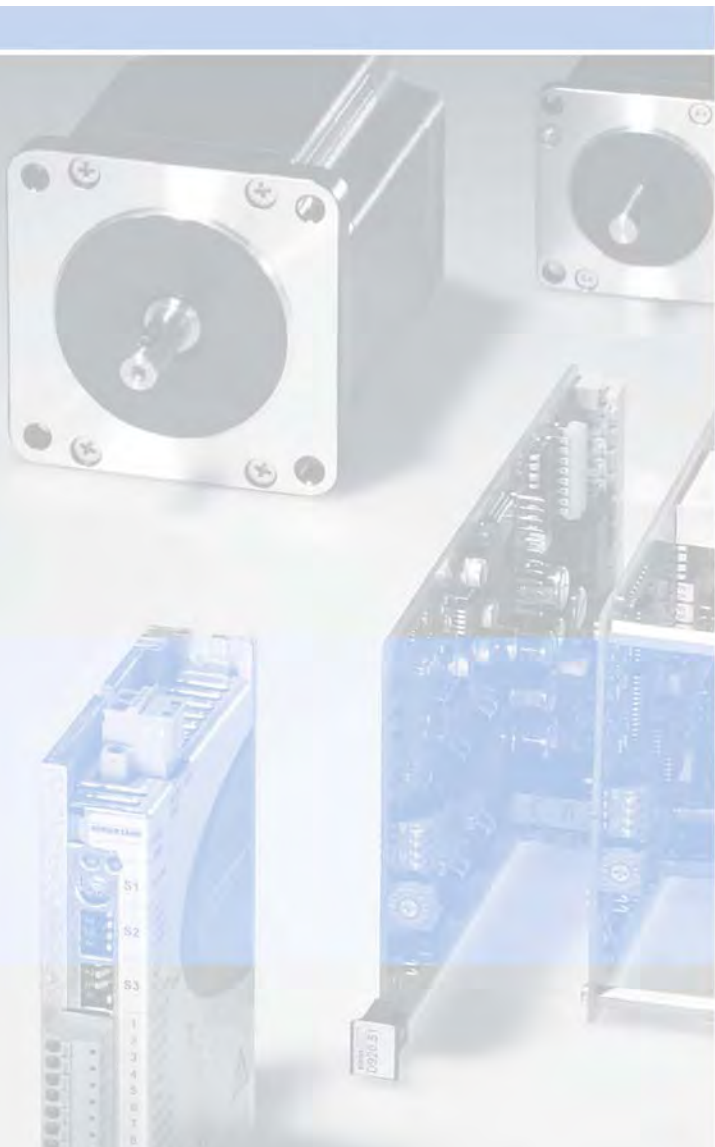


## Catalogue

### Stepper motor drives SD3 15, D9••

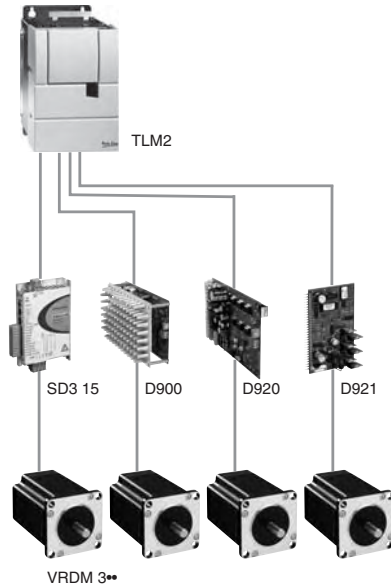




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## Product overview

The SD3 15 stepper motor drive and the D9•• stepper motor drive boards are suitable for all applications. Reference values are set as pulse/direction signals by a master PLC or a Berger Lahr Motion Controller (e.g. TLM2). This range of products can be used to control series VRDM 36• and VRDM 39• motors. The nominal torques of these motors range from 0.45 to 6 Nm.

## Special features

### Compactness

Due to their small size, the stepper motor drive boards require very little installation space.

### Simplicity

Parameter switches allow for quick and easy commissioning. Commissioning software is not required.

### Flexibility

Stepper motor drive boards are available as plug-in units for 19" rack mounting or a 3HU boards (D900, D920) for wall mounting or DIN rail mounting (SD3 15), as well as a power module (D921) for integration of customer-specific electronics.

Power is supplied via an external power supply unit e. g. 24 V<sub>DC</sub> (D920, D921, SD3 15) or 130 V<sub>DC</sub> (D900).

5 V or 24 V input signals are used to control the units.

## Application options

The Berger Lahr stepper motor drive have excellent constant velocity characteristics which are required for applications such as scanning or exposure.

Due to the high torque at low speeds, the stepper motor drive is particularly suited for short-distance positioning.

Another advantage is its high holding torque at standstill. This allows for the highly economic implementation of automation tasks such as "pick and place".

**Assignment of stepper motors, stepper motor drives SD3 15 and D9••**

3-phase stepper motors		SD3 15	D900	D920	D921
Power supply		24 ... 48 V <sub>DC</sub> , max. 10 A	80 ... 140 V <sub>DC</sub> , max. 4 A	18 ... 40 V <sub>DC</sub> , max. 6 A	18 ... 40 V <sub>DC</sub> , max. 5 A
					
<b>Motors with H winding</b>					
VRDM 364 / 50L H	Nm	0.51 / 0.45 <sup>1)</sup>		0.51 / 0.45	0.51 / 0.45
VRDM 366 / 50L H	Nm	1.02 / 0.90		1.02 / 0.90	1.02 / 0.90
VRDM 368 / 50L H	Nm	1.70 / 1.50		1.70 / 1.50	1.70 / 1.50
VRDM 397 / 50L H	Nm	2.26 / 2.00		1.92 / 1.70	1.92 / 1.70
VRDM 3910 / 50L H	Nm	4.80 / 4.00		4.18 / 3.70	4.18 / 3.70
VRDM 3913 / 50L H	Nm	6.50 / 5.75		5.65 / 5.00	
<b>Motors with N winding</b>					
VRDM 366 / 50L N	Nm		1.02 / 0.90		
VRDM 368 / 50L N	Nm		1.70 / 1.50		
VRDM 397 / 50L N	Nm		2.26 / 2.00		
VRDM 3910 / 50L N	Nm		4.52 / 4.00		
VRDM 3913 / 50L N	Nm		6.78 / 6.00		

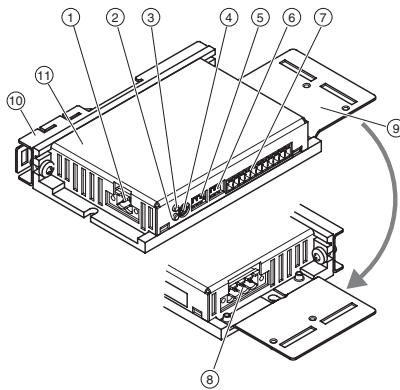
<sup>1)</sup> The 1st value is the holding torque  $M_H$  when the stepper motor is at a standstill, the 2nd value is the nominal torque  $M_N$  when the motor is in operation.

## Stepper motor drive SD3 15

### Product description

The SD3 15 stepper motor drive is used to control 3-phase stepper motors with H windings: VRDM36...LH and VRDM39...LH.

### Device overview



- (1) Power supply CN1
- (2) LED1 (green)
- (3) LED2 (red)
- (4) Rotary switch S1 for adjustment of the current reduction
- (5) Parameter switch S2
- (6) Parameter switch S3
- (7) Signal interface CN2
- (8) Motor connection CN3
- (9) EMC mounting plate (accessories)
- (10) DIN rail adapter (accessories)
- (11) Nameplate with quick reference

### Power supply CN1

Power is supplied via connection CN1. The supply voltage  $V_{DC}$  is at the same time the control voltage.

The control voltage supply unit at the drive system has no inrush current limitation. If the voltage is applied via contacts, these may be destroyed.

### Signal interface CN2

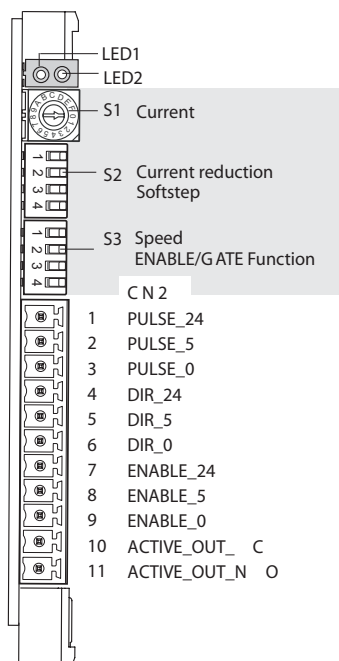
The reference position of the stepper motor is preset as a pulse signal by a controller via the CN2 signal interface. One pulse corresponds to one step of the motor. In addition, the following functions can be activated via input signals:

- Enable/disable power amplifier or pulses
- Direction of rotation left/right
- Increase/decrease number of steps by a factor of 10
- Change motor current

An electronic relay contact reports operating readiness. All input signals can be supplied as 5 V or 24 V signals via optocouplers.

### Motor connection CN3

Motor lines U, V and W and the shield connection are connected to motor connection CN3.

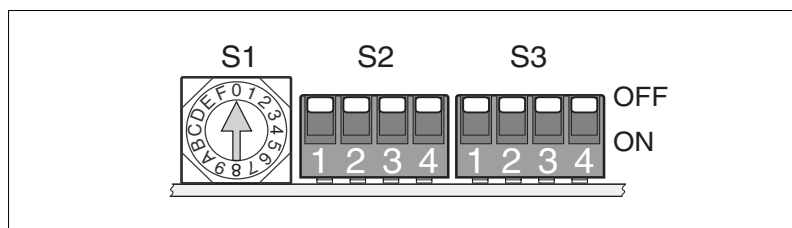


## Functions

### Parameterisation

The following functions can be activated via the parameter switch of the SD3 15:

- Motor phase current
- Steps per revolution
- Current reduction during standstill
- "Softstep"
- Type of release ("ENABLE" or "GATE")



Parameter switches

### Setting motor phase current

The motor phase current is set with rotary switch S1. The set value should correspond to the nominal motor current  $I_N$ , see motor nameplate. A low motor phase current produces a low torque.

#### Adjustments with rotary switch S1

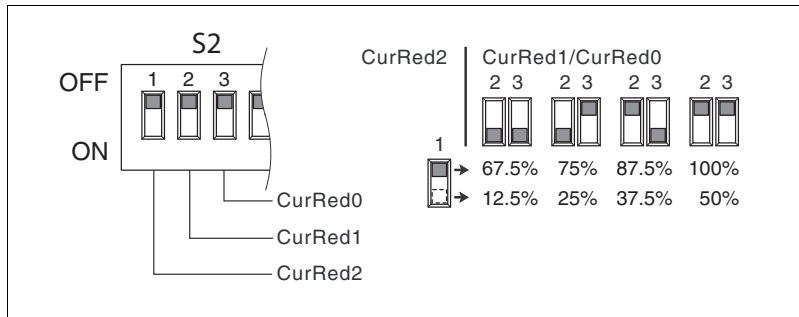
Switch setting S1	Motor phase current in A
0 (factory setting)	3
1	3.7
2	4.4
3	4.8
4	5.2
5	5.5
6	5.8
7	6.2
8	6.6
9	7
A	7.5
B	8
C	8.5
D	9
E	9.5
F	10

### Setting current reduction

If the full holding torque is not required at standstill, the "current reduction" function can be used to reduce the holding torque. Motor and electronics heat up less and the efficiency is improved.

When the last pulse edge has been received, the motor phase current is reduced to the percentage value set with parameter switch S2.

#### Adjustments with parameter switch S2



Setting current reduction

### Setting steps per revolution

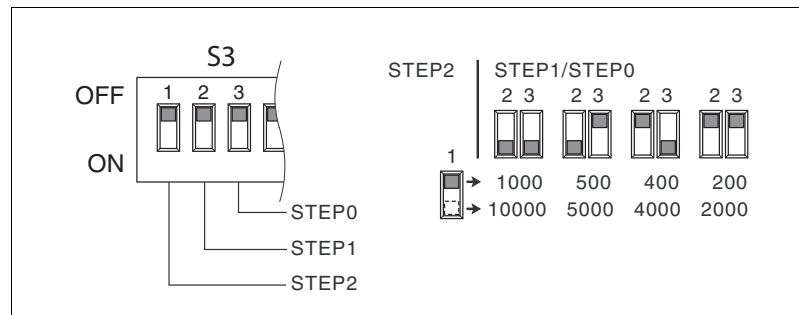
The resolution of the stepper motor drive is set via the number of steps.

Example:

At a number of steps of 1000 and at 1000 pulses, the stepper motor drive turns the motor exactly one complete revolution. At a pulse frequency of 1 kHz this results in a speed of 60 1/min.

#### Adjustments with parameter switch S3

Number of steps: 200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000 per revolution



Setting steps per revolution

### Activating the "Softstep" function

If the "Softstep" function is activated, the reference value is internally set to a higher resolution. The motor then runs much more smoothly, in particular at low speeds or sudden changes in the reference value

The motor accelerates and decelerates virtually without jerking. The transitions are smoothed, i.e. the motor can follow the reference values much more easily with fast changes of frequency.

#### Adjustments with parameter switch S2.4

Activate/deactivate "Softstep" function

## Setting release type

The release type can be set with parameter switch S3.4.

Switch setting S3.4	Description
OFF (factory setting)	"ENABLE" function Activating and deactivating the power amplifier
ON	"GATE" function Enable or disable reference values

## Signal inputs and outputs

All signal inputs are available as a 5 V or 24 V optocoupler inputs.

**ENABLE signal input**

Signal input **ENABLE** activates or deactivates the power amplifier. In addition, an error message is reset with a rising edge.

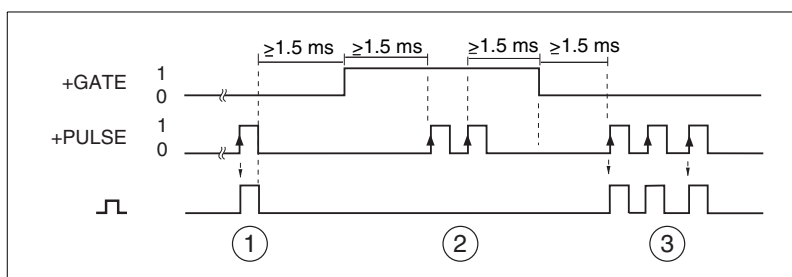
Signal value	Description
Rising edge	Activate power amplifier
Falling edge	Deactivate power amplifier and reset error message

If no error condition is present, signal output **ACTIVE\_OUT** signals readiness for operation approx. 500 ms after activation of the power amplifier .

**GATE signal input**

Signal input **GATE** blocks the signals at the signal interface without disabling the operating readiness. In a multi-axis system, you can select individual axes via **GATE**.

Signal value	Description
Rising edge	Block signals
Falling edge	Enable signals



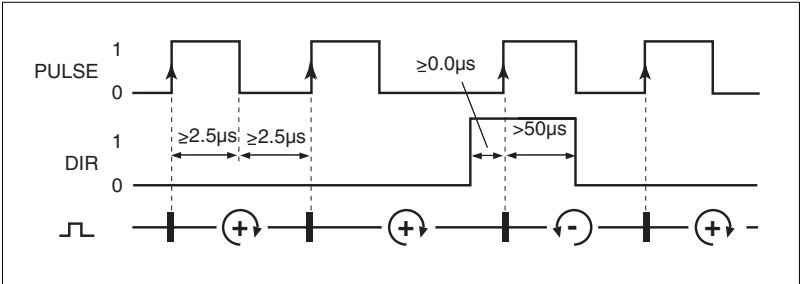
Signal sequences in case of activation via GATE

- (1) Motor step
- (2) No motor steps
- (3) Motor steps

No pulse may be applied for 1.5 ms before and after the GATE signal changes to ensure that the drive can follow the preset pulse step by step.

PULSE/DIR signal input

The motor executes a motor step with the rising edge of the PULSE signal. The direction of rotation is controlled by the DIR signal.



"PULSE/DIR" interface mode

Signal	Signal value	Description
PULSE	Rising edge	Motor step
DIR	0 level	Positive rotation
	1 level	Negative rotation

The maximum frequency is 200 Hz.

ACTIVE\_OUT signal output

The signal output ACTIVE\_OUT indicates operating readiness.

Signal value	Description
Open	Power amplifier deactivated, motor without current
Closed	Power amplifier activated, motor has current

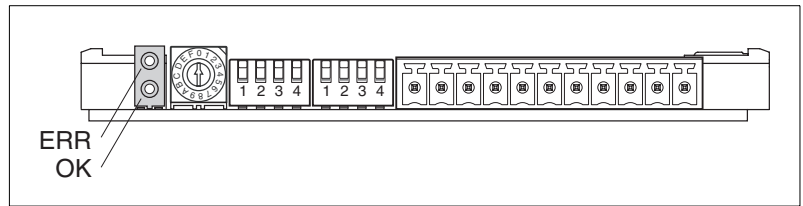
Monitoring functions

The monitoring functions are provided to protect the equipment. These monitoring functions are not designed to protect personnel.

The following errors and limit values can be monitored:

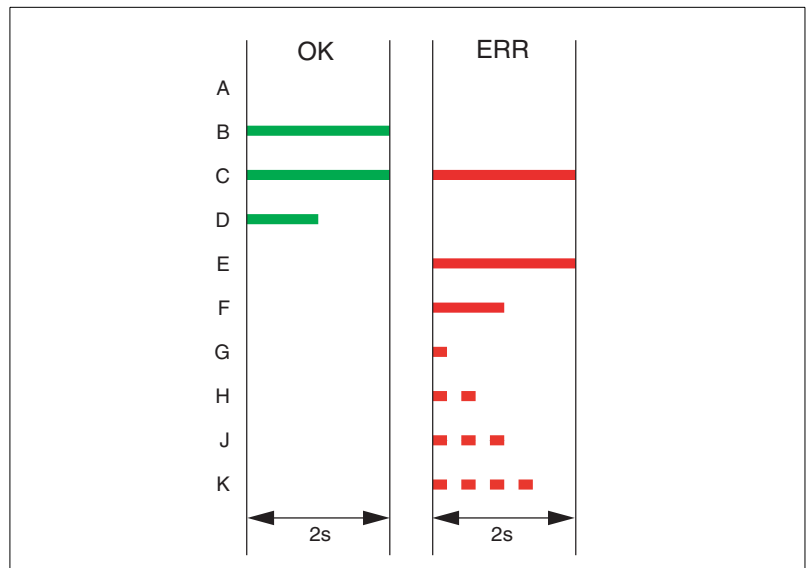
Monitoring	Task	Protective function
Overvoltage and undervoltage	Monitoring for overvoltage and undervoltage of the power supply	Functional safety and device protection
Overtemperature	Monitoring device for overtemperature	Device protection
Short circuit	Monitoring for short circuits between the motor phases	Device protection

### Status display



Status display via LEDs

The LEDs display the current operating status.



Flash codes of LED OK and LED ERR

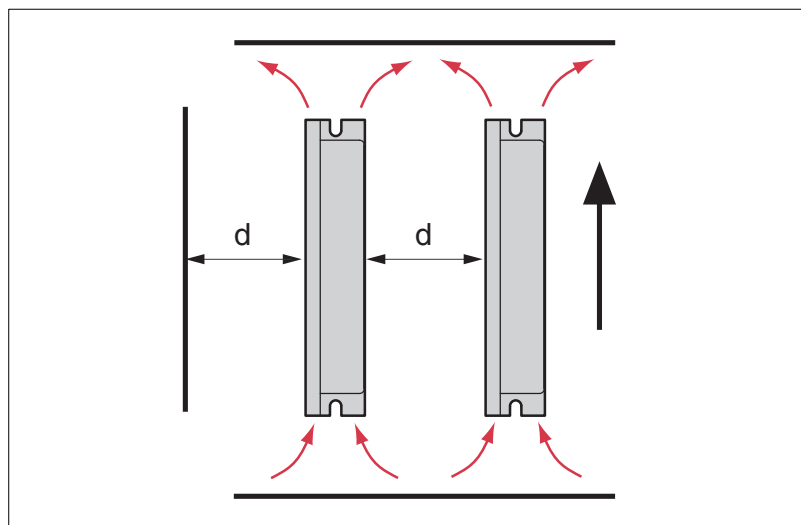
- (A) No power supply.
- (B) Power amplifier is activated.
- (C) Reserved
- (D) Power amplifier is deactivated.
- (E) Reserved
- (F) Power amplifier overtemperature
- (G) Overvoltage, also in case of regeneration conditions.
- (H) Undervoltage
- (J) Reference signal frequency too high
- (K) Short circuit between two motor phases.

## Mounting and installation

### Mounting distances and ventilation

When selecting the position of the device in the control cabinet, note the following instructions:

- Adequate cooling of the device must be ensured by complying with the minimum installation distances. Prevent heat accumulation.
- The device must not be installed close to heat sources or mounted on flammable materials.
- The warm airflow from other devices and components must not heat the air used for cooling the device.
- The drive will switch off as a result of overtemperature when operated above the thermal limits.



Installation distances and air circulation

The specified continuous current is applicable if the following distances are maintained and the device is installed vertically.

- At least 10mm of free space is required in front of the device.
- At least 50 mm of free space is required above the device.
- For "d" ist mindestens 30 mm Freiraum einzuhalten.
- At least 200mm of free space is required below the to ensure that cables can be routed without excessive bending.

If other components are installed in these areas, the possible continuous current is reduced.

The SD3 15 stepper motor drive meets the EMC requirements for the second environment as per IEC 61800-3.

