Power control card
for 5-phase
stepping motors
without rotation monitoring

D 550.00/01

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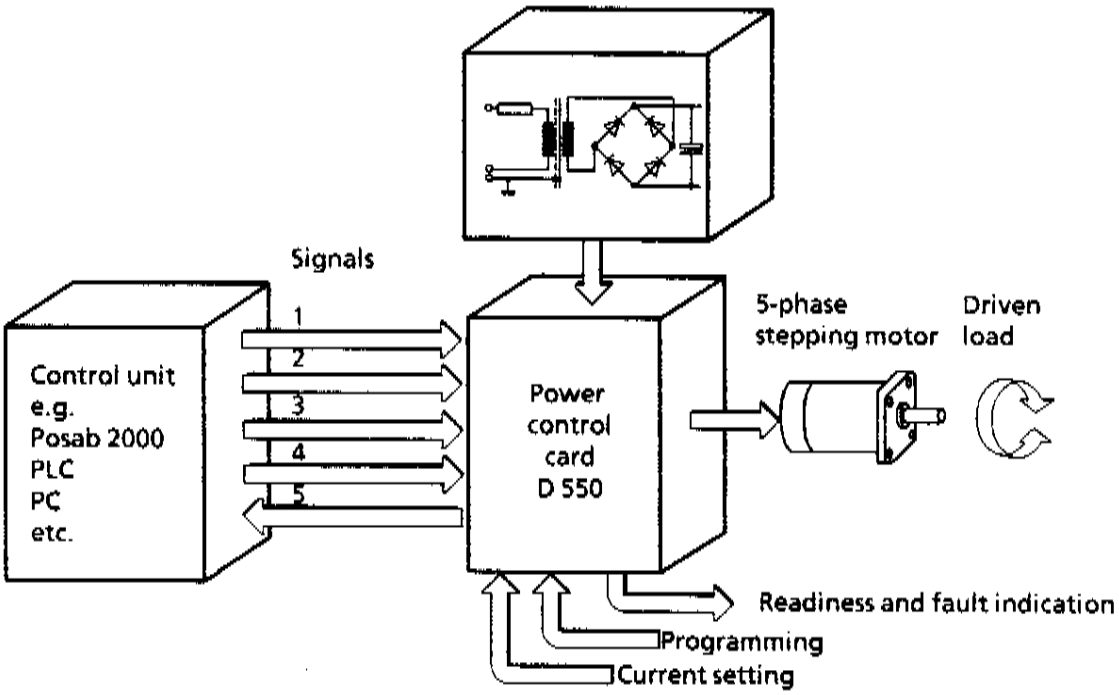
1 Drive system with power control card D 550



Input signals:
1 Pulse
2 Direction
3 Gate
4 PWM current control/boost

Output signal:
5 Readiness

Fig. 1-1 Drive system with power control card D 550

2 Dimensional drawing

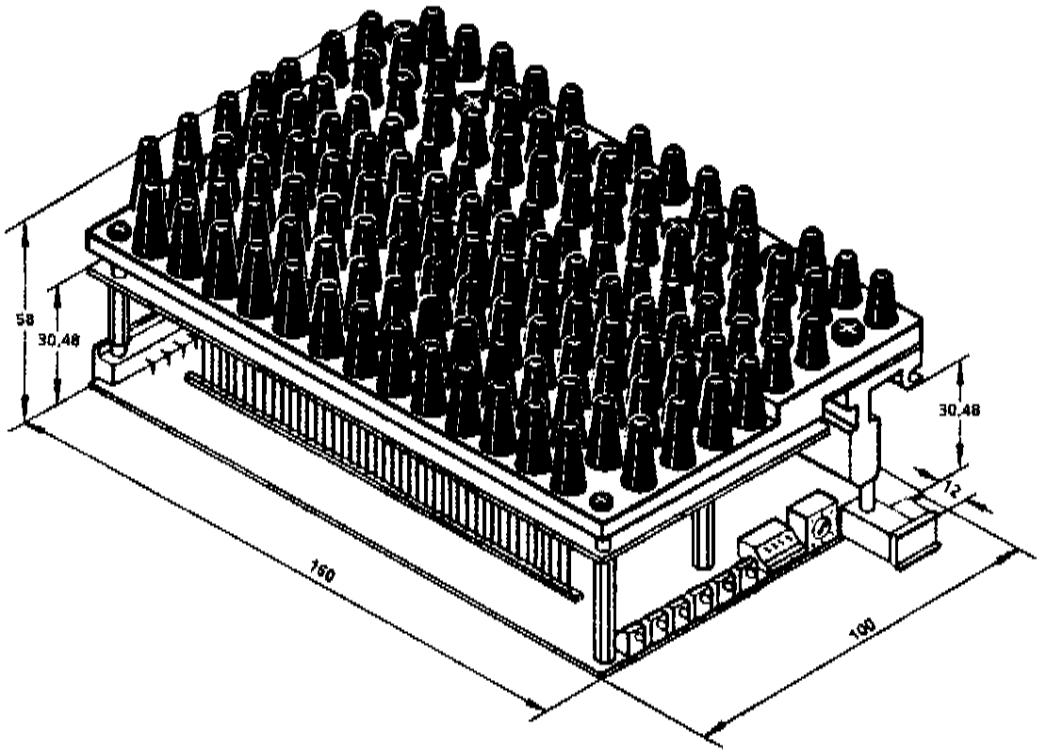


Fig. 2-1 Dimensional drawing

3 General description

3.1 Standard versions

The power control card D 550 is suited for driving BERGER LAHR 5-phase stepping motors.

It converts digital movement instructions into format adapted to the stepping motor which, consequently, performs the desired functions. The D 550 thus establishes the connection between the motor control system and the stepping motor (see chapter 1).

High operational reliability, ease of operation and versatility are achieved by the following features:

- Five jumpers (5-H circuit)
- Joint digital current setting for all 5 phases
- Maximum phase current 2.8 A
- Various programming possibilities such as
  * Full, half step
  * Direction reversed
  * Current reduction
  * PWM-current control or boost function
- Various protective or monitoring functions in case of
  * Short circuit or misconnected motor cables
  * Excessive temperature
  * Interruption of the motor circuit (phase interruption)
  * Under- or overvoltage
- Acknowledgement of the ready state or indication of malfunctions (readiness)
- Visual display of malfunctions
- Unstabilized operating voltage of 35...70 VDC
- High immunity to interference due to optocoupler inputs
- Self-protecting card in case of an externally driven motor
- Up-to-date Power-FET technology
- Standard Eurocard format

