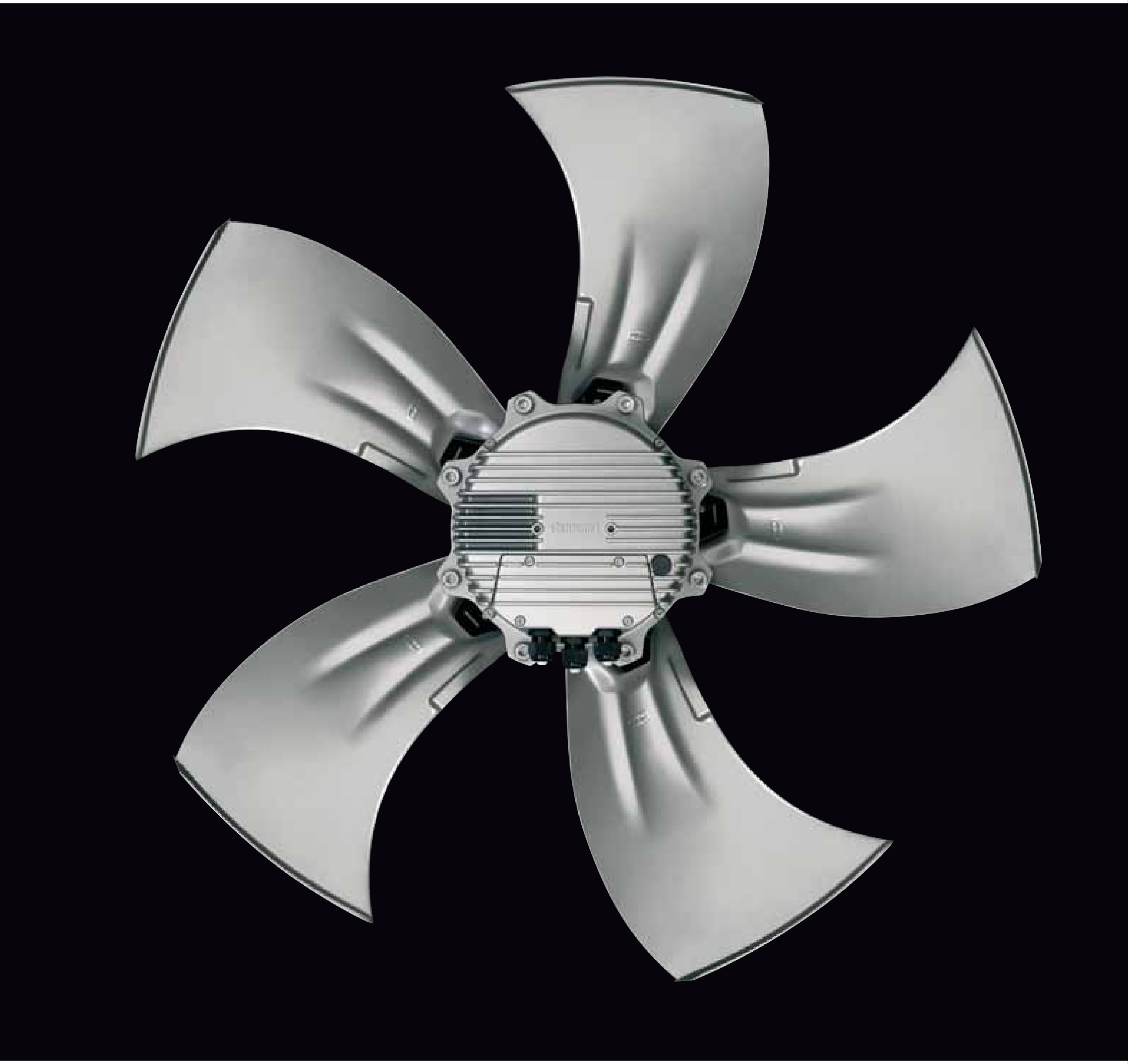
Technology



Technical parameters & scope

High standards for all ebm-papst products

Here at ebm-papst, we constantly strive to further improve our products in order to be able to offer you the best possible product for your application. Careful monitoring of the market ensures that technical innovations are reflected in the improvements of our products.
Based on the technical parameters listed below and the ambience you want our product to operate in, we here at ebm-papst can always work out the best solution for your specific application.

General performance parameters
Any deviations from the technical data and parameters described here are listed on the product-specific data sheet.

Type of protection
The type of protection is specified in the product-specific data sheets.

Insulation class
The insulation class is specified in the product-specific data sheets.

Mounting position
The mounting position is specified in the product-specific data sheets.

Condensate discharge holes
Information on the condensate discharge holes is provided in the product-specific data sheets.

Mode of operation
The mode of operation is specified in the product-specific data sheets.

Protection class
The protection class is specified in the product-specific data sheets.

Service life
The service life of ebm-papst products depends on two major factors:
- The service life of the insulation system
- The service life of the bearing system

The service life of the insulation system mainly depends on voltage level, temperature and ambient conditions, such as humidity and condensation.
The service life of the bearing system depends mainly on the thermal load on the bearing.
The majority of our products use maintenance-free ball bearings for any mounting position possible. As an option, sleeve bearings can be used, which is indicated on the product-specific data sheet wherever applicable.
The service life L10 of the ball bearings can be taken as approx. 40,000 operating hours at an ambient temperature of 40 °C, yet this estimate can vary according to the actual ambient conditions.
We will gladly provide you with a lifetime calculation taking into account your specific operating conditions.

Motor protection / thermal protection
Information on motor protection and thermal protection is provided in the product-specific data sheets.
Depending on motor type and field of application, the following protective features are realised:
- Thermal overload protection (TOP), either in-circuit or external
- PTC with electronic diagnostics
- Impedance protection
- Thermal overload protection (TOP) with electronic diagnostics
- Current limitation via electronics

If an external TOP is connected, the customer has to make sure to connect a conventional trigger device for switching it off.
All fans with 1~ AC voltage are equipped with a TOP that is connected in the winding circuit.
Products without fitted TOP and without protection against improper use, a motor protection complying with the valid standards has to be installed.

Left: Endurance test room
Middle: Shock test
Right: Chamber test rig

Mechanical strain / performance parameters

All ebm-papst products are subjected to comprehensive tests complying with the normative specifications. In addition to this, the tests also reflect the vast experience and expertise of ebm-papst.

Vibration test

Vibration tests are carried out in compliance with
- Vibration test in operation according to DIN IEC 68, parts 2-4
- Vibration test at standstill according to DIN IEC 68, parts 2-4

Shock load

Shock load tests are carried out in compliance with
- Shock load according to DIN IEC 68, parts 2-27

Balancing quality

Testing the balancing quality is carried out in compliance with
- Residual imbalance according to DIN ISO 1940
- Standard balancing quality level G 6.3

Should you require a higher balancing quality level for your specific application, please let us know and specify this when ordering your product.

Chemo-physical strain / performance parameters

Should you have questions about chemo-physical strain, please direct them to your ebm-papst contact.

Fields of application, industries and applications

Our products are used in various industries and applications:
Ventilation, air-conditioning and refrigeration technology, clean room technology, automotive and rail technology, medical and laboratory technology, electronics, computer and office technology, telecommunications, household appliances, heating, machines and plants, drive engineering.
Our products are not designed for use in the aviation and aerospace industry!

Legal and normative directives

The products described in this catalogue are designed, developed and produced in keeping with the standards in place for the relevant product and, if known, the conditions governing the relevant fields of application.

Standards

Information on standards is provided in the product-specific data sheets.

EMC

Information on EMC standards is provided in the product-specific data sheets.
Complying with the EMC standards has to be established on the final appliance, as different mounting situations can result in changed EMC properties.

Leakage current

Information on the leakage current is provided in the product-specific data sheets.
The measurement takes place according to Fig. D.1 according to IEC 60990, Fig. 4.

Approvals

In case you require a specific approval for your ebm-papst product (VDE, UL, GOST, CCC, CSA, etc.) please let us know.
Most of our products can be supplied with the relevant approval.
Information on existing approvals is provided in the product-specific data sheets.

Air performance measurements

All air performance measurements are carried out on inlet-side chamber test rigs in conformity with the requirements of DIN 24163 and ISO 5801. The fans being tested are installed on the measuring chamber at free air intake and discharge (installation type A according to DIN 24163 Part 1) and are operated at nominal voltage (for AC, also at nominal frequency) without additional attachments such as the guard grille.
As required by the standard, the air performance curves correspond to an air density of 1.2 kg/m^3.


Room for precision noise measuring

Measurement conditions for air and noise measurement

ebm-papst products are measured under the following conditions:

- Axial and centrifugal fans with direction of air flow "V", without guard grille and in the wall ring
- Backward curved centrifugal fans, free-running and with inlet nozzle
- Forward curved single and dual inlet centrifugal fans with housing

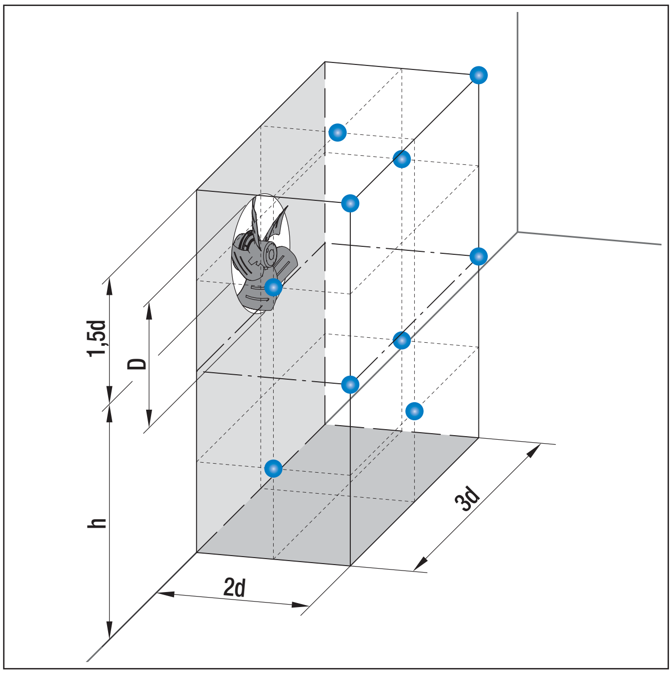
Noise measurements

All noise measurements are carried out in low-reflective test rooms with reverberant floor. Thus the ebm-papst acoustic test chambers meet the requirements of precision class 1 according to DIN EN ISO 3745. For noise measurement, the fans being tested are placed in a reverberant wall and operated at nominal voltage (for AC, also at nominal frequency) without additional attachments such as the guard grille.

Sound pressure level and sound level

All noise levels are measured in conformity to DIN 45635 and ISO 3744/3745 according to precision class 2 and specified A-weighted. When the sound pressure level (L_p) is measured, the microphone is on the intake side of the fan being tested, usually at a distance of 1 m on the fan axis.

To measure the sound level (L_W), 10 microphones are distributed over an enveloping surface on the intake side of the fan being tested (see graphic). The sound level measured can be roughly calculated from the sound pressure level by adding 7 dB.



<u>Measurement configuration</u> according to DIN 45635 T38:

● 10 measuring points

$d \geq D$

$h = 1.5d$ to $4.5d$

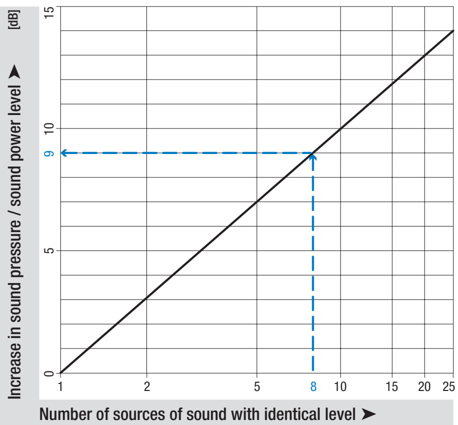
Measurement area $S = 6d^2 + 7d\ (h + 1.5d)$

Curves

Adding multiple noise sources with the same level

Adding 2 noise sources with the same volume results in a level increase of approx. 3 dB. The noise characteristics of multiple identical fans can be determined in advance based on the noise values specified in the data sheet. This is shown in the diagram opposite.

