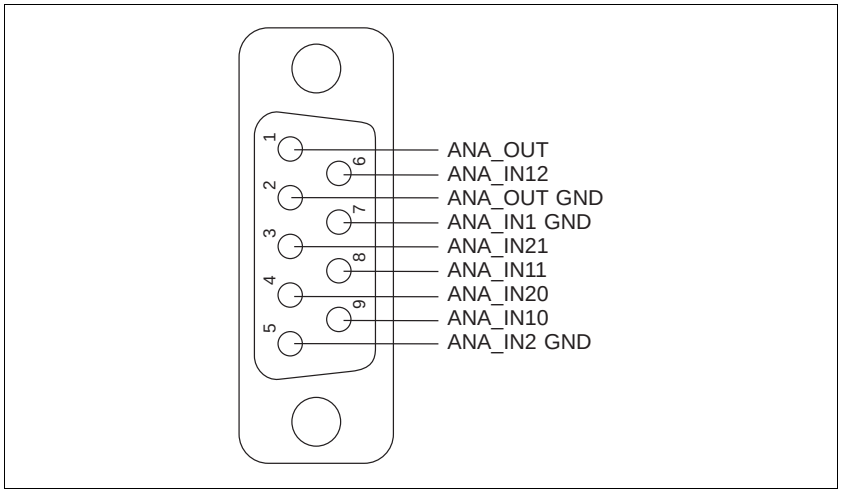


Fig. 2-20 Interface connector - device end

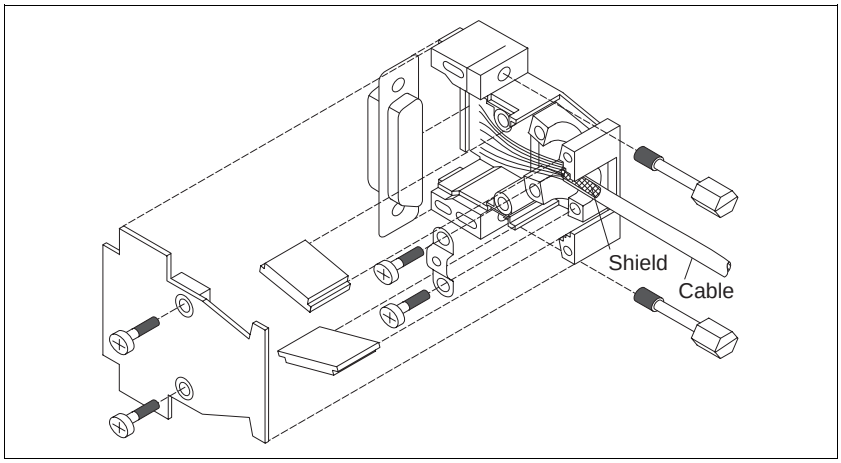


Fig. 2-21 Interface connector assembly

2.5 Setup

2.5.1 Defaults

After switching on, and after program start, the unit is set to the following default parameters:

Parameter	**Default**	
Axis operating mode	Point-to-point	
Motor position	Not defined	
Maximum system speed	32767 Hz	
Set speed	1000 Hz	
Start speed	200 Hz	
Safety distance for reference movement	10 steps	
Acceleration	10 Hz/ms (ramp 1)	
	Ramp	Linear acceleration
	1	10 Hz/ms
	2	50 Hz/ms
	3	100 Hz/ms
	4	200 Hz/ms
	5	300 Hz/ms
	6	400 Hz/ms
	7	500 Hz/ms
	8	600 Hz/ms
	9	700 Hz/ms
	10	800 Hz/ms
Signal evaluation	limp, limn, stop, ref, ampnotready, swstop	
Normalizing factors for position for speed for acceleration for electronic gear for encoder (position, indexer)	 Numerator 1; denominator 1; half-steps Numerator 256; denominator 1; Hz (steps/second) Numerator 1000; denominator 1; Hz/ms Numerator 0; denominator 1; gear ratio 0 Numerator 1; denominator 1	
Motor current at standstill during acceleration/deceleration at constant speed	 50% 100% 80%	
Encoder	Not linked to axis; single evaluation of encoder signals; contouring error limit = 18 encoder units; encoder position = 0	

NOTE
For the parameters which can be changed, see BPRO3 programming manual or ProOED3 documentation.

1. The unit's supply voltage must not be switched on.

ATTENTION
Before switching on, check that the signal inputs for the limit switches, for the reference switch and stop are properly wired; see fig. 2-14.

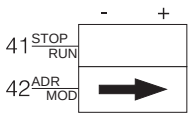
2. Check that all connectors are properly connected.

3. Deactivate the current reduction for BERGER LAHR power controllers, since current reduction is performed by the controller (see PWM signal, chapter 2.4.1).

4. Plug in the mains connector and switch on the supply voltage; see chapter 3.2.

5. Press the selector switch (item 41) in STOP position.
   → The controller assumes RESET status.

MODE settings



Perform the subsequent MODE settings as follows:
– Keep the selector switch (item 42) pressed in MOD position. After 2 seconds, the seven-segment displays (item 40) start flashing.
– Select the desired number by pressing + or – on the selector switch (item 41).
– Release the selector switch (item 42).
  → The latest selection appears flashing in the seven-segment displays.
– Press + or – on selector switch (item 41) to select the desired setting.
– Press the selector switch (item 42) again to accept the setting.

6. Set the operating mode (see description above).

MODE	Operating mode	Setting
01	Application mode	–
60	On-line command processing via serial interface in adapter slot 51	00 = OFF* 01 = ON
63	On-line command processing via CAN bus in adapter slot 51 – simple CAN bus protocol – CAL protocol	 01* 02
70	On-line command processing via serial interface in adapter slot 53	00 = OFF* 01 = ON
73	On-line command processing via CAN bus in adapter slot 53 – simple CAN bus protocol – CAL protocol	 01* 02
91	Manual mode	–

* Default

7. Set the network address for the serial interface, Profibus-DP or CAN bus (see description above).

MODE	Network address	Setting
61	Address for operation via interface adapter slot 51	01* to 31 with RS 485 LS serial interface; 00 to 126* with Profibus-DP or CAN bus
71	Address for operation via interface adapter slot 53	

* Default
The hundred's digit of the address is identified by the superscript dot, e.g. ˙26 = address 126.

NOTE
The network address for operation via interface adapter slot 51 can also be set with the selector switch (item 42) in ADR position.

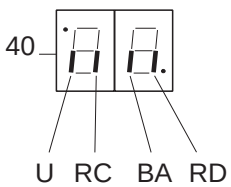
NOTE
With an RS 232 interface, the network address is set to 1 and cannot be changed.

8. Set the baud rate for on-line command processing via serial interface or CAN bus (see description above).

MODE	Baud rate	in kbauds for serial interface	in kbauds for CAN bus
62	Baud rate for operation via slot 51	01 = 9.6* 02 = 19.2 03 = 38.4	01 = 500 02 = 250 03 = 125* 04 = 100 05 = 50 06 = 20 07 = 10
72	Baud rate for operation via slot 53		

* Default

9. Set the Interbus-S diagnostics (for a description, see separate Interbus-S documentation). This is not applicable for controllers with the OED3 software installed.



MODE	Interbus-S diagnostics	Setting
65	Diagnosis via adapter slot 51	–
75	Diagnosis via adapter slot 53	–

U Operating voltage
RC Interbus-S link o.k.
BA Interbus-S transmission active
RD No other Interbus-S slave available

2.5.2 Test

A manual movement should be executed as described in chapter 3.3 in order to check the motor wiring and the basic settings.

A program test can be effected in application mode with the BPRO3 programming system or the ProOED3 programming interface; see BPRO3 operating manual or ProOED3 documentation.

3 Operation

3.1 Operating modes of the controller

Processor unit status display	Operating mode	Function	Reference
01	Application mode	Programming with BPRO3 or ProOED3 software, program execution, program test	See chapter 3.4
60	On-line command processing	Setting the on-line command processing mode via the serial interface, adapter slot 51	See chapter 3.5
63	On-line command processing	Setting the on-line command processing mode via the CAN bus interface, adapter slot 51	See chapter 3.5
70	On-line command processing	Setting the on-line command processing mode via the serial interface, adapter slot 53	See chapter 3.5
73	On-line command processing	Setting the on-line command processing mode via the CAN bus interface, adapter slot 53	See chapter 3.5
91/M	Manual mode	Setting up and testing the drive	See chapter 3.3

NOTE
Further operating modes with OED3 are described in the ProOED3 documentation.