4 Block circuit diagram D 550

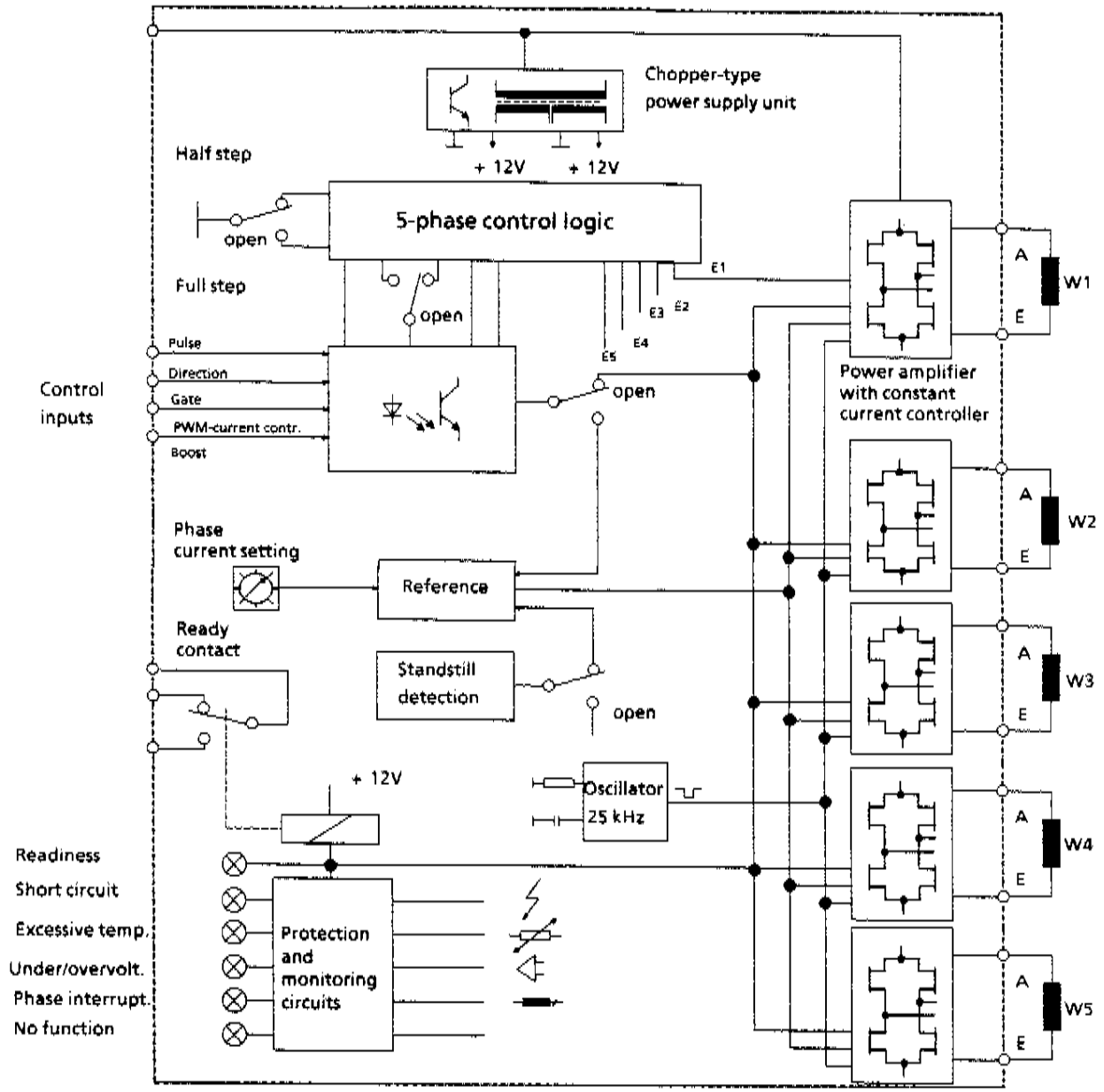


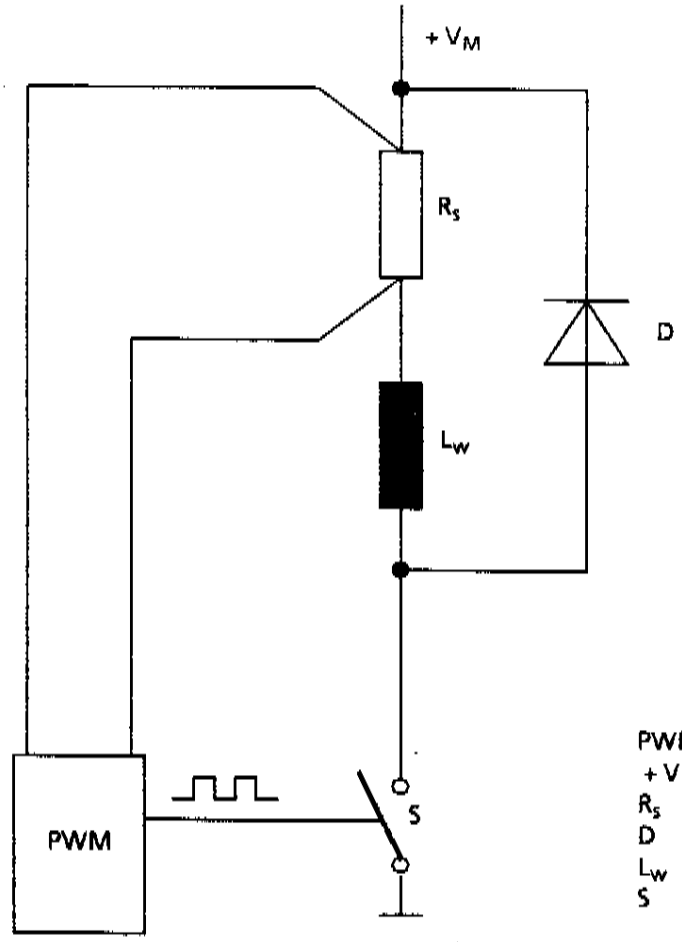
Fig. 4-1 Block circuit diagram

5 Constant-current control principle

Stepping motors require a phase current which should not depend on the torque, in order to ensure optimum operation.

As the motor windings produce inductances, the current can be regulated quite efficiently according to the switching controller principle using pulse width modulation (PWM). Control is effected by periodically closing switch S (see fig. 5-1) with the controller giving the time of closure.

The frequency is approximately 25 kHz and thereby well beyond the audible range.



PWM : Pulse width modulation
+ V_M : Motor supply voltage
R_S : Sensor resistance
D : Free wheeling diode
L_W : Winding inductance
S : Electric switch

Fig. 5-1 Constant-current control principle

6 Control inputs

6.1 Control input circuits

Optocouplers are used as control inputs for pulse, direction, gate or PWM current control or boost.