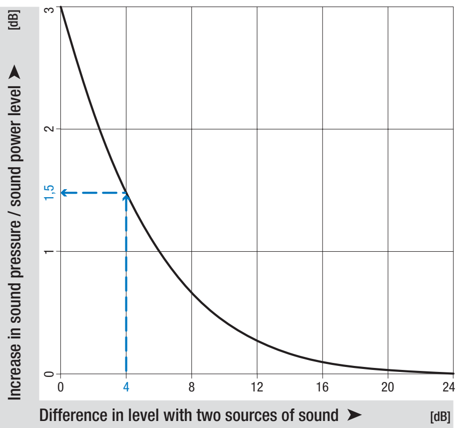
Example: 8 A3G800 axial fans are on a condenser. According to the data sheet, the sound pressure level of a fan is approximately 75 dB(A). The level increase measured from the diagram is 9 dB. Thus the overall sound level of the installation can be expected to be 84 dB(A).



Adding two noise sources with different levels

The acoustic performance of two different fans can be predetermined based on the sound levels given in the data sheet. This is shown in the diagram opposite.

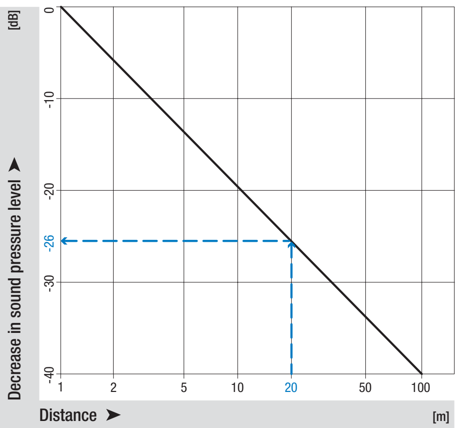
Example: There is an axial fan A3G800 with a sound pressure level of 75 dB(A) at the operating point and an axial fan A3G710 with 71 dB(A) in a ventilation unit. The level difference is 4 dB. The level increase can now be read in the diagram as approx. 1.5 dB. This means that the overall sound level of the unit can be expected to be 76.5 dB(A).



Inverse square laws

The sound level is independent of the distance from the noise source. Conversely, the sound pressure level decreases as distance from the noise source increases. The diagram to the right shows the level decrease expressed in terms of an output measurement at a distance of 1 m from the noise source under far-field conditions.

Example: An axial fan A3G800 has a sound pressure level of 75 db(A) at the operating point. Now, you want to measure the noise characteristics at a distance of 20 m. In the diagram to the right, you can now read a reduction of 26 dB for the 20 m distance.



General information
AC centrifugal, backward
AC centrifugal, forward
EC centrifugal, backward
EC centrifugal, back-ward for clean rooms
EC centrifugal, forward
EC-SYSTEMS
Accessories
Technology
Contacts

Impellers

Impellers made by ebm-papst

Like pumps and compressors, fans and blowers belong to the category of aerodynamic and fluid work machines.
A fan consists of an impeller, a drive motor and a housing for suspension and for guiding the air flow. The blades spaced along the circumference of the impeller are designed in such a way as to cause the flowing work medium to change direction, thus passing on pressure and speed energy.

ebm-papst construction designs

Depending on the geometrical shape of the impeller, there are different construction designs, with their names taken from the main flow direction in the impeller.

The most important designs are:
- Axial fans
- Centrifugal fans with backward curved blades
- Single or dual inlet centrifugal blowers with forward curved blades
- Diagonal (mixed flow) fans (a cross between axial and centrifugal fans)

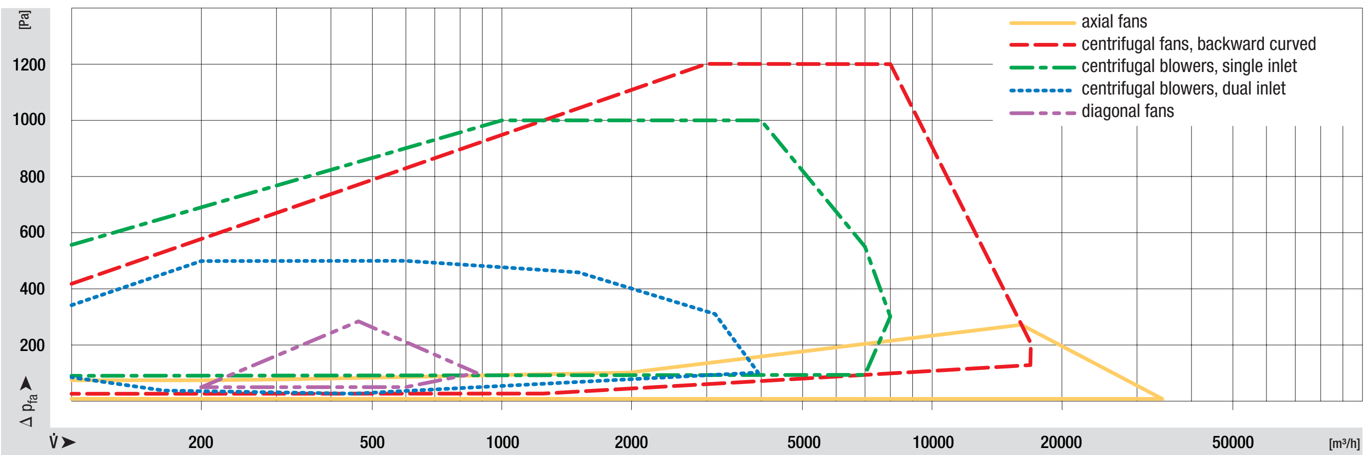
Relevant fields of application of the various construction designs

The different ebm-papst fan and blower designs correspond to the different fields of application:
- Small back pressures: axial fans
- High back pressures: centrifugal fans with backward curved blades and single or dual inlet centrifugal blowers
- Threshold between axial and centrifugal fans: diagonal fans

Application-specific selection parameters

When selecting an application-specific fan or blower, the main parameters to be taken into account are these:
- Air flow at given back pressure
- Constructional design
- Speed/rpm
- Impeller diameter
- Ambient conditions governing suction and exhaust side

Characteristic curves of the various designs



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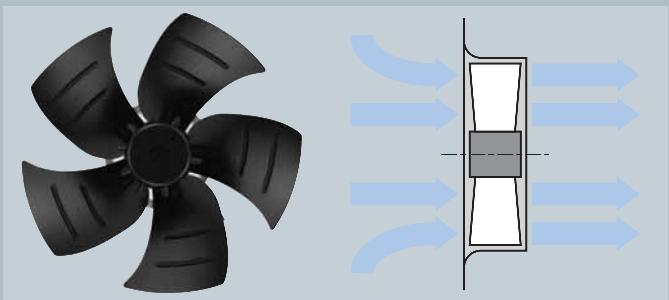


Axial fans

Operating range

To the right of the "saddle" (right part of the air performance curve):

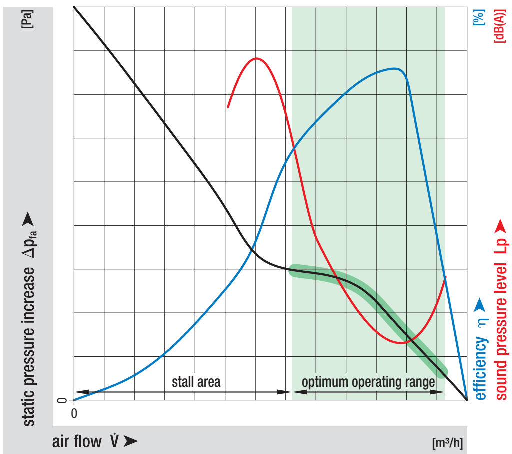
- Maximum efficiency
- Minimal noise

To the left of the "saddle" (left part of the air performance curve):

- Stall area
- Drop in efficiency
- Soaring noise

The optimum operating range of the fan is shaded in green in the curve given here.

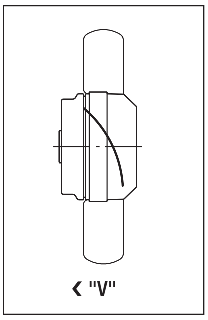
Noise / efficiency curve



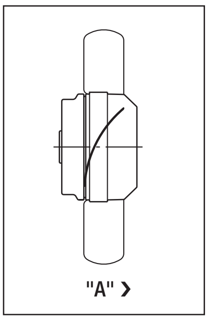
Direction of air flow

The direction of air flow is given as follows:

Direction of air flow "V"



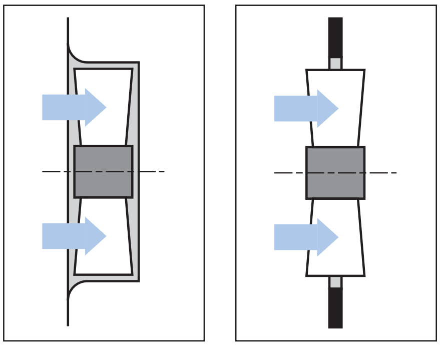
Direction of air flow "A"

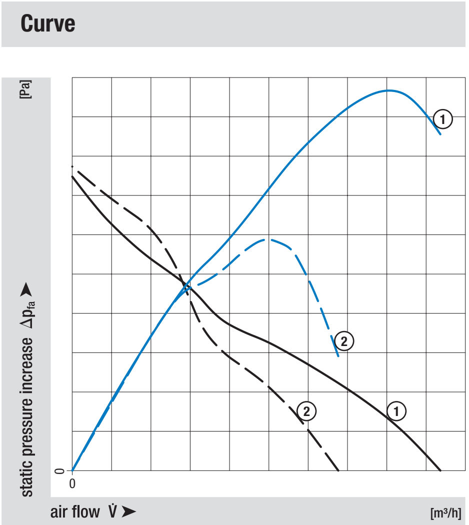


Effects when mounted in wall ring or in the aperture

Mounting the fan in a wall ring can significantly increase the air performance in the operating range.

① Wall ring ② Aperture





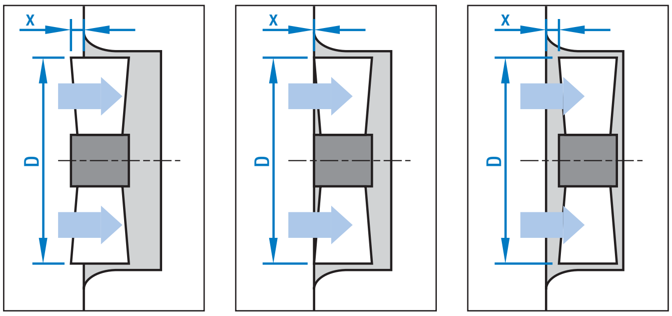
Effects with axial position in the wall ring

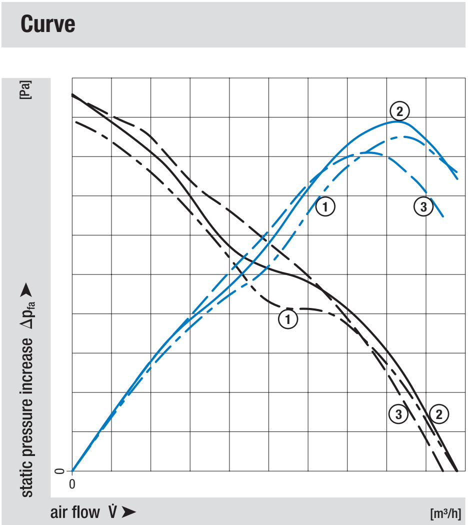
Axial position in the wall ring influences air performance and efficiency.

① Projecting on inlet side x / D = 7 %

② Flush on inlet side x / D = 0 %

③ Immersed on inlet side x / D = -7 %





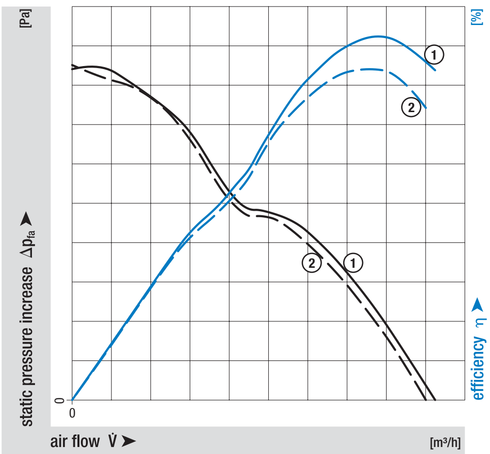
Effects with guard grilles

Mounting a guard grille reduces the air performance of the axial fan.