3.2 Switching on

DANGER
Live parts of the device or system may never be touched by persons or with electrically conductive objects.

DANGER
The movement range of the system must be kept clear of persons and objects.

ATTENTION
The basic settings of the unit must conform to the actual requirements; see chapter 2.5.

The following requirements must be fulfilled before switching on the unit:

Requirement	**Reference**
Ambient conditions in line with the technical data?	See chapter 1.4
Wiring of the unit (in particular signal inputs for limit switches, reference switch and stop) carried out properly?	See chapter 2.4

ATTENTION
If the controller was in RUN status when switching off, it will automatically assume RUN status again when switching on and start the program.
This can be prevented by actuating the STOP selector switch (item 41) while switching on.

1. Connect the supply voltage.
   After power-on, the controller performs a self-test with the hardware and software components. Fig. 3-1 shows the power-on sequence of the controller.

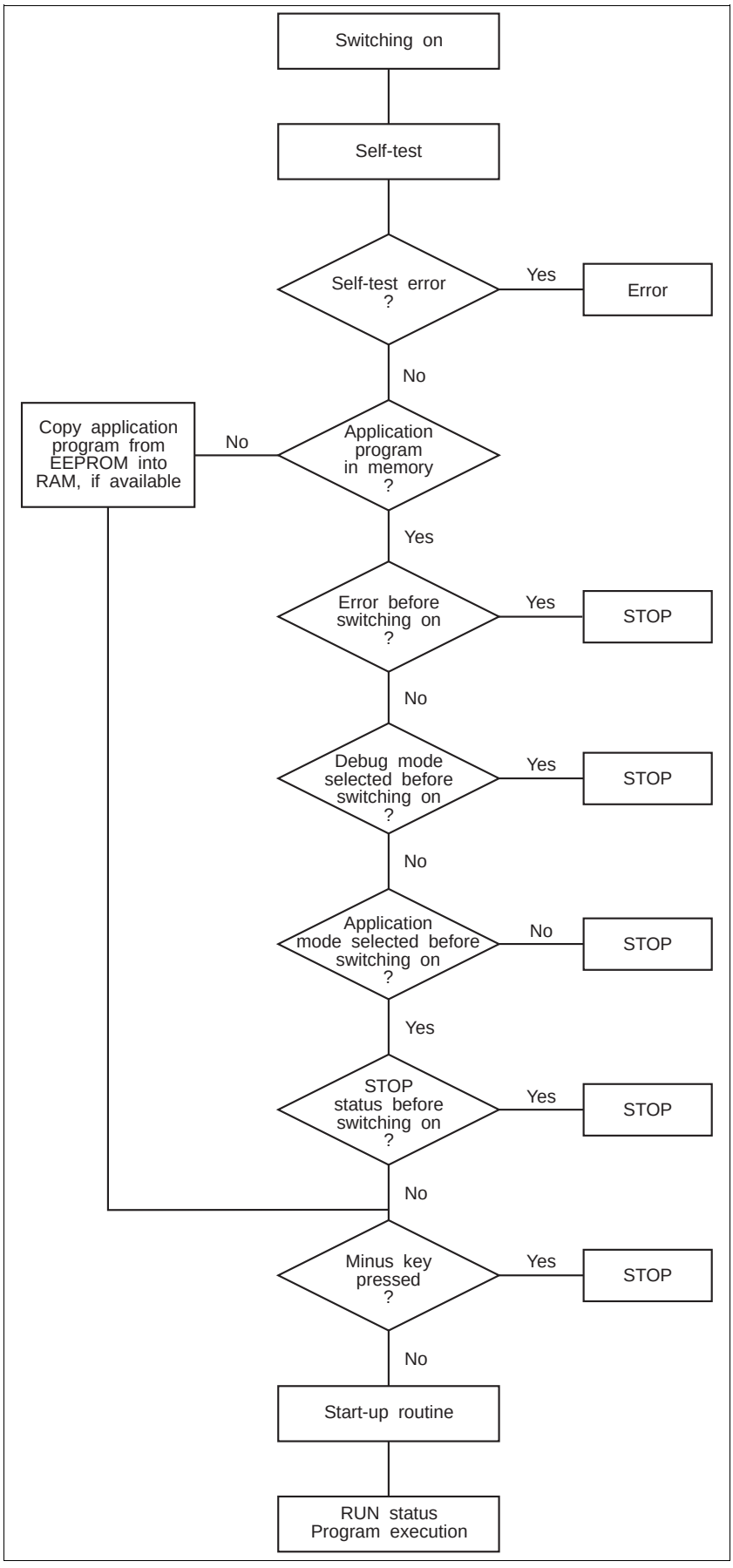


Fig. 3-1 Power-on sequence

Self-test

If an error occurs during the self-test, the controller assumes error status and indicates the error; see chapter 4.
If no error occurs, the controller assumes the status and mode it had before switching off.

The operating mode can be changed in STOP status.
In STOP status, no application program is active, i.e. no program is executed.

2. When the LEDs (item 20 and 22) light up, the power controller is “ready”.
   In STOP status, the seven-segment displays for the processor unit (item 40) indicate the number of the set operating mode.

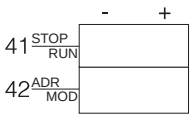
After power-on and self-test, the controller configuration is as follows:

– Operating mode: Application mode
– Serial interface 1 parameters: BNET, 9600 bauds, network address 1
– Serial interface 2 not configured
– 1000 flag words (0 remanent flag words)
– Process image for local I/O modules
– Default axis parameters
– Maximum number of program objects

The controller configuration can be modified using the programming device.

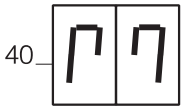
3.3 Manual mode

In manual mode it is only possible to rotate the stepping motor to the left or right at speed 1 kHz.



1. Use the selector switch (item 41) to set STOP.

2. Keep the selector switch (item 42) pressed in MOD position. After 2 seconds, the seven-segment displays (item 40) start flashing. Set no. 91 for manual mode by pressing + or – on the selector switch (item 41).
   Release the selector switch (item 42) to accept the setting.
   A flashing “M” appears in the seven-segment displays (item 40) to indicate manual mode.



3. The motor can be run in single steps or in continuous operation.

– Single step: Press the selector switch (item 41) briefly.
– Continuous operation: Keep the selector switch (item 41) pressed.

– Clockwise motor rotation: Press the selector switch (item 41) in + position.
– Counterclockwise motor rotation: Press the selector switch (item 41) in – position.

NOTE
In manual mode, all limit switches are monitored.

4. Exit manual mode by pressing selector switch (item 42) in MOD position.

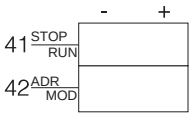
3.4 Application mode

In this mode, an application program can be executed which was developed using the BPRO3 programming system or the ProOED3 programming interface.

Program start with BPRO3

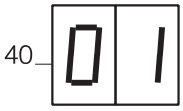
As a prerequisite, an application program must have been loaded from the programming device into the WP-311; see BPRO3 operating manual.

NOTE
An application program can also be started, stopped or tested ("debugged") from the programming device ("on-line").

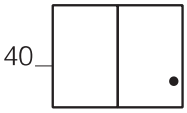


1. Use the selector switch (item 41) to set STOP.

2. Keep the selector switch (item 42) pressed in MOD position. After 2 seconds, the seven-segment displays (item 40) start flashing.
   Set no. 01 for application mode by pressing + or – on the selector switch (item 41).
   Release the selector switch (item 42) to accept the setting.



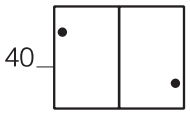
3. Start a loaded program by pressing the selector switch (item 41) in RUN position.



– Keep the selector switch pressed for at least **2 s**.
– The program is always executed from program start.
  → A dot appears in the status display (item 40).

NOTE
The functions of the selector switches (items 41 and 42) and the status displays for the processor unit (item 40) can be determined by the application program; see BPRO3 programming manual.

Program start with ProOED3



If an application program was created with ProOED3, the program is automatically activated at power-on.
  → Two dots appear in the status display (item 40).

NOTE
Refer to the ProOED3 documentation for more information.