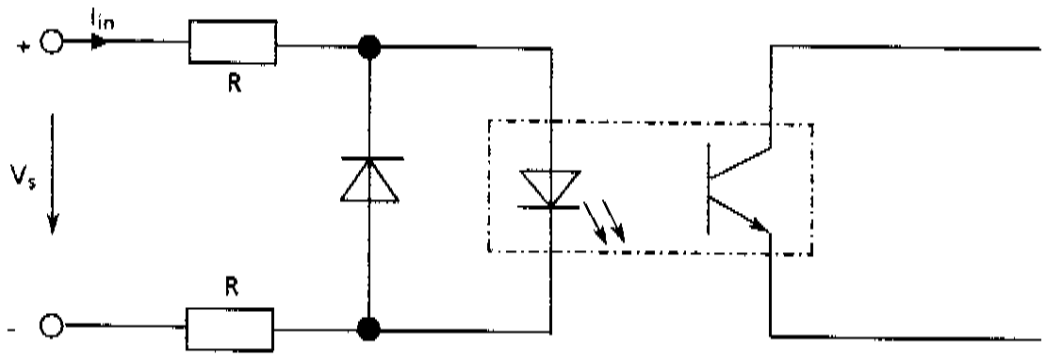


Fig. 6-1 Optocoupler input

D 550.00

Logical 1 min.	Signal level	Logical 1 max.
20 V	V_s	30 V
10 mA	I_{in}	25 mA
Logical 0 min.	Signal level	Logical 0 max.
-3 V	V_s	3 V
-30 mA	I_{in}	1 mA

R = 1000 ohms

D 550.01

Logical 1 min.	Signal level	Logical 1 max.
2.5 V	V_s	5.25 V
5 mA	I_{in}	25 mA
Logical 0 min.	Signal level	Logical 0 max.
-5.25 V	V_s	0.4 V
-30 mA	I_{in}	0.1 mA

R = 75 ohms

6.2 Pulse input

Control input	current rising ↑	current falling ↓	stationary
Motor	performs a step	stationary	stands still

6.3 Direction input

Control input	no input current		active	
Switch position	UPPER	LOWER	UPPER	LOWER
Sense of rot. *	right	left	left	right

* viewed from front to shaft

6.4 Gate input

Control input	no input current	active
Motor	rotates *	does not rotate

* when pulses are applied

6.5 Boost input (see also chapter 7 and 8)

Control input	no input current	active
Switch position	LOWER	LOWER
Phase current	I_{nom}	I_{nom} x 1.2

6.6 PWM current control input

Control input	no input current	active	f = 20 kHz
Switch position	UPPER	UPPER	UPPER
Phase current	I_{nom}	0 A	$I = t_{on}/50\mu s \times I_{nom}$

6.7 Control possibilities

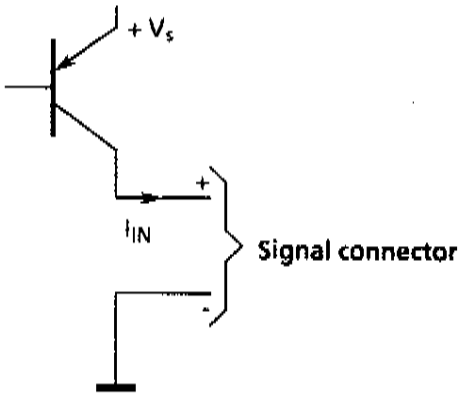


Fig. 6-2 pnp control

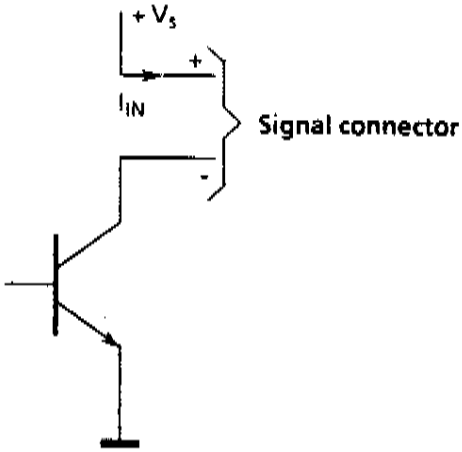


Fig. 6-3 npn control

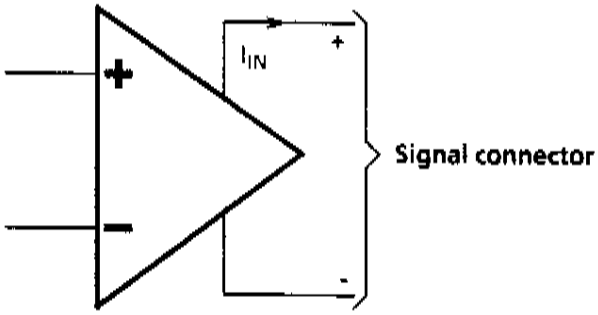
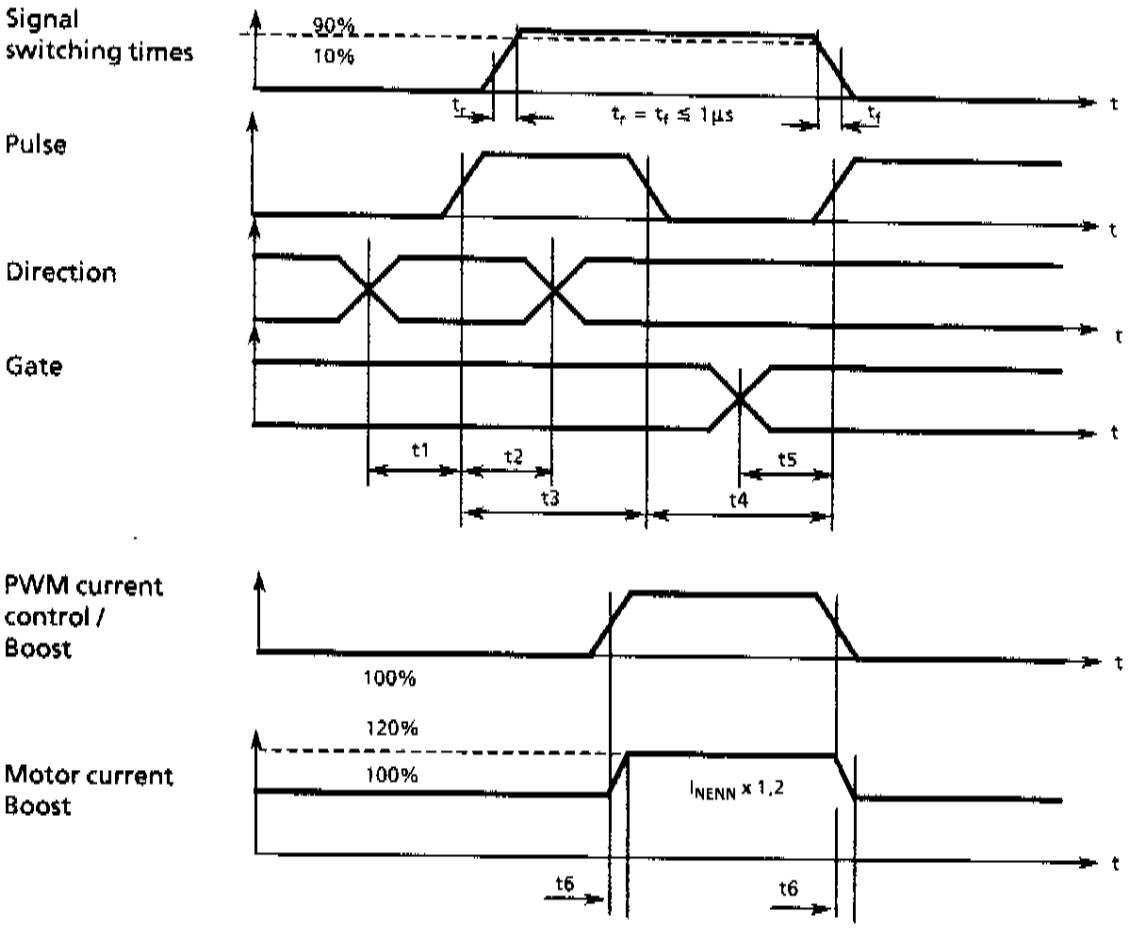