① Without guard grille

② With guard grille

Curve



The pressure drop in Pa can be roughly calculated according to the following equation:

$$\Delta p_{GG} = \epsilon_{GG} \cdot 10^{-8} \cdot \dot{V}^2 \qquad \dot{V} \text{ in } [m^3/h]$$

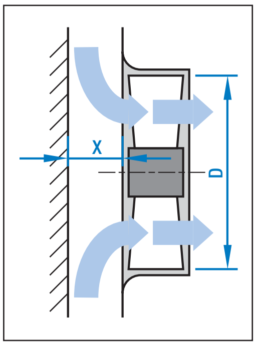
For the guard grilles used at ebm-papst, the correction factor ϵ_{GG} can be used depending on the impeller diameter D from the table to the right.

Diameter D	Correction factor ϵ_{GG}
130	10000
143	6600
180	2550
200	1650
250	650
300	300
315	240
350	150
400	90
450	55
500	35
560	20
630	11
710	6
800	3
910	1.5
990	0.9

Effects of obstructions on the suction or exhaust side

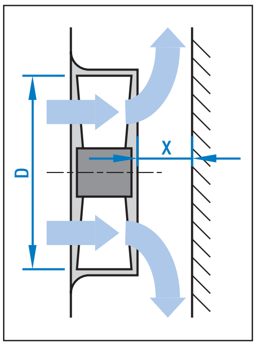
Disturbances or obstructions on the suction or pressure side reduce the air performance of the axial fan.

Obstructions on the inlet side



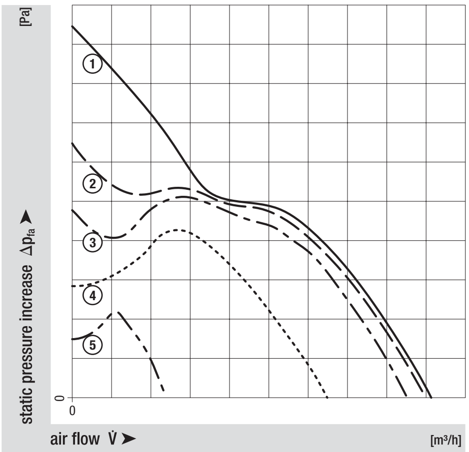
① x / D = ∞
② x / D = 35 %
③ x / D = 18 %
④ x / D = 9 %
⑤ x / D = 5 %

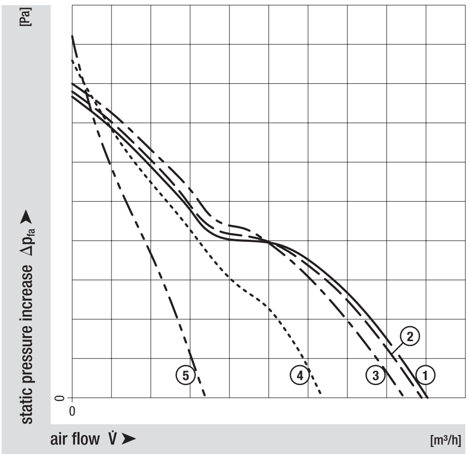
Obstructions on the exhaust side



① x / D = ∞
② x / D = 35 %
③ x / D = 18 %
④ x / D = 9 %
⑤ x / D = 5 %

Curve





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Centrifugal fans with backward curved blades

Operating range

Middle part of air performance curve:

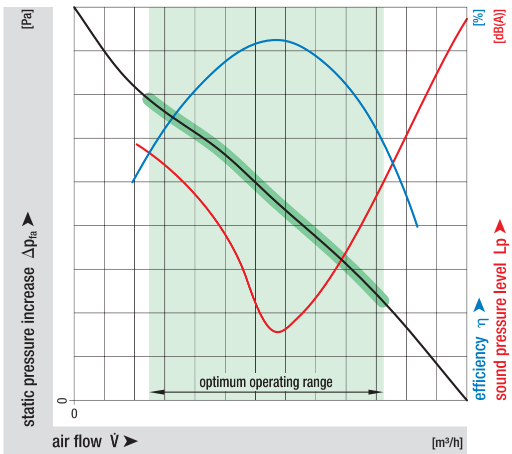
- Maximum efficiency
- Minimal noise

To the right and the left of the middle part of the air performance curve:

- Reduced efficiency
- Increasing noise

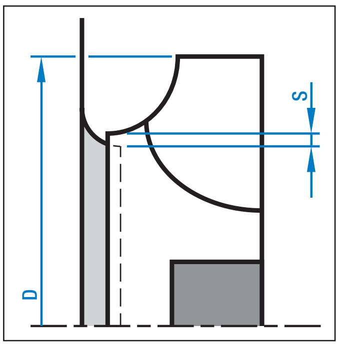
The optimum operating range of the fan is shaded in green in the curve given here.

Noise / efficiency curve



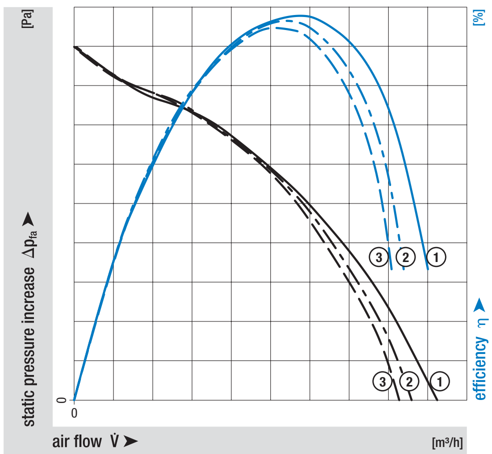
Effects of nozzle gap dimension

The centrifugal air gap between the inlet nozzle and impeller cover plate influences the air performance and efficiency of the centrifugal fan.



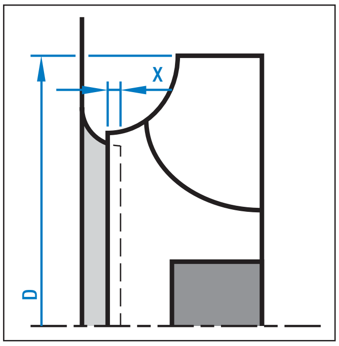
① s / D = 0.4 %
② s / D = 1.0 %
③ s / D = 1.4 %

Curve



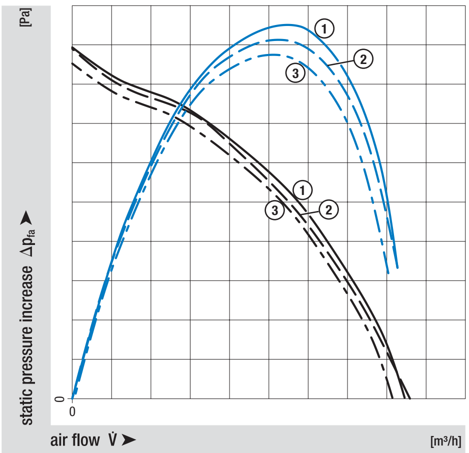
Effects of overlapping dimension

The axial overlap between the inlet nozzle and impeller cover plate influences the air performance and efficiency of a centrifugal fan.



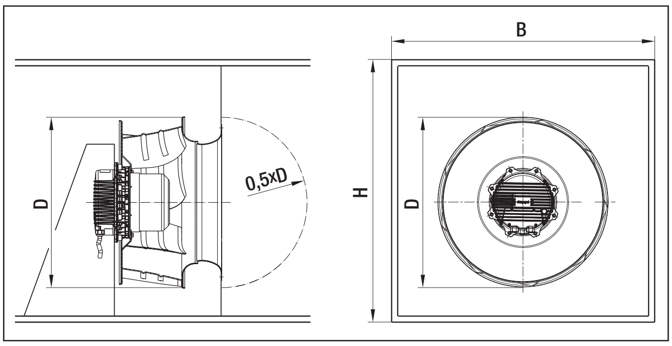
① x / D = 0.6 %
② x / D = 0 %
③ x / D = -0.8 %

Curve

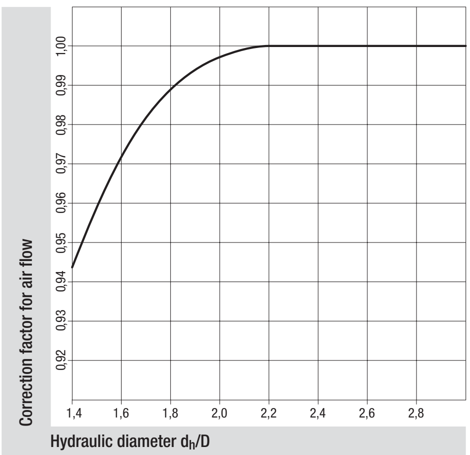


Effects of installation space

When mounting our product in a rectangular box, air performance might be reduced.



Curve



d_h = Hydraulic diameter

Formula: $d_h = 2 \times B \times H / (B + H)$

B = Width of box

H = Height of box

D = Outer diameter of the fan

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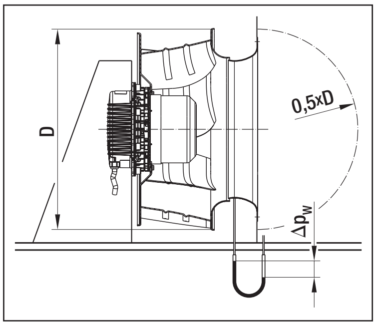
Air flow measurement for inlet nozzles with pressure-measuring point

The differential pressure approach compares the static pressure before the inlet nozzle with the static pressure inside the inlet nozzle.



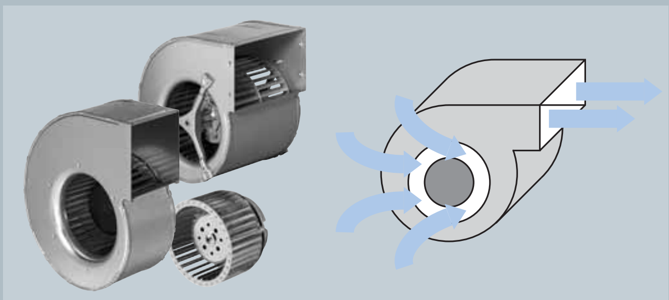
Air flow can be calculated on the basis of the differential pressure (difference in pressure of the static pressures) in keeping with the following equation:

$\dot{V} = k \cdot \sqrt{\Delta p_W}$ $\dot{V}$ in [m³/h] and Δp_W in [Pa]

If constant air flow control is used, then the nozzle pressure has to be kept constant: $\Delta p_W = \dot{V}^2 : k^2$

k takes into account the specific nozzle characteristics.

One or four pressure measuring points are spaced along the circumference of the inlet nozzle. Connection on the customer side is accomplished via a premounted T tube connector. This tube connector is suited for pneumatic hoses with an internal diameter of 4 mm.



Single and dual inlet centrifugal blowers with forward curved blades

The forward curved centrifugal impeller must always be operated inside a scroll housing.
A dual inlet centrifugal blower shows the same behaviour as two single inlet blowers operated in parallel: with size, speed and pressure being identical, double the air flow is achieved.

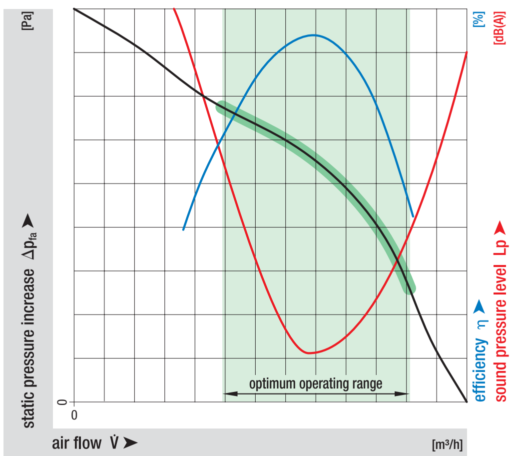
Operating range

Middle part of air performance curve:
- Maximum efficiency
- Minimal noise
- higher performance density than with the backward curved centrifugal fan

To the right and the left of the middle part of the air performance curve:
- Reduced efficiency
- Increasing noise

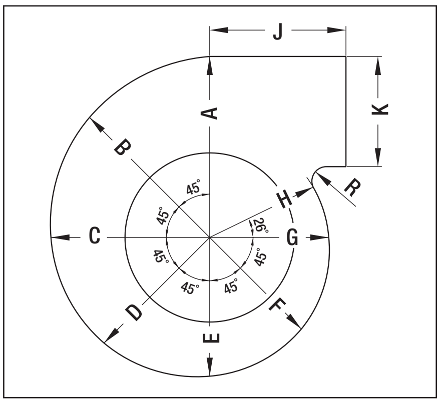
The optimum operating range of the fan is shaded in green in the curve given here.