3.4.1 Controller states in application mode with BPRO3

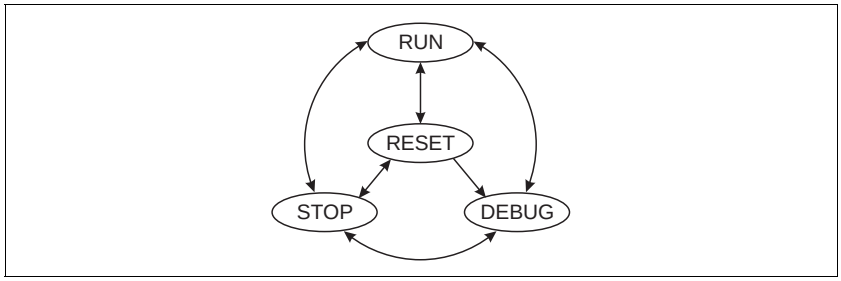
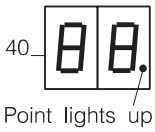
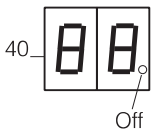


Fig. 3-2 Status changes

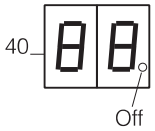
In application mode, the controller can assume the following states (the current state is indicated by the dot on the right of the seven-segment displays (item 40)):



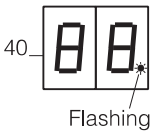
RUN
In RUN status, the application program is executed. RUN status is activated by pressing the selector switch (item 41) on the front panel or by selecting the BPRO3 menue option “Cont. contr.”.



STOP
In STOP status, the application program is stopped and the drive inactive, or no application program has been loaded. The outputs are disabled.
STOP status is activated by selecting the BPRO3 menue option “Stop controller” or after an error of error class 0 to 3 occurred (see chapter 3.4.2, “Error handling”).
Program execution can be resumed by selecting the BPRO3 menue option “Cont. contr.”.



RESET
In RESET status, the application program is stopped and reset.
The program can only be restarted at the program start. The outputs are reset.
In RESET status, the controller operating mode can be changed.
RESET status is activated by pressing the selector switch (item 41) on the front panel or by selecting the BPRO3 menue option “Reset controller”.



DEBUG
In DEBUG status, the application program can be tested.
DEBUG status is activated by selecting any of the following BPRO3 menue options:

- “Set breakpoint”
- “Continue task, Stop task, Reset task”
- “Single cycle”
- “View on”
- “Disable, set/reset inputs/outputs”, “Disp./change var.”

NOTE
The “debug” function of the controller library can be used for defining the characteristics of the drive and the outputs in DEBUG status after stopping the application program (see BPRO3 programming manual).

DEBUG status can only be exited by selecting the BPRO3 menue option “Reset controller” or by switching off the controller.

NOTE
If the link between the programming system and the controller is disrupted, the controller changes to RESET status. In this case, the drive is stopped and the outputs are reset.

The behaviour of the controller depends on whether operation is via the BPRO3 programming system or via the front panel.

Operation via BPRO3:

Action	**Effect**
“Stop controller”	The application program is stopped. The serial and encoder interfaces remain functional. Subsequent status: STOP, if RUN was active. ***ATTENTION*** ***In electronic gear mode, positions continue to be processed.*** *NOTE* *In DEBUG status, the charact-eristics of the drive and the outputs can be determined with the “debug” function.*
“Reset controller”	The application program is reset. The drive is initialized and the outputs are reset. If DEBUG status was active, it is disabled, (all breakpoints are deleted, viewing is deactivated). All error messages are deleted from the controller error memory (except class 0 errors). Subsequent status: RESET
“Cont. contr.”	The stopped application program is resumed if no class 0 error occurred. The drive and the outputs are enabled. Outputs disabled after STOP will have the same status as before disabling. Subsequent status: RUN, if STOP was active. ***ATTENTION*** ***Any stopped movements are resumed.***

Operation via front panel:

Action	Effect
RUN key pressed	"Reset controller", then "Cont. contr."; see Operation via BPRO3. Subsequent status: RUN *NOTE* *In DEBUG status, the application program is resumed.*
STOP key pressed	"Reset controller"; see operation with BPRO3. Subsequent status: RESET

NOTE
For operating a controller with the OED3 software, see ProOED3 documentation.

3.4.2 Troubleshooting with BPRO3

Error classes

Runtime errors are structured according to error classes. Error classes are distinguished by the error type and the effect on the controller.

Error class Significance	**Controller response**	**Rectification**
Error class 0 System error	STOP status, RUN status not available. The error is stored in the error memory and can only be cleared by booting.	Call BERGER LAHR
Error class 1 Fatal error in application program	STOP status, RUN status available. The error is stored in the error memory.	Modify and reload the application program
Error class 2 Non-fatal error in application program	STOP status, RUN status available. The error is stored in the error memory.	See troubleshooting table, chapter 4.2.1
Error class 3 Setting error	STOP status, RUN status available. The error is stored in the error memory.	See troubleshooting table, chapter 4.2.1
Error class 4 Programming error	The application program continues to execute. The error is stored in the error memory and registered in the resource error word. The resource error word can be read from the application program with the “geterror_sr” function; see BPRO3 programming manual.	See troubleshooting table, chapter 4.2.1
Error class 5 Signal monitoring	The application program continues to execute. Drive movement is stopped, depending on the active signal. Any active signal is registered in the resource signal word and can be read from the application program with the “getsig_sr” function; see BPRO3 programming manual. The error is stored in the error memory.	Can be determined by the user

Error memory and error display

Class 0 to 4 errors are displayed as a flashing number in the processor unit status displays (item 40) and stored in the error memory of the controller.
A maximum of 16 errors can be stored in the controller error memory (the first 8 and the last 8 errors occurred). The errors stored in the error memory can be sequentially displayed in the processor unit status displays (item 40) by pressing the selector switch (item 42) in the ADR position.
With the BPRO3 programming system, the contents of the error memory, the error class and a detailed description of the errors can be displayed; see BPRO3 operating manual.
The errors stored in the error memory are cleared when “Reset controller” is selected or the application program is restarted, with the exception of system errors (error class 0).

NOTE
Errors occurring during programming or debugging with the BPRO3 programming system are displayed as messages on the PC screen.

3.5 On-line command processing

This mode is available if the unit has a serial interface RS 232 or RS 485 LS installed in adapter slot 51 or 53 or a field bus interface (e.g. Interbus-S or Profibus-DP) installed in adapter slot 53.

In this mode, single movement commands and other commands are transmitted to the controller and executed immediately. A comprehensive command set is available for this purpose.

NOTE
The following parameters must have been set (see chapter 2.5):
- *For a serial interface, operating mode with MODE 60 or 70*
- *For a CAN bus interface, operating mode with MODE 63 or 73*
- *Network address with MODE 61 or 71 (only for RS 485 LS, Profibus-DP or CAN bus)*
- *Baud rate with MODE 62 or 72 (not necessary for Profibus-DP)*

In controller application mode (see chapter 3.4), on-line command processing is enabled.
Start by activating the power controller with the INITDRIVE command before executing any movement commands.

ATTENTION
Any transmitted values will be lost after switching off.

Reference documentation

On-line command processing mode is described in the following documentations:
- On-line Command Processing and Upload/Download via Serial Interface
- On-line Command Processing via CAN bus
- On-line Command Processing via Interbus-S
- On-line Command Processing via Profibus-DP

The following table contains a summary of the available read and write commands.

Write command	**Meaning**
BRAKE	Define output for brake
CLRERROR	Clear error information
CLRSIG_SR	Clear temporarily stored axis signals
CONT	Continue interrupted shaft movement
ENSIG	Enable or disable axis signals
INITDRIVE	Initalize axis
MOVE	Incremental (relative) positioning operation
POS	Absolute positioning operation
RAMP_EXP	Set exponential ramp
RAMP_LIN	Set linear ramp
RAMP_SIN	Set sine square ramp

Write command	Meaning
REF_OUT_DISTANCE	Set maximum allowed distance from limit switch for reference movement
REFPOS_LIMN	Reference movement towards CCW limit switch
REFPOS_LIMP	Reference movement towards CW limit switch
REFPOS_REF	Reference movement towards reference switch
ROTMON_DISABLE	Disable rotation monitoring or blocking detection
ROTMON_ENABLE	Enable rotation monitoring or blocking detection
ROTMON_RESET	Reset rotation monitoring or blocking detection
SETCURRENT	Set motor current
SETENCODER	Set encoder signal type
SETHARDWARE	Set hardware settings
SETMODE	Set operating mode
SETNORM_GEAR_DEN	Set gear ratio denominator
SETNORM_GEAR_NUM	Set gear ratio numerator
SETOFFSET	Set reference variable offset
SETPOS	Set current position
SETSIG_ACTIV_H	Set active state of axis signals
SETVEL_START	Set start/stop speed
SETVEL_SYS	Set maximum system speed
STOP_AXIS	Stop shaft movement
TIMEOUT*	Set or disable timeout monitoring
VEL	Set the set speed
WRITE_OUTPUT	Set outputs directly

* Not available for units with Profibus-DP interface.