Fig. 6-4 Push-pull control

6.8 Timing



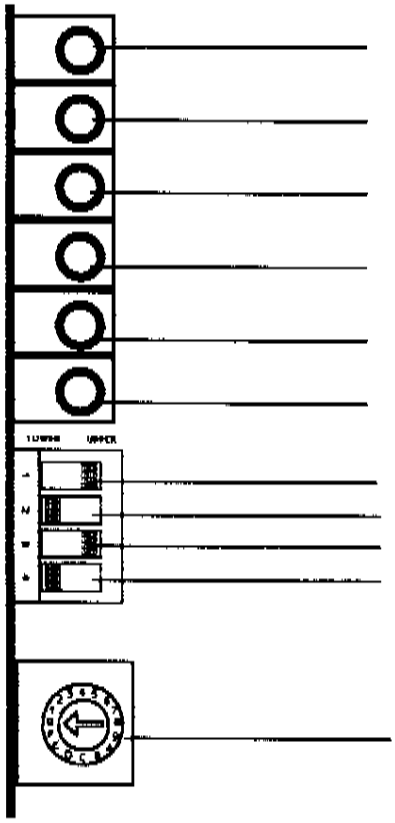
t1: Preparation time for direction signal	0 µs
t2: Hold time for direction signal	5 µs
t3: Pulse duration	5 µs
t4: Pulse interval	5 µs
t5: Response time of gate signal	0 µs
t6: Response time of motor current to boost	30...100 µs

7 Displays and programming switches

At the front of the card there are:

- Indication of readiness and malfunction
- Toggle switches for programming various functions
- Rotary switch for setting the phase current (see chapter 8)

D 550.0X



	green	Readiness	LED 1
	red	Short circuit, overload	LED 2
	red	Excessive temperature	LED 3
	red	Under-/overvoltage	LED 4
	red	Phase interruption	LED 5
	red	No function	LED 6
			Basic setting
	Boost or PWM current control		PWM current control
	Current reduction		Current reduction active
	Reverse direction		Clockwise direction
	Step angle		Step angle: half step
	Phase current setting		0.55 A

7.1 Phase current (given in A)

I (A)	0.55	0.70	0.85	1.0	1.15	1.3	1.45	1.6	1.75	1.9
Position	0	1	2	3	4	5	6	7	8	9

I (A)	2.05	2.2	2.35	2.5	2.65	2.8				
Position	A	B	C	D	E	F				

7.2 Current reduction

Switch position	LOWER		UPPER	
Pulse frequency	< 10 Hz	> 10 Hz	< 10 Hz	> 10 Hz
Motor current I	I_{nom} x 0.6	I_{nom}	I_{nom}	I_{nom}

7.3 Step angle

Switch position	LOWER	UPPER
Step angle	Half step 1000 steps per rotation ($\propto$ = 0.36°)	Full step 500 steps per rotation ($\propto$ = 0.72°)

7.4 Sense of rotation *

Switch position	LOWER	UPPER
Signal input current applied	clockwise rotation	counterclockwise rotation
Signal input currentless	counterclockwise rotation	clockwise rotation

* viewed from front to shaft

8 Motor phase current adjustment

8.1 Manual setting

The phase current permitted for the motor is adjusted with the rotary switch according to the table (see chapter 7 and 11). If the admissible phase current is not listed in the table, set the switch to the next lower value.

NOTE

Do not exceed the motor current as otherwise the motor and card may be overloaded.

8.2 Electronic current reduction

The phase current can be reduced via the PWM current control input steplessly and as desired in special applications. This is accomplished by feeding a pulse-width-modulated signal at a frequency of 20 kHz ± 10% to this input. The phase current is calculated according to the following formula:

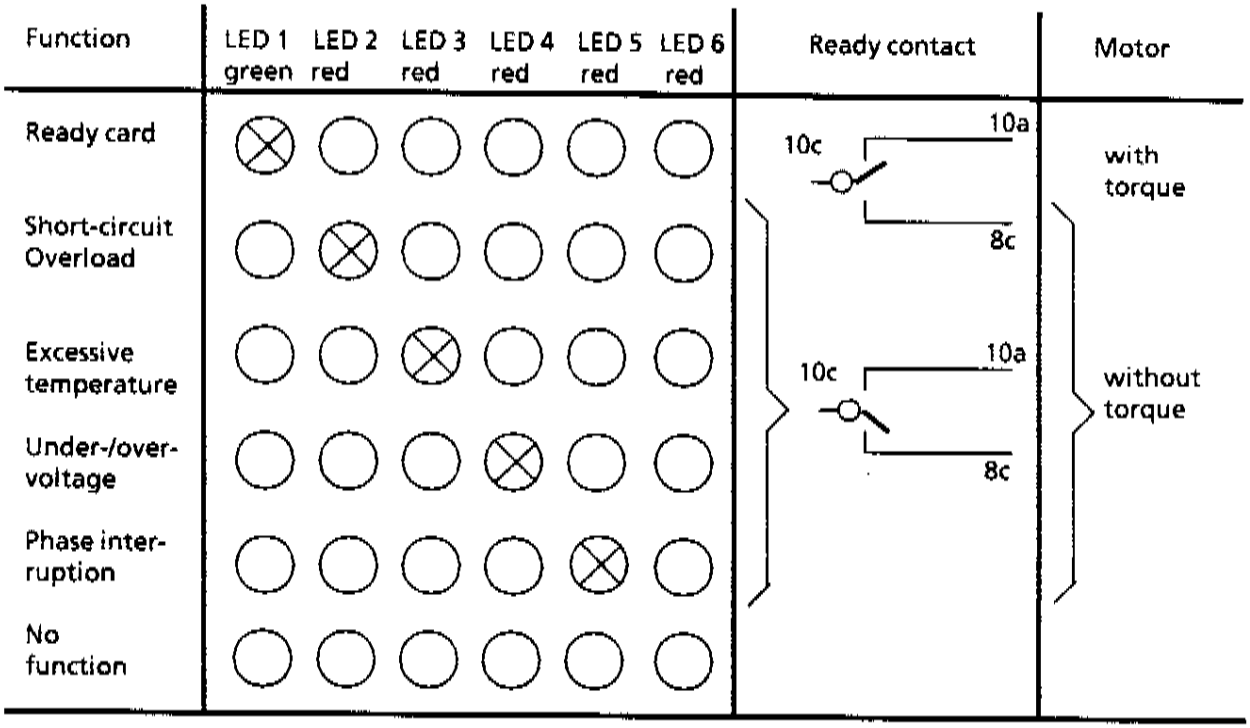
$I_{phase} = (1 - t_{on}/T) \times$ adjusted value

9 Readiness and malfunctions

A series of monitoring and protective functions ensure proper operation of the power control card (see chapter 7).