Noise / efficiency curve



Dimensioning of the scroll

The dimensions of a typical scroll can be calculated with the following formulae, subject to the impeller diameter D:



A = 1.062 · D
B = 0.992 · D
C = 0.922 · D
D = 0.853 · D
E = 0.784 · D
F = 0.715 · D
G = 0.646 · D
H = 0.612 · D
J = 0.720 · D
K = 0.689 · D
R = 0.073 · D

Adjusting the dimensions to diminished mounting spaces is possible.

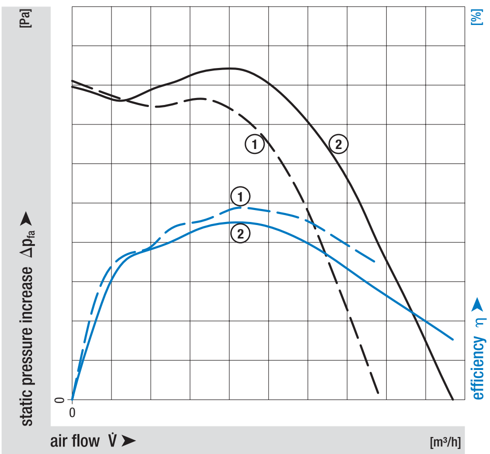
Effects of step diffusers

A diffuser mounted on the exhaust side with connected exhaust tunnel increases air performance and efficiency of the centrifugal blower.

① without step diffuser

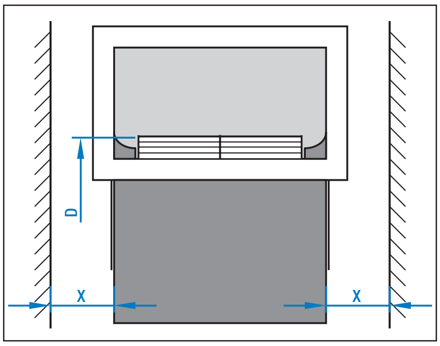
② with step diffuser

Curve



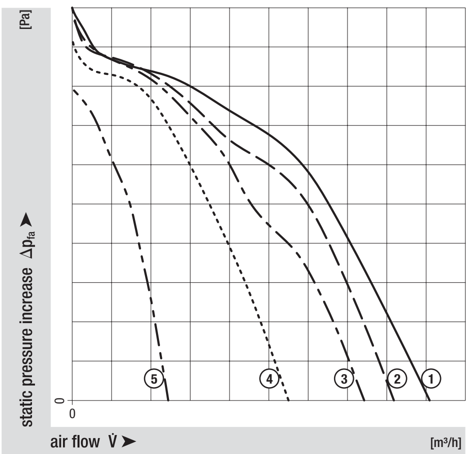
Effects of obstructions on the intake side

Obstructions on the air intake side reduce the air performance of the centrifugal blower.



① x / D = ∞
② x / D = 30 %
③ x / D = 23 %
④ x / D = 15 %
⑤ x / D = 7.5 %

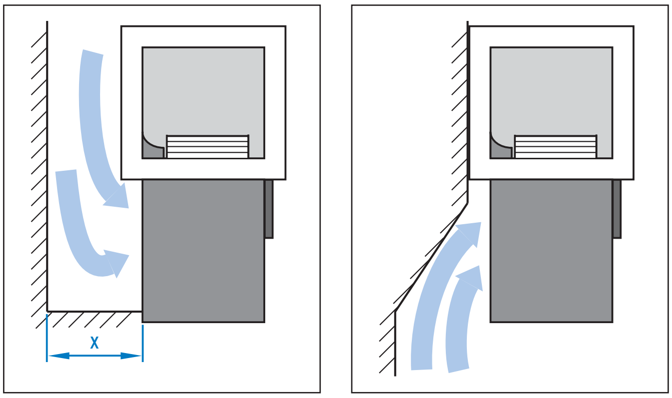
Curve



Effects caused by obstructions on the inlet side for constant air flow EC centrifugal blowers

Constant air flow is attained with unimpaired inflow only.
An obstructed (e. g. asymmetrical or partially blocked) air flow can have a significant effect on the curve behaviour and cause large deviations from a constant air flow curve.

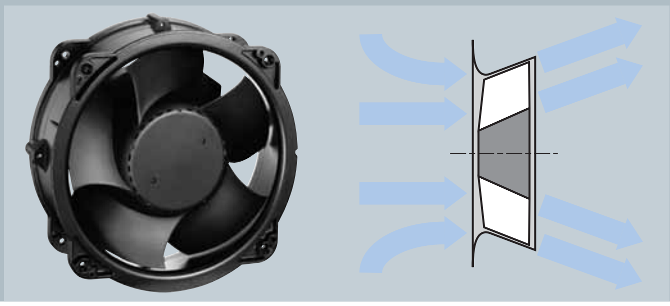
Examples of obstructed inflows



Instructions for designing a sufficiently unobstructed inflow:

– The distance x between the blower intake and neighbouring walls or obstructions should be at least 25 % of the impeller diameter.
– Inflows with angular momentum or asymmetrical rotation should be avoided.
– The inflow can be made more uniform using resistances such as those from filters or grilles.

On request, we offer calibrated blower designs that incorporate a specific installation situation.



Diagonal fans (axial design)

Operating range

Directly to the right of the "saddle" (right part of the air performance curve):

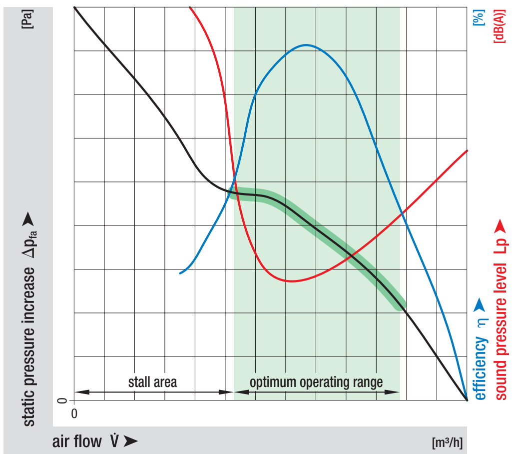
- Maximum efficiency
- Minimal noise

To the left of the "saddle" (left part of the air performance curve):

- Stall area
- Drop in efficiency
- Soaring noise

The saddle of the diagonal / mixed flow fan is slightly higher than that of the axial fan. This means that the technical ratings in the optimal operating range are better than those of the axial fan.
The optimum operating range of the fan is shaded in green in the curve given here.

Noise / efficiency curve



Mounting information

The conical housing (part of delivery) makes sure the necessary gap dimension is kept.

Effects

The effects of the diagonal / mixed flow fan are similar to those listed for the axial fan (p. 577-580).

Dimensioning / change in speed

Influence of speed n

A change in speed influences:

- Air flow $\dot{V}$

  $\dot{V} \sim n$

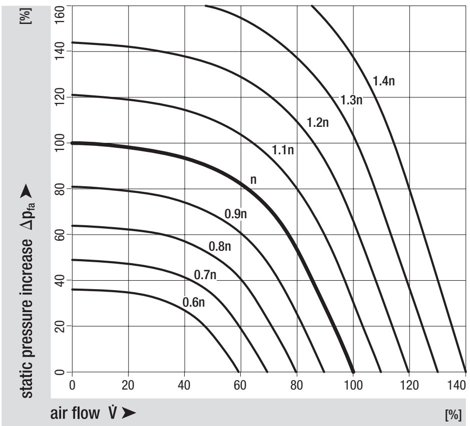
- Static pressure increase Δp_{fa}

  $\Delta p_{fa} \sim n^2$

- Requirement of energy P_1

  $P_1 \sim n^3$

Curve



Influence of the speed n on the sound level Lw

When the speed changes, the approximate sound level can be determined using the diagram to the right and the following formula:

$Lw_2 - Lw_1 = 50\text{ dB} \cdot \log (n_2 : n_1)$

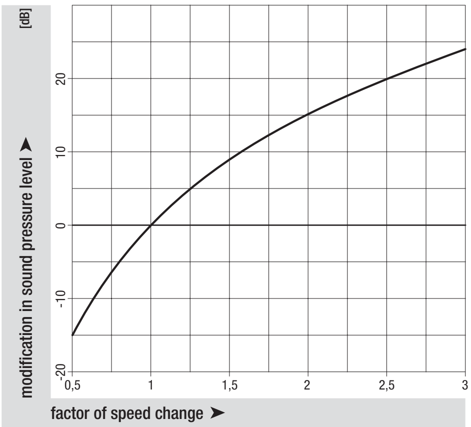
Lw_1 = Sound level after speed change

Lw_2 = Sound level before speed change

n_1 = Changed speed

n_2 = Starting speed

Curve



ebmpapst

Influence of impeller diameter D

A change in impeller diameter influences:

- Air flow $\dot{V}$

  $\dot{V} \sim D^3$

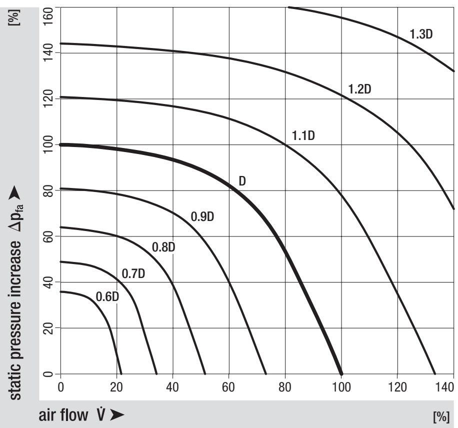
- Static pressure increase Δp_{fa}

  $\Delta p_{fa} \sim D^2$

- Requirement of energy P_1

  $P_1 \sim D^5$

Curve



Influence of width of air discharge b (only for centrifugal impellers)

A change in width of the air discharge influences, in approximation:

- Air flow $\dot{V}$

  $\dot{V} \sim b$

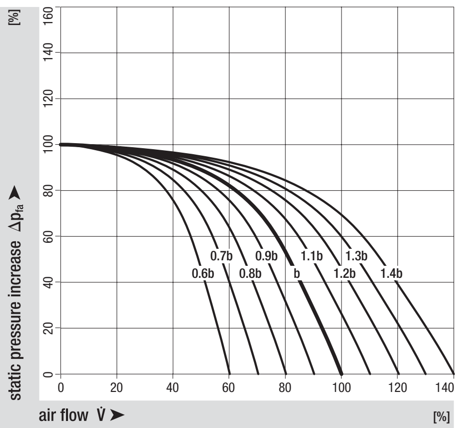
- Static pressure increase Δp_{fa}

  $\Delta p_{fa} = const$

- Requirement of energy P_1

  $P_1 \sim b$

Curve



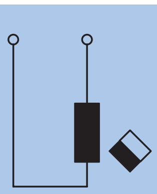
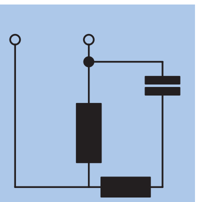
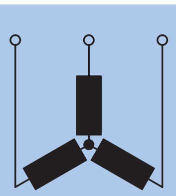
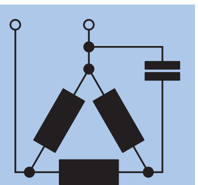
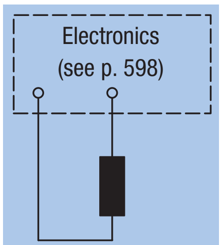
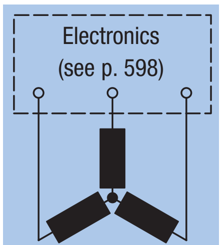
Motors

Motors made by ebm-papst

In AC and EC technology, ebm-papst relies on the proven external-rotor motor principle, with the rotor turning around the stator within. Advantages of the ebm-papst external-rotor principle are:

- *Space saving design due to integrated bearings and direct installation inside the impeller*
- *lower load and more precise balancing of the bearing due to the fixed connection of all rotating elements*
- *Prolonged service life due to the motor-impeller unit placed right within the air flow*

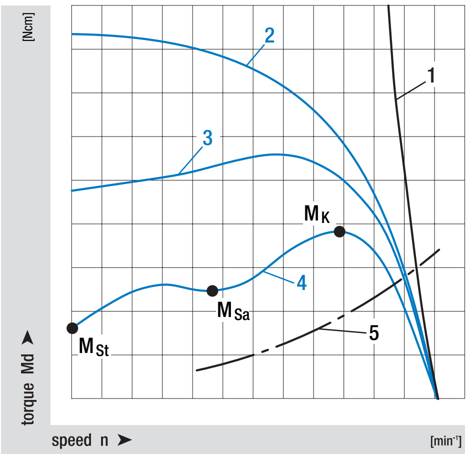
The ebm-papst motors achieve very good results in efficiency and acoustic behaviour when used in EC technology.