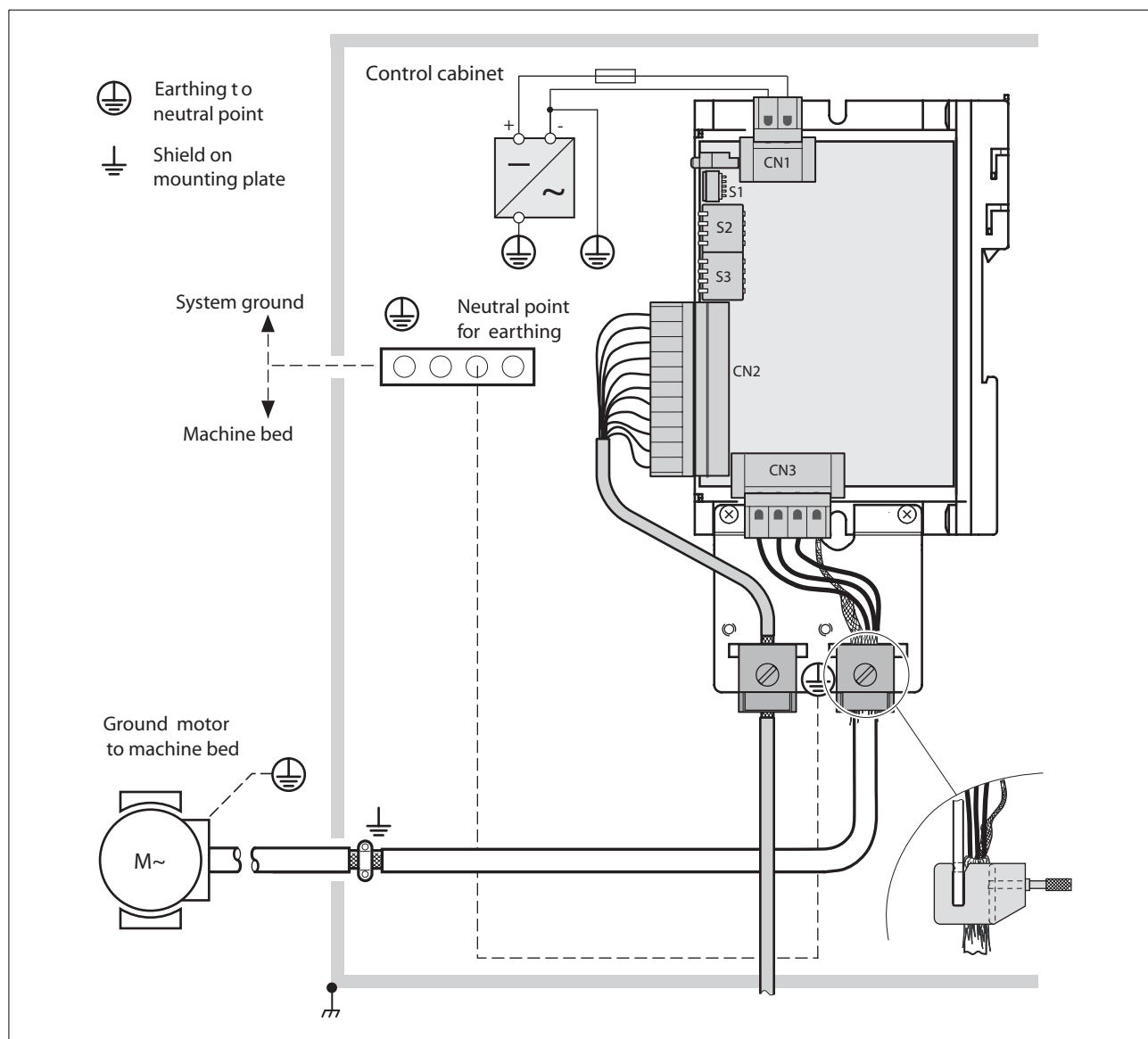
An EMC-compliant design is required to maintain the specified limit values, see documentation.

## EMC-compliant installation

The SD3 15 stepper motor drive meets the EMC requirements for the second environment as per IEC 61800-3.

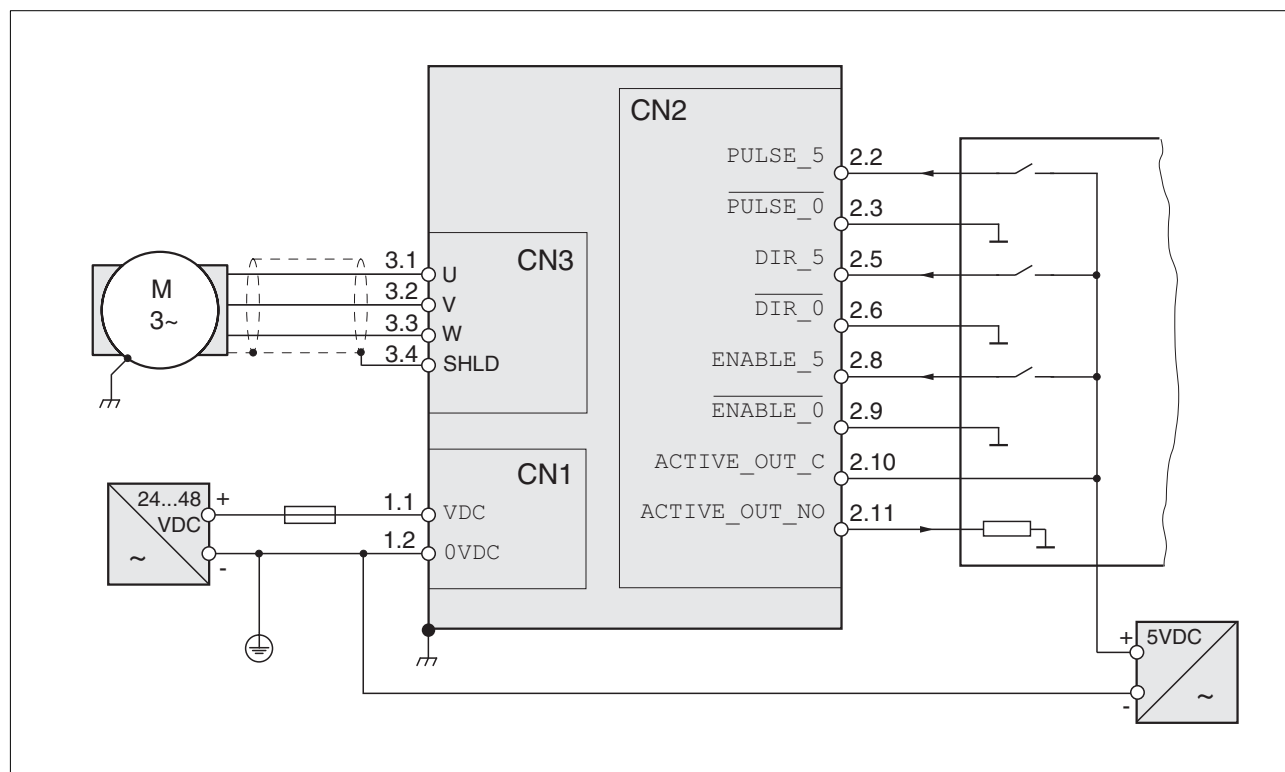
An EMC-compliant design is required to maintain the specified limit values, see documentation.

### EMC measures for the SD3 15 stepper motor drive

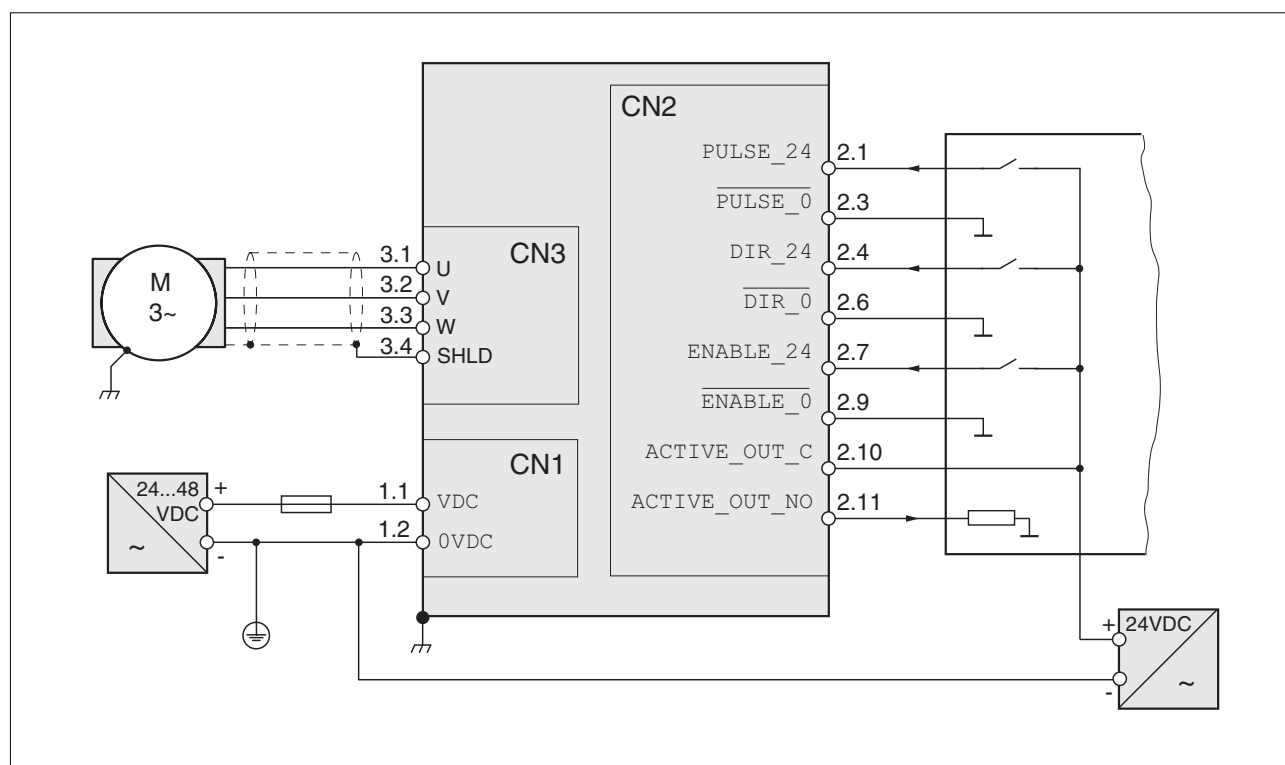


EMC measures

## Wiring examples



Wiring example with 5 V



Wiring example with 24 V

**Technical data****Mechanical data**

		<b>SD3 15</b>
Dimensions (W x H x D)	mm	74.5 x 117 x 23.5
Weight	kg	0.25
Type of cooling		Free convection

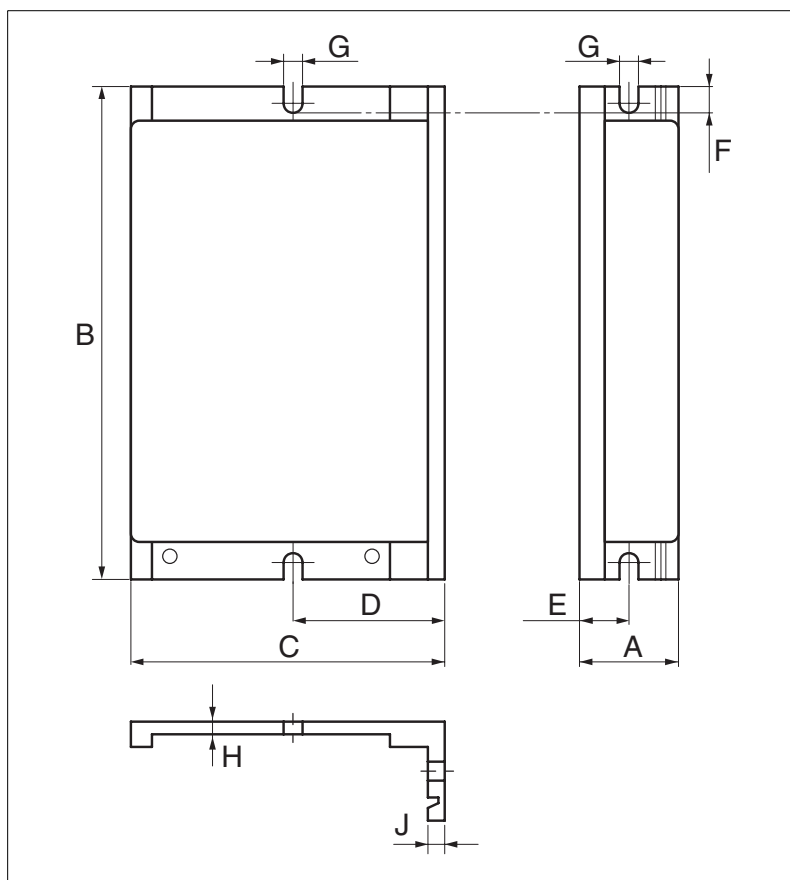
**Electrical data**

		<b>SD3 15</b>
<b>Power supply at CN1</b>		
Supply voltage	V <sub>DC</sub>	24 ... 48
Limit values	V <sub>DC</sub>	19.2 ... 60
Max. current consumption	A	7.5
Residual ripple	%	<5
Power loss	W	<7
Fuse, external	A	<10
<b>Signal interface CN2</b>		
5 V optocoupler input signals		
• Logic 1 (U <sub>high</sub> )	V	+2.5 ... +5.25
• Logic 0 (U <sub>low</sub> )	V	≤0.4
• Input current	mA	≤25
• Max. input frequency	kHz	≤200
24 V optocoupler input signals		
• Logic 1 (U <sub>high</sub> )	V	+15 ... +30
• Logic 0 (U <sub>low</sub> )	V	≤5
• Input current	mA	≤7
• Max. input frequency	kHz	≤200
Signal output "Readiness"		Electronic relay
• Max. switching voltage	V <sub>DC</sub>	≤30
• Max. switching current	mA	≤200
• Voltage drop at 50 mA load	V	≤1
<b>Motor connection at CN3</b>		
Max. motor phase current	A <sub>pk</sub>	14
	A <sub>rms</sub>	10
Number of phases		3

**Ambient conditions**

Operating / ambient temperature	°C	0 ... +50%, no icing allowed
Transport and storage temperature	°C	-25 ... +70
Pollution degree		2
Relative humidity	%	5 ... 85%, no condensation allowed
Installation height above mean sea level for 100% power	m	< 1000
Installation height	m	<2000 at max. Ambient temperature 40 °C, set up with gap at side of >20 mm
Oscillation and vibration		As per IEC/EN 60068-2-6
	mm	1.5; sine 3 ... 13 Hz
	m/s <sup>2</sup>	10; sine 13 ... 150 Hz
Shock loading		As per IEC/EN 60068-2-27
	m/s <sup>2</sup>	150; half-sine 11 ms
Degree of protection		IP 20

## Dimensional drawings



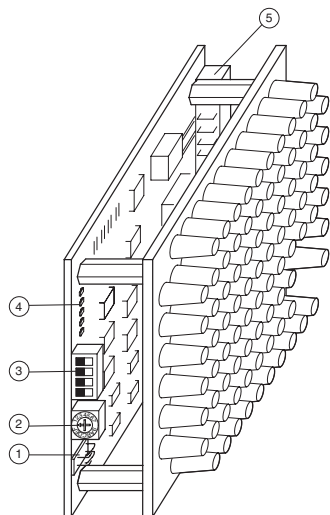
Dimensions SD3 15

A	mm	23.5
B	mm	117
C	mm	74.5
D	mm	36
E	mm	11.75
F	mm	6.25
G	mm	4.5
H	mm	3
J	mm	4

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**Order number**

Type	Order number
SD3 15D N10 B4 00	0062050003001



## D900 stepper motor drive board

### Product description

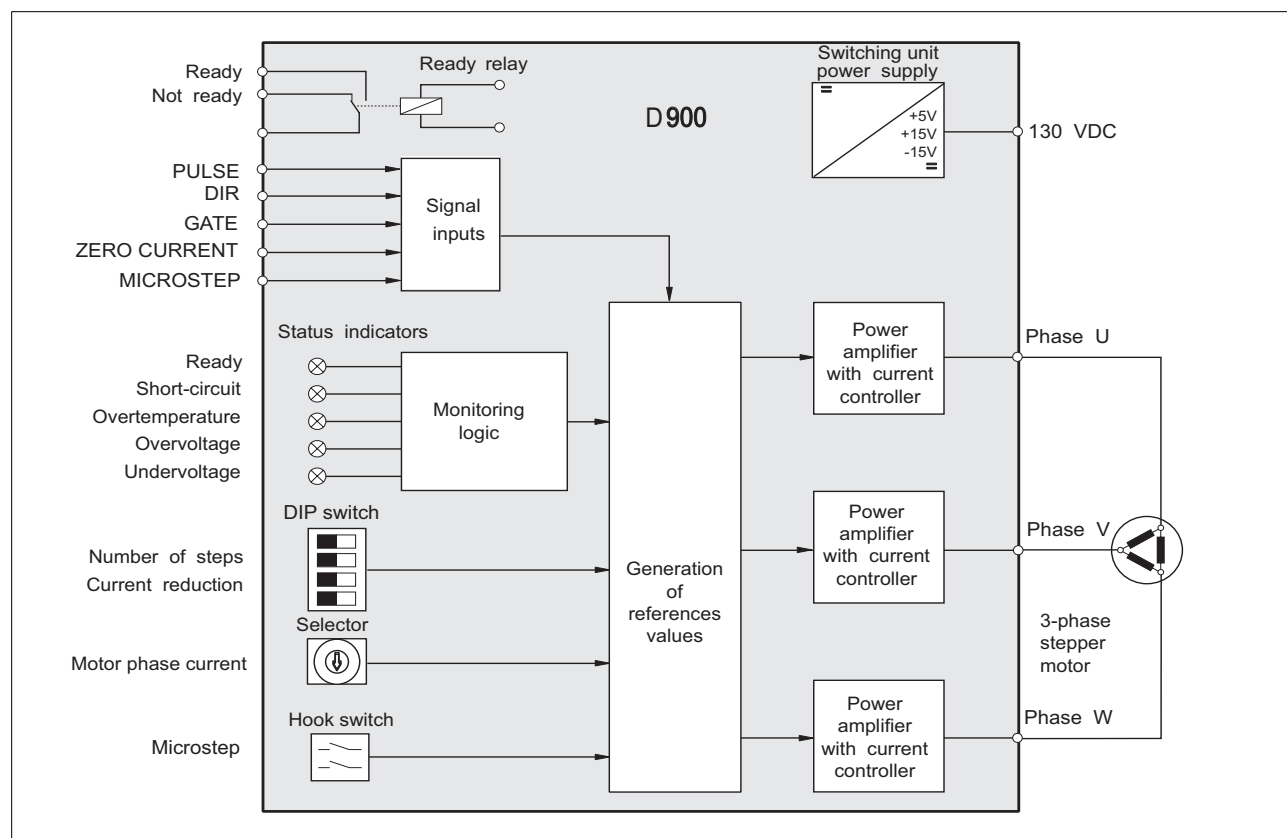
The D900 stepper motor drive board is used to control 3-phase stepper motors with N windings: VRDM 36...LN and VRDM 39...LN.

This board is available in two versions:

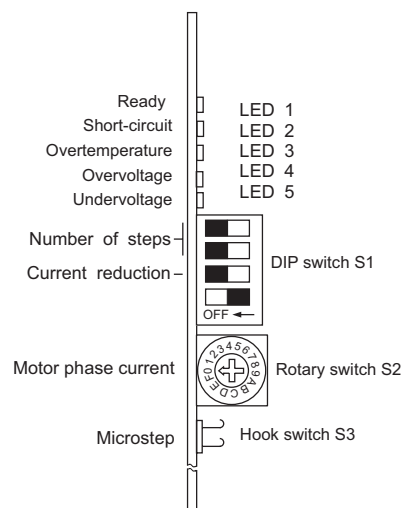
- D 900.50 (control with 24 V)
- D 900.51 (control with 5 V)

### Device overview

- (1) Hook switch for setting the "Microstep" function
- (2) Parameter switch for setting the motor phase current
- (3) Parameter switch for setting the number of steps and the current reduction
- (4) 5 LEDs
- (5) Plug-in unit 19" rack mounting housing (3HU)



Block diagram D900



## Functions

### Parameterisation

The following functions can be set via the parameter switches of the stepper motor drive board:

- Motor phase current
- Steps per revolution
- Current reduction during standstill
- "Microstep"

### Setting motor phase current

The motor phase current is set with rotary switch S2. The set value should correspond to the nominal motor current  $I_N$ , see motor nameplate. A low motor phase current produces a low torque.

### Adjustments with rotary switch S2

Switch position S2	Motor phase current in A
0 (factory setting)	1.35
1	1.65
2	1.90
3	2.20
4	2.45
5	2.75
6	3.00
7	3.30
8	3.60
9	3.90
A	4.15
B	4.40
C	4.70
D	5.00
E	5.20
F	5.50

### Setting steps per revolution

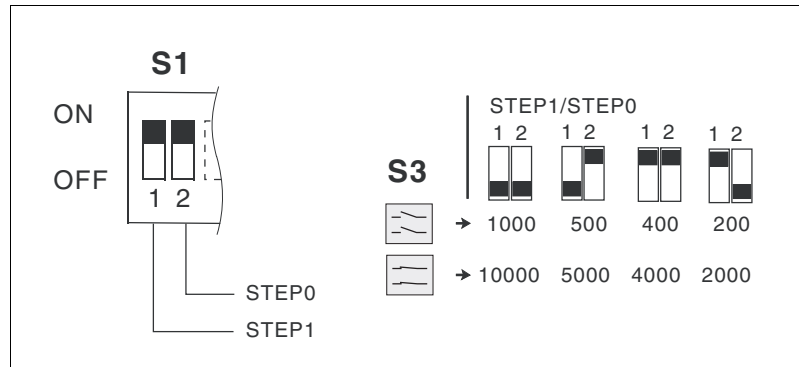
The resolution of the stepper motor drive is set via the step number.

Example:

With a step number of 1000, the stepper motor drive performs exactly one revolution for 1000 pulses. With a pulse frequency of 1 kHz, the result is therefore a speed of rotation of 60 1/min.

### Adjustments with parameter switches S1 and S3

Number of steps: 200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000 per revolution



Setting steps per revolution

The setting of hook switch S3 can be inverted via the input signal MICROSTEP. This increases or decreases the number of steps by a factor of 10.

### Activating the current reduction

If the full holding torque is not required at standstill, the "current reduction" function can be used to reduce the holding torque. Motor and electronics heat up less and the efficiency is improved.

The motor phase current is reduced to approximately 60% of the set current value after the last pulse edge was received.

### Adjustments with parameter switch S1.3

Activate/deactivate current reduction

### Activating the "Microstep" function

The "Microstep" function can be activated in two ways. Mechanically via hook switch S3 and digitally via the input signal at the MICROSTEP signal input.

Activating the "Microstep" function increases the resolution and the number of motor steps by a factor of 10.

### Adjustments with hook switch S3

Activate/deactivate "Microstep" function

### Signal inputs and outputs

#### PULSE signal input

In order to generate a rotary movement of the motor shaft, square pulses must be supplied at the pulse input. Each positive pulse edge triggers one motor step when the gate input is without current.

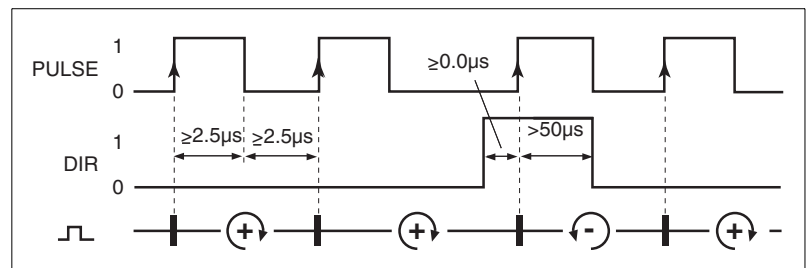
The direction of rotation is controlled by the DIR input.