On the absence of malfunctions, the card signals readiness approx. 0.5 s after the operating voltage has been switched on. The "ready" state is indicated by the green LED and attraction of the "ready" relay.

9.1 Function displays



Ready card	This is indicated, if none of the following faults occur.
Short circuit	This is indicated, if the phase current has exceeded a value of > 10A for 2µs.
Excessive temperature	This is indicated, if the heatsink temperature exceeds approx. 85°C.
Under-/overvoltage	This is indicated in case of operating voltages < 35 VDC and > 85 VDC.
Phase interruption	This is indicated if there is an interruption in the motor circuit. The circuit is tested for phase interruption only when switching on the operating voltage. It is not checked during operation.

9.2 Effects of malfunctions

The above mentioned faults have the following results:

In case of under-/overvoltage

- Motor loses holding moment
- Ready relay is released
- LED 1 goes out (at least 10 ms)
- LED 4 lights up

In case of other malfunctions

- Motor loses holding moment
- Ready relay is released
- LED 1 goes out
- LED 2, 3 or 5 lights up

In all cases

- Switch off the card and machines!
- Find the reason
- Correct the problem
- Switch on again

10 Power supply

Absolute limit values	V_{op} min. 35 VDC V_{op} max. 85 VDC
Nominal voltage	70 VDC
Current consumption	I_{op} max. = 6 A (see also chapter 11)
Charging capacitor C_C in the power supply unit	$C_C \geq 6800\ \mu F$
Cable length between power supply unit and D 550	max. 1 m

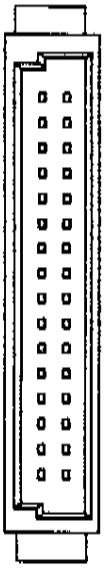
11 Applicable motors, phase current, current consumption and adjustment

Motor	admissible phase current	max. current consumption of the D 550 I_M max	recommended switch position
RDM 564/50	0.75 A	1.2 A	1
RDM 566/50	0.75 A	1.1 A	1
RDM 599/50	1.15 A	1.8 A	4
RDM 596/50	1.25 A	2.1 A	4
RDM 566/50 H	1.3 A	2.2 A	5
RDM 569/50	1.4 A	2.2 A	5
RDM 599/50 H	2.3 A	4.4 A	C
RDM 569/50 H	2.3 A	4.0 A	C
RDM 596/50 H	2.7 A	5.5 A	E
RDM 5913/50	2.8 A	4.5 A	F

NOTE
Setting the current to lower values than indicated in the table is permissible.
However, the torque will be reduced approximately in proportion to the current.

12 Connection diagram

12.1 Card connector



Connector 32-pole,
counterconnector: female
connector in accordance
with DIN 41612 type D