Features	AC motors			EC motors	
	Shaded-pole motor	**Single-phase capacitor motor**	**3-phase motor**	**Single-core motor**	**3-core motor**
1~ AC voltage connector	Yes	Yes	Limited use (Steinmetz circuit)	Yes	Yes
3~ AC voltage connector	No	No	Yes	No	Yes
DC voltage connector	No	No	No	Yes	Yes
Design of circuit diagram - Stator -			  Steinmetz circuit		
Rotor principle	Squirrel cage	Squirrel cage	Squirrel cage	Magnetic rotor	Magnetic rotor
Efficiency	Low	Medium	Good	Excellent	Excellent
Continuous speed setting integrated	No	No	No	Yes	Yes
Noise behaviour	Medium	Good	Excellent	Medium	Excellent

AC motors

AC motors (induction motors) are based in their function on the principle of the asynchronous rotation of the stator rotating field and rotor.

Torque curves of the motor types



Key:

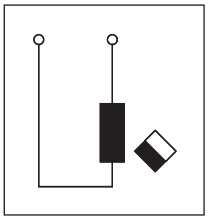
1	– EC motor	5	– System characteristic
2	– 3-phase motor	M_{St}	– Starting torque
3	– Single-phase motor	M_{Sa}	– Saddle torque
4	– Shaded-pole motor	M_K	– Breakdown torque

Start-up current

The start-up current of our AC motors is maximally 4x higher than the nominal current given.

Shaded-pole motor

Each pole of the motor is divided electro-magnetically into a main and auxiliary pole (split) via a cage winding in order to generate a starting torque.
At ebm-papst, shaded-pole motors are available as 2 or 4-pole symmetrical external or internal rotor designs.

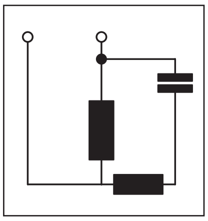


Advantages:

- Extremely robust motor design due to cast squirrel cage rotor and stable bearing system
- Cost-efficient motor
- Extremely easy to connect
- Long service life

Single-phase capacitor motor

Two cores (main winding MW and auxiliary winding AW) generate the rotating field of the single-phase capacitor motor via a capacitor connected in series to form an auxiliary winding.

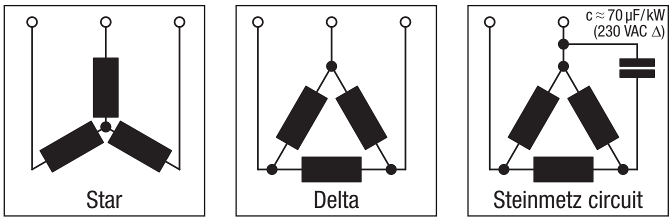


Advantages:

- Extremely robust motor design due to cast squirrel cage rotor and stable bearing system
- Diverse options for setting speed
- Efficiency between 30 % and 75 % (depending on motor size)
- Long service life
- Good vibration and noise behaviour

3-phase motor

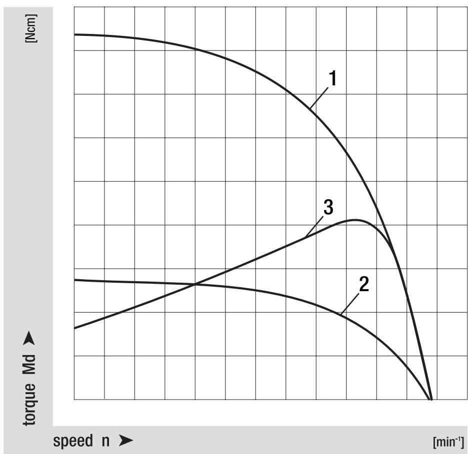
The three motor cores are offset by 120° and generate a circular rotating field when connected to the 3-phase mains.



Advantages:

- Extremely robust motor design due to cast squirrel cage rotor and stable bearing system
- Very good vibration and noise behaviour
- Efficiency between 40 % and 80 % (depending on the motor size)
- Long service life

Torque curves of 3-phase motors



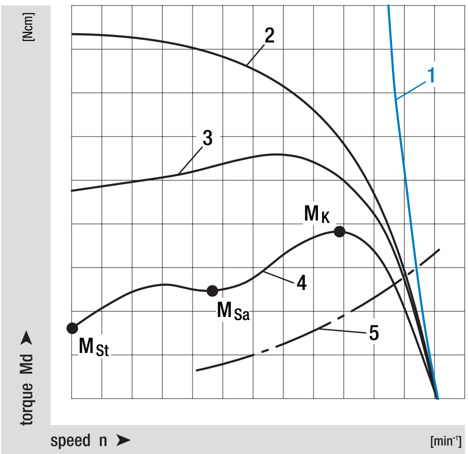
Key:

1 – Delta
2 – Star
3 – Steinmetz circuit

EC motors

EC motors are based in their function on the principle of the synchronous rotation of stator rotating field and rotor.

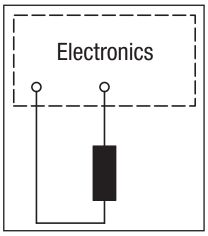
Torque curves of the motor types



Key:

1	– EC motor	5	– System characteristic
2	– 3-phase motor	M_{St}	– Starting torque
3	– Single-phase motor	M_{Sa}	– Saddle torque
4	– Shaded-pole motor	M_K	– Breakdown torque

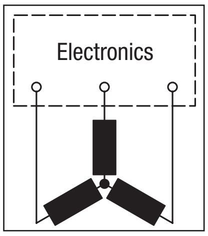
Single-core motor



Advantages:

- Integrated speed setting
- Efficiency between 50 % and 80 % (depending on the motor size)
- Long service life

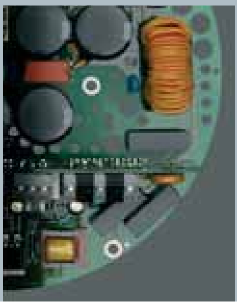
3-core motor



Advantages:

- Integrated speed setting
- Good efficiency between 60 % and 90 % (depending on the motor size)
- Long service life
- Very good vibration and noise behaviour even in controlled operation
- Can be used as drive motor

Control technology



Open and closed loop control using ebm-papst technology

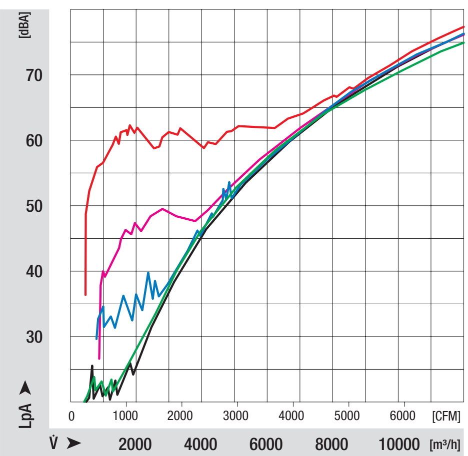
Depending on the field of application, fan speed has to be adjusted. In AC technology, the speed setting option can result in an increase in installation expenditure and, typically, a less favourable noise performance and an increase in power input.

Here, ebm-papst EC technology is a more eco-friendly and cost-efficient alternative. The EC motor with integrated commutation electronics offers high efficiency across the entire speed range and optimal acoustic performance at minimal installation expenditure.

Features	AC							EC commutating electronics		
	Series resistance	Transformer	Speed stepping	Phase-angle control	Phase-angle control with sine filter	Frequency inverter	Frequency inverter with sine filter	integrated	integrated with switch power supply	external
Installation	+	–	+	–	–	–	–	++	–	–
Noise behaviour	+	++	–	––	–	–	+	++	+	+
Power input	––	–	–	–	–	+	+	++	+	+
Service life	+	+	–	–	+	–	+	+	+	+

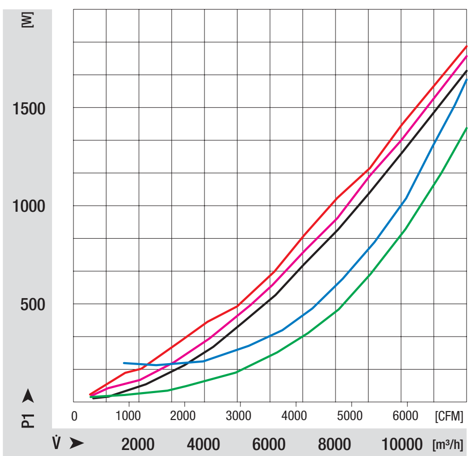
+ = positive ++ = very positive – = negative –– = very negative

Acoustic performance of controlled motors



Key:
- ebm-papst EC controls
- Frequency inverter with sine filter
- Phase-angle control without sine filter
- Phase-angle control with sine filter
- Transformer

Power input of controlled motors

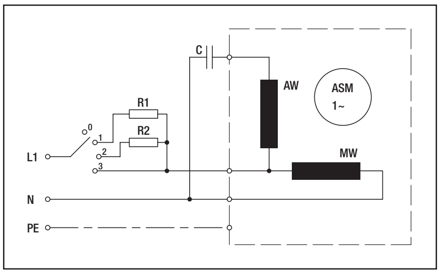


Key:
- ebm-papst EC controls
- Frequency inverter with sine filter
- Phase-angle control without sine filter
- Phase-angle control with sine filter
- Transformer

Speed setting with AC motors

Speed setting helps to optimise power input and the flow noise as requested.

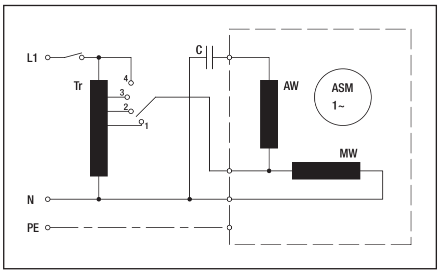
When selecting a voltage controller, note that the nominal current in the partial load range can be up to 20 % (depending on the controller) above the specified maximum current.



Series resistance

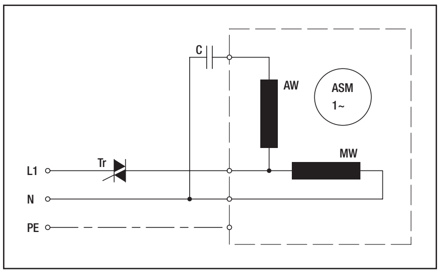
– Fixed speed steps
– Speed setting via change in motor voltage
– Cost-efficient
– Small capacities

Note: Capacitors or chokes reduce the loss capacity.



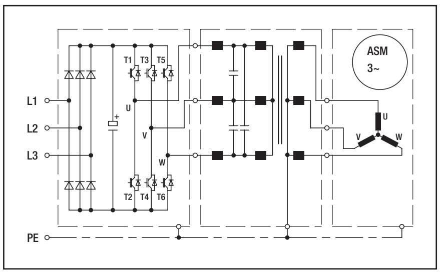
Transformer

– Fixed speed steps
– Speed setting via change in motor voltage



Phase-angle control

– Continuous speed setting
– Speed setting via change in motor voltage
– Cost-efficient
– Acoustic performance and warming has to be reviewed in the application



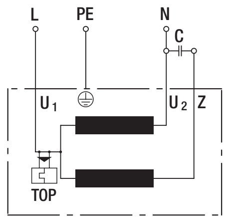
Frequency inverter with sine filter

– Continuous speed setting
– Speed setting via change in frequency of rotating field
– High efficiency

Note: An all-pole sine filter (phase-phase and phase-earth) has to be used.