Read command	Meaning
GETCURRENT	Read electrical current values
GETENSIG	Read enabled or disabled axis signals
GETERROR	Read error
GETMODE	Read operating mode
GETPOS	Read position values
GETSIG	Read current axis signal states
GETSIG_ACTIV_H	Read active state of axis signals
GETSIG_SR	Read temporarily stored axis signals
GETSTATE	Read error status of an axis
GETVEL	Read speed value
READ_INPUT	Read inputs directly

3.6 Programming

Programming of the unit can be effected using the BPRO3 programming system or the ProOED3 programming interface.

3.6.1 Programming with BPRO3

Programming of the unit with BPRO3 is effected in application mode using a PC as the programming device.

Reference documentation

Three documentation manuals are supplied with the BPRO3 programming software:

– BPRO3 programming manual
contains all information required for developing a control program using the BPRO3 programming system.

– BPRO3 operating manual
contains information on installation and operation of the BPRO3 programming system.

– BPRO3 library
describes the sample programs and the user library included in the BPRO3 software package.

3.6.2 Programming with ProOED3

Programming of the unit is effected with the ProOED3 programming interface and a PC. For this purpose, OED3 must be installed on the positioning unit.

Reference documentation

Programming an application program with ProOED3 is described in the ProOED3 documentation.

3.7 Switching off

1. It may be necessary to press STOP before switching off so that the controller assumes STOP status after switching on again.
   If RUN status is active before switching off, the application program is executed after switching on again.

NOTE
When switching on the supply voltage, the controller always assumes the status which was active before switching off.

ATTENTION
The connected motor is deenergized after disconnecting the power controller supply voltage, i.e. it does not have any holding torque. Before disconnecting the supply voltage, ensure that any vertical loads are prevented from falling down (e.g. use motor with brake).

2. Disconnect the supply voltage.

4 Malfunctions

4.1 Status indicators

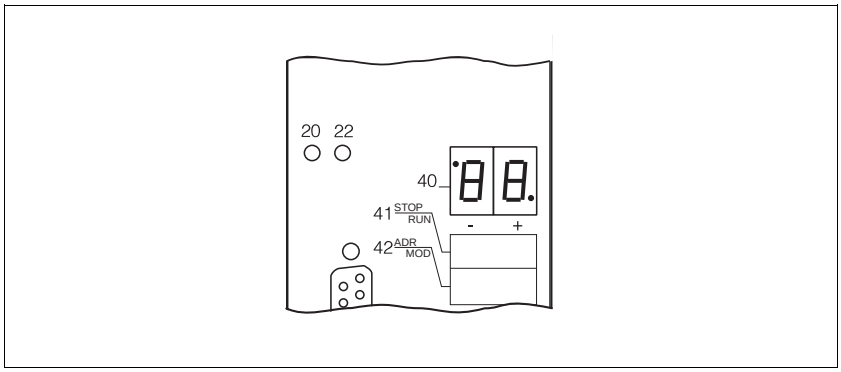


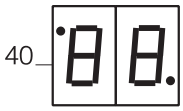
Fig. 4-1 Status indicators

Power controller status indicators

The LEDs (item 20 and 22) indicate the operating states of the external power controller:

LED 20 (green) Power controller ready
LED 22 (green) Power controller enabled

Processor unit status displays



The two seven-segment displays (item 40) indicate operating states and any malfunctions on the processor unit if the selector switch (item 42) is in the central position; see chapter 4.2.1 for a troubleshooting table.

Luminous displays

The luminous displays 00 to 99 indicate the following operating modes:

Display	Meaning
01	Application mode
60, 70	On-line command processing via serial interface
63, 73	On-line command processing via CAN bus interface
91/M	Manual mode

NOTE
The display can also be modified from the application program (in the range from 00 to 99); see the "display" function in the BPRO3 programming manual.

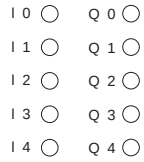
Flashing displays

Flashing displays indicate any errors and malfunctions on the processor unit; see chapter 4.2.1.

The dots on the right and left of the processor unit's seven-segment displays (item 40) indicate the following states:

L.h. dot	R.h. dot	Meaning
–	–	STOP or RESET status
–	lights	Program execution (RUN status)
–	flashes	Program execution (DEBUG status)
lights	lights/flashes	Selector switch functions (items 41 and 42) according to application program (RUN status/DEBUG status)

NOTE
The meanings of other displays during operation with OED3 is described in the ProOED3 documentation.

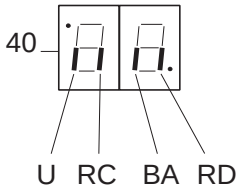


Input and output status indicators

The LEDs I 0 to I 20 show the status of the signal inputs and Q 0 to Q 9 show the status of the signal outputs.
The input I 15 is not available.

Interbus-S diagnostics

The following four indications are used for diagnostic purposes on units with Interbus-S interface.



U Operating voltage
RC Interbus-S link o.k.
BA Interbus-S transmission active
RD No further Interbus-S slave available

The diagnosis settings are made as follows:

1. Press the selector switch (item 42) in MOD position.
   → After 2 seconds, the seven-segment displays (item 40) start flashing.

2. Select the desired number by pressing + or - on the selector switch (item 41).

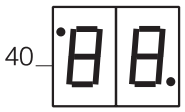
MODE	Interbus-S diagnostics
65	Diagnosis via adapter slot 51
75	Diagnosis via adapter slot 53

   → Release the selector switch (item 41) to accept the setting.

   Refer to the Interbus-S documentation for a detailed description.

4.2 Troubleshooting tables

4.2.1 Processor unit malfunctions



Runtime errors are displayed as a flashing number in the processor unit status displays (item 40) and stored in the controller error memory. With the BPRO3 programming system, the contents of the error memory and a detailed description of the errors can be displayed; see BPRO3 operating manual.
The following table summarizes the possible errors, their causes and methods for rectification.

NOTE
Error messages occurring during operation with OED3 are also described in the ProOED3 documentation.

Display	Cause	Rectification
04	Power controller not ready	See power controller troubleshooting table
	Line interruption	Disconnect the unit and check the cable
07	Power controller overtemperature	Let the power controller cool down while the motor is at a standstill.
		Install a fan on the power controller
08	Error on encoder for electronic gear Line broken	Check encoder wiring
09	Motor overtemperature	Reduce the phase current
		Reduce the load
12	Rotation monitoring active, contouring error	Check mechanical components for ease of movement
16	Short-circuit on one output Q	Check signal connector wiring
20	Incorrect limit switch LIMP or limit switch malfunction	Check wiring and function of the limit switch or the sense of rotation of the motor; see chapter 2.5. LIMP must be approached with CW rotation of the motor.
21	Incorrect limit switch LIMN or limit switch malfunction	Check wiring and function of the limit switch or the sense of rotation of the motor; see chapter 2.5. LIMN must be approached with CCW rotation of the motor.
22	CW limit switch LIMP actuated	Move out of the limit switch range
23	CCW limit switch LIMN actuated	Move out of the limit switch range
30	STOP input active	Disable STOP input
40 41 42	Error in application program: 40 = Error in INIT task 41 = Error in SEQUENCE task 42 = Error in PLC task	A detailed description of the error can be displayed by selecting the BPRO3 menue option “Error memory”
		For controller errors, see ProOED3 documentation

Display	Cause	Rectification
48	No application program loaded or OED3 operating system not available	Load application program or install OED3 operating system on positioning unit
51	Admissible PLC cycle time exceeded due to endless loop in application program	Perform debugging with BPRO3
	Admissible PLC cycle time exceeded due to application program too long	Shorten the application program; consider transferring program parts to the SEQUENCE or INIT task
		Change the admissible cycle time (see “cycletime” function in BPRO3 programming manual)
		Disable cycle time monitoring (see “cycletime” function in BPRO3 programming manual)
52	No link via RS 485 HS interface	Check wiring
		Specify correct number of input/output cards
53	Revision levels of controller and BPRO3 programming system do not match	Check the revision levels: The revision level of BPRO3 is displayed on the screen after invoking BPRO3. The revision level of the controller can be determined via the BPRO3 menue option “Controller status”.
		Use matching revision levels
54	Programming error: Invalid address for input or output	Check application program
	When programming with BPRO3, an incorrect controller configuration was specified	Input the application program with the actual “Controller config.”
55	System faulty	Call Technical Services department.
56	No EEPROM available	Call Technical Services department.
57	EEPROM write error	Call Technical Services department.
80	Battery voltage low, battery used up ⚠ ***ATTENTION*** ***After switching off the controller, data or the application program may be lost!***	Replace the battery; see chapter 5.1
97	OED3 version of controller and ProOED3 version do not match	Use the same software versions of OED3 and ProOED3, e.g. OED3 version 3 and ProOED3 version 3
Other errors indications	System error	Call Technical Services department.