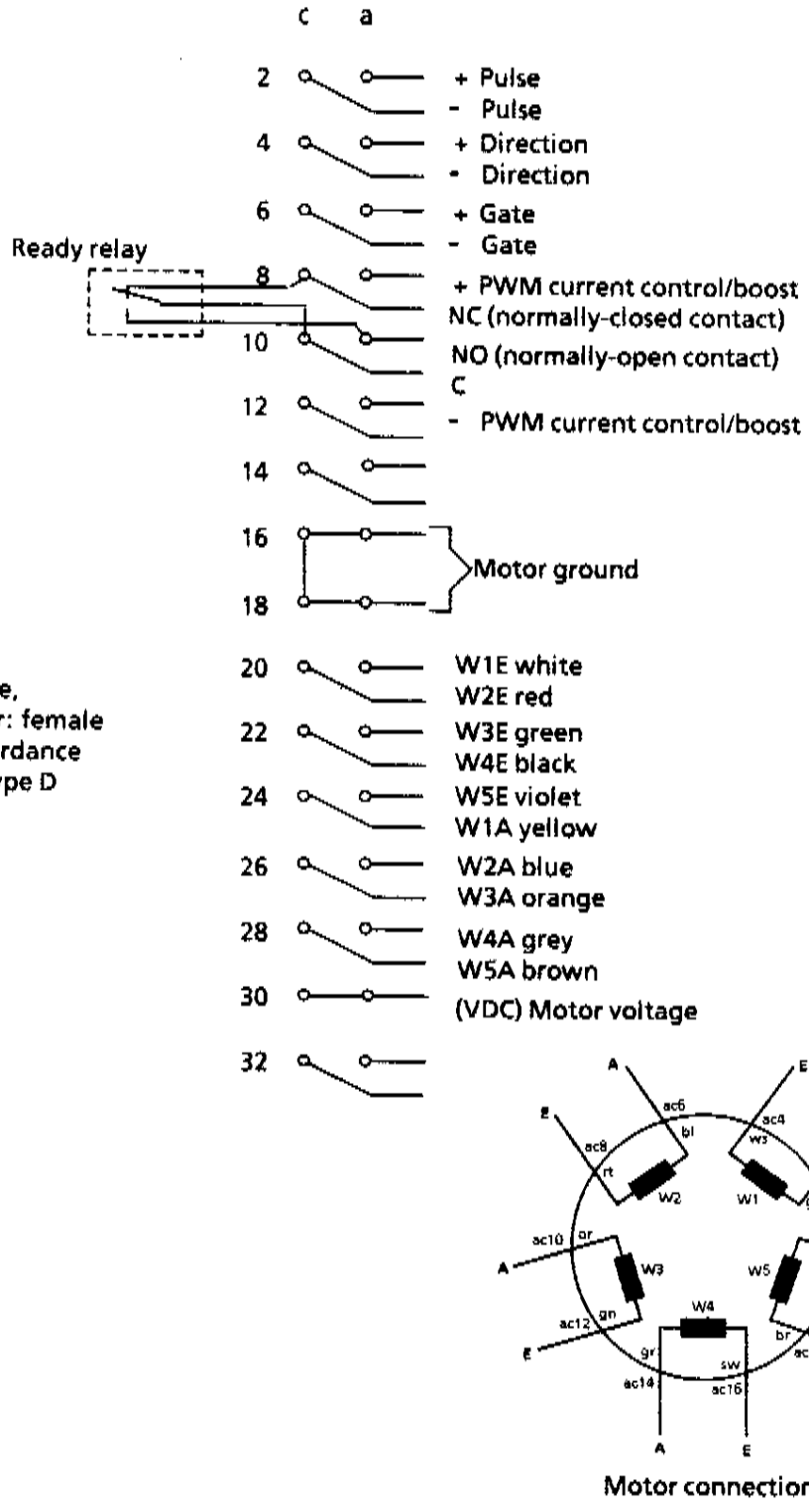


Fig. 12-1 Connection diagram D 550

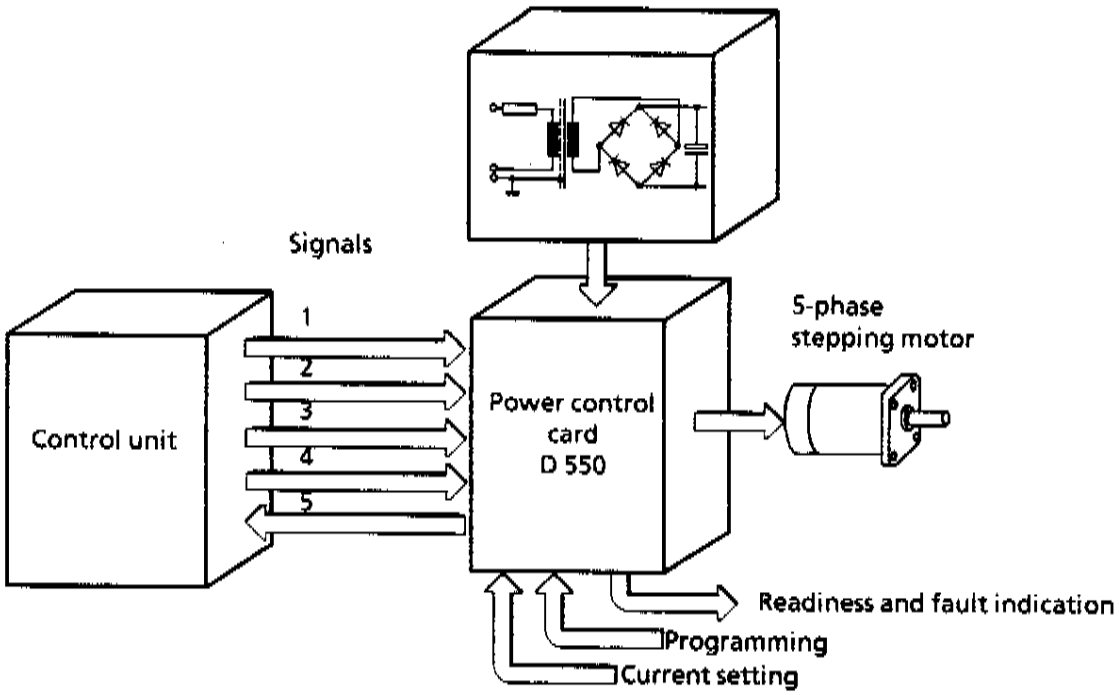
13 Connecting the card

ATTENTION
Never connect or disconnect the D 550 with operating voltage applied!

The card is connected as follows:

- Wire the connector according to the connection diagram (see chapter 12). Take special care that the motor and operating voltage connections are wired correctly.
- Do not use undesignated connector pins as solder tags (internal assignment).
- Set admissible phase current and programming switch to the desired function.
- Switch on the operating voltage and test all functions.
- If any unexpected faults occur (red LED lights up), refer to chapter 22.

13.1 Application



Input signals:
1 Pulse
2 Direction
3 Gate
4 PWM current control/boost

Output signal:
5 Readiness

Fig. 13-1 Typical application with the D 550 card

13.2 Operation with several axles

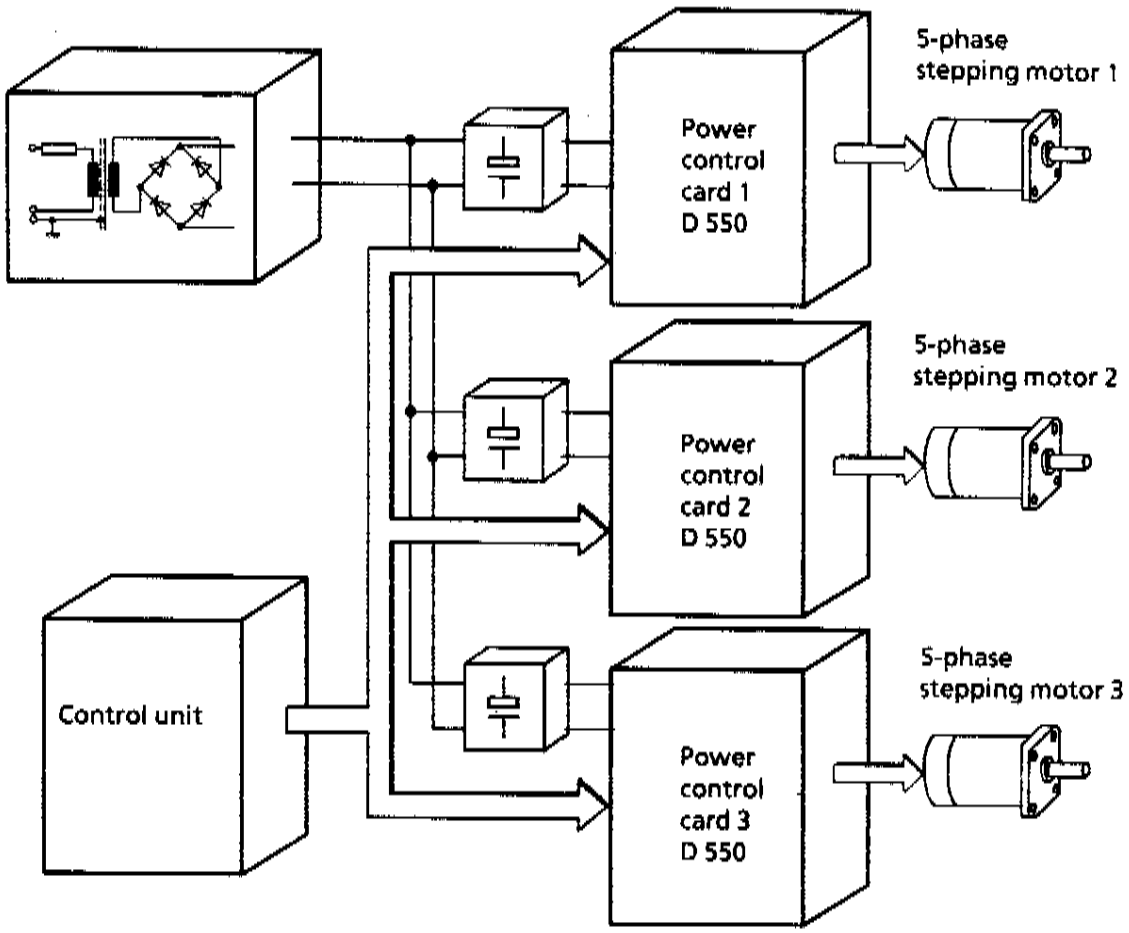


Fig. 13-2 Driving of 3 stepping motors

14 Operating voltage and motor cable requirements

14.1 Operating voltage cables

In order to avoid power loss, the operating voltage lines should have a minimum cross-section of 0.75 mm².