#### DIR signal input

When the DIR signal input is currentless, the motor turns clockwise, viewed from the front onto the motor shaft. If the signal input is live, the motor runs anticlockwise. It is possible to invert the direction of rotation by changing two motor phases.

#### PULSE/DIR interface mode

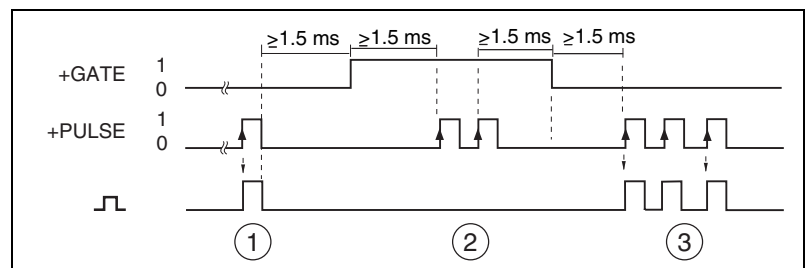
The motor executes an angular step with the rising edge of the PULSE signal. The direction of rotation is controlled by the DIR signal. The pulse maximum frequency is 200 kHz.



PULSE/DIR interface mode

#### GATE signal input

The "GATE" function blocks the pulses at the reference value input without switching off the operating readiness. In a multi-axis system, individual axes can be selected with the "Gate" function.



Signal sequences in case of activation via the "GATE" function

- (1) Motor step
- (2) No motor steps
- (3) Motor steps

#### MICROSTEP signal input

The "MICROSTEP" function is selected via the MICROSTEP signal input or with the hook switch S3. The time sequence of the MICROSTEP signal input and that of the GATE signal input are the same.

**ZERO CURRENT signal input**

When the signal input is live, the motor phase current is switched off. At a standstill, the motor has no holding torque.

**Signal output**

If the board is working correctly, the operating readiness contact is closed and the ready for operation LED lights up.

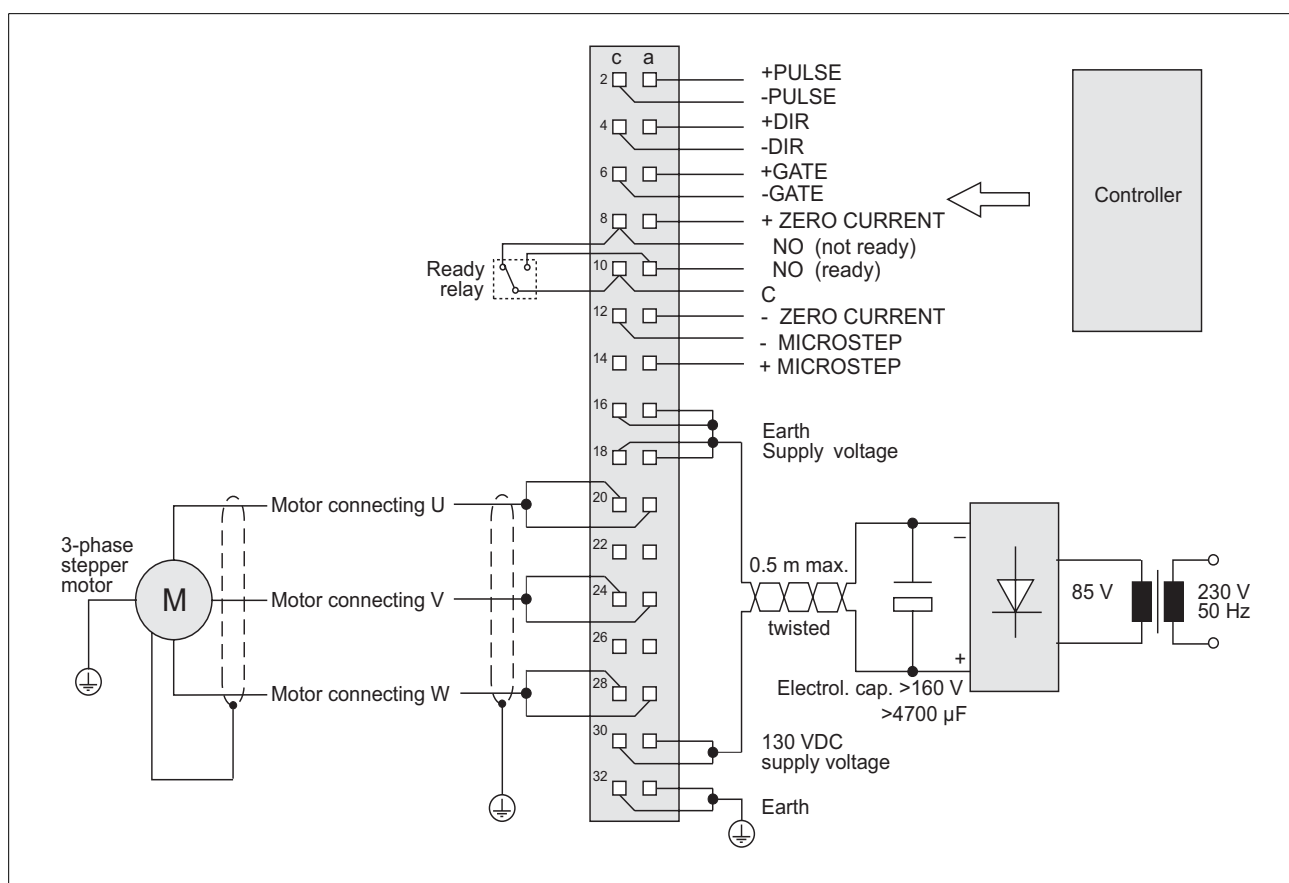
**Status display LED**

The five LEDs on the board show the operating status and any malfunctions.

- LED 1: Readiness
- LED 2: Short circuit
- LED 3: Overtemperature
- LED 4: Overvoltage
- LED 5: Undervoltage

**Mounting and installation**

The board is mounted in a 19" rack mounting housing (3HU). When mounting the board, make sure to keep a distance of at least 5 cm between the board and the housing wall or the next board. The board can be ventilated longitudinally or transversely.



Wiring example D900

**Technical data****Mechanical data**

Dimensions (W x H x D)	mm	100 x 160 x 51
Weight	kg	0.5

**Electrical data**

Power supply			
Supply voltage	V <sub>DC</sub>	80 ... 140	
Max. current consumption	A	4	
Max. power loss	W	40	
Max. length supply cable, twisted	m	5	
Motor connection			
Motor phase current	A	1.35 ... 5.5	
Motor voltage	V	3 x 130	
Motor cable as per EN 60204			
• Max. length	m	50	
• Cross section at cable length ≤ 30m	mm <sup>2</sup>	0.75	
• Cross section at cable length > 30m	mm <sup>2</sup>	≥1.5	
• Shield connection		at both ends	
Signal connection <sup>1)</sup>		D900.50	D900.51
Voltage control			
• Logic 1 (U <sub>high</sub> )	V	2.5 ... +5.25 <sup>2)</sup>	20 ... 30
• Logic 0 (U <sub>low</sub> )	V	+0.4 ... -5.25	-3 ... +3
• Input current	mA	≤30	≤20
Current control			
• Logic 1 (I <sub>high</sub> )	mA	+7 ... +25	+7 ... +15
• Logic 0 (I <sub>low</sub> )	mA	+0.2 ... -25	+0.2 ... -15
• Input voltage	V	≤5.25	≤30
Input resistance	Ω	150	2000
Max. input frequency	kHz	≤200	
Readiness signal output		Electronic relay (resistive load)	
• Max. switching voltage	V <sub>DC</sub>	≤36	
• Switching current	mA	10 ... 200	

<sup>1)</sup> The PULSE, DIR, GATE, ZERO CURRENT, MICROSTEP signal inputs are optocoupled and protected against reverse polarity

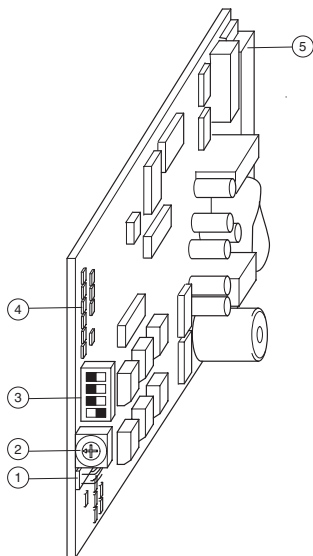
<sup>2)</sup> Pulse signal voltage 3.5 V to 5.25 V for pulse duration/pulse pause <10 μs

**Ambient conditions**

Operating / ambient temperature	°C	0 ... +50%, no icing allowed
Transport and storage temperature	°C	-25 ... +70
Pollution degree		2
Relative humidity	%	5 ... 85%, no condensation allowed
Installation height above mean sea level for 100% power	m	< 1000
Installation height	m	<2000 at max. ambient temperature 40 °C, set up with gap at side of >20 mm
Oscillation and vibration		As per IEC/EN 60068-2-6
	mm	1.5; sine 3 ... 13 Hz
	m/s <sup>2</sup>	10; sine 13 ... 150 Hz
Shock loading		As per IEC/EN 60068-2-27
	m/s <sup>2</sup>	150; half-sine 11 ms
Degree of protection		IP 00

**Order numbers**

Type	Order number
D900.50 (24 V signal voltage)	0062010900503
D900.51 (5 V signal voltage)	0062010900513



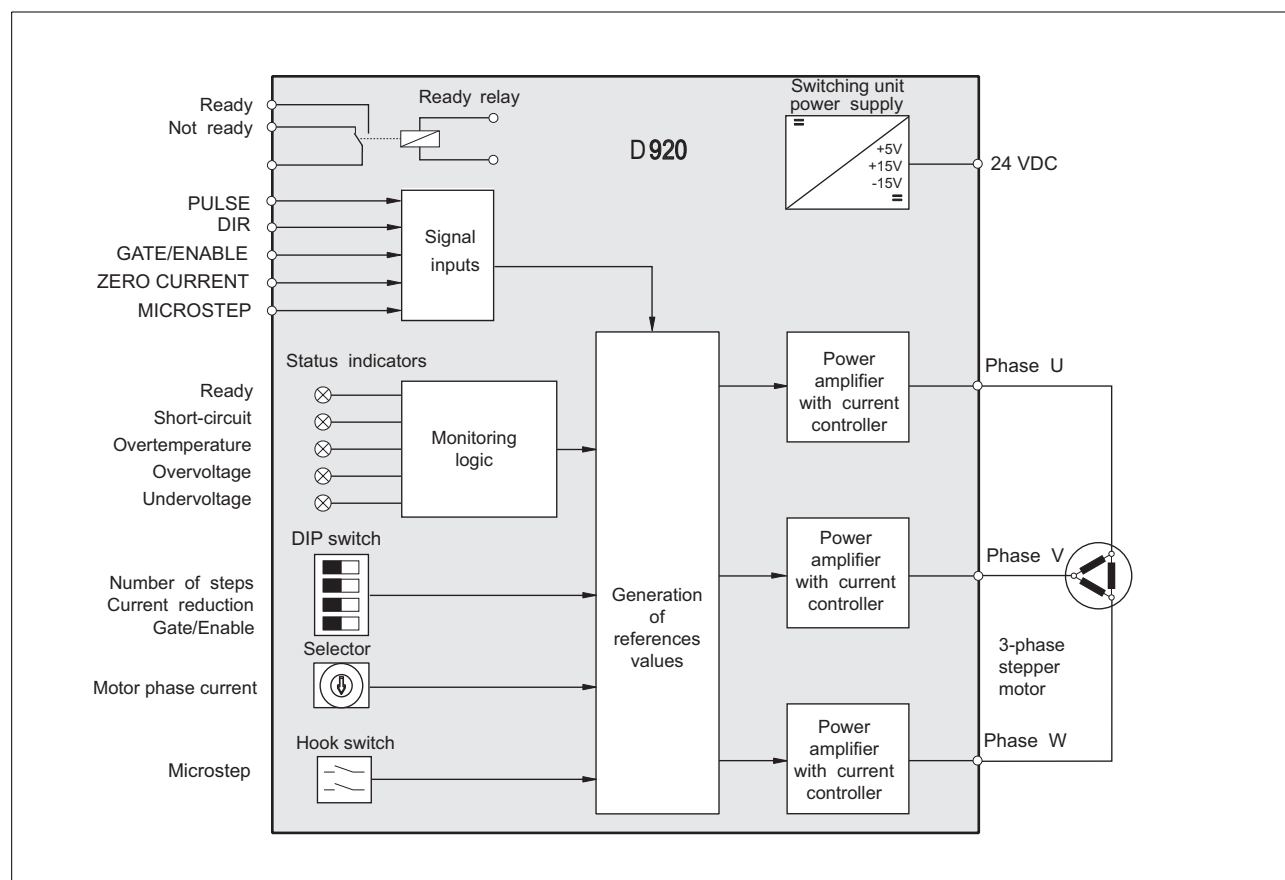
## D920 stepper motor drive board

### Product Description

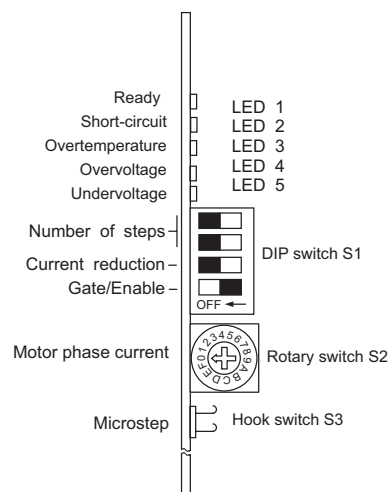
The D920 stepper motor drive board is used to control 3-phase stepper motors with H windings: VRDM 36...LH and VRDM 39...LH.

### Device overview

- (1) Hook switch for setting the Microstep
- (2) Parameter switch for setting the motor phase current
- (3) Parameter switch for setting the number of steps and the current reduction
- (4) 5 LEDs
- (5) Plug-in unit 19" rack mounting housing (3HU)



Block diagram D920



## Functions

### Parameterisation

The following functions can be set via the parameter switches of the stepper motor drive board:

- Motor phase current
- Steps per revolution
- Current reduction during standstill
- "Microstep"

### Setting motor phase current

The motor phase current is set with rotary switch S2. The set value should correspond to the nominal motor current  $I_N$ , see motor nameplate. A low motor phase current produces a low torque.

### Adjustments with rotary switch S2

Switch position S2	Motor phase current in A
0 (factory setting)	1.45
1	1.75
2	2.05
3	2.30
4	2.60
5	2.90
6	3.20
7	3.50
8	3.75
9	4.05
A	4.35
B	4.60
C	4.90
D	5.20
E	5.50
F	5.80

### Setting steps per revolution

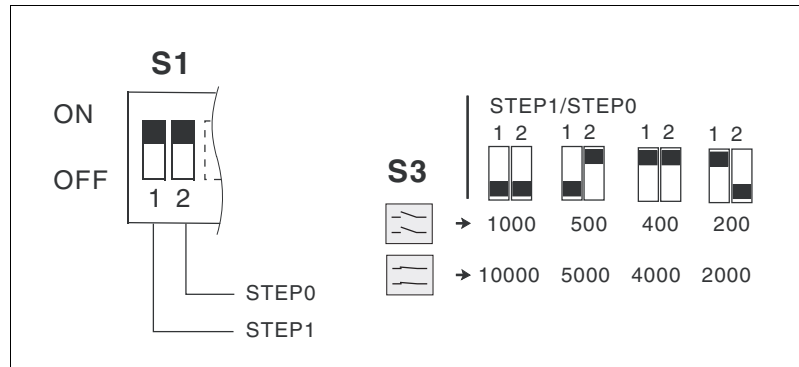
The resolution of the stepper motor drive is set via the step number.

Example:

With a step number of 1000, the stepper motor drive performs exactly one revolution for 1000 pulses. With a pulse frequency of 1 kHz, the result is therefore a speed of rotation of 60 1/min.

### Adjustments with parameter switches S1 and S3

Number of steps: 200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000 per revolution



Setting steps per revolution

The setting of hook switch S3 can be inverted via the input signal MICROSTEP. This increases or decreases the number of steps by a factor of 10.

### Activating the current reduction

If the full holding torque is not required at standstill, the "current reduction" function can be used to reduce the holding torque. Motor and electronics heat up less and the efficiency is improved.

The motor phase current is reduced to approximately 60% of the set current value after the last pulse edge was received.

### Adjustments with parameter switch S1.3

Activate/deactivate current reduction

### Activating the "Microstep" function

The "Microstep" function can be activated in two ways. Mechanically via hook switch S3 and digitally via the input signal at the MICROSTEP signal input.

Activating the "Microstep" function increases the resolution and the number of motor steps by a factor of 10.

### Adjustments with hook switch S3

Activate/deactivate "Microstep" function

### Signal inputs and outputs

#### PULSE signal input

In order to generate a rotary movement of the motor shaft, square pulses must be supplied at the pulse input. Each positive pulse edge triggers one motor step when the gate input is without current.

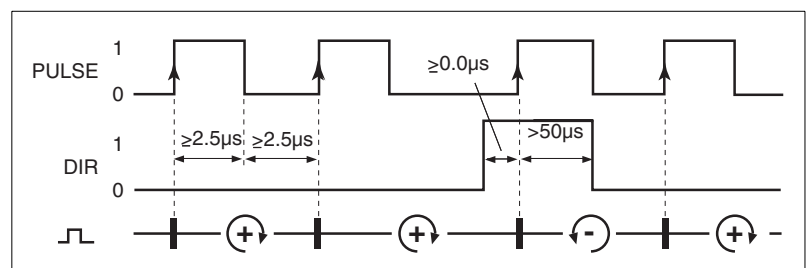
The direction of rotation is controlled by the DIR input.

#### DIR signal input

When the DIR signal input is currentless, the motor turns clockwise, viewed from the front onto the motor shaft. If the signal input is live, the motor runs anticlockwise. It is possible to invert the direction of rotation by changing two motor phases.

#### PULSE/DIR interface mode

The motor executes an angular step with the rising edge of the PULSE signal. The direction of rotation is controlled by the DIR signal. The pulse maximum frequency is 200 kHz.



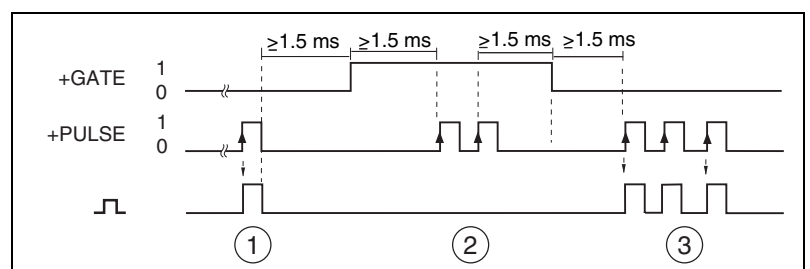
PULSE/DIR interface mode

#### ENABLE signal input

The ENABLE function enables the power amplifier to allow control of the motor.

#### GATE signal input

The "GATE" function blocks the pulses at the reference value input without switching off the operating readiness. In a multi-axis system, individual axes can be selected with the "Gate" function.



Signal sequences in case of activation via the "GATE" function

- (1) Motor step
- (2) No motor steps
- (3) Motor steps

#### MICROSTEP signal input

The "MICROSTEP" function is selected via the MICROSTEP signal input or with the hook switch S3. The time sequence of the MICROSTEP signal input and that of the GATE signal input are the same.

**ZERO CURRENT signal input**

When the signal input is live, the motor phase current is switched off. At a standstill, the motor has no holding torque.

**Signal output**

If the board is working correctly, the operating readiness contact is closed and the ready for operation LED lights up.

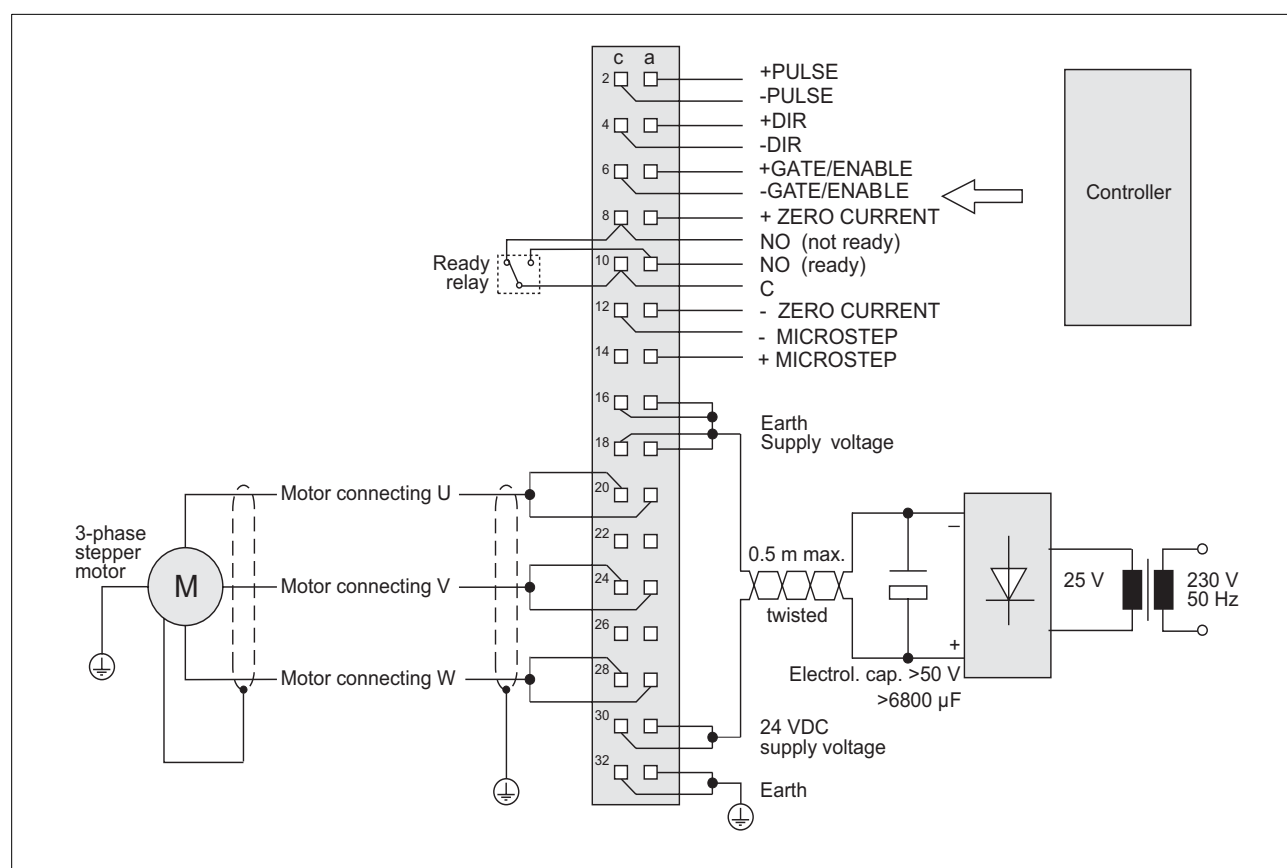
**Status display LED**

The five LEDs on the board show the operating status and any malfunctions.