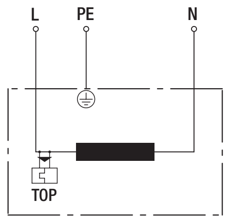
Fans (1~ 230 VAC power line)

A1) Single-phase capacitor motor
with TOP wired internally



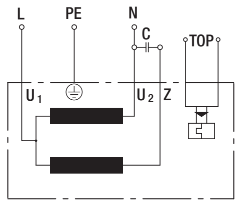
U_1 = blue
U_2 = black
Z = brown
⏚ = green/yellow

B) Shaded pole motor
with TOP wired internally



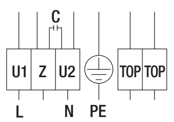
L = blue
N = brown
⏚ = green/yellow

A2a) Single-phase capacitor motor
with connection for external TOP



U_1 = blue
U_2 = black
Z = brown
⏚ = green/yellow

A2b) Single-phase capacitor motor
with connection for external TOP

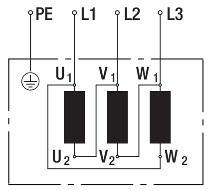


U_1 = blue
U_2 = black
Z = brown
⏚ = green/yellow

Fans
with terminal box

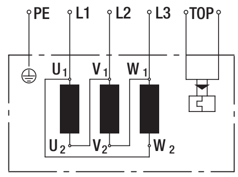
Fans, 1 speed (3~ 230 VAC power line)

C1) Delta connection (3~ 230 VAC power system)
without TOP



U_1 = black
U_2 = green
V_1 = blue
V_2 = white
W_1 = brown
W_2 = yellow
⏚ = green/yellow

D1) Delta connection (3~ 230 VAC power line)
with TOP

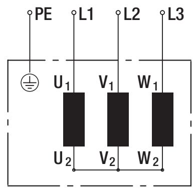


U_1 = black
U_2 = green
V_1 = blue
V_2 = white
W_1 = brown
W_2 = yellow
⏚ = green/yellow

Direction of rotation is reversed by swapping two line phases.

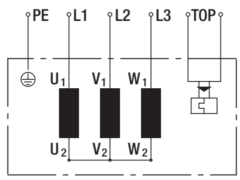
Fans, 1 speed (3~ 400 VAC power line)

C2) Star connection (3~ 400 VAC power system) without TOP



U_1 = black
U_2 = green
V_1 = blue
V_2 = white
W_1 = brown
W_2 = yellow
⏚ = green/yellow

D2) Star connection (3~ 400 VAC power line) with TOP

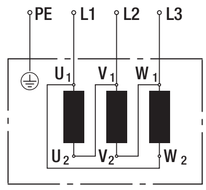


U_1 = black
U_2 = green
V_1 = blue
V_2 = white
W_1 = brown
W_2 = yellow
⏚ = green/yellow

Direction of rotation is reversed by swapping two line phases.

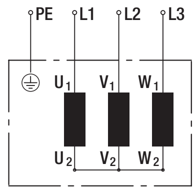
Fans, 2 speeds via Δ/Y-switch (3~ 400 VAC power line)

E1) Delta connection (high speed) without TOP



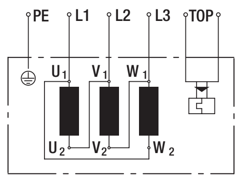
U_1 = black
U_2 = green
V_1 = blue
V_2 = white
W_1 = brown
W_2 = yellow
⏚ = green/yellow

E2) Star connection (low speed) without TOP



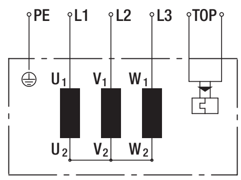
U_1 = black
U_2 = green
V_1 = blue
V_2 = white
W_1 = brown
W_2 = yellow
⏚ = green/yellow

F1a) Delta connection (high speed) with TOP



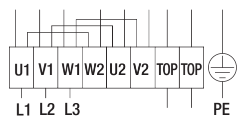
U_1 = black
U_2 = green
V_1 = blue
V_2 = white
W_1 = brown
W_2 = yellow
⏚ = green/yellow

F2a) Star connection (low speed) with TOP



U_1 = black
U_2 = green
V_1 = blue
V_2 = white
W_1 = brown
W_2 = yellow
⏚ = green/yellow

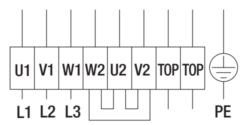
F1b) Delta connection (high speed) with TOP



Fans with terminal box

U_1 = black
U_2 = green
V_1 = blue
V_2 = white
W_1 = brown
W_2 = yellow
⏚ = green/yellow

F2b) Star connection (low speed) with TOP



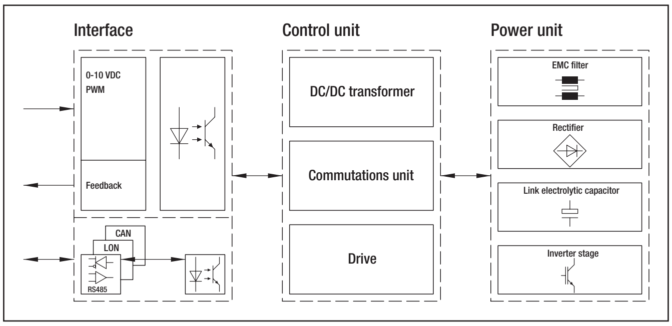
Fans with terminal box

U_1 = black
U_2 = green
V_1 = blue
V_2 = white
W_1 = brown
W_2 = yellow
⏚ = green/yellow

Direction of rotation is reversed by swapping two line phases.

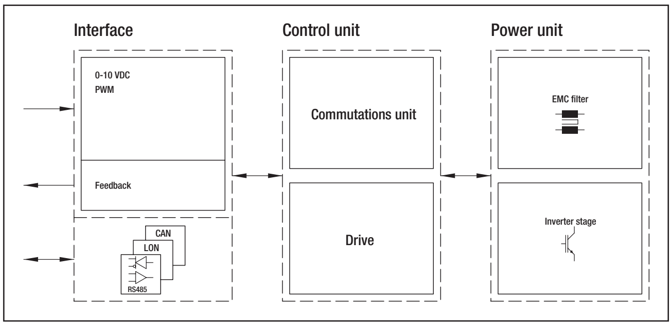
The speed of EC motors is set via commutation electronics. Via electronic circuits and depending on the rotor position, this commutation switches the motor currents on and off.

Principle of AC-fed commutation electronics



(with electrically isolated interface)

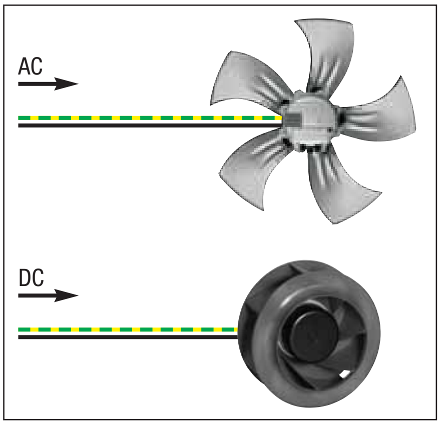
Principle of DC-fed commutation electronics



Integrated commutation electronics

- Compact unit
- Easy to install
- Low installation expenditure
- Can be operated all over the world

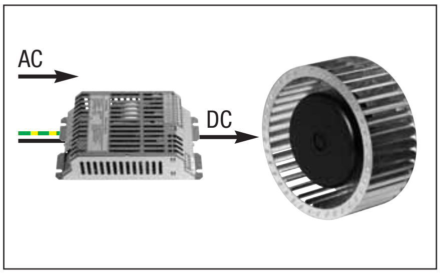
Note: Motors with 12-72 VDC supply voltage have to be fed via electrically isolated supply unit.



Integrated commutation electronics with switch power supply

- Protective extra-low voltage 24 / 48 VDC

Note: Switch power supply is not included but has to be ordered as accessory.



Typical features of the ebm-papst commutation electronics:

- Input for analogue and digital signals
- Open and closed loop control as well as monitoring of the motor
- Integrated EMC filter
- High efficiency throughout the entire speed range
- Speed setting via linear set value (0-10 VDC) or PWM signal
- Low-noise operation across the entire speed range
- minimal extra costs for additional functions (open / closed loop control)
- Optional BUS interface

Types of alarms and reactions with EC motors

With DC-fed EC motors, certain faults in modes of operation are recognised by the electronics, and the motor is automatically restarted.
With AC-fed EC motors, certain faults in modes of operation are recognised by the electronics, and the motor is switched off.
The motor restarts automatically after the following failures have been diagnosed:

- Line failure
- Phase failure
- Line under-voltage
- DC link voltage too high or too low
- Locked rotor

With the following types of failures, there is no automatic restart.
Here, hardware or software reset is required:

- Motor temperature too high
- Temperature of cooling element or ambient temperature of electronics too high
- Hall failure

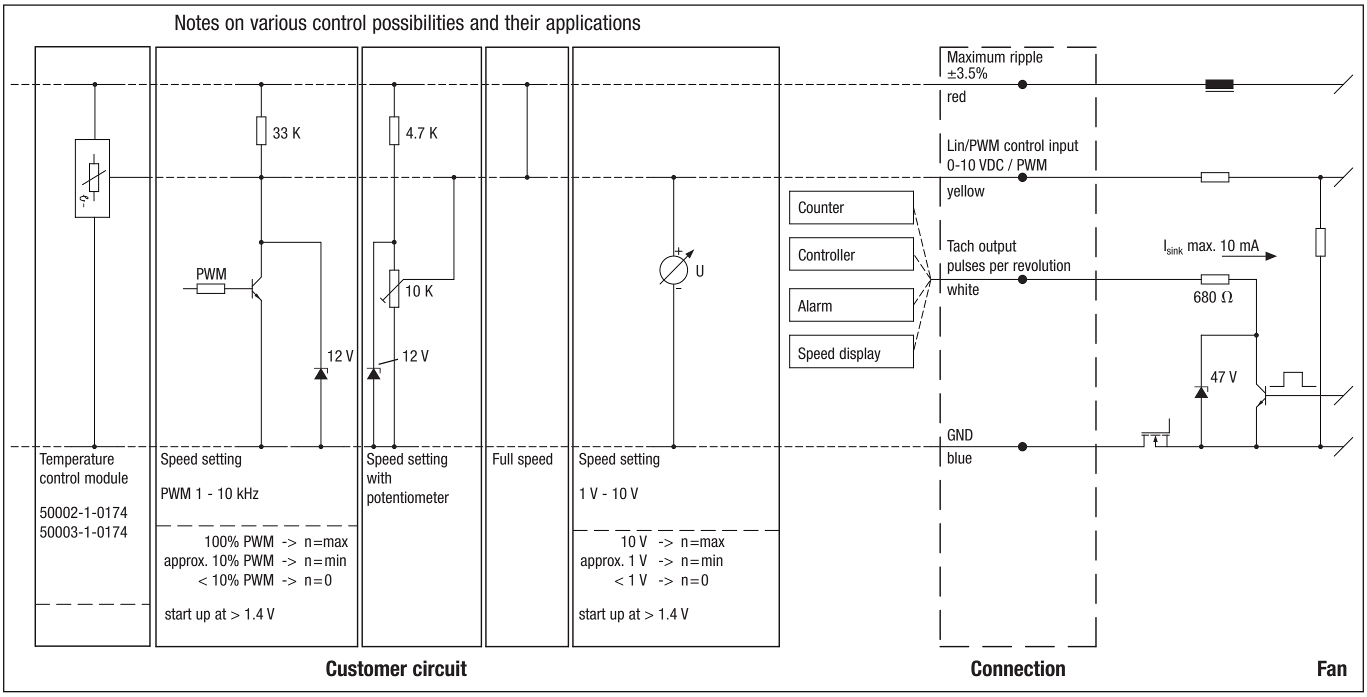
Hardware reset

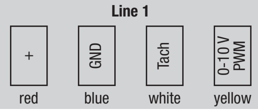
Switching off the fan and restarting it after one minute results in hardware reset.

Software reset

Software reset is via ebmBUS and LISA software, hand-held control terminal, or PDA with Fan Control Software.