Owing to the HF-currents present in these cables the regulations as per VDE 0871 have to be observed (shielding, twisting, etc.).

14.2 Motor cables

The motor lines should also have a minimum cross-section in order to keep power loss to a minimum.

Recommended value: Line resistance ≤ Winding resistance

$R_L \leq R_W$

For example: Line length = 22 m
Motor RDM 5913/50 R_W = 1Ω

$R_L \leq 1\Omega$

see table (see chapter 15) cross-section ≥ 0.75 mm²

Line lengths and resistances exceeding the recommended value may result in reduced torque and increased supply current from the power supply unit.

15 Table for selecting the line cross-section

Cable length	Line cross-section	
	0.75 mm²	1.5 mm²
10 m	0.46	0.23
25 m	1.15	0.58
50 m	2.30	1.15
100 m	4.60	2.30
	Line resistance R_L (Ω)	

15.1 Winding resistances of the BERGER LAHR 5-phase stepping motors

Type RDM	564	566	569	596	599	5913	596 H	599 H	566 H	569 H
R_W/Ω	2.5	4.0	2.3	2.1	3.25	1.0	0.43	0.7	1.4	0.85

16 Interference protection

In order to observe the interference protection regulations according to VDE 0871 a shielded motor cable is required.

Use a shielded signal cable to avoid interference in the signal lines.

The interference protection regulations according to VDE 0871 also apply to operating voltage cables.

Suitable cables are listed in chapter 17.

17 Recommended motor and signal cables

17.1 Recommended signal cables

Cable
Order no. H6-928-30

Signal cable for RS 422
Cross-section 0.23 mm² (7 x 0.2 mm) AWG 24
6 x 2 wires twisted in pairs
Screening: copper braiding with strand
Outside diameter: 9.4 mm
PVC-sheath

Supplier: BERGER LAHR GmbH
Max. length delivered: 1000 m
Max. laid length: 300 m

Belden (US)

UL-approved signal cable
Type 9833 for RS 422
Cross-section 0.23 mm² (7 x 0.2 mm) AWG 24
7 x 2 wires twisted in pairs
Screening: copper braiding with strand
Outside diameter: 9.4 mm
PVC-sheath

Supplier: Firma Elkab, 7700 Singen
Lengths delivered: 30.5 m - 152.4 m - 304.8 m
Max. laid length: 300 m

17.2 Recommended motor cables

Numbered cable
Order no. H6-928-14

Cross-section 0.75 mm^2 (24 x 0.2 mm)
5 x 2 wires twisted in pairs
Screening: copper braiding with strand 0.75 mm^2
Outside diameter approx. 14 mm
PVC-sheath
Oil resisting

Supplier: BERGER LAHR GmbH
Max. length delivered: 1000 m

Numbered cable
Order no. H6-928-26

Cross-section 1.5 mm^2 (30 x 0.25 mm)
5 x 2 wires twisted in pairs
Screening: copper braiding with strand 1.42 mm^2
Outside diameter approx. 16 mm
PVC-sheath
Oil resisting

Supplier: BERGER LAHR GmbH
Max. length delivered: 1000 m
Max. laid length: 100 m

The actual motor output depends on the cable length and cable cross-section.

ATTENTION
When laying other cables, the noise immunity may be reduced. Therefore make sure that the cables are screened and the wires are twisted in pairs.

18 Ventilation

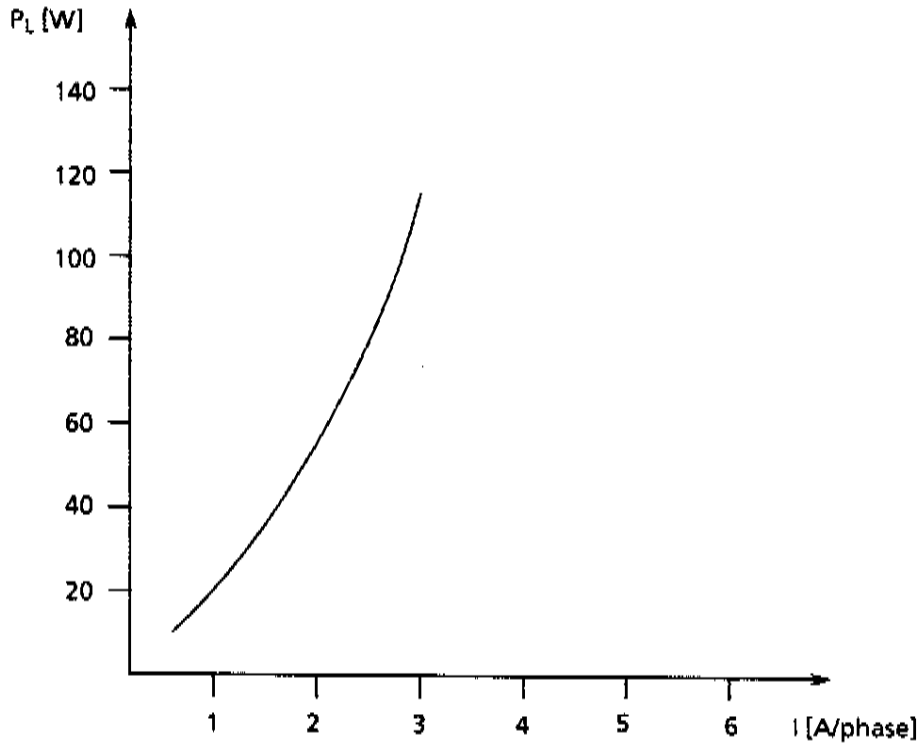
The D 550 may be operated without forced air cooling, if the phase current does not exceed 1.4 A and the ambient temperature does not exceed 40°C. Forced cooling is mandatory to dissipate the power loss on the card.

Therefore take special care that:

- adequate air circulation is provided through and around the card.

If the heatsink temperature exceeds 85°C, the card is switched off.

The following diagram illustrates the power loss P_L of power control card D 550.



19 Externally driven motor

In applications where the step motor is externally driven temporarily (generator effects), a special protective circuit prevents the operating voltage from rising owing to the generator effect, thus protecting the card and the power supply unit against excessive voltages.

Please note that the READY relay is released and the under-/overvoltage LED lights up on responding of the protective circuit. As a result, the motor position is also lost.