4.3 Repair work

ATTENTION
Any necessary repair work must not be carried out except by BERGER LAHR!

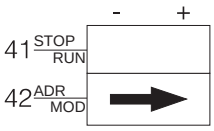
Mark all connections when disassembling the unit.

The set parameters and the mounting location number of the old unit must be transferred to the new one when replacing a unit.

4.4 Booting the controller

After replacing or installing an interface or a memory module, the controller must be re-booted. An application program stored in the EEPROM or PROM is then loaded into the controller memory.

To boot the controller, proceed as follows:



1. Switch off the 24 V supply voltage of the unit.
2. Press and hold the selector switch (item 42) in MOD position.
3. Switch on the 24 V supply voltage.
   → The seven-segment displays show “A1” to “A4”.
4. When “A4” is constantly displayed, press the selector switch (item 41) in – position first, then in + position.
5. Release the selector switch (item 42).
   → The seven-segment displays start flashing. An application program stored in the EEPROM or PROM is loaded into the controller memory and executed.

4.5 Storage, shipment

The following requirements apply when storing units or PC boards:

- The maximum air humidity must not be exceeded (see chapter 1.4).
- The storage temperature specification must be observed (see chapter 1.4).
- Stored parts must be protected against dust and dirt.
- Units or PC boards marked with the symbol 

  may only be unpacked, stored and installed in an electrostatically protected environment.
- The original packing material must be kept for later use.

The following requirements apply when shipping units or PC boards:

- Units or PC boards must be shipped in their original packing material.
- PC boards without batteries or accumulators must be packed in wrapping which is electrically conductive on both sides (use original wrapping, if possible).
- PC boards with batteries or accumulators must be packed in wrapping which is electrically conductive on the outside and antistatic on the inside (use original wrapping, if possible).
- Units or PC boards marked with the symbol 

  may only be packed in an electrostatically protected environment.

5 Maintenance

5.1 Replacing the battery

NOTE
The battery should be replaced at least every 2 years in order to avoid the risk of data loss.

DANGER
Disconnect the mains connector before replacing the battery.

1. Dismount the unit.
2. For WP-311 in 3-phase housing:
   Unscrew two screws each at the top and bottom of the unit and remove the side panel.
   For WP-311 in 5-phase housing:
   Unscrew four screws on the right side and push the side panel out towards the front.

ATTENTION
CMOS circuits are sensitive to touching!

3. Connect the terminals of the new battery to the 2nd battery connection.
4. Disconnect the terminals of the used battery.
5. Remove the used battery and install the new battery.
6. Fasten the side panel with the four screws.
7. Remount the unit.

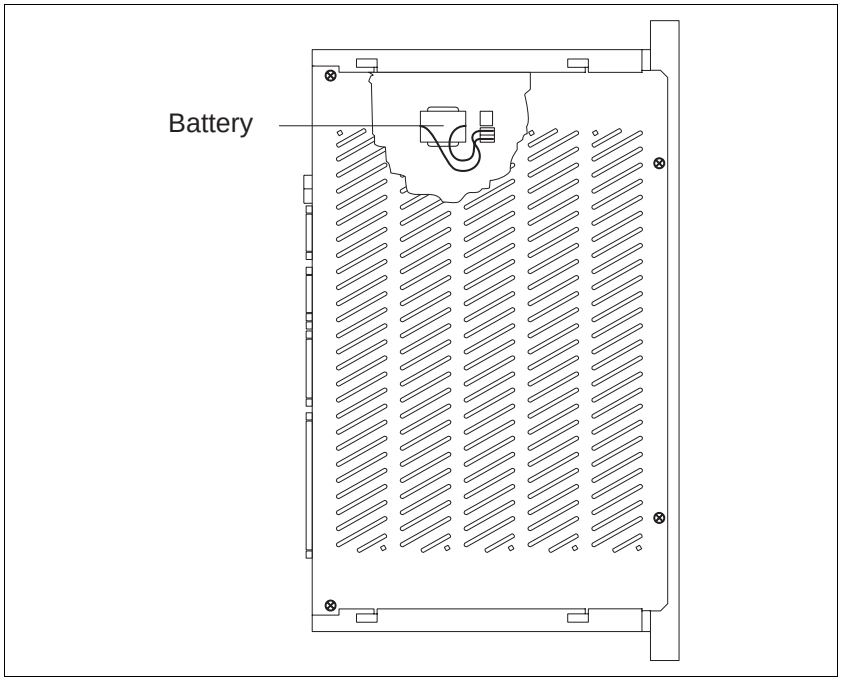


Fig. 5-1 Battery in 5-phase housing of WP-311

5.2 Customer service

The Technical Services department offer the following services under the phone numbers given:

– **Spare part information** by direct line

Phone: +49 (0) 7821 - 946 - 606

Express spare part shipment from Lahr;
reaches most destinations in Europe within 24 hours.

– **Technical advice in case of failures** by hotline

Phone: +49 (0) 7808 - 943 - 226

Fax: +49 (0) 7808 - 943 - 499

Internet e-mail: hotline@berger-lahr.com

Of course, the Technical Services department also offer the following services:

– **On-site maintenance** and

– **direct communication with your service specialist.**

6 Appendix

6.1 Device variants

The following device variants are available, depending on the interface configuration and the operating system software used. Please refer to the sales documentation of the controller for the available device variants.

Interface 1 (slot 51)	**Interface 2 (slot 53)**	**Encoder interface (slot 55)**	**Software**
RS 232 RS 485 LS	RS 232 RS 485 LS RS 485 HS ANOZ IBS PBDP CAN SUCONET	LRS 422 IN	– For programming software ProOED3 – For programming software BPRO3 or on-line command processing via field bus or serial interface

NOTE
The interfaces installed in the unit are indicated on the type plate.

ANOZ	*Analog interface*
CAN	*CAN bus interface*
IBS	*Interbus-S interface*
PBDP	*Profibus-DP interface*
LRS 422-IN	*RS 422 encoder interface*
RS 232	*Serial interface RS 232*
RS 485 LS	*Serial interface RS 485*
RS 485 HS	*Serial interface for MP 926 input/output card, Lauer operating panel or SUCONET (without OED3)*

*Type: WP-311.XXX**OED3***
Operating system software for ProOED3

Type: WP...not specified
Operating system software for BPRO3 or on-line command processing

The standard unit is provided with an EEPROM for storing the application program.