- LED 1: Readiness
- LED 2: Short circuit
- LED 3: Overtemperature
- LED 4: Overvoltage
- LED 5: Undervoltage

**Mounting and installation**

The board is mounted in a 19" rack mounting housing (3HU). When mounting the board, make sure to keep a distance of at least 5 cm between the board and the housing wall or the next board. The board can be ventilated longitudinally or transversely.



Wiring example

**Technical data****Mechanical data**

Dimensions (W x H x D)	mm	100 x 160 x 51
Weight	kg	0.15

**Electrical data**

Power supply			
Supply voltage	V <sub>DC</sub>	18 ... 40	
Max. current consumption	A	6	
Max. power loss	W	20	
Max. length supply cable, twisted	m	5	
Motor connection			
Motor phase current	A	1.45 ... 5.8	
Motor voltage	V	3 x 24	
Motor cable as per EN 60204			
• Max. length	m	50	
• Cross section at cable length ≤ 30m	mm <sup>2</sup>	1.5	
• Capacitance per 100 m	nF	10	
• Shield connection		at both ends	
Signal connection <sup>1)</sup>		D920.50	D920.51
Voltage control			
• Logic 1 (U <sub>high</sub> )	V	2.5 ... +5.25 <sup>2)</sup>	20 ... 30
• Logic 0 (U <sub>low</sub> )	V	+0.4 ... -5.25	-3 ... +3
• Input current	mA	≤30	≤20
Current control			
• Logic 1 (I <sub>high</sub> )	mA	+7 ... +25	+7 ... +15
• Logic 0 (I <sub>low</sub> )	mA	+0.2 ... -25	+0.2 ... -15
• Input voltage	V	≤5.25	≤30
Input resistance	Ω	150	2000
Max. input frequency	kHz	≤200	
Readiness signal output		Electronic relay (resistive load)	
• Max. switching voltage	V <sub>DC</sub>	≤36	
• Switching current	mA	10 ... 200	

<sup>1)</sup> The PULSE, DIR, GATE, ZERO CURRENT, MICROSTEP signal inputs are optocoupled and protected against reverse polarity

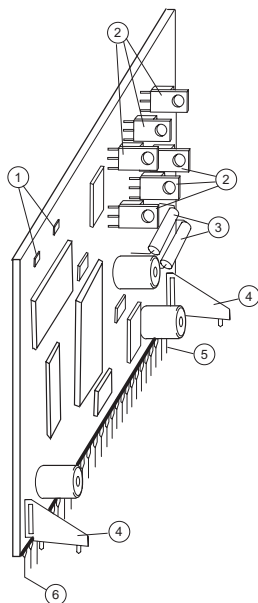
<sup>2)</sup> Pulse signal voltage 3.5 V to 5.25 V for pulse duration/pulse pause <10 μs

**Ambient conditions**

Operating / ambient temperature	°C	0 ... +50%, no icing allowed
Transport and storage temperature	°C	-25 ... +70
Pollution degree		2
Relative humidity	%	5 ... 85%, no condensation allowed
Installation height above mean sea level for 100% power	m	< 1000
Installation height	m	<2000 at max. ambient temperature 40 °C, set up with gap at side of >20 mm
Oscillation and vibration		As per IEC/EN 60068-2-6
	mm	1.5; sine 3 ... 13 Hz
	m/s <sup>2</sup>	10; sine 13 ... 150 Hz
Shock loading		As per IEC/EN 60068-2-27
	m/s <sup>2</sup>	150; half-sine 11 ms
Degree of protection		IP 00

**Order numbers**

Type	Order number
D920.50 (24 V signal voltage)	0062010920503
D920.51 (5 V signal voltage)	0062010920513



## D921 stepper motor drive board

### Product description

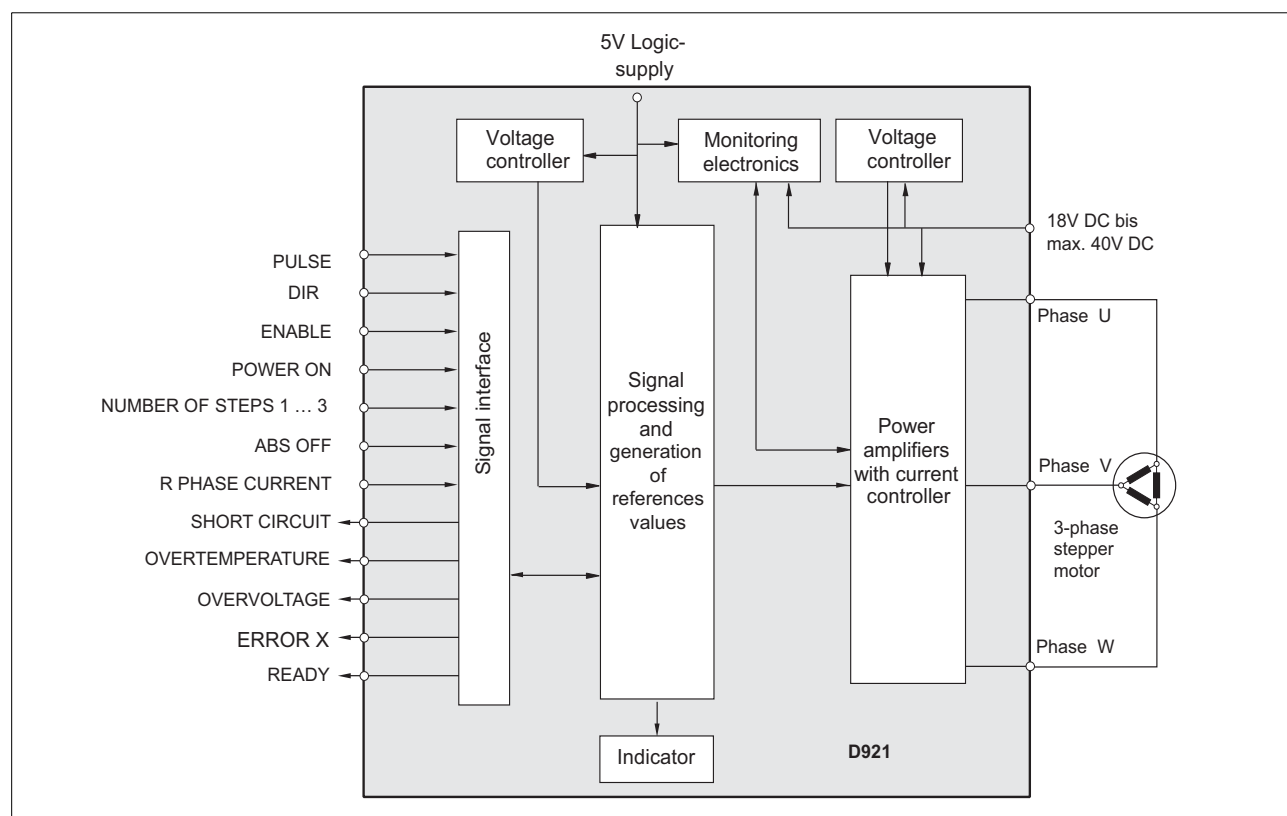
The D921 stepper motor drive board is used to control 3-phase stepper motors with H windings: VRDM 36...LH and VRDM 39...LH. It is installed in a customer-specific electronic system as a power module.

The D921 stepper motor drive board is available in two versions:

- with angled connecting pins, without fastening bracket
- with straight connecting pins and fastening bracket

### Device overview

- (1) LED
- (2) Power transistors
- (3) Power resistors
- (4) Fastening brackets for solder mounting
- (5) Pin 31
- (6) Pin 1



Block diagram D921

## Functions

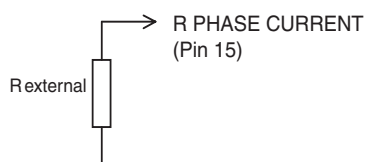
### Parameterisation

The following functions can be set via the inputs of the stepper motor drive board:

- Motor phase current
- Steps per revolution
- Automatic current reduction function

### Setting motor phase current

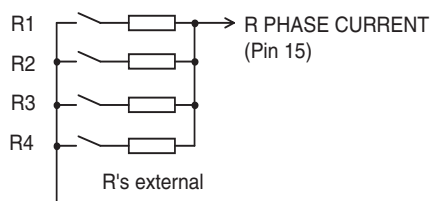
To set the motor phase current, a resistor must be earthed at the input R PHASE CURRENT. Alternatively, a resistor network consisting of 4 resistors can be used. This allows the nominal motor current to be adjusted in 16 steps. The set value should correspond to the nominal motor current  $I_N$ , see motor nameplate. A low motor phase current produces a low torque.



### Wiring suggestion 1

Resistor circuit for 16 current settings:

External resistor in k $\Omega$	Motor phase current in A
0	1.45
330	1.75
165	2.05
110	2.30
82.5	2.60
66	2.90
55	3.20
47	3.50
41.2	3.75
36.6	4.05
33	4.35
30	4.60
27.5	4.90
25.4	5.20
23.5	5.50
22	5.80



### Wiring suggestion 2

Resistor circuit an external resistor network consisting of four resistors. With the selected resistors, the motor phase current can be set in 16 steps using a hexadecimal switch.

R1 (330 k $\Omega$ )	R2 (165 k $\Omega$ )	R3 (82.5 k $\Omega$ )	R4 (41.2 k $\Omega$ )	Motor phase current in A
0	0	0	0	1.45
1	0	0	0	1.75
0	1	0	0	2.05
1	1	0	0	2.30
0	0	1	0	2.60
1	0	1	0	2.90
0	1	1	0	3.20
1	1	1	0	3.50
0	0	0	1	3.75
1	0	0	1	4.05
0	1	0	1	4.35
1	1	0	1	4.60
0	0	1	1	4.90
1	0	1	1	5.20
0	1	1	1	5.50
1	1	1	1	5.80

### Setting steps per revolution

The resolution of the stepper motor drive is set via the step number.

Example:

With a step number of 1000, the stepper motor drive performs exactly one revolution for 1000 pulses. With a pulse frequency of 1 kHz, the result is therefore a speed of rotation of 60 1/min.

### Adjustments via the three signal inputs NUMBER OF STEPS 1 ... 3

Number of steps: 200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000 per revolution

Resolution	NUMBER OF STEPS 1	NUMBER OF STEPS 2	NUMBER OF STEPS 3
200	0	0	0
400	1	0	0
500	0	1	0
1000	1	1	0
2000	0	0	1
4000	1	0	1
5000	0	1	1
10000	1	1	1

### Activating motor phase current reduction at standstill

If the full holding torque is not required at standstill, the "current reduction" function can be used to reduce the holding torque. Motor and electronics heat up less and the efficiency is improved.

The motor phase current is reduced to approximately 60% of the set current value after the last pulse edge was received.

### Adjustments with the signal input ABS OFF

Activate/deactivate current reduction

### Signal inputs and outputs

#### PULSE signal input

In order to generate a rotary movement of the motor shaft, square pulses must be supplied at the pulse input. Each positive pulse edge triggers one motor step when the gate input is without current.

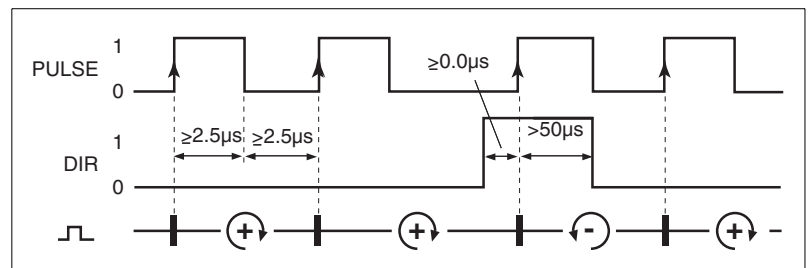
The direction of rotation is controlled by the DIR input.

#### DIR signal input

When the DIR signal input is currentless, the motor turns clockwise, viewed from the front onto the motor shaft. If the signal input is live, the motor runs anticlockwise. It is possible to invert the direction of rotation by changing two motor phases.

#### PULSE/DIR interface mode

The motor executes an angular step with the rising edge of the PULSE signal. The direction of rotation is controlled by the DIR signal. The pulse maximum frequency is 200 kHz.



PULSE/DIR interface mode

#### ENABLE signal input

The ENABLE function enables the power amplifier to allow control of the motor.

#### POWER ON signal input

The power amplifier is enabled (signal = 1) or blocked (signal = 0) via the signal input POWER ON. When the power amplifier is blocked, the motor current is switched off. The motor no longer has a holding torque.

This status is not displayed. The stepper motor drive board remains ready for operation.

#### Signal outputs

The signals for malfunctions and operating readiness are provided at the signal outputs SHORT CIRCUIT, OVERTEMPERATURE, OVERVOLTAGE, ERROR X and READY.

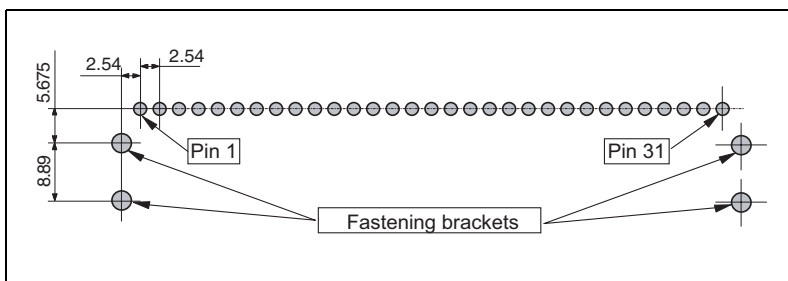
### Mounting and installation

The D921 stepper motor drive board is available in two versions:

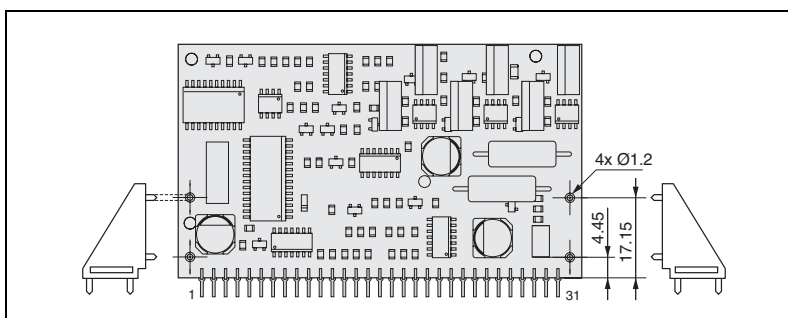
- with angled connecting pins, without fastening bracket
- with straight connecting pins, with fastening bracket

The two fastening brackets supplied are soldered onto the board. This supports the board laterally. Then the board is soldered onto the printed circuit board. The right angle (at Pin 31) serves as an additional heat sink and is connected to supply potential (18 ... 40 V).

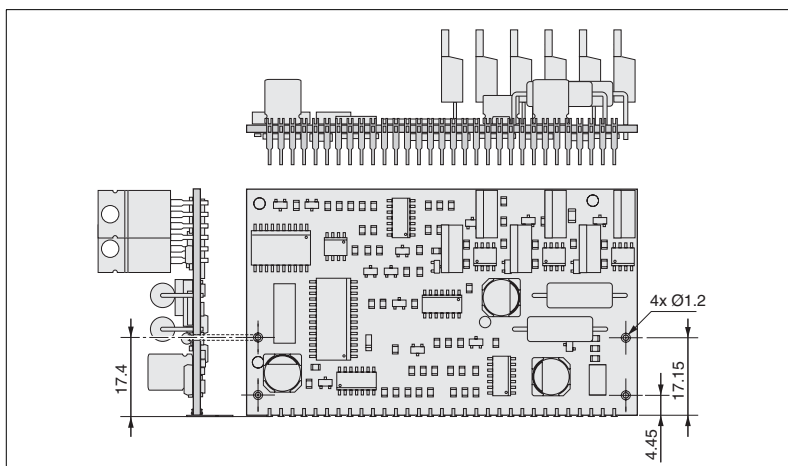
Soldered contacts		
Pin grid dimensions	mm	2.54
Contacts		31 pins
Diameter of holes for solder pins (31 holes)	mm	0.9 +0.15
Diameter of holes for bracket	mm	1.3 +0.15



D921 board with solder contacts

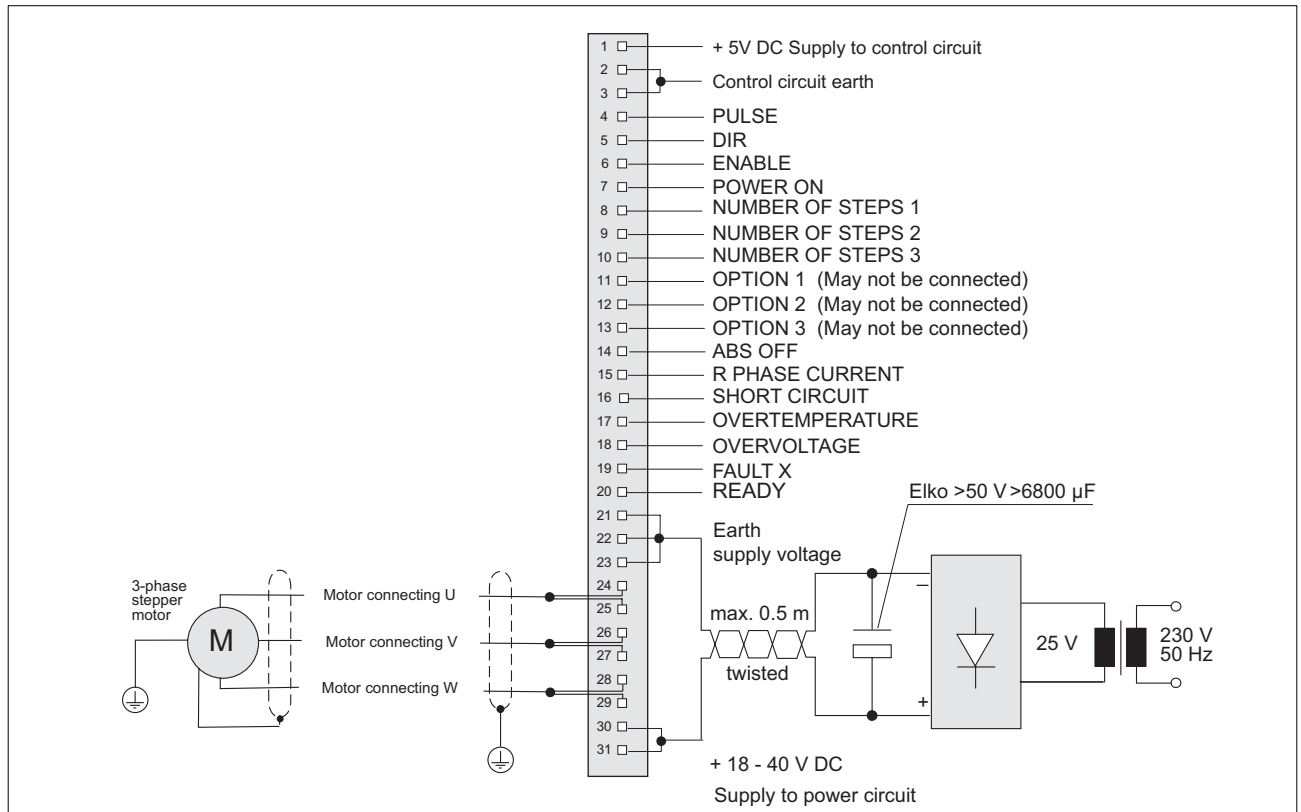


D921 with straight connecting pins (for mounting with fastening brackets)



D921 with angled connecting pins (for mounting without fastening brackets)

## Wiring example



Wiring example D921

**Technical data****Mechanical data**

Dimensions (W x H x D)	mm	86.5 x 52 x 23
Weight	g	45

**Electrical data**

<b>Power circuit</b>		
Supply voltage	V <sub>DC</sub>	18 ... 40
Max. ripple	V <sub>SS</sub>	3.6
Max. current consumption	A	5
Max. power loss	W	15
External fuse		10 A slow-blow
<b>Control circuit</b>		
Supply voltage	V	5 ± 5%
Residual ripple	mV <sub>SS</sub>	20
Max. current consumption	A	0.1
<b>CMOS inputs: PULSE, DIR, ENABLE, POWER ON, STEP NUMBER 1 ... 3</b>		
Max. signal voltage	V	5.25
PULSE		
• U <sub>high min.</sub>	V	2.1
• U <sub>low max.</sub>	V	0.5
DIR, ENABLE, POWER ON, STEP NUMBER 1 ... 3		
• U <sub>high min.</sub>	V	2.0
• U <sub>low max.</sub>	V	0.8
<b>CMOS outputs: SHORT CIRCUIT, OVERTEMPERATURE, OVERVOLTAGE, ERROR X, READY</b>		
Max. output current	A	±0.004
• U <sub>high min.</sub>	V	3.5
• U <sub>low max.</sub>	V	0.8
<b>FET input: ABS OFF</b>		
Max. signal voltage	V	10
• U <sub>high min.</sub>	V	6.5
• U <sub>low max.</sub>	V	0.8
<b>OP input: R PHASE CURRENT</b>		
Min. external resistance	kΩ	22
• R <sub>min.</sub>	kΩ	6.5
• R <sub>max.</sub>		as high as required
<b>Motor connection</b>		
Motor phase current (operation)	A	1.45 ... 5.8
Motor phase current (standstill)	A <sub>DC</sub>	≤8.2
Motor chopper voltage	V	≤40
Motor cable as per EN 60204		
Max. length	m	10
Cross section	mm <sup>2</sup>	1.5
• Capacitance per 100 m	nF	10
Shield connection		at both ends

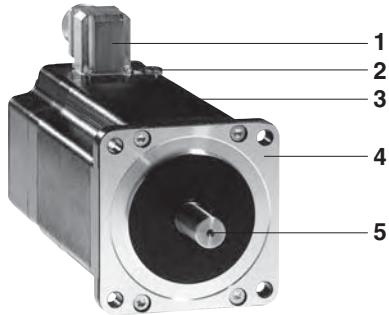
**Ambient conditions**

Operating / ambient temperature	°C	0 ... +50%, no icing allowed
Transport and storage temperature	°C	-25 ... +70
Pollution degree		2
Relative humidity	%	5 ... 85%, no condensation allowed
Installation height above mean sea level for 100% power	m	< 1000
Installation height	m	<2000 at max. ambient temperature 40 °C, set up with gap at side of >20 mm
Oscillation and vibration		As per IEC/EN 60068-2-6
	mm	1.5; sine 3 ... 13 Hz
	m/s <sup>2</sup>	10; sine 13 ... 150 Hz
Shock loading		As per IEC/EN 60068-2-27
	m/s <sup>2</sup>	150; half-sine 11 ms
Degree of protection		IP 00

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**Order numbers**

Type	Order number
D921.00 with straight connecting pins	0062010921006
D921.01 with angled connecting pins	0062010921016



### Product offer

The 3-phase stepper motors from Berger Lahr are extremely robust, maintenance-free motors. They carry out precise step-by-step movements that are controlled by a stepper motor drive. A stepper motor drive system consists of a stepper motor and the matching stepper motor drive. Maximum performance can only be obtained if motor and electronics are perfectly tuned to each other.