G) EC motors (nominal voltage 24 / 48 VDC)

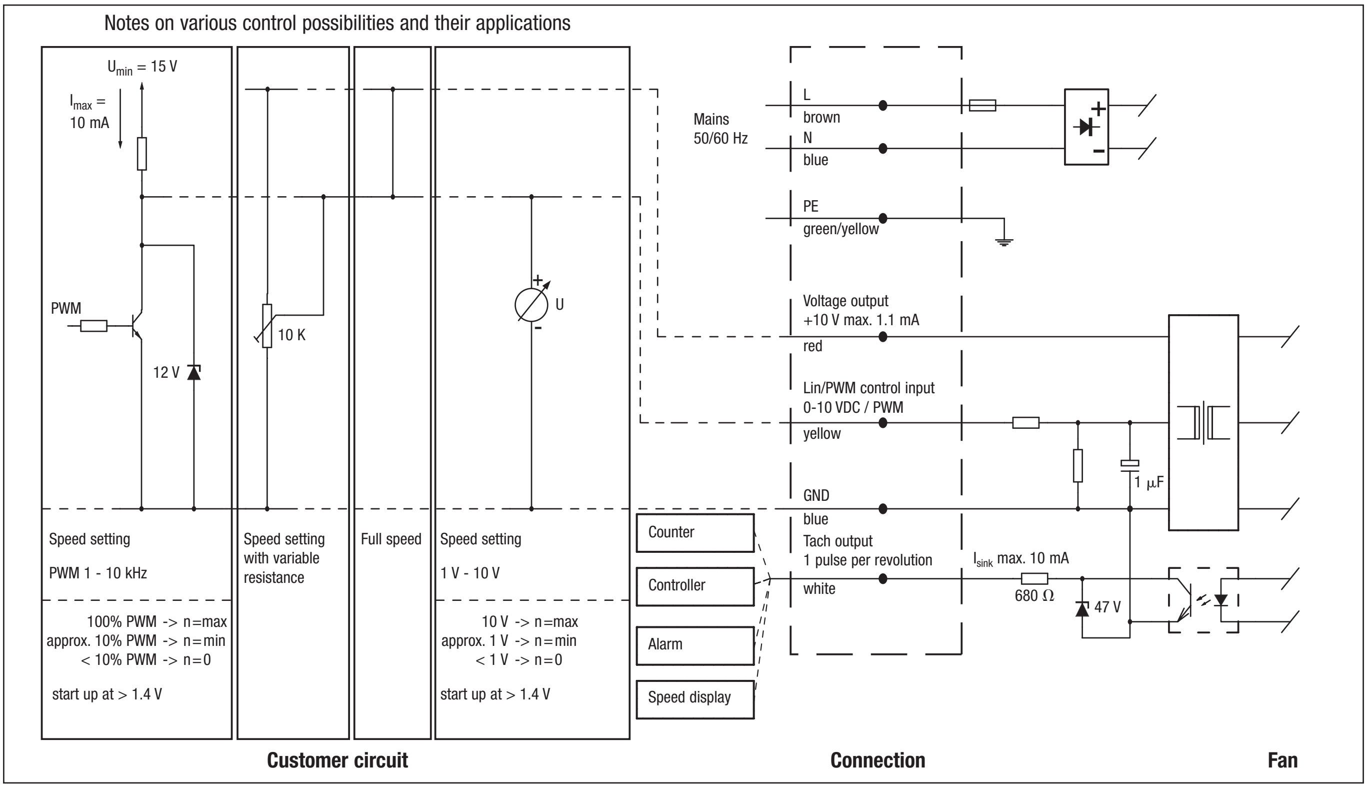


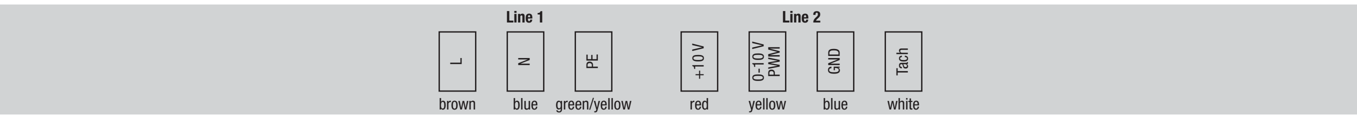


Line	Connection	Colour	Assignment / function
1	+	red	Maximum ripple ± 3.5 %
	GND	blue	GND

Line	Connection	Colour	Assignment / function
1	Tach	white	Tach output:
			2 pulses / revolution (M1G045/M1G055)
			3 pulses / revolution (M1G074/M3G084)
	0-10 V / PWM	yellow	Control input (Impedance 100 kΩ)

H1) EC motors (size 055, line-fed)

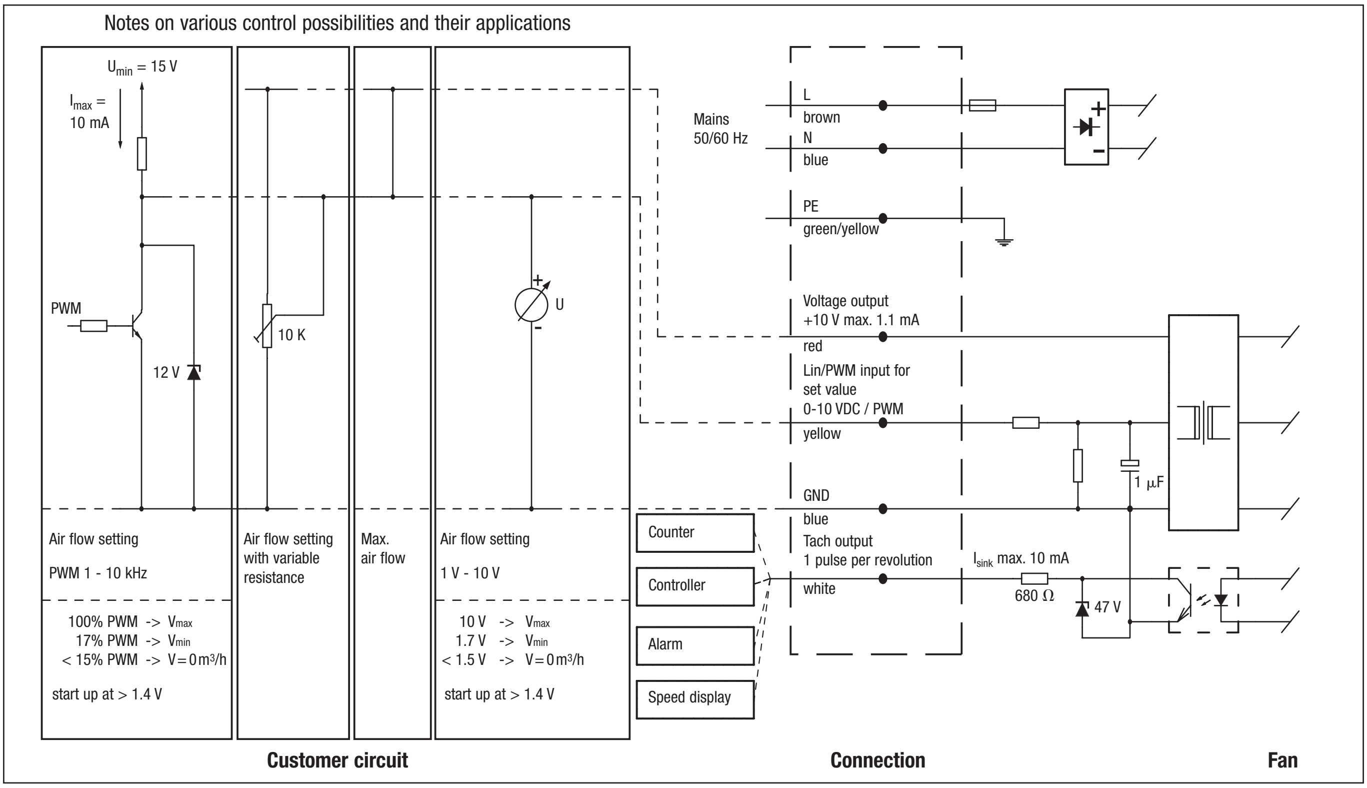


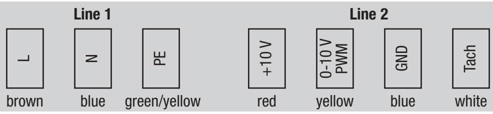


Line	Connection	Colour	Assignment / function
1	L	brown	Mains 50/60 Hz, phase
	N	blue	Mains 50/60 Hz, neutral
	PE	green/yel	Protective earth

Line	Connection	Colour	Assignment / function
2	+10 V	red	Voltage output +10 V max. 1.1 mA
	0-10 V / PWM	yellow	Control input (Impedance 100 kΩ)
	GND	blue	GND
	Tach	white	Tach output: 1 pulse per revolution

H2) EC motors (size 055, line-fed and constant air flow)

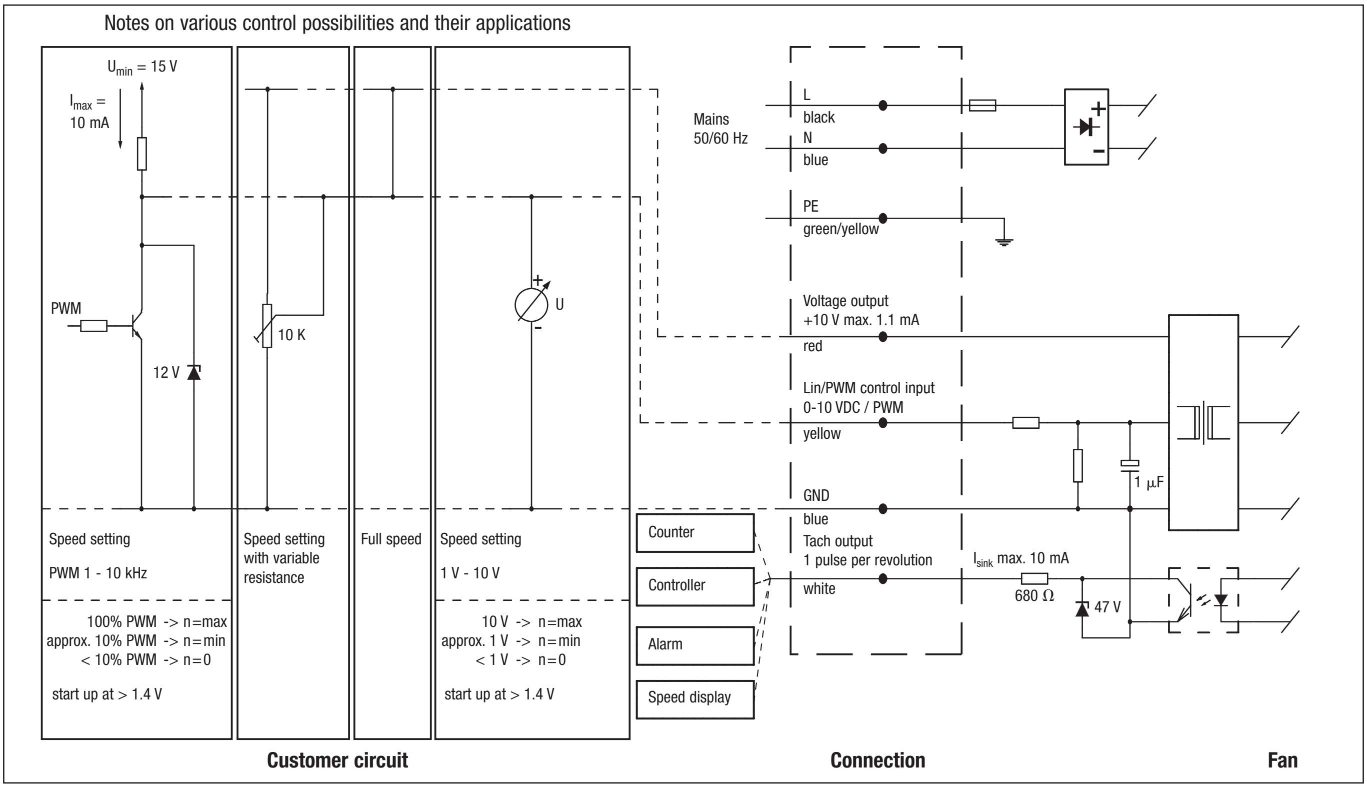


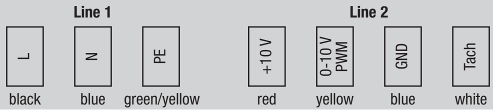


Line	Connection	Colour	Assignment / function
1	L	brown	Mains 50/60 Hz, phase
	N	blue	Mains 50/60 Hz, neutral
	PE	green/yel	Protective earth