6.2 Description of accessories

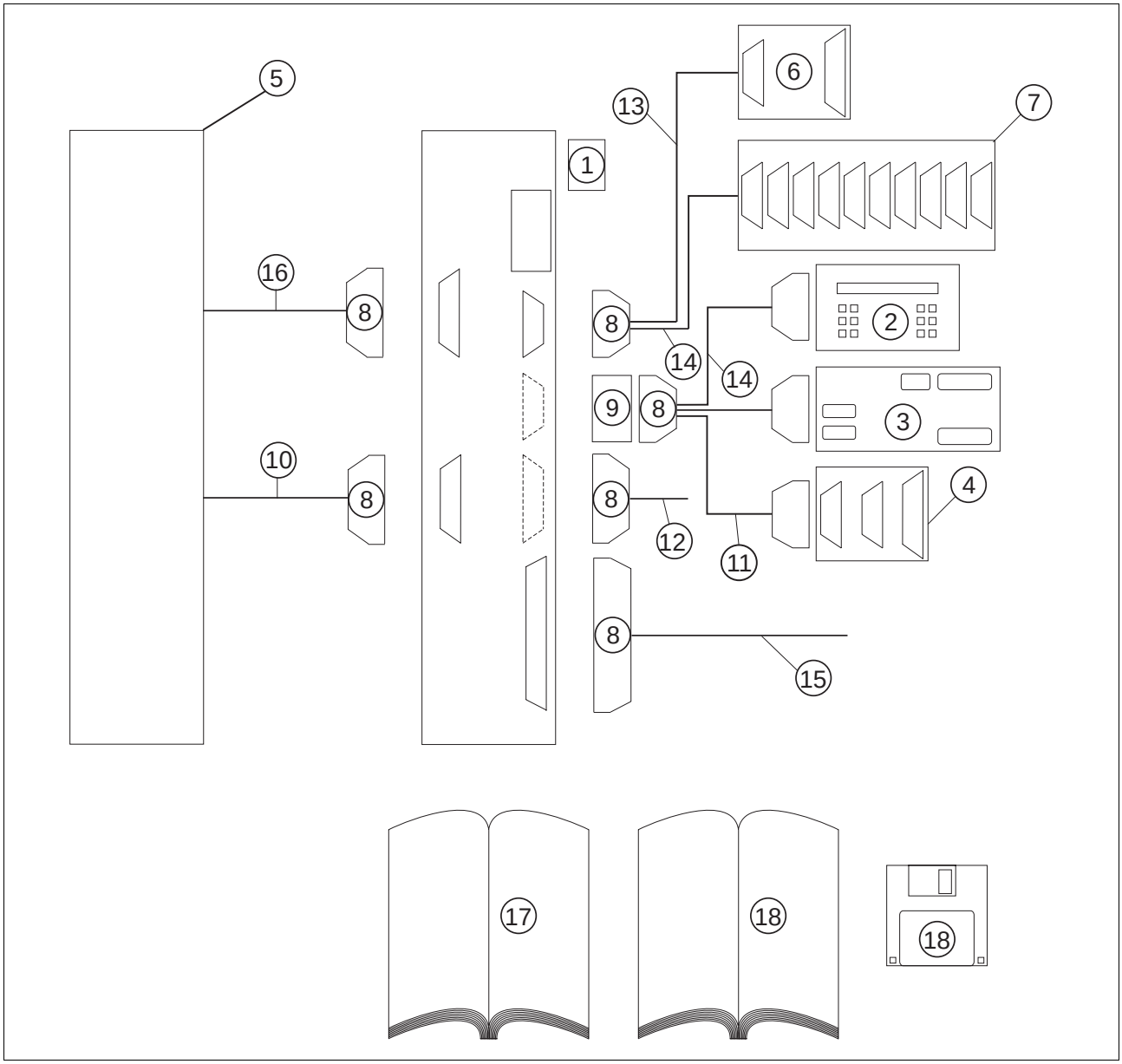


Fig. 6-1 Accessories

The following accessories are available and may be ordered separately (see fig. 6-1):

Item no.	Designation	Reference
1	Battery for wall mounting units	–
2	FT 2000 operating terminal	See chapter 6.2.1
3	MP 926 input/output card (16 inputs/16 outputs)	MP 926 documentation
4	MP 927 Interbus-S interface adapter	Interbus-S documentation
5	Power controller, e.g. WD3-008 or WD5-008	See sales documentation
6	MP 923 interface converter (RS 485 LS/RS 232)	See chapter 6.2.2
7	MP 924 interface distributor	See chapter 6.2.3
8	WP-311 set of connectors (all sub-D connectors)	–
9	Crossover adapter for master/slave operation via RS 485 LS interface	See chapter 6.2.4
10	Encoder cable	See sales documentation
11	Interbus-S/MP 927 signal cable	
12	Electronic gear cable	
13	RS 485 LS interface cable, male/female	
14	RS 485 LS interface cable, male/male	
15	Signal cable	
16	Signal cable for power controller	
17	On-line Command Processing via Serial Interface documentation	Doc. no. 212.986
18	BPRO3 programming system or ProOED3 programming interface for device variant with OED3 operating system software (appropriate documentation and diskettes)	–

NOTE
Refer to the sales documentation of the WP-311 positioning unit for the accessory order numbers.

6.2.1 FT 2000 operating terminal

The FT 2000 operating terminal is a straightforward data input and display terminal which is used for BERGER LAHR controllers. It has eight parallel inputs and eight parallel outputs which can be addressed in master/slave operation (fig. 6-2).

The unit has been designed for installation into an operating panel or a front panel.

The FT 2000 operating terminal can be configured for master/slave or terminal operation. In terminal mode, the parallel inputs and outputs cannot be addressed.

NOTE
The transmit and receive lines between the operating terminal and the controller must be crossed over between the units. For this purpose, a crossover adapter can be used; see chapter 6.2.4.

Connection to the positioning unit is made via an RS 485 LS serial interface.

Operating terminal	Order number
FT 2000 German	62512000003
FT 2000 English	62512000004
FT 2000 French	62512000005

For more information, refer to the FT 2000 operating terminal documentation.

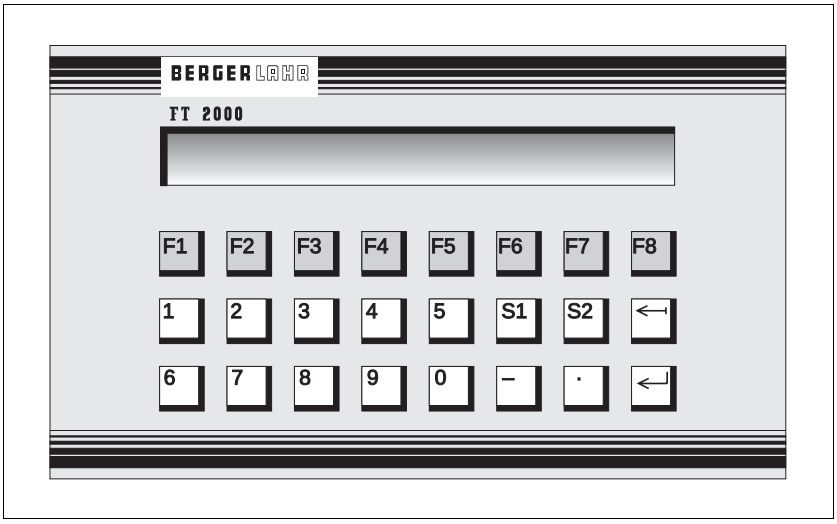


Fig. 6-2 FT 2000 operating terminal

6.2.2 MP 923 interface converter

6.2.2.1 General description

The MP 923 interface converter is used for data transmission from an RS 485 LS (RS 422) interface to a V24 (RS 232) interface and vice versa. The interface converter must be powered with 12 VDC either via the power supply unit connection (2-pin female diode connector) or via the RS 485 LS (RS 422) connector. With BERGER LAHR positioning units (e.g. WDP5), power is supplied via the RS 485 LS (RS 422) connection.

6.2.2.2 Technical data

Electrical data

Voltage supply	9.6 to 15 VDC/150 mA
Interfaces	RS 485 LS (RS 422)
	V24 (RS 232)

Mechanical data

Dimensions	97 x 65 x 30 mm
Weight	approx. 130 g

Ambient conditions

Storage temperature	-25°C to +70°C
Operating temperature	0°C to +55°C
Humidity class, components	F acc. to DIN 40 040
Humidity class, tested to IEC 68 part 2-3 at:	
Air temperature	+40°C, +2°C
Relative humidity non-condensing	93%, +2%, -3%

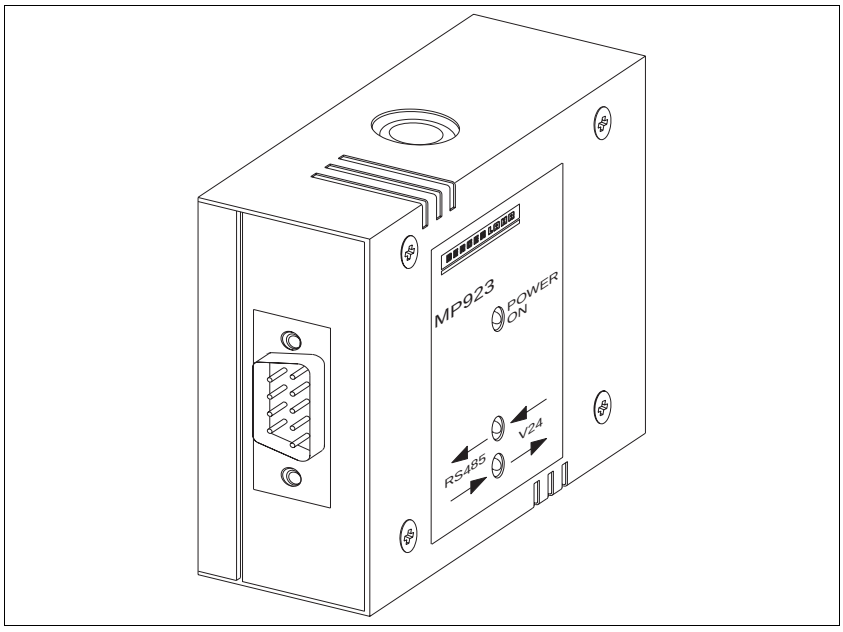


Fig. 6-3 MP 923 interface converter

6.2.2.3 Setup

1. Wire the MP 923 interface converter in accordance with fig. 6-4.

NOTE
The 12 VDC voltage for the MP 923 is supplied either via the power supply unit connection or via the RS 485 LS (RS 422) connection (e.g. for BERGER LAHR WDP5 positioning units).