The 3-phase stepper motors can be operated at very high resolutions depending on the stepper motor drive.

Options such as rotation monitoring and holding brake as well as robust, low-play planetary gears extend the application options.

### Special features

#### Quiet

As a result of the sine commutation and the special mechanical design of the motors, the stepper motors are very quiet and run virtually without resonance.

#### Strong

The optimised internal geometry of the motor ensures a high power density;

#### Flexible

With a flexible modular system and modern variant management, a wide variety of motor types can be manufactured and delivered in a very short time.

### Structure

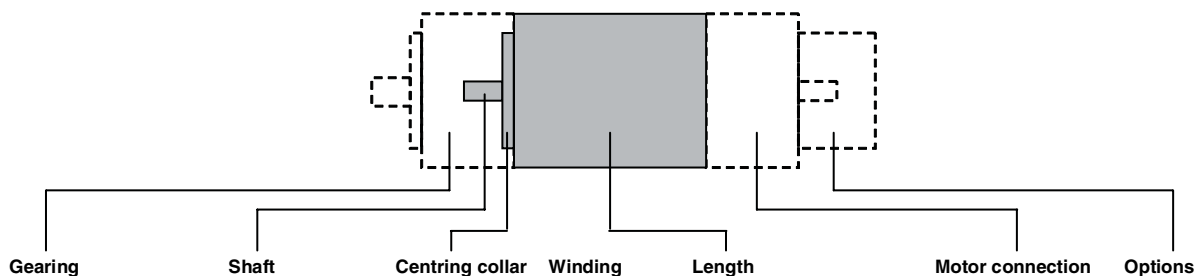
- (1) Motor connection, here a version with an angular connector
- (2) Additional terminal for protective conductor
- (3) Housing, with black protective coating
- (4) Axial flange with four mounting points as per DIN 42918
- (5) Smooth shaft end as per DIN 42918

**Product quotation****3-phase stepper motors****VRDM 36•****VRDM 39•**

Size		6	9
Max. torque $M_{\max}$	Nm	0.45...1.50	1.7...6.0
Holding torque $M_H$	Nm	0.51...1.70	1.92...6.78
Number of steps $z$ <sup>1)</sup>		200 / 500 / 1000 / 2000 / 4000 / 5000 / 10000	
Step angle $\alpha$ <sup>1)</sup>	°	1.8 / 0.9 / 0.72 / 0.36 / 0.18 / 0.09 / 0.072 / 0.036	

<sup>1)</sup> With suitable control

## Motor types



Motortyp	Length (Without shaft)	Winding <sup>1)</sup>	Shaft		Centring collar	Motor-connection <sup>2)</sup>	Options <sup>3)</sup>	Gearing <sup>4)</sup>
<b>VRDM 36•</b>								
VRDM 364	4 (42 mm)	H	smooth	Ø 6.35 mm	Ø 38.1 mm	Wires, Connector, Terminal box	2th schaft end, Holding brake, Encoder	PLE 40, PLE 60, PLS 70
VRDM 366	6 (56 mm)	H, N		Ø 8 mm				PLE 60, PLS 70
VRDM 368	8 (79 mm)							
<b>VRDM 39•</b>								
VRDM 397	7 (68 mm)	H, N	smooth, Woodruff key	Ø 9.5 mm, Ø 12 mm	Ø 60 mm, Ø 73 mm	Wires, Connector, Terminal box	2th schaft end, Holding brake, Encoder	PLE 80, PLS 90
VRDM 3910	10 (98 mm)							
VRDM 3913	13 (128 mm)							

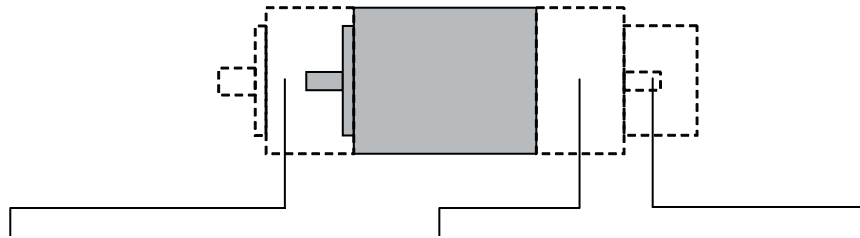
<sup>1)</sup> Winding type for nominal voltage : H = 24 / 35 V<sub>DC</sub>; N = 130 V<sub>DC</sub>

<sup>2)</sup> In case of motors with terminal box, the terminal block is located inside the motor; the cable gland is sealed and EMC-tested

<sup>3)</sup> Alternatively: 2nd shaft end or holding brake. Motors with encoder are only available in connector version; 2nd shaft end or holding brake are not possible with this version.

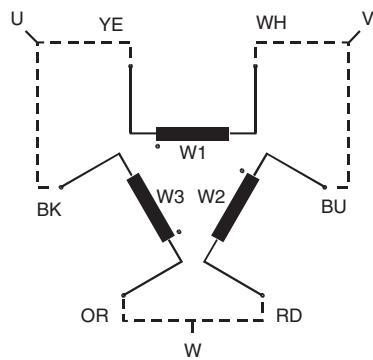
<sup>4)</sup> All PLE and PLS gearings are available with the gear ratios 3:1, 5:1 and 8:1.

## Degree of protection



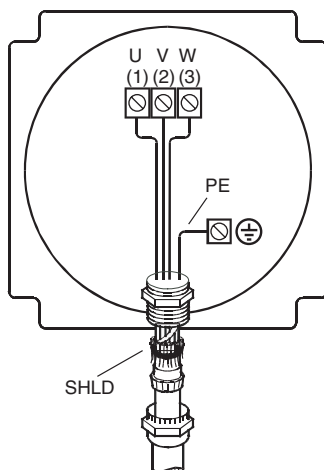
Front of motor		Shaft bushing	Motor connection		Rear of motor	
Gearing			Wires	Terminal box Connector	2nd shaft end	Holding brake Encoders
PL, PLE	PLS					
IP 54	IP 65	IP 41 IP 56 (optional with VRDM 39*)	IP 41	IP 56	IP 41	IP 56

## Motor connection



## Motor connection wire version

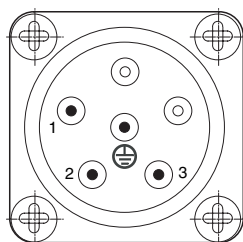
Designation	Motor wire colour as per DIN IEC 757	Motor wire colour
U	BK and YE	Black and yellow
V	WH and BU	White and blue
W	OR and RD	Orange and red



## Motor connection in terminal box version

Designation	Pin	Wire colour as per DIN IEC 757	Wire colour <sup>1)</sup>
U	1	BR	Brown
V	2	BU	Blue
W	3	BK	Black
PE		GN/YE	Green/yellow
SHLD	Shield		

<sup>1)</sup> Berger Lahr motor cable



## Motor connection in connector version

Designation	Pin
U	1
V	2
W	3
PE	4

## VRDM 36•

### Technical data

Motor type		VRDM 364	VRDM 366		VRDM 368	
Winding		H	H	N	H	N
Max. supply voltage $U_{\max}$	$V_{AC}$	34	34	92	34	92
Max. voltage to PE	$V_{AC}$	42	42	125	42	125
Nominal voltage DC bus $U_N$	$V_{DC}$	24 / 36 / 48	24 / 36 / 48	130	24 / 36 / 48	130
Nominal torque $M_N$	Nm	0.45	0.90		1.50	
Holding torque $M_H$	Nm	0.51	1.02		1.70	
Rotor inertia $J_R$	kgcm <sup>2</sup>	0.1	0.22		0.38	
Number of steps $z$ <sup>1)</sup>		200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000				
Step angle $\alpha$	°	1.8 / 0.9 / 0.72 / 0.36 / 0.18 / 0.09 / 0.072 / 0.036				
Systematic angle tolerance $\Delta\alpha_s$ <sup>2)</sup>	'	±6				
Max. starting frequency $f_{Aon}$	kHz	8.5	8.0	8.	6.0	8.5
Nominal motor current $I_N$	$A_{rms}$	5.2	5.8	1.6	5.8	1.9
Winding resistance $R_W$	$\Omega$	0.42	0.5	5.3	0.7	4.8
Current rise time constant	ms	2.1	3.3		4.6	
Mass $m$ <sup>3)</sup>	kg	1.3	1.6		2.0	
Shaft load <sup>4)</sup>						
• Max. radial force 1st shaft end <sup>5)</sup>	N	24	24		50	
• Max. radial force 2nd shaft end (optional) <sup>6)</sup>	N	25 / 40				
• Max. axial tensile force	N	100				
• Max. axial force pressure	N	8.4				
• Nominal bearing service life $L_{10h}$ <sup>7)</sup>	h	20000				

<sup>1)</sup> Depending on the control

<sup>2)</sup> Measured at 1000 steps/revolution, unit: angular minutes

<sup>3)</sup> Mass of the motor version with cable gland and connector

<sup>4)</sup> Conditions for shaft load: speed of rotation 600 min<sup>-1</sup>, 100% duty cycle at nominal torque, ambient temperature 40 °C (bearing ≈ 80 °C)

<sup>5)</sup> Radial force acts at centre of shaft end

<sup>6)</sup> Radial force acts at centre of shaft end ; 1st value: motors with terminal box, connector or encoder; 2nd value: motors with wires

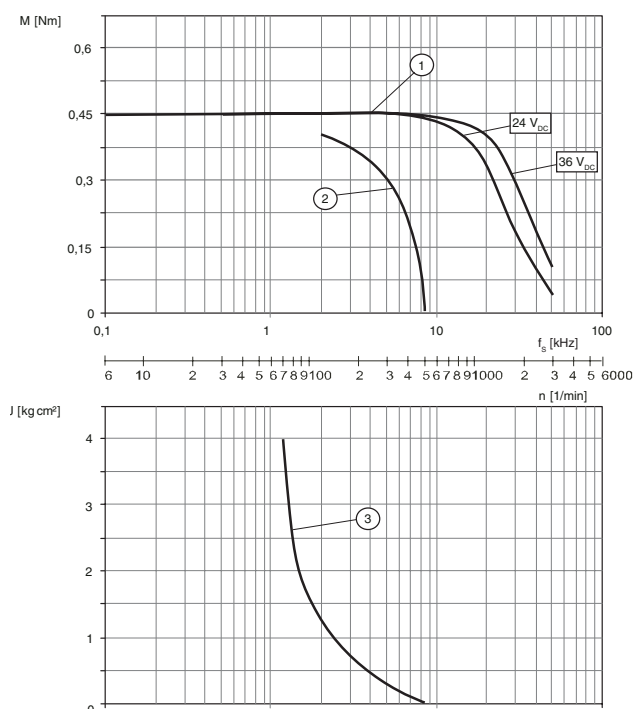
<sup>7)</sup> Operating hours at a probability of failure of 10%

### Ambient conditions

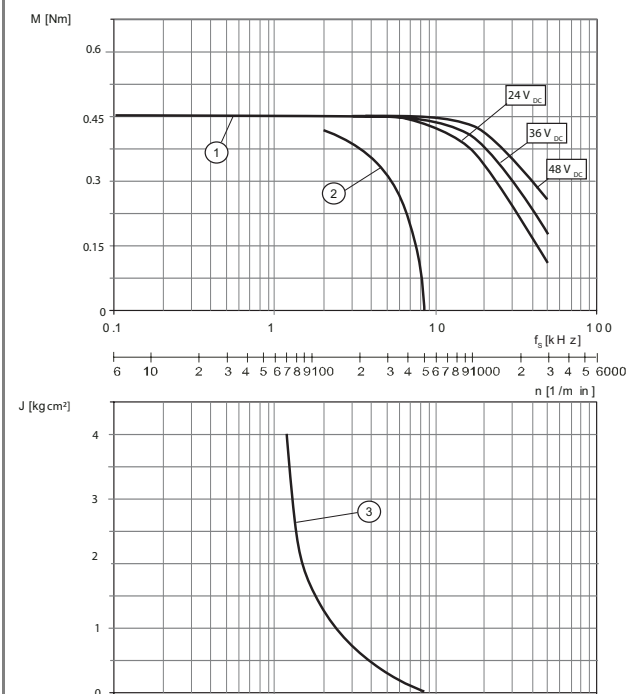
Ambient temperature	°C	-25 ... +40
Installation height without power reduction	m a. MSL	< 1000
Transport and storage temperature	°C	-25 ... +70
Relative humidity	%	75 (on annual average), 95 (in 30 days, no condensation)
Vibration grade in operation as per EN 60034-14		A
Continuous shocks as per DIN EN 60068-2-29		
• Number of shocks per direction		100
• Peak acceleration	m/s <sup>2</sup>	20
Degree of protection as per EN 60034-5		
• Total except shaft bushing		IP 56
• Shaft bushing without shaft seal ring		IP 41
Therm class as per EN 60034-1		155 (F)
Shaft wobble and perpendicularity		As per EN 50 347 (IEC 60072-1)
Maximum rotary acceleration	rad/s <sup>2</sup>	200000

## Characteristic curves

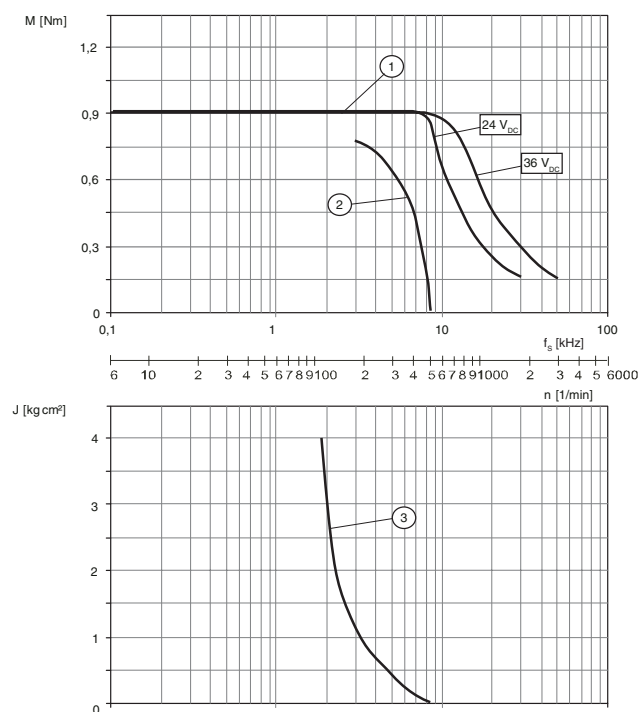
VRDM 364 / 50L H with D920 and D921



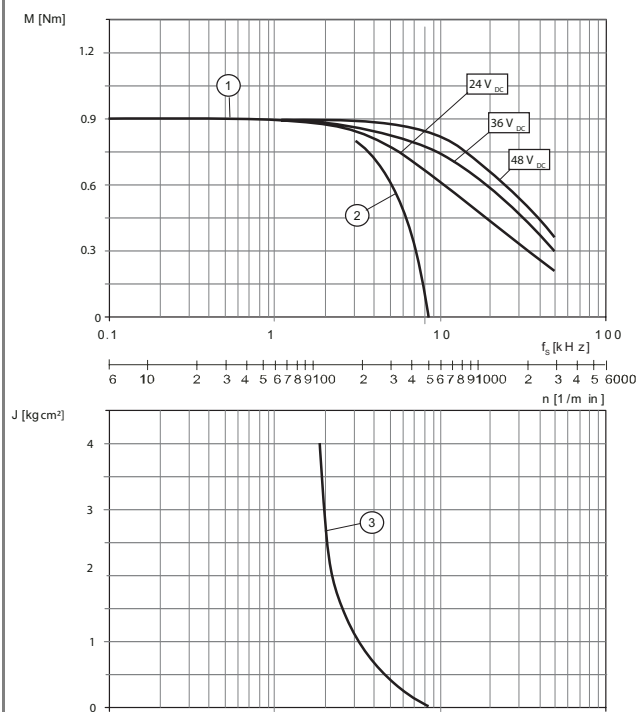
VRDM 364 / 50L H with SD3 15



VRDM 366 / 50L H with D920 and D921



VRDM 366 / 50L H with SD3 15

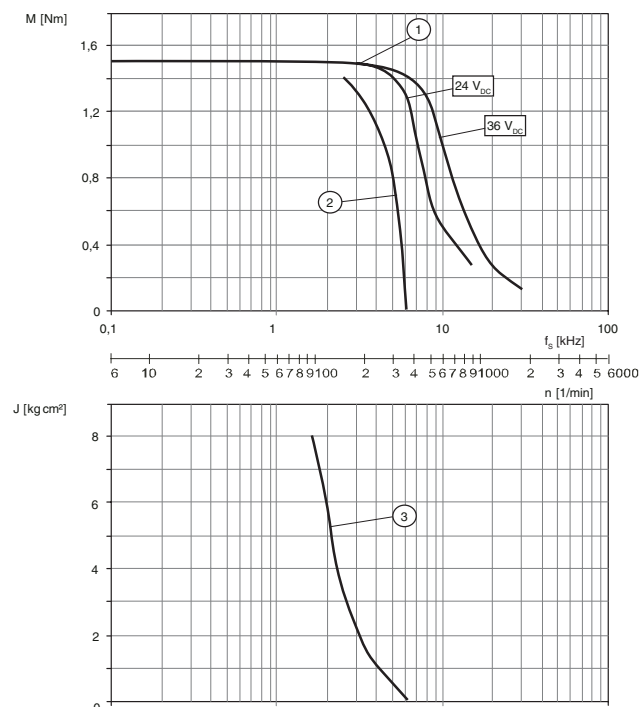


Measurement at 1000 steps/revolution, nominal voltage DC bus  $U_N$  and phase current  $I_N$

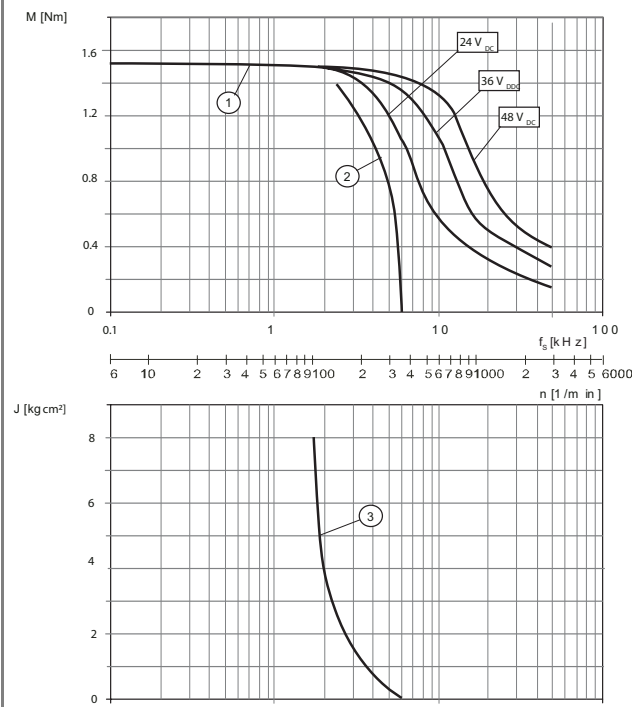
- (1) Pull-out torque
- (2) pull-in torque
- (3) Maximum load inertia