20 Technical data

Operating voltage	35...70 VDC
Residual ripple	< 10%
Current consumption	max. 6 A
Power loss of the card	max. 90 W
Phase current adjustable	0.55...2.8 A in steps of 150 mA
Boost function	I_{nom} x 1.2
Current reduction with pulse frequencies	< 10 Hz I_N x 0.6
Load	max. 150 mA
Signal voltage at D 550.00 at D 550.01	24 V - see table 5 V - see table
Input currents	typ. 10 mA
Input signals, electrically isolated	Pulse, direction, gate, PWM current control/boost
Relay contact output (changeover contact)	36 VDC / 30 VAC, 0.2 A
Operating temperature	0...55°C
Storage temperature	0...70°C
Humidity class	"F" DIN 40040
Mechanical dimensions	100 x 160 x 58 mm
Weight	950 g

D 550.00

Logical 1 min.	Signal level	Logical 1 max.
20 V	V_s	30 V
10 mA	I_{in}	25 mA
Logical 0 min.	Signal level	Logical 0 max.
-3 V	V_s	3 V
-30 mA	I_{in}	1 mA

R = 1000 ohms

D 550.01

Logical 1 min.	Signal level	Logical 1 max.
2.5 V	V_s	5.25 V
5 mA	I_{in}	25 mA
Logical 0 min.	Signal level	Logical 0 max.
-5.25 V	V_s	0.4 V
-30 mA	I_{in}	0.1 mA

R = 75 ohms

21 Type code, accessories, order numbers

21.1 Type code

Type	Signal level
D 550.00	24 V
D 550.01	5 V

21.2 Accessories and order numbers

Standard accessories

32-pole female connector for wire connection — Order no. n4-673-96

Technical documentation No. 220.550/DGB

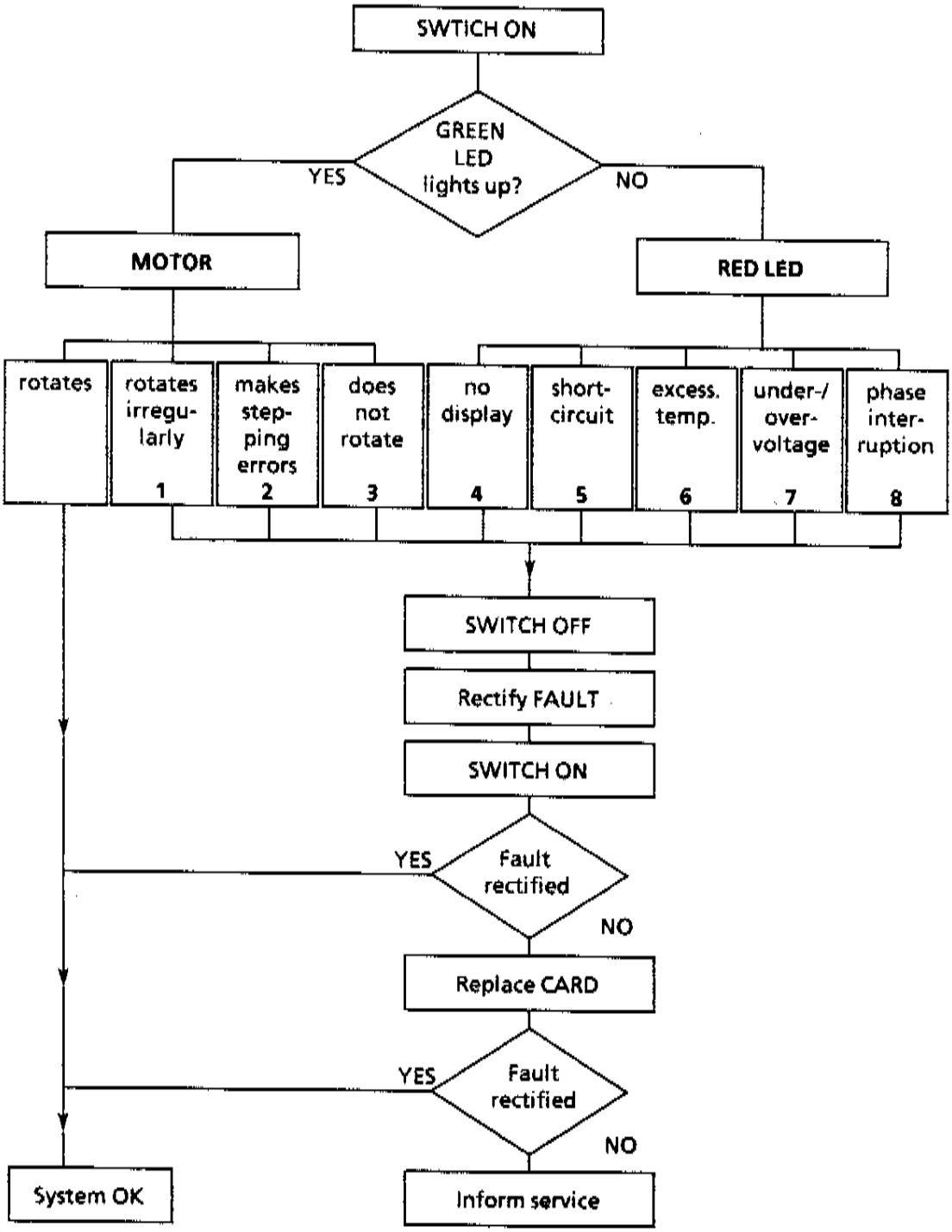
Further accessories

The following accessories can be ordered separately:

Screened signal cable, 12 wires	Order no. H6-928-30
Screened motor cable, 10 wires, 0.75 mm^2	Order no. H6-928-14
Screened motor cable, 10 wires, 1.5 mm^2	Order no. H6-928-26
32-pole female connector for pc-board installation	Order no. n4-673-97
32-pole female connector for wire connection	Order no. n4-673-96

22 Troubleshooting and rectification

22.1 Troubleshooting chart



22.2 Malfunction rectification table

Detected fault		Possible causes	Rectification
1	Motor rotates irregularly	- Interchanged connections - Load moment too high - Defective motor	- Connect correctly - Check load relations - Replace motor
2	Motor makes stepping errors	- Interchanged connections - Load moment too high - Motor defective - Electrical noise of control signals	- Connect correctly - Check load relations - Replace motor - Suppress noise
3	Motor does not rotate	- Signal relations - Pulse, PWM current control, gate not in order	- Activate as specified
4	No display	- Operating voltage too low - Operating voltage wrongly connected	- Set correctly - Connect correctly
5	Short-circuit, overload	- Short-circuit in connector, cable, motor	- Remove short-circuit or replace motor
6	Excessive temperature	- Amb. temperature too high - Ventilator has failed or insufficient ventilation - Short-circuits in motor or cable	- Cool down - Vent sufficiently - Remove short-circuit
7	Under-/over-voltage	- Operating voltage $< 36V$ or $> 85V$ - Overvoltage caused by externally driven motor or rapid braking in operation	- Adjust correctly - No further measures
8	Phase interruption	- Interruption in connector, cable or motor - Misconnected motor lines	- Eliminate interruption or replace motor - Connect correctly

TABLE OF FIGURES

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BERGER LAHR GmbH

Breslauer Str. 7
Postfach 1180

D-7630 LAHR

Proposals
Improvements

D 550.00/01
Device documentation

Power control card
for 5-phase stepping motors
without rotation monitoring

Edition: a 294 Dec. 89
Doc. no. 220.550/DGB 12.89

Sender:

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Proposals and/or improvements