ATTENTION
The interface cables must be shielded on both ends via the connector shells!

ATTENTION
For reasons of noise immunity, the V24 (RS 232) cable should be as short as possible (15 m max.)!

2. Switch on the mains voltage.
   → The LED “POWER ON” lights up. The two other LEDs remain dark.

3. Start data transmission.
   → Either the LED marked “RS 485 LS → V24” or the LED marked “RS 485 LS ← V24” flashes depending on the sense of the data transmission.

6.2.2.4 Status indicators

The status indicators show the operating status or any malfunction.

LED	**Lit**	**Not lit**	**Flashing**
“POWER ON”	Supply voltage available	Supply voltage not available	
“RS 485 LS → V24”	RS 485 LS (RS 422) interface incorrectly wired (signal lines TXD ($\overline{\text{TXD}}$) and RXD ($\overline{\text{RXD}}$) interchanged)	No data transmission from RS 485 LS (RS 422) to V24 (RS 232)	Data transmission from RS 485 LS (RS 422) to V24 (RS 232)
“RS 485 LS ← V24”	V24 (RS 232) interface incorrectly wired (pins 2 and 3 interchanged)	No data transmission from V24 (RS 232) to RS 485 LS (RS 422)	Data transmission from V24 (RS 232) to RS 485 LS (RS 422)

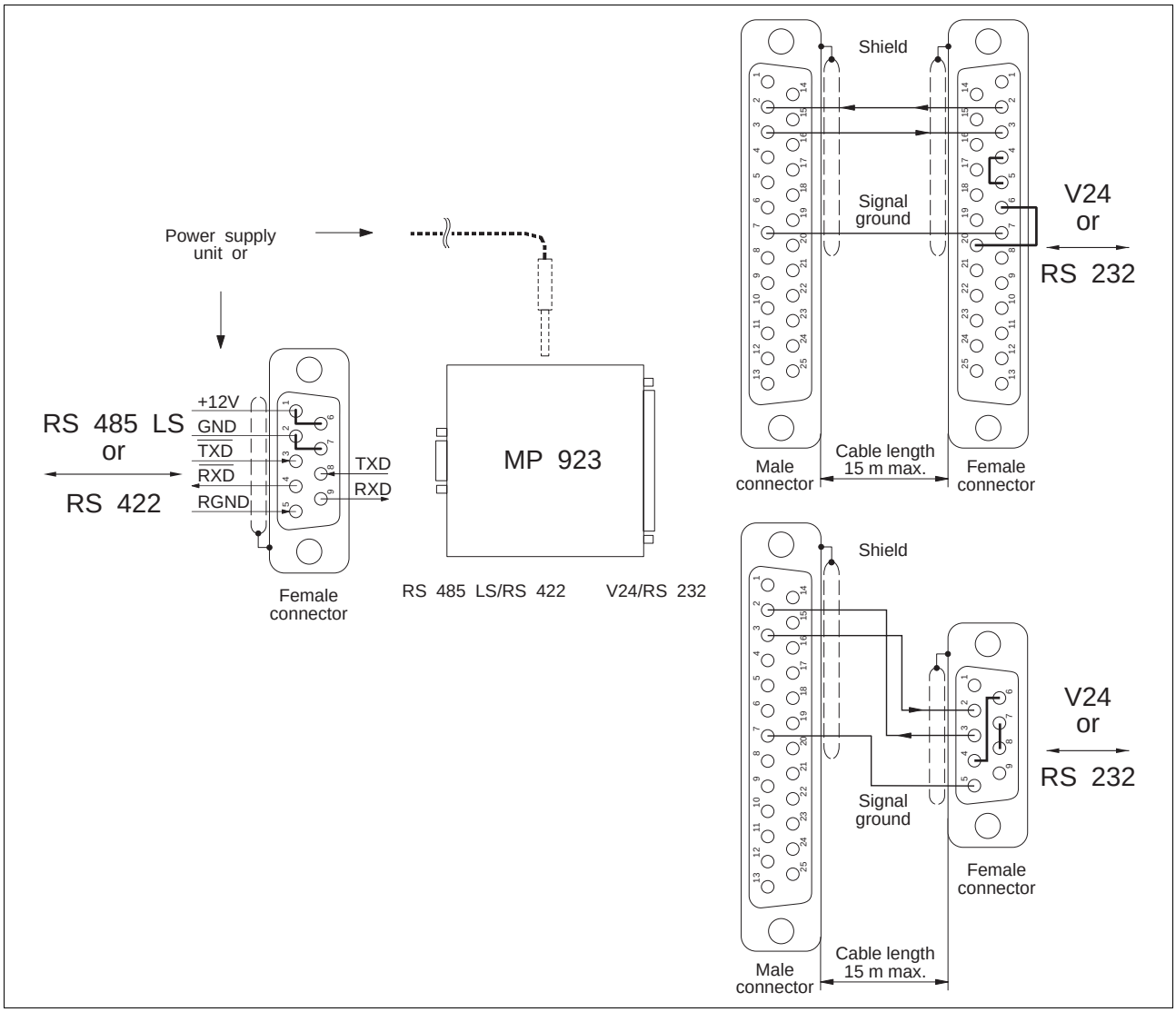


Fig. 6-4 MP 923 interface converter wiring

6.2.3. MP 924 interface distributor

6.2.3.1 General description

Up to nine networkable BERGER LAHR units can be controlled from one PC when using an MP 924 interface distributor. If more than nine units are planned to be used in a network, several MP 924 interface distributors must be combined.

6.2.3.2 Technical data

Electrical data

10 serial interfaces	RS 485 LS (RS 422)

Mechanical data

Dimensions	approx. 205 x 80 x 32 mm
Weight	approx. 260 g

Ambient conditions

Storage temperature	-25°C to +70°C
Operating temperature	0°C to +55°C
Humidity class, components	F acc. to DIN 40040
Humidity class, tested to IEC 68 part 2-3 at:	
Air temperature	+40°C, +2°C
Relative humidity non-condensing	93%, +2%, -3%