# Characteristic curves

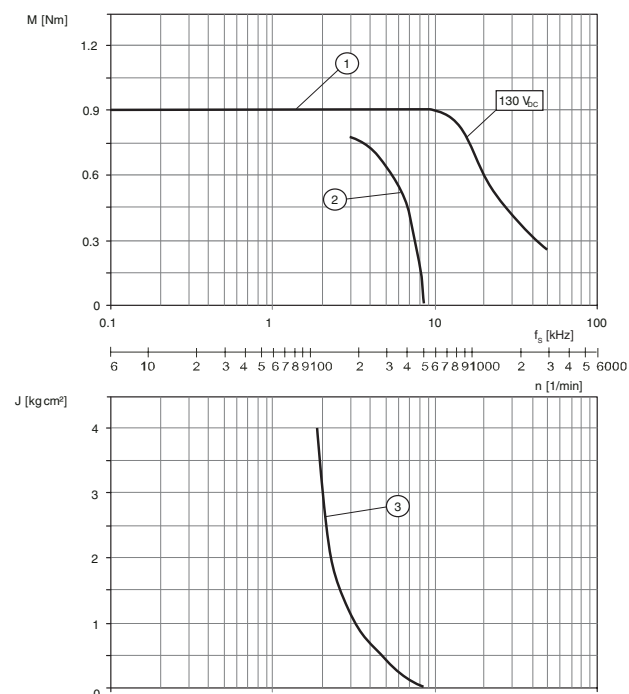
VRDM 368 / 50L H with D920 and D921



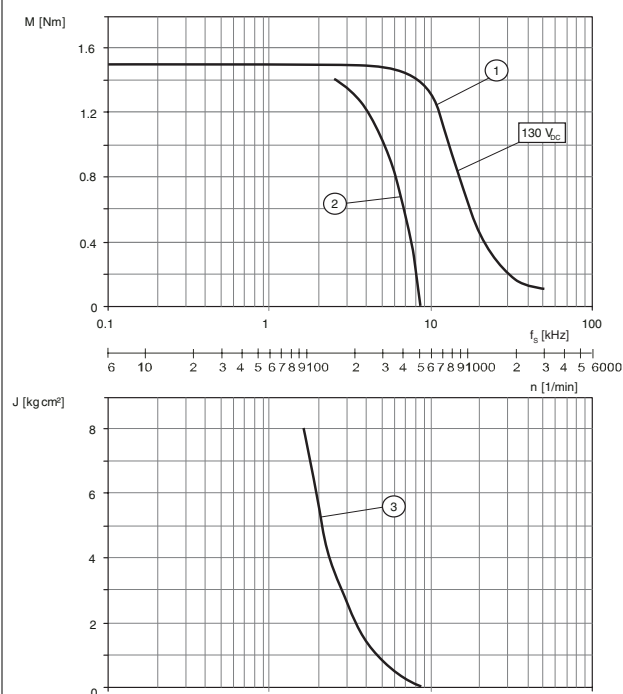
VRDM 368 / 50L H with SD3 15



VRDM 366 / 50L N with D900



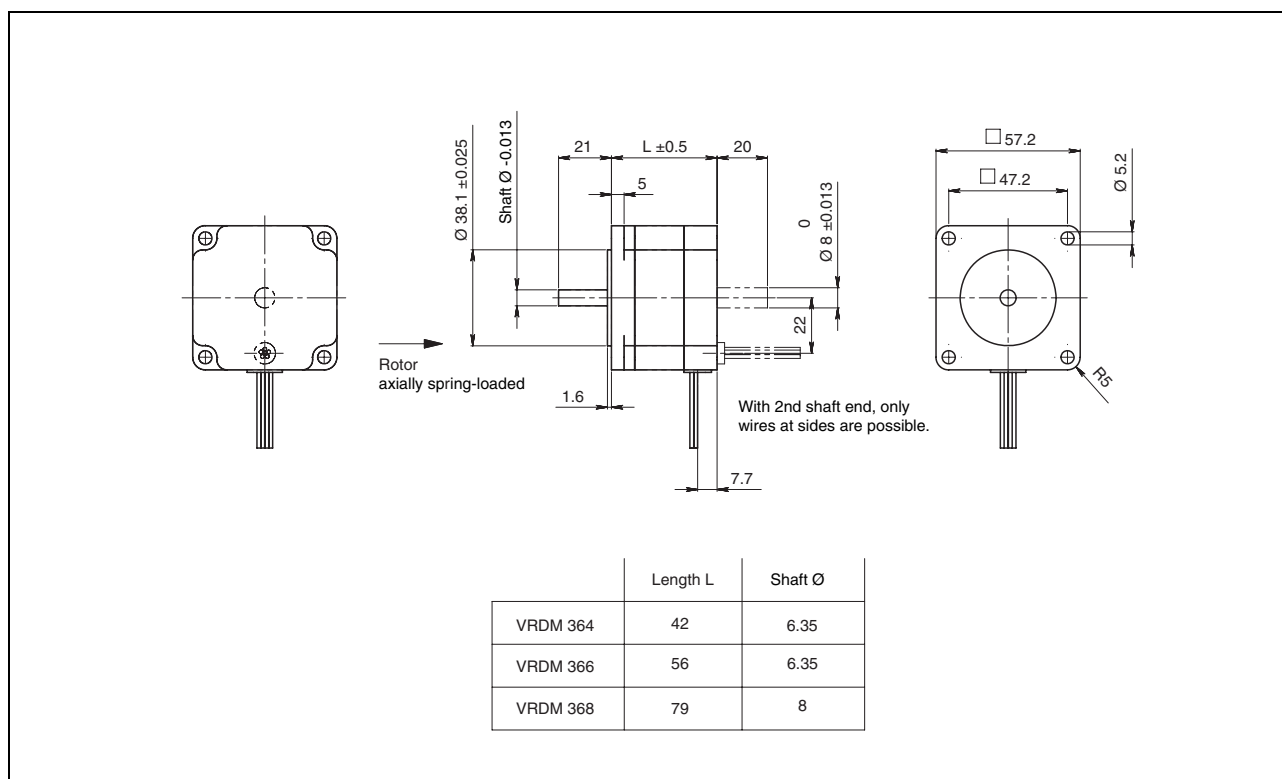
VRDM 368 / 50L N with D900



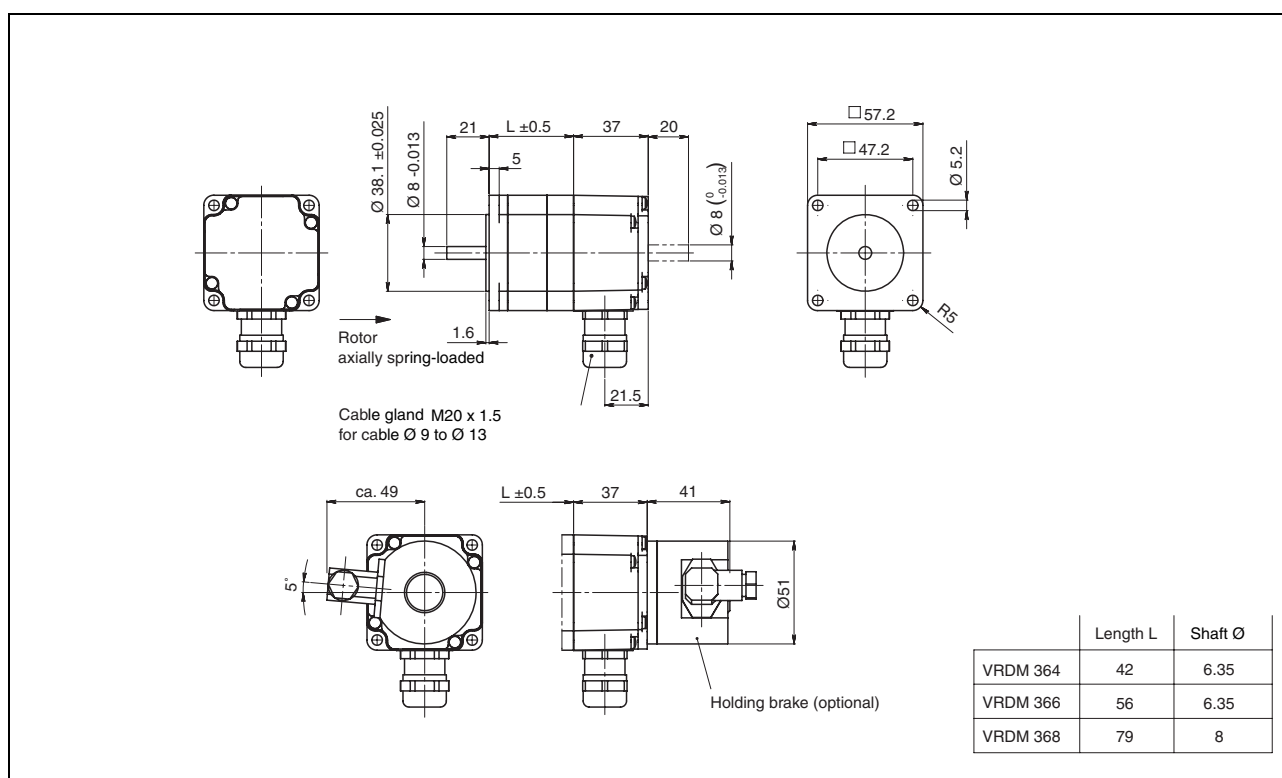
Measurement at 1000 steps/revolution, nominal voltage DC bus  $U_N$  and phase current  $I_N$

- (1) Pull-out torque
- (2) Pull-in torque
- (3) Maximum load inertia

## Dimensional drawings

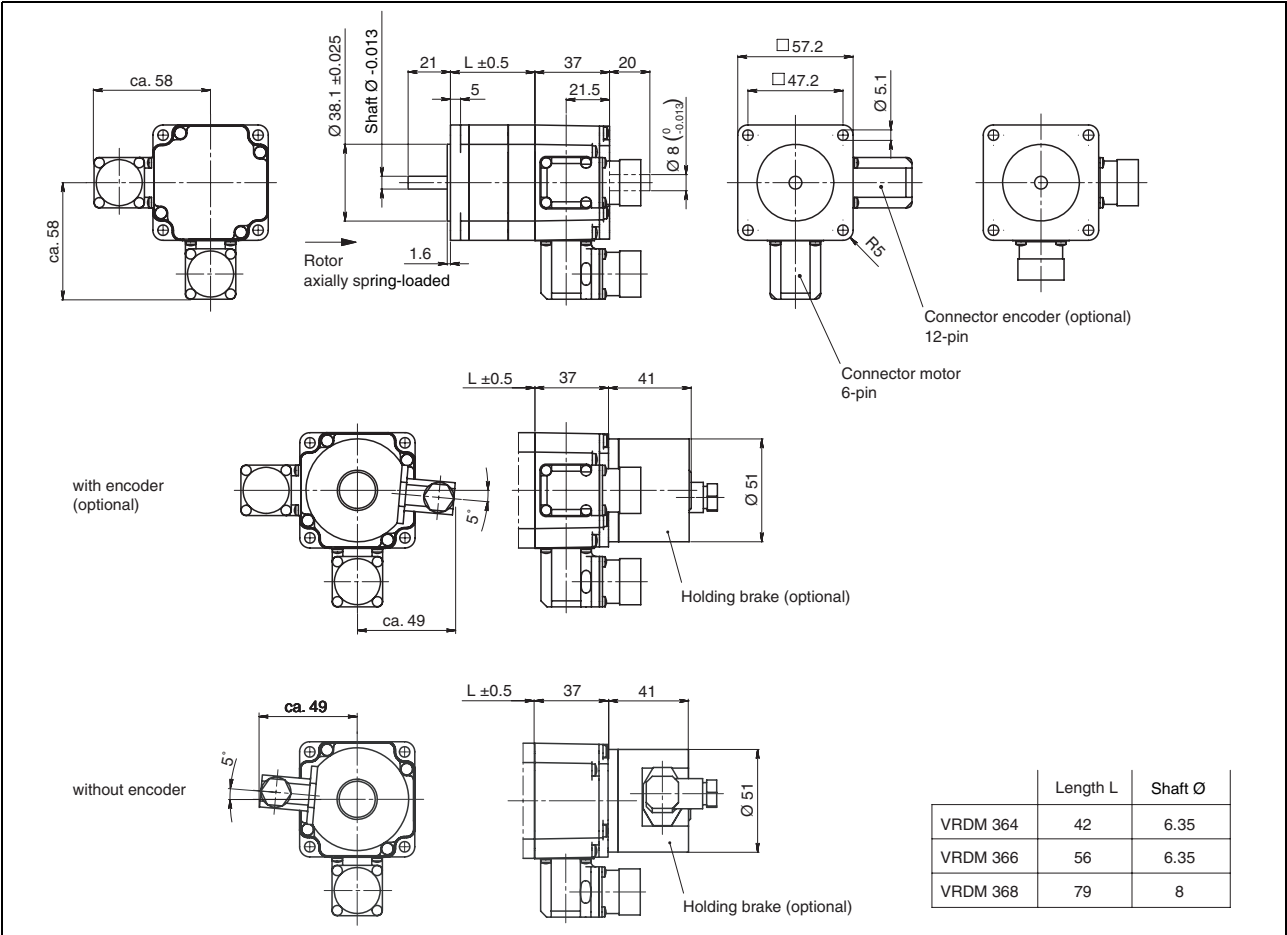


3-phase stepper motor VRDM 36• in wire version



3-phase stepper motor VRDM 36• in terminal box version

Dimensional drawings



3-phase stepper motor VRDM 36• in connector version

Type code																						
<b>Example:</b>	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Number of phases</b> 3	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Size (flange)</b> 6 = 57.2 mm	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Length</b> 4 = 42 mm 6 = 56 mm 8 = 79 mm	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Number of pole pairs</b> 50	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	B	OOO
<b>Rotor</b> L = laminated rotor plate	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Maximum voltage</b> H = 34 V <sub>AC</sub> (48 V <sub>DC</sub> ) N = 92 V <sub>AC</sub> (130 V <sub>DC</sub> )	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	B	OOO
<b>Connection type</b> A = Wires B = Terminal box C = Connector	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Position capture</b> E = Encoder (1000 increments/revolution) O = Without encoder	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Holding brake</b> B = Brake O = Without brake	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Degree of protection</b> IP41 = IP41 at shaft bushing	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Gearing type</b> O = Without gearing 1 = PLE 40 2 = PLE 60 A = PLS 70	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Gear ratio</b> O = Without gearing 3 = 3:1 5 = 5:1 8 = 8:1	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Shaft diameter*</b> D6 = 6.35 mm D8 = 8 mm DO = With gearing	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Shaft design front</b> O = Smooth shaft or gearing	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Centring collar</b> 38 = 38.10 mm OO = with gearing	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Second shaft:</b> O = without 2 = with	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Connection direction motor plug</b> <sup>1)</sup> O = Without, L = Left, R = Right B = Back, F = Front, S = Straight	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Coonection direction encoder plug</b> <sup>1)</sup> O = Without, L = Left, R = Right B = Back, F = Front, S = Straight	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Wire output</b> O = Without S = Side B = Back	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO
<b>Wire length</b> OOO = None xxx = xxx mm (max. 400 mm)	VRDM	3	6	8	/	50	L	H	C	E	O	IP41	1	5	DO	O	OO	2	B	B	O	OOO

<sup>1)</sup> Connection direction viewed from front at 1st shaft end, connector up.

**\* Note:** Please note the description of the possible motor types on page 38.

## VRDM 39•

### Technical data

Motor type		VRDM 397		VRDM 3910		VRDM 3913	
Winding		H	N	H	N	H	N
Max. supply voltage U <sub>max</sub>	V <sub>AC</sub>	34	92	34	92	34	92
Max. voltage to PE	V <sub>AC</sub>	42	125	42	125	42	125
Nominal voltage DC bus U <sub>N</sub>	V <sub>DC</sub>	24 / 36 / 48	130	24 / 36 / 48	130	24 / 36 / 48	130
Nominal torque M <sub>N</sub>	Nm	2	2	4	4	5.75	6
Holding torque M <sub>H</sub>	Nm	2.26	2.26	4.80	4.52	6.50	6.78
Rotor inertia J <sub>R</sub>	kgcm <sup>2</sup>	1.1		2.2		3.3	
Number of steps z <sup>1)</sup>		200 / 400 / 500 / 1000 / 2000 / 4000 / 5000 / 10000					
Step angle α	°	1.8 / 0.9 / 0.72 / 0.36 / 0.18 / 0.09 / 0.072 / 0.036					
Systematic angle tolerance Δα <sub>s</sub> <sup>2)</sup>	'	±6					
Max. starting frequency f <sub>Aom</sub>	kHz	4.6	5.3	4.8	5.3	4.5	5.3
Nominal motor current I <sub>N</sub>	A <sub>rms</sub>	5.8	4.4	5.8	5	5.8	5
Winding resistance R <sub>W</sub>	Ω	0.35	1	0.55	1.2	0.63	1.3
Current rise time constantτ	ms	~7		~9		~10	
Mass m <sup>3)</sup>	kg	2.1		3.2		4.3	
Shaft load <sup>4)</sup>							
• Max. radial force 1st shaft end <sup>5)</sup>	N	100		100		110	
• Max. radial force 2nd shaft end (optional) <sup>6)</sup>	N	50 / 75					
• Max. axial tensile force	N	175					
• Max. axial force pressure	N	30					
• Nominal bearing service life L <sub>10h</sub> <sup>7)</sup>	h	20000					

<sup>1)</sup> Depending on the control

<sup>2)</sup> Measured at 1000 steps/revolution, unit: angular minutes

<sup>3)</sup> Mass of motor version with cable gland or connector

<sup>4)</sup> Conditions for shaft load: speed of rotation 600 min<sup>-1</sup>, 100% duty cycle at nominal torque, ambient temperature 40 °C (bearing temperature ≈ 80 °C)

<sup>5)</sup> Radial force acts at centre of shaft end

<sup>6)</sup> Radial force acts at centre of shaft end ; 1st value: motors with terminal box, connector or encoder; 2nd value: motors with wires

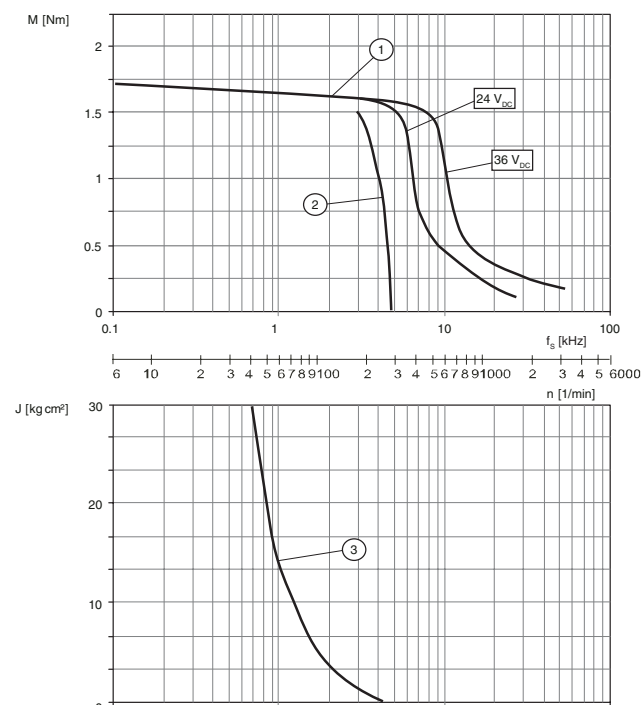
<sup>7)</sup> Operating hours at a probability of failure of 10%

### Ambient conditions

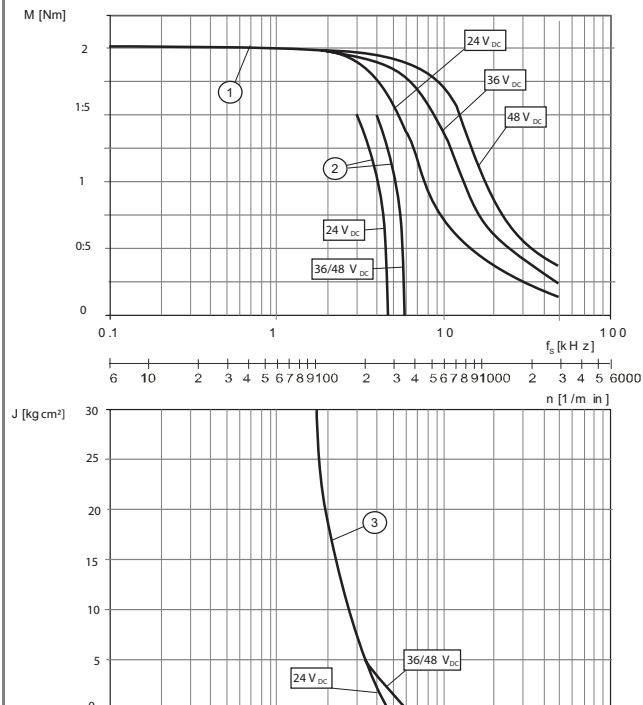
Ambient temperature	°C	-25 ... +40
Installation height without power reduction	m a. MSL	< 1000
Transport and storage temperature	°C	-25 ... +70
Relative humidity	%	75 (on annual average), 95 (in 30 days, no condensation)
Vibration grade in operation as per EN 60034-14		A
Continuous shocks as per DIN EN 60068-2-29		
• Number of shocks per direction		100
• Peak acceleration	m/s <sup>2</sup>	20
Degree of protection as per EN 60034-5		
• Total except shaft bushing		IP 56
• Shaft bushing without shaft seal ring		IP 41
Therm class as per EN 60034-1		155 (F)
Shaft wobble and perpendicularity		As per EN 50 347 (IEC 60072-1)
Maximum rotary acceleration	rad/s <sup>2</sup>	200000

## Characteristic curves

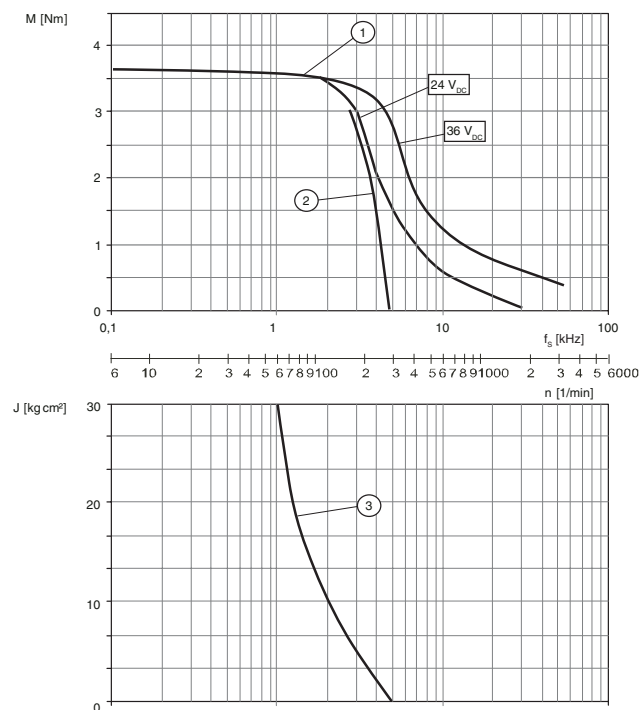
VRDM 397 / 50L H with D920 and D921



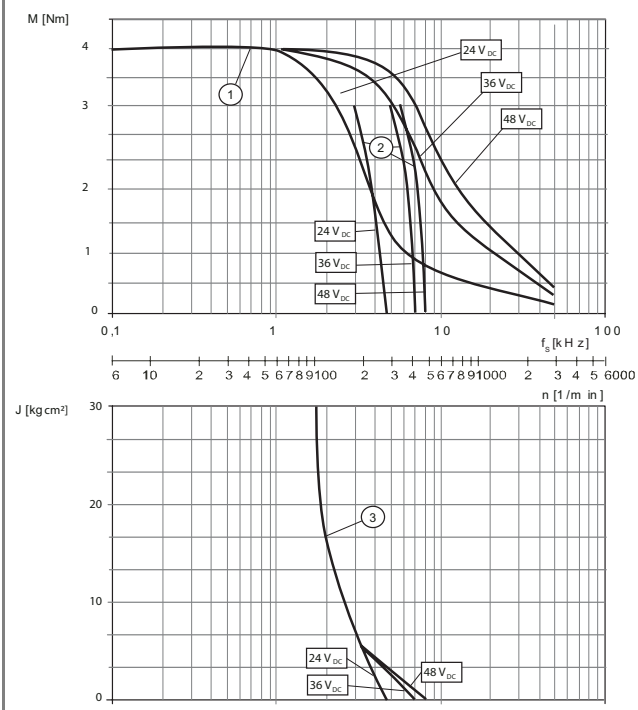
VRDM 397 / 50L H with SD3 15



VRDM 3910 / 50L H with D920 and D921



VRDM 3910 / 50L H with SD3 15

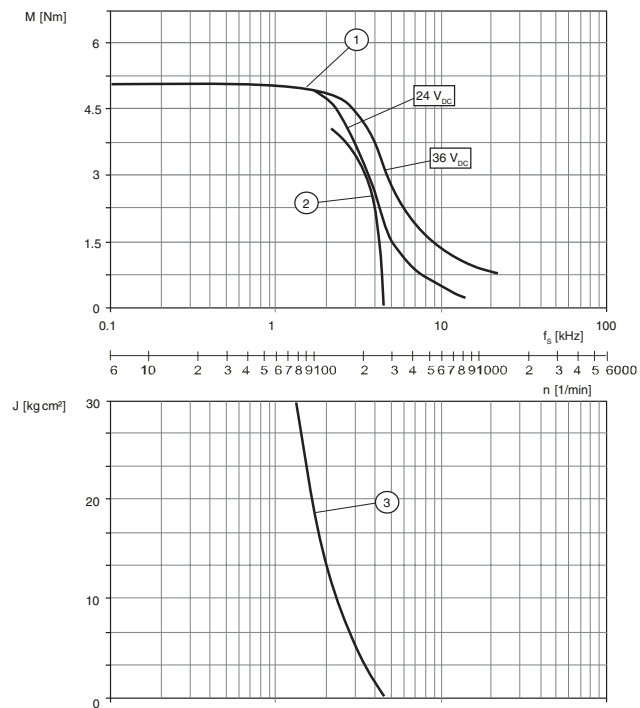


Measurement at 1000 steps/revolution, nominal voltage DC bus  $U_N$  and motor phase current  $I_N$