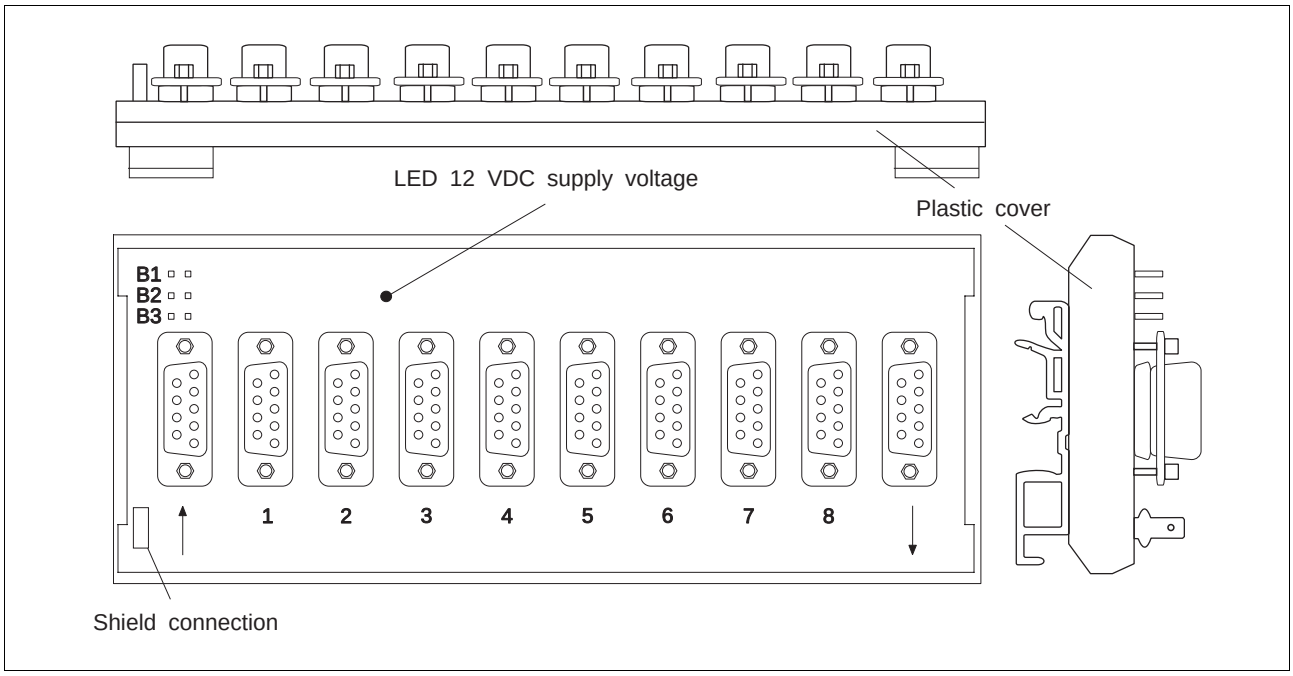


Fig. 6-5 MP 924 interface distributor

6.2.3.3 Setup

1. Wire the MP 924 interface distributor in accordance with fig. 6-6. For interface conversion RS 232 ↔ RS 485 LS (RS 422), use the MP 923 interface converter (see chapter 6.2.2).

ATTENTION
The interface cables must be shielded on both ends (connect shield on MP 924 to protective ground).

ATTENTION
For reasons of noise immunity, the RS 232 cable should be as short as possible (15 m max.)!

ATTENTION
Never connect a terminator.

2. If several MP 924 interface distributors are used, combine them as illustrated in fig. 6-6.

3. Set the connected units to network mode and switch them on.

ATTENTION
The same baud rate must be set on all units for network mode.

ATTENTION
When using an MP 923 interface converter, at least one unit attached to the first MP 924 interface distributor must be switched on in order to ensure that power is supplied to the MP 923.

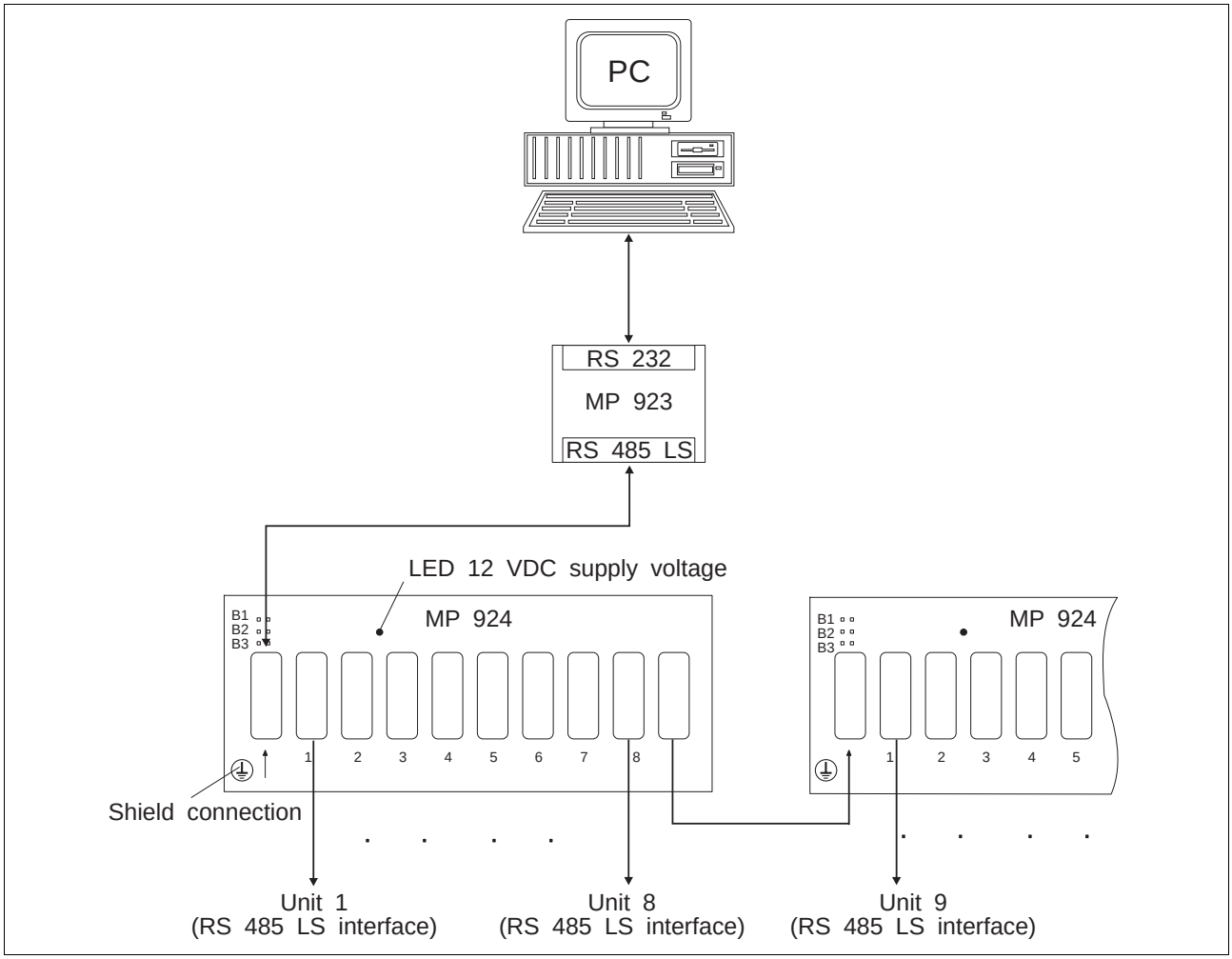


Bild 6-6 MP 924 interface distributor wiring

6.2.4 Crossover adapter

The 9-pin crossover adapter is used for interchanging the transmit and receive lines for master/slave operation via the RS 485 LS interface.

6.3 Glossary

Additional reference switch
An additional travel switch for reference movements.

CCW (counterclockwise) rotation, negative or left direction
Sense of rotation of the motor in a counterclockwise direction (as seen from front towards the motor shaft).

Contouring error
The difference between set and actual position.

CW (clockwise) rotation, positive direction
Sense of rotation of the motor in a clockwise direction (as seen from front towards the motor shaft).

Gear ratio
Multiplication factor for positioning operations, which is composed of a numerator and a denominator (step-down gearing or step-up gearing).

Incremental encoder
Incremental encoders have a specific number (N) of marks on a disk which are used for determining changes in position.

Limit switch
Switch for limiting the travel and for reference movements.

Network mode
An operating mode used for a network of positioning units. Several units are connected to a host via a physical link. Selection of the units to be addressed is effected by a device polling command.

Phase current
The current flowing through the winding of a stepping motor.

Phase sensor
Incremental encoders only are flanged to the motor shaft as a position sensing system.

Power control card
An electronic card for controlling the motor.

Reference movement
Motor movement towards the r.h. or l.h. limit switch or additional reference switch for setting a reference point for the system of dimensions.

Reference movement frequency
Speed of the motor when moving towards the limit or reference switch and when moving from the limit or reference switch to the reference point.

Reference position
Position value after a reference movement or after setting the reference point.

Remanent flag
A flag which retains the programmed status after disconnecting the supply voltage.

RS 485 LS interface
Serial interface for a network configuration.

Settling time
The time that an input signal status must be stable so that the positioning unit is able to recognize it.

Step angle
The angle of rotation by which the motor shaft turns with each control pulse.

6.4 Abbreviations

AC	Alternating current
AF	Width across flats
ASCII	American Standard Code for Information Interchange
CAL	CAN Application Layer
CAN	CAN bus interface
CMOS	Complementary Metal-Oxide Semiconductor
DC	Direct current
Doc. no.	Documentation number
E	Encoder
HU	Height unit
LED	Light Emitting Diode
M	Motor
N	Number of encoder marks
PC	Personal Computer
PELV	Protected Extra Low Voltage
PLC	Programmable Logic Controller

7 Index

8 Corrections and additions

At present there are no corrections or additions.