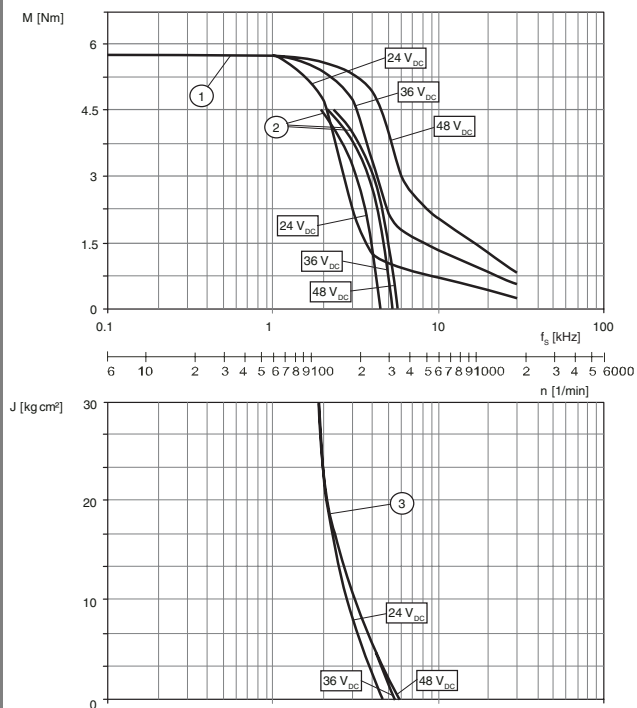
- (1) Pull-out torque
- (2) Pull-in torque
- (3) Maximum load inertia

# Characteristic curves

VRDM 3913 / 50L H with D920



VRDM 3913 / 50L H with SD3 15

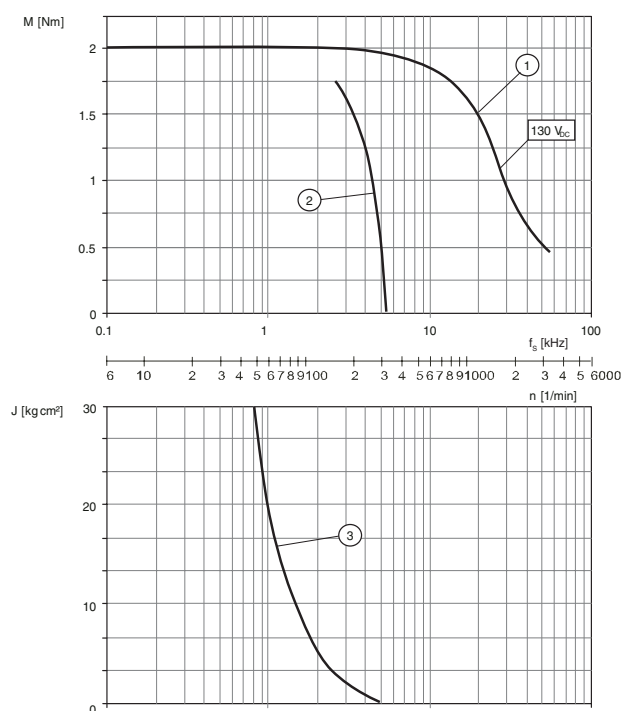


Measurement at 1000 steps/revolution, nominal voltage DC bus  $U_N$  and motor phase current  $I_N$

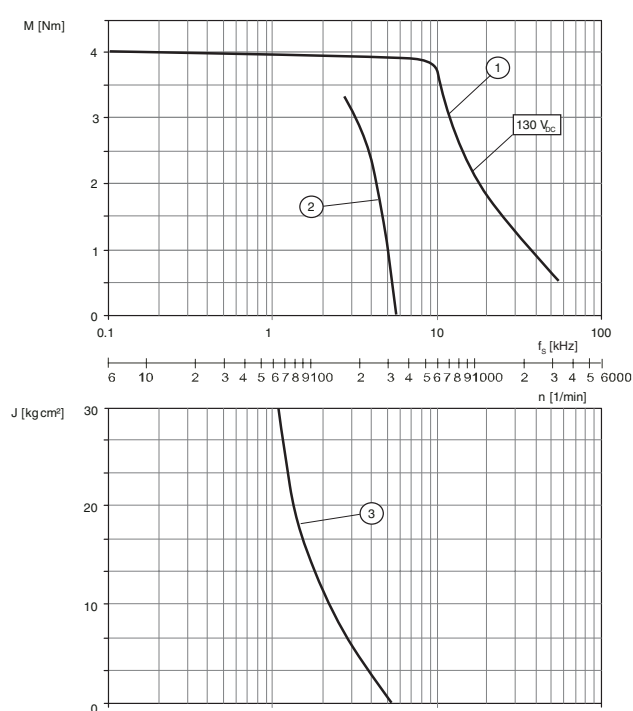
- (1) Pull-out torque
- (2) Pull-in torque
- (3) Maximum load inertia

## Characteristic curves

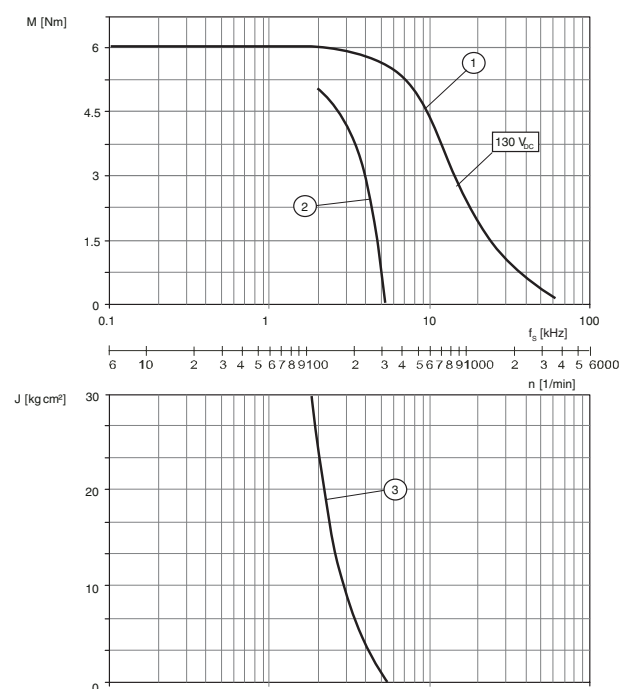
VRDM 397 / 50L N with D900



VRDM 3910 / 50L N with D900



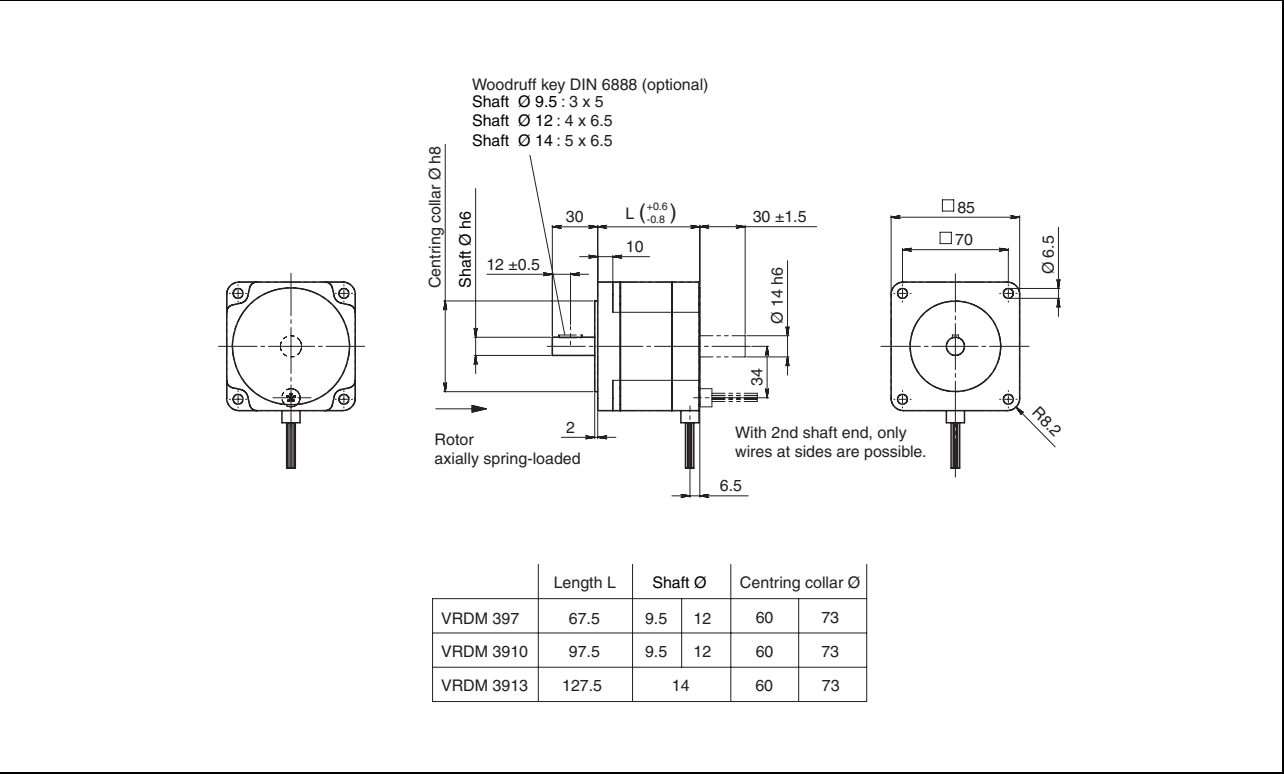
VRDM 3913 / 50L N with D900



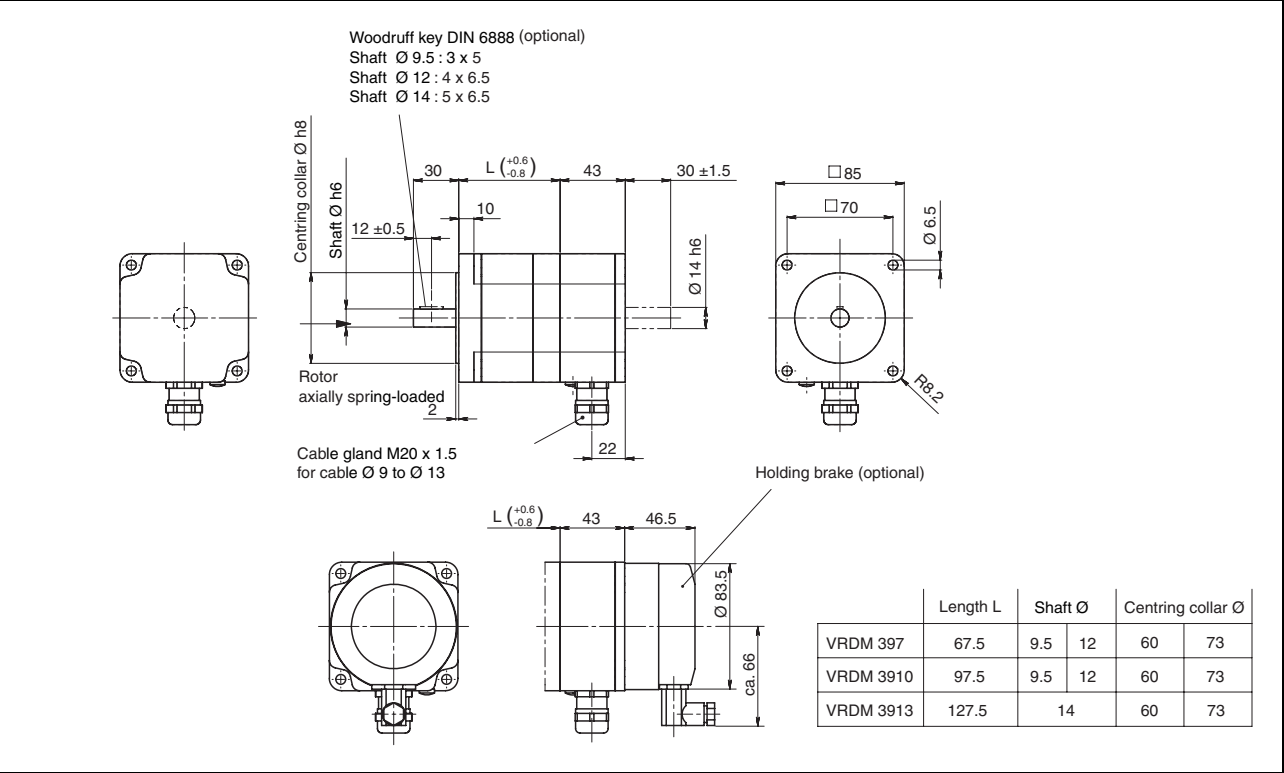
Measurement at 1000 steps/revolution, nominal voltage DC bus  $U_N$  and motor phase current  $I_N$

- (1) Pull-out torque
- (2) Pull-in torque
- (3) Maximum load inertia

Dimensional drawings

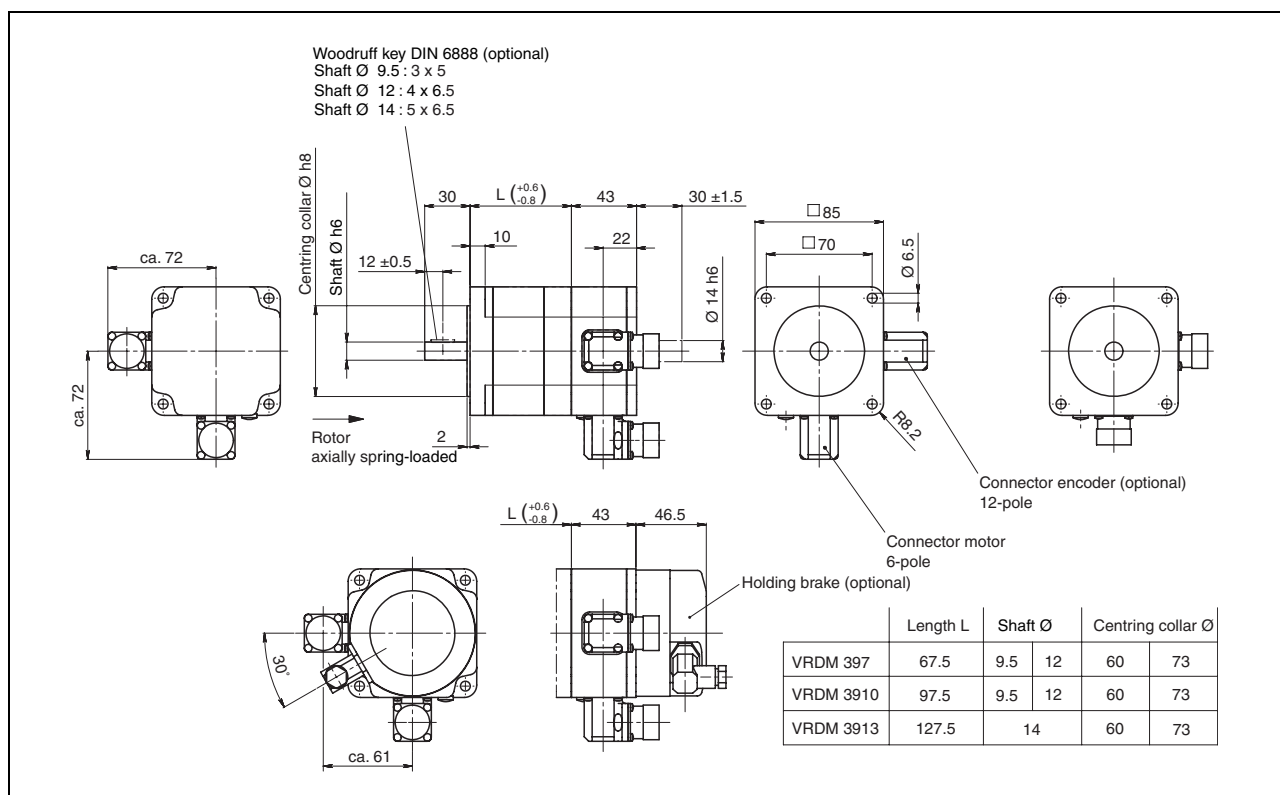


3-phase stepper motor VRDM 39• in wire version



3-phase stepper motor VRDM 39• in terminal box version

## Dimensional drawings

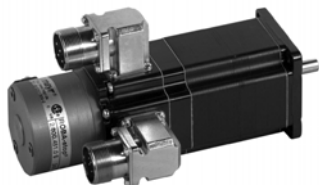


3-phase stepper motor VRDM 39• in connector version

Type code																									
<b>Example:</b>	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Number of phases</b> 3	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Size (flange)</b> 9 = 85 mm	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Motor length</b> 7 = 68 mm 10 = 98 mm 13 = 128 mm	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Number of pole pairs</b> 50	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	B	OOO			
<b>Rotor</b> L = laminated rotor plate	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Maximum voltage</b> H = 34 V <sub>AC</sub> (48 V <sub>DC</sub> ) N = 92 V <sub>AC</sub> (130 V <sub>DC</sub> )	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	B	OOO			
<b>Connection type</b> A = Wires B = Terminal box C = Connector	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Position capture</b> E = Encoder (1000 increments/revolution) O = Without encoder	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Holding brake</b> B = Brake O = Without brake	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Degree of protection</b> IP41 = IP 41 at shaft bushing IP56 = IP 56 at front shaft bushing	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Gearing type</b> O = Without gearing 3 = PLE 80 B = PLS 90	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Gear ratio</b> O = Without gearing 3 = 3:1 5 = 5:1 8 = 8:1	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Shaft diameter*</b> D9 = 9.5 mm D2 = 12 mm D4 = 14 mm DO = With gearing	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Shaftdesignfront</b> O = smooth shaft or gearing K = Woodruff key as per DIN 6888	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Centring collar</b> 60 = 60 mm 73 = 73 mm OO = Without gearing	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Second shaft</b> O = without 2 = with	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Connection direction motor plug</b> <sup>1)</sup> O = Without, L = Left, R = Right B = Back, F = Front, S = Straight	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Connection direction encoder plug</b> <sup>1)</sup> O = Without, L = Left, R = Right B = Back, F = Front, S = Straight	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Wire output</b> S = side B = back O = without	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			
<b>Wire length</b> OOO = without xxx = xxx mm (max. 400 mm)	VRDM	3	9	10	/	50	L	H	C	E	O	IP41	3	5	DO	O	OO	2	B	B	O	OOO			

<sup>1)</sup> Connection direction viewed from front at 1st shaft end, connector up.

**\*Note:** Please note the description of the possible motor types on page 38.



## Options

### Holding brake

The holding brake is an electromagnetic spring force brake and fixes the motor axis after switching off the motor current (e.g. in case of power failure or emergency stop). The shaft must be fixed with torque loads resulting from gravity, e.g. with Z-axes in handling technology.

### Technical data

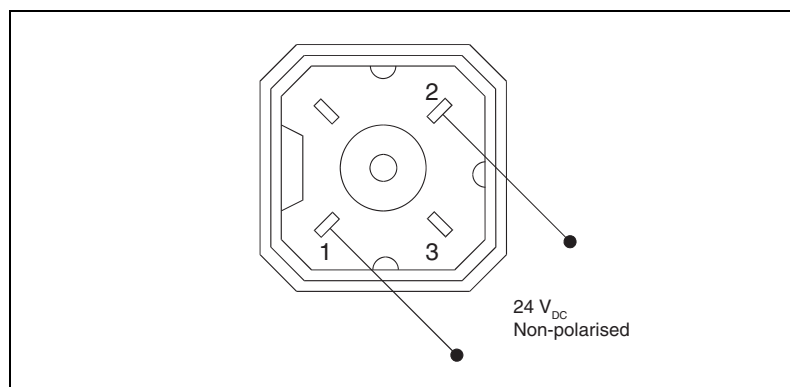
Holding brake for motor type		VRDM 36•	VRDM 39•
Nominal voltage	V	24	24
Holding torque	Nm	1	6
Pull-in power	W	8	24
Moment of inertia	kgcm <sup>2</sup>	0.016	0.2
Energise time (release brake)	ms	58	40
Shutdown time (apply brake)	ms	14	20
Mass	kg	Approx. 0.5	Approx. 1.5

**Note:** In order to ensure the safe function of the holding brake for Z-axes, the static load torque must be no greater than 25% of the holding torque of the motor.

### Wiring diagram

The connector is a part of the scope of supply.

Connector designation: Hirschmann Type G4 5M



Wiring diagram of the connector for the holding brake



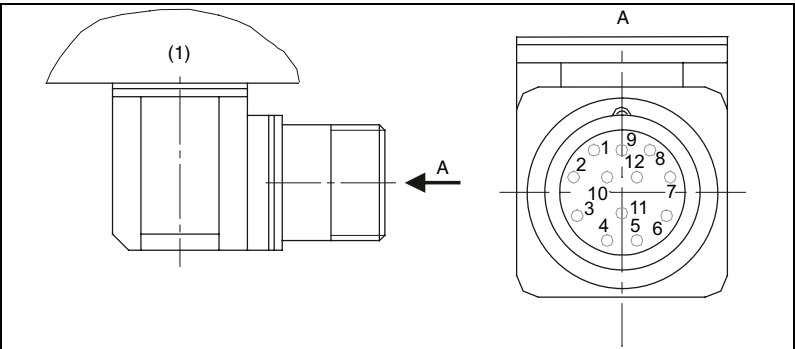
Encoder

Three-phase stepper motors from Berger Lahr can be fitted with an encoder. If the stepper drive is fitted with rotation monitoring electronics, the encoder operates as a measurement system for reporting the actual position of the rotor. The rotation monitoring compares the setpoint and actual position of the motor and reports errors if the actual position deviates from the setpoint position. For example, this enables detection of mechanical overload of the motor.

**Note:** an encoder can only be used with motors with connector. A temperature sensor is integrated to protect the encoder from high temperatures.

Technical data		
Resolution	Inc/rev.	1000
Index plus	Inc/rev.	1
Output		RS 422
Signals		A; B; I
Signal shape		Rectangular
Supply voltage	V	5 ± 5%
Supply current	A	max.0.125

Wiring diagram



Wiring diagram of encoder plug on VRDM 3••  
(1) Motor housing

Pin	Designation
1	A
2	A negated
3	B
4	B negated
5	C, I
6	C negated, negated
7	5V <sub>GND</sub>
8	+ 5
9	-SENSE
10	+SENSE
11	Temperature sensor
12	not connected

## Gearing



Stepper motors from Berger Lahr can also be fitted with integrated planetary gear. The PLE gearings are economical planetary gears that meet most requirements for accuracy. The PLS gear is a high-quality gearing with very low torsional play. These gearings can be supplied with one of three gear ratios: 3:1, 5:1 and 8:1. The output torque of the gearing is determined by multiplying the torque of the motor with the gear ratio and the efficiency of the gearing (0.96). The following table shows the recommended gearings for the motors.

Motor type	Gearing type	
VRDM 364	PLE 40, PLE 60	PLS 70
VRDM 366	PLE 60	PLS 70
VRDM 368	PLE 60	PLS 70
VRDM 39*	PLE 80	PLS 90

## Technical data PLE gearing

### PLE-gearing general

Gear stages		1
Bearing service life <sup>1)</sup>	h	10000
Efficiency at full load	%	96
Housing material		aluminium
Surface		black anodised
Shaft material		C 45
Bearings		roller bearing
Operating temperature <sup>2)</sup>	°C	-25 ... +90, shortly +120
Degree of protection <sup>3)</sup>		IP 54
Lubrication		lifetime lubrication

<sup>1)</sup> Life time with an output speed at 100 1/min and T = 30 °C

<sup>2)</sup> Referring to the housing surface

<sup>3)</sup> With mounting position IM V3 (drive shaft vertical, shaft end upward) only degree of protection IP 41 is guaranteed

Size PLE		40	60	80	120
Max. radial force <sup>1) 2)</sup>	N	200	500	950	2000
Max. axial force <sup>1)</sup>	N	200	600	1200	2800
Torsional play	arcmin	<30	<20	<12	<8
Max. drive speed	1/min	18000	13000	7000	6500
Recommended drive speed	1/min	4500	4000	4000	3500
Torsional stiffness	Nm/arcmin	1.0	2.3	6	12
Weight	kg	0.35	0.9	2.1	6.0

<sup>1)</sup> The information refers to min. 20000 h bearing service life with an output speed of 100 1/min and application factor K = 100 min and S1-operating mode for electrical machines and T = 30 °C

<sup>2)</sup> Refers to the centre of the drive shaft and 50% duty cycle.

**Attention:** the actual output torque must be less than the nominal output torque of the gearing, otherwise the gearing may be destroyed.

## Technical data PLS gearing

Size PLS		70	90
Max. radial force <sup>1) 2)</sup>	N	3000	4000
Max. axial force <sup>1)</sup>	N	6000	9000
Torsional play	arcmin	<3	<3
Max. drive speed	1/min	14000	10000
Recommended drive speed	1/min	5000	4500
Torsional stiffness	Nm/arcmin	6	9
Weight	kg	3.0	4.3

<sup>1)</sup> The values refer to a min. bearing service life of 20000 h at an output speed of 100 1/min and an application factor K = 100 min and S1 operating mode for electrical machines and T = 30 °C

<sup>2)</sup> Referring to centre of output shaft and 50% duty cycle

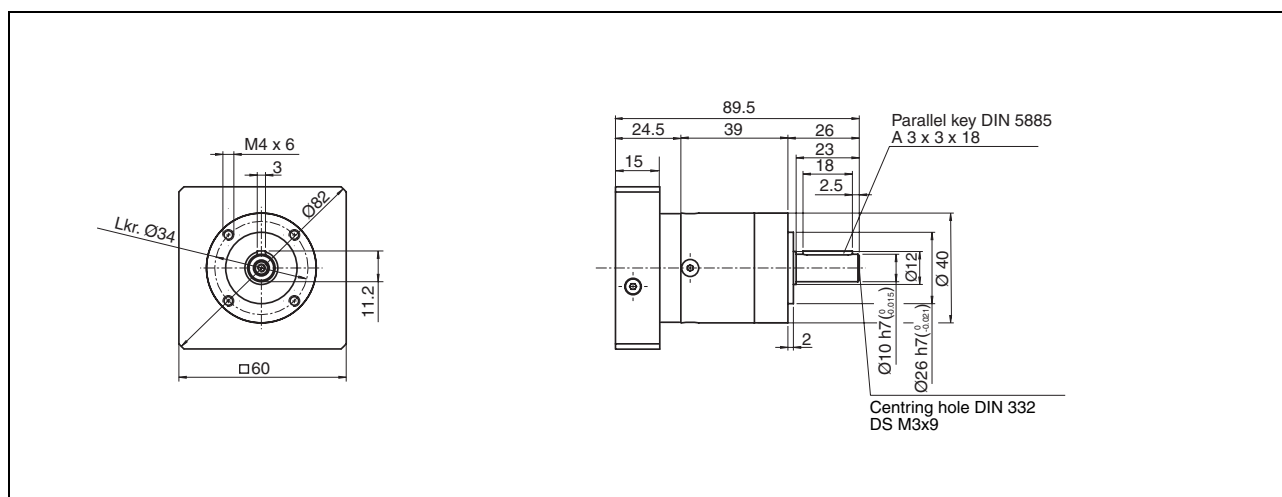
**PLS gearing general**

Gear stages		1
Life time <sup>1)</sup>	h	20000
Efficiency at full load	%	98
Housing material		aluminium
Surface		black anodised
Shaft material		C 45
Bearings		tapered roller bearings
Operating temperature <sup>2)</sup>	°C	-25 ... +100, shortly +124
Degree of protection <sup>3)</sup>		IP 65
Lubrication		lifetime lubrication

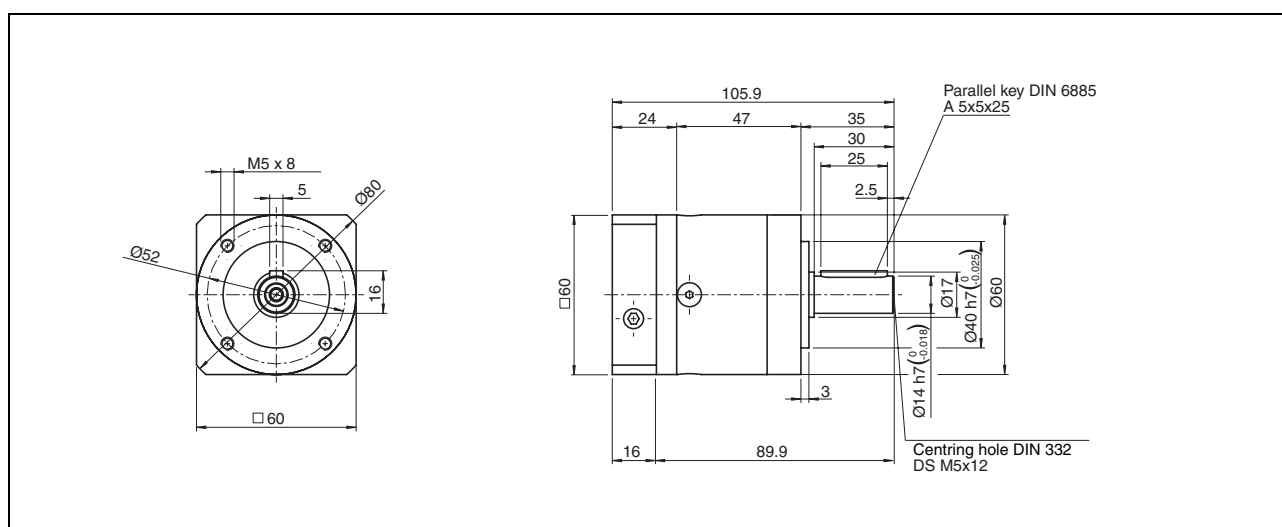
<sup>1)</sup> Life time with an output speed of 100 1/min and T = 30 °C

<sup>2)</sup> Referring to the housing surface

<sup>3)</sup> With mounting position IM V3 (drive shaft vertical, shaft end upward) only protection class IP 41 is guaranteed

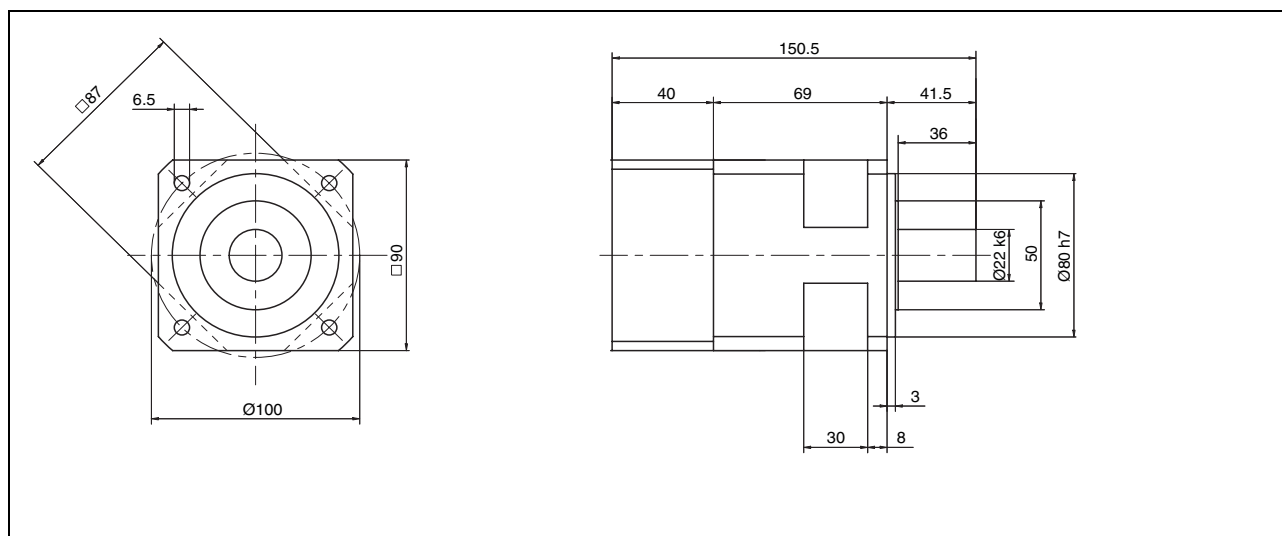
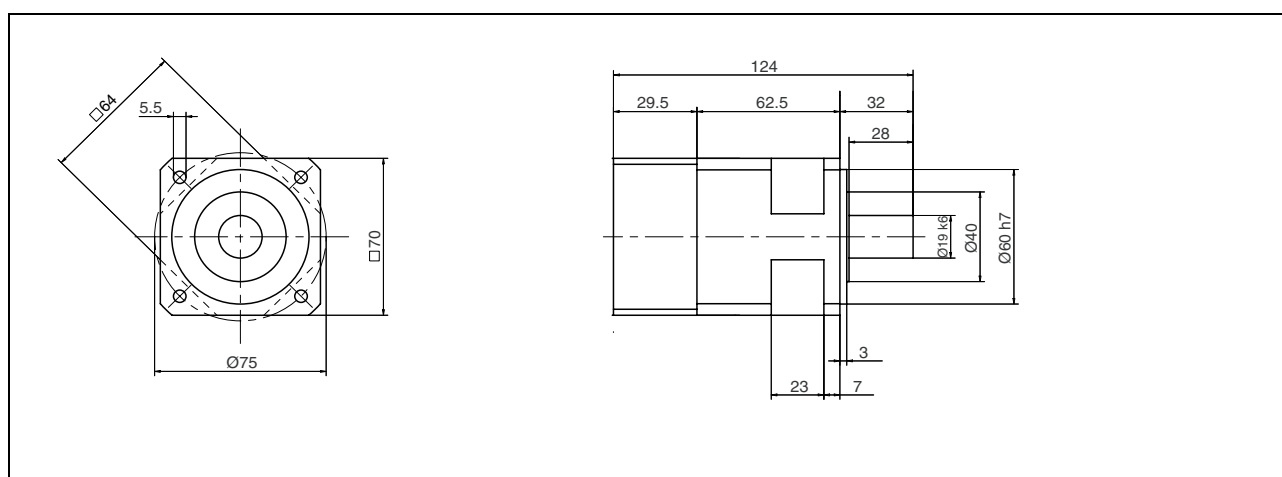
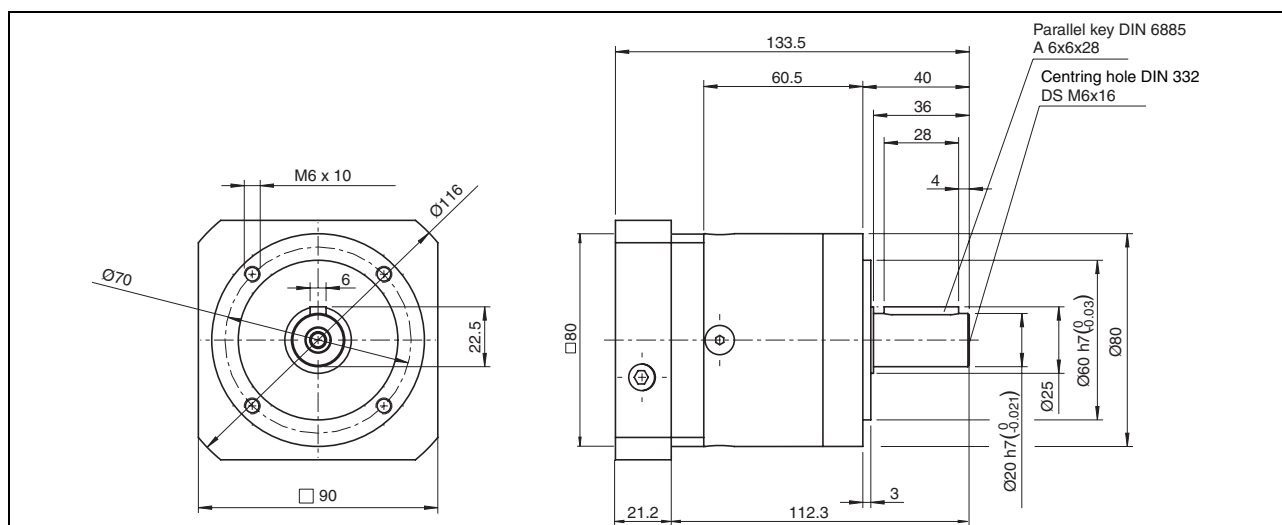
**Dimensional drawings**

PLE 40 gearing, single-stage



PLE 60 gearing, single-stage

## Dimensional drawings



**Accessories****Order data**

Designation	Description	Order number
<b>Motor cable</b>		
<b>Cable for 3-phase stepper motor</b>	4 x 1.5 mm, shielded; Motor end with 6-pin circular plug; other cable end open	3m
		VW3S5101R30
		5 m
		VW3S5101R50
		10 m
		VW3S5101R100
		15 m
		VW3S5101R150
		20 m
		VW3S5101R200
	4 x 1.5 mm, shielded; both cable ends open	3 m
		VW3S5102R30
		5 m
		VW3S5102R50
		10 m
		VW3S5102R100
		15 m
		VW3S5102R150
		20 m
		VW3S5102R200
<b>Adapter plate for SD3 15</b>	For DIN rail mounting	MNA3MFDINR1
<b>EMC kit for SD3 15</b>	For shield connection of shielded cable	MNA3CS013
<b>Spring clamp connector kit for SD3 15D</b>	2 ,4 and 11 pins	MNA3CS008
<b>Spring clamp connector kit for SD3 15O</b>	2 ,4, 11 and 12 pins	MNA3CS009
<b>Connector for D900 and D920</b>	Signal, motor and supply connection	0098050060238

## Conversion tables

## Rotor inertia

	lb-in <sup>2</sup>	lb-ft <sup>2</sup>	lb-in-s <sup>2</sup>	lb-ft-s <sup>2</sup> slug-ft <sup>2</sup>	kg-cm <sup>2</sup>	kg-cm-s <sup>2</sup>	g-cm <sup>2</sup>	g-cm-s <sup>2</sup>	oz-in <sup>2</sup>	oz-in-s <sup>2</sup>
lb-in <sup>2</sup>	–	$6.94 \times 10^{-3}$	$2.59 \times 10^{-3}$	$2.15 \times 10^{-4}$	2.926	$2.98 \times 10^{-3}$	$2.92 \times 10^3$	2.984	16	$4.14 \times 10^{-2}$
lb-ft <sup>2</sup>	144	–	0.3729	$3.10 \times 10^{-2}$	421.40	0.4297	$4.21 \times 10^5$	429.71	2304	5.967
lb-in-s <sup>2</sup>	386.08	2.681	–	$8.33 \times 10^{-2}$	$1.129 \times 10^3$	1.152	$1.129 \times 10^6$	$1.152 \times 10^3$	$6.177 \times 10^3$	16
lb-ft-s <sup>2</sup> slug-ft <sup>2</sup>	$4.63 \times 10^3$	32.17	12	–	$1.35 \times 10^4$	13.825	$1.355 \times 10^7$	$1.38 \times 10^4$	$7.41 \times 10^4$	192
kg-cm <sup>2</sup>	0.3417	$2.37 \times 10^{-3}$	$8.85 \times 10^{-4}$	$7.37 \times 10^{-6}$	–	$1.019 \times 10^{-3}$	1000	1.019	5.46	$1.41 \times 10^{-2}$
kg-cm-s <sup>2</sup>	335.1	2.327	0.8679	$7.23 \times 10^{-2}$	980.66	–	$9.8 \times 10^5$	1000	$5.36 \times 10^3$	13.887
g-cm <sup>2</sup>	$3.417 \times 10^{-4}$	$2.37 \times 10^{-6}$	$8.85 \times 10^{-7}$	$7.37 \times 10^{-8}$	$1 \times 10^{-3}$	$1.01 \times 10^{-6}$	–	$1.01 \times 10^{-3}$	$5.46 \times 10^{-3}$	$1.41 \times 10^{-6}$
g-cm-s <sup>2</sup>	0.335	$2.32 \times 10^{-3}$	$8.67 \times 10^{-4}$	$7.23 \times 10^{-5}$	0.9806	$1 \times 10^{-3}$	980.6	–	5.36	$1.38 \times 10^{-2}$
oz-in <sup>2</sup>	0.0625	$4.3 \times 10^{-4}$	$1.61 \times 10^{-6}$	$1.34 \times 10^{-6}$	0.182	$1.86 \times 10^{-4}$	182.9	0.186	–	$2.59 \times 10^{-3}$
oz-in-s <sup>2</sup>	24.3	0.1675	$6.25 \times 10^{-2}$	$5.20 \times 10^{-3}$	70.615	$7.20 \times 10^{-2}$	$7.06 \times 10^4$	72	386.08	–

## Torque

	lb-in	lb-ft	oz-in	Nm	kg-m	kg-cm	g-cm	dyne-cm
lb-in	–	$8.333 \times 10^{-2}$	16	0.113	$1.152 \times 10^{-2}$	1.152	$1.152 \times 10^3$	$1.129 \times 10^6$
lb-ft	12	–	192	1.355	0.138	13.825	$1.382 \times 10^4$	$1.355 \times 10^7$
oz-in	$6.25 \times 10^{-2}$	$5.208 \times 10^{-3}$	–	$7.061 \times 10^{-3}$	$7.200 \times 10^{-4}$	$7.200 \times 10^{-2}$	72.007	$7.061 \times 10^4$
Nm	8.850	0.737	141.612	–	0.102	10.197	$1.019 \times 10^4$	$1 \times 10^7$
kg-m	86.796	7.233	$1.388 \times 10^3$	9.806	–	100	$1 \times 10^5$	$9.806 \times 10^7$
kg-cm	0.8679	$7.233 \times 10^{-2}$	13.877	$9.806 \times 10^{-2}$	$10^{-2}$	–	1000	$9.806 \times 10^5$
g-cm	$8.679 \times 10^{-4}$	$7.233 \times 10^{-5}$	$1.388 \times 10^{-2}$	$9.806 \times 10^{-5}$	$1 \times 10^{-5}$	$1 \times 10^{-3}$	–	980.665
dyne-cm	$8.850 \times 10^{-7}$	$7.375 \times 10^{-8}$	$1.416 \times 10^{-5}$	$10^{-7}$	$1.019 \times 10^{-8}$	$1.0197 \times 10^{-6}$	$1.019 \times 10^{-6}$	–

## Power

	H.P.	W
H.P.	–	745.7
W	$1.31 \times 10^{-3}$	–

## Length

	in	ft	yd	m	cm	mm
in	–	0.0833	0.028	0.0254	2.54	25.4
ft	12	–	0.333	0.3048	30.48	304.8
yd	36	3	–	0.914	91.44	914.4
m	39.37	3.281	1.09	–	100	1000
cm	0.3937	0.03281	$1.09 \times 10^{-2}$	0.01	–	10
mm	0.03937	0.00328	$1.09 \times 10^{-3}$	0.001	0.1	–

## Speed

	1/min (rpm)	rad/sec	deg./sec
1/min (rpm)	–	0.105	6.0
rad/sec	9.55	–	57.30
deg./sec	0.167	$1.745 \times 10^{-2}$	–

## Mass

	lb	oz	slug	kg	g
lb	–	16	0.0311	0.453592	453.592
oz	$6.35 \times 10^{-2}$	–	$1.93 \times 10^{-3}$	0.028349	28.35
slug	32.17	514.8	–	14.5939	$1.459 \times 10^4$
kg	2.20462	35.274	0.0685218	–	1000
g	$2.205 \times 10^{-3}$	$3.527 \times 10^{-3}$	$6.852 \times 10^{-5}$	0.001	–

## Temperature

	°F	°C
°F	–	$(\text{°F} - 32) \times \frac{5}{9}$
°C	$\frac{9}{5} \times 32 + 32$	–

## Force

	lb	oz	gf	dyne	N
lb	–	16	453.592	$4.448 \times 10^5$	4.4482
oz	0.0625	–	28.35	$2.780 \times 10^4$	0.27801
gf	$2.205 \times 10^{-3}$	0.03527	–	980.665	N.A.
dyne	$2.248 \times 10^{-6}$	$3.59 \times 10^{-6}$	$1.02 \times 10^{-3}$	–	0.0001
N	0.22481	3.5967	N.A.	100,000	–

Example for conversion:

Conversion of 10 inches to metres. Search for "in" (inches) in the left column of the "length" table and "m" (metres) in the header row. The box at the intersection of column and row gives you the conversion factor: "0.0254". Multiply 10 inches by 0.0254, and you have the value in metres:  $10 \text{ in} \times 0.0254 = 0.254 \text{ m}$ .

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