Line	Connection	Colour	Assignment / function
2	+10 V	red	Voltage output +10 V max. 1.1 mA
	0-10 V / PWM	yellow	Input for set value (impedance 100 kΩ)
	GND	blue	GND
	Tach	white	Tach output: 1 pulse per revolution

J1) EC motors (size 074, line-fed)

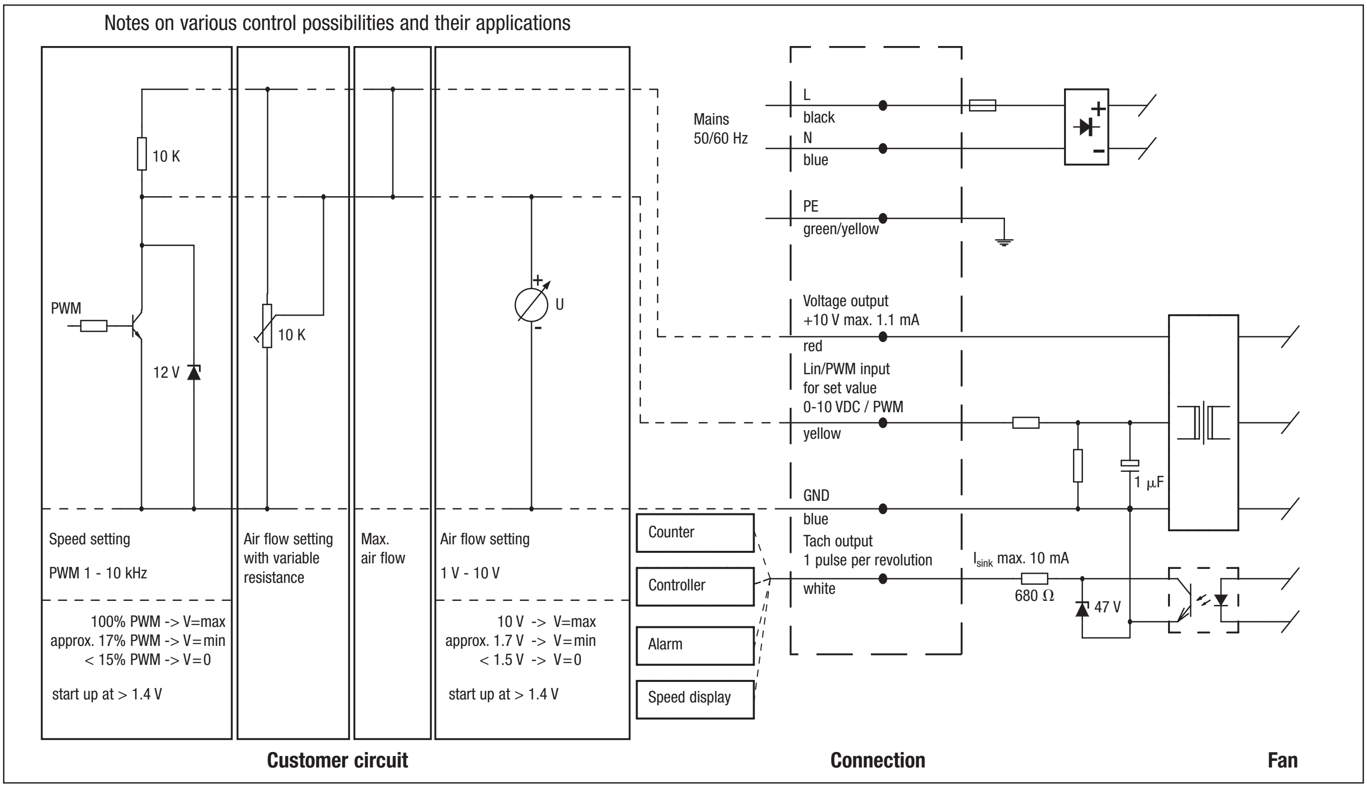


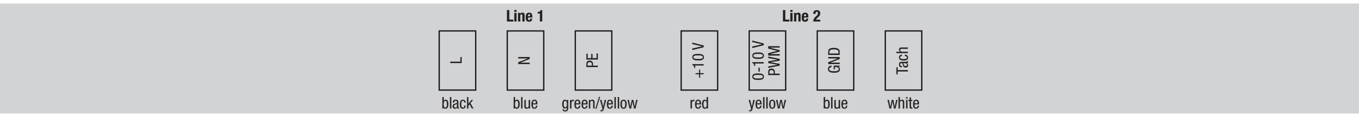


Line	Connection	Colour	Assignment / function
1	L	black	Mains 50/60 Hz, phase
	N	blue	Mains 50/60 Hz, neutral
	PE	green/yel	Protective earth

Line	Connection	Colour	Assignment / function
2	+10 V	red	Voltage output +10 V max. 1.1 mA
	0-10 V / PWM	yellow	Control input (Impedance 100 kΩ)
	GND	blue	GND
	Tach	white	Tach output: 1 pulse per revolution

J2) EC motors (size 074, line-fed and constant air flow)

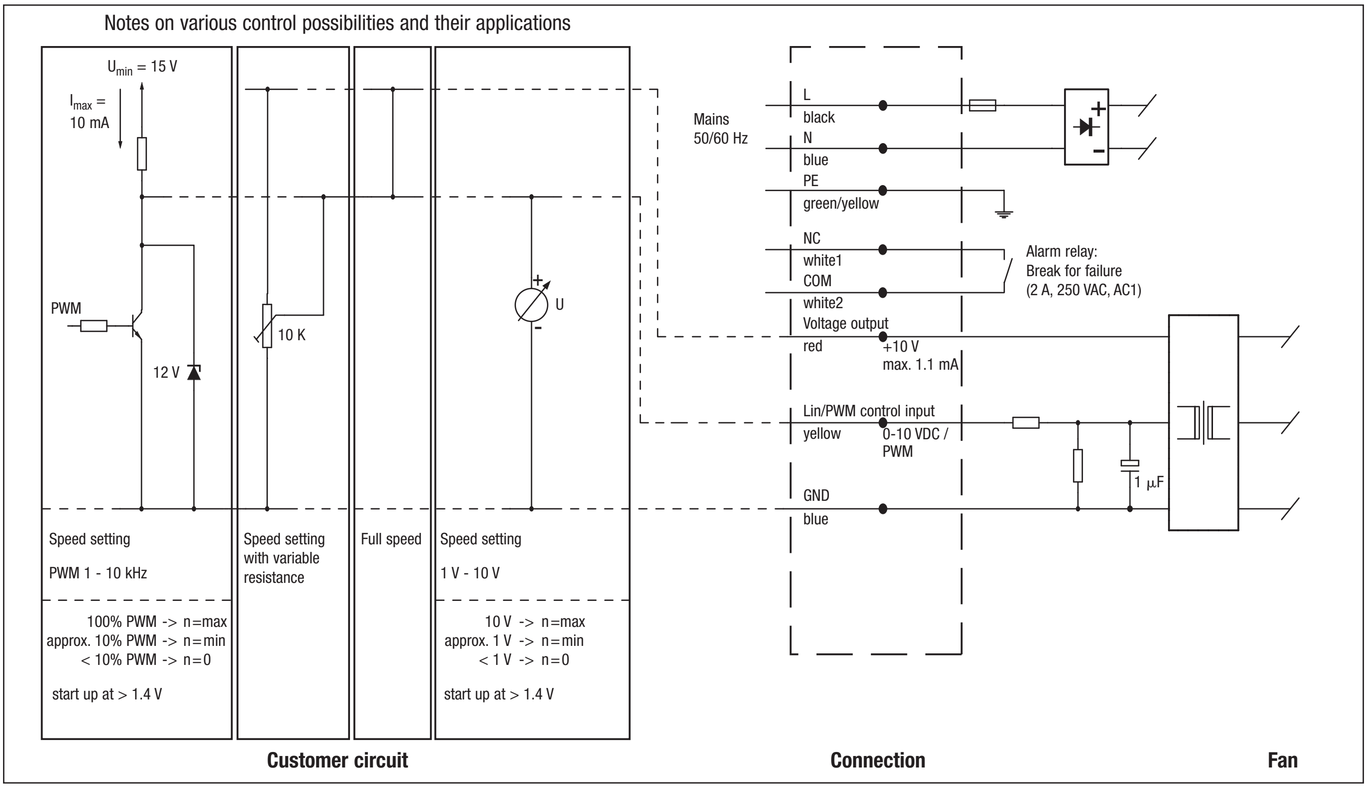


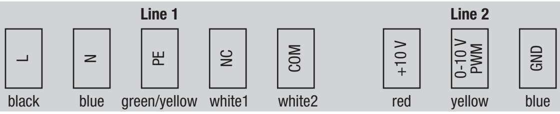


Line	Connection	Colour	Assignment / function
1	L	black	Mains 50/60 Hz, phase
	N	blue	Mains 50/60 Hz, neutral
	PE	green/yel	Protective earth

Line	Connection	Colour	Assignment / function
2	+10 V	red	Voltage output +10 V max. 1.1 mA
	0-10 V / PWM	yellow	Input for set value (impedance 100 kΩ)
	GND	blue	GND
	Tach	white	Tach output: 1 pulse per revolution

K1) EC motors (size 084, line-fed)

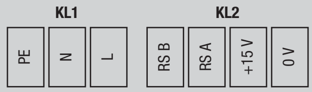




Line	Connection	Colour	Assignment / function
1	L	black	Mains 50/60 Hz, phase
	N	blue	Mains 50/60 Hz, neutral
	PE	green/yel	Protective earth
	NC	white1	Alarm relay, break for failure
	COM	white2	Alarm relay, COMMON

Line	Connection	Colour	Assignment / function
2	+10 V	red	Voltage output +10 V max. 1.1 mA
	0-10 V / PWM	yellow	Control input (Impedance 100 kΩ)
	GND	blue	GND

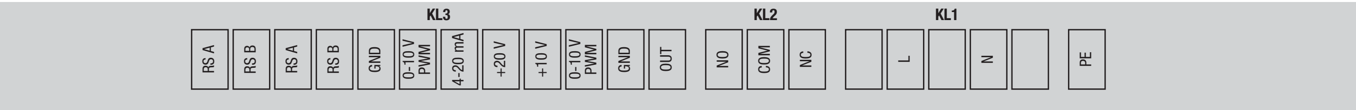
K2) EC motors (size 084/112 with ebmBUS, mains-powered)



Connector	Connection	Assignment / function
KL1	PE	Protective earth
	N	Mains 50/60 Hz, neutral
	L	Mains 50/60 Hz, phase

Connector	Connection	Assignment / function
KL2	RS B	RS485 interface for ebmBUS; RS B
	RS A	RS485 interface for ebmBUS; RS A
	+15 V	Operation: +15 V (50 mA); Alarm: 0 V
	0 V	Operation: 0 V; Alarm: +15 V (50 mA)

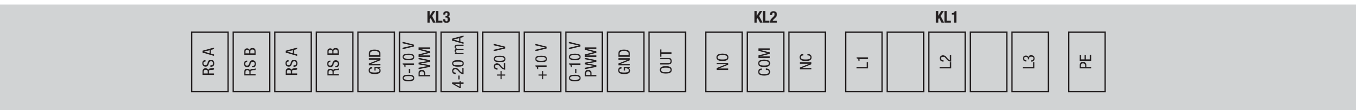
L1) EC motors (size 112, single-phase mains-powered)



Connector	Connection	Assignment / function
PE	PE	Protective earth
KL1	N	Mains 50/60 Hz, neutral
	L	Mains 50/60 Hz, phase
KL2	NC	Alarm relay, break for failure
	COM	Alarm relay, COMMON (2A, 250 VAC, AC1)
	NO	Alarm relay, make for failure

Connector	Connection	Assignment / function
KL3	OUT	Master output 0-10 V max. 3 mA
	GND	GND
	0-10 V / PWM	Control / Actual value input (Impedance 100 kΩ)
	+10 V	Supply for external potentiometer,
		10 VDC (+10 %) @ 10 mA
	+20 V	Supply for external sensor,
		20 VDC (±20 %) @ 50 mA
	4-20 mA	Control / Actual value input
	0-10 V / PWM	Control / Actual value input
	GND	GND
	RSB	RS485 interface for ebmBUS; RS B
	RSA	RS485 interface for ebmBUS; RS A
	RSB	RS485 interface for ebmBUS; RS B
	RSA	RS485 interface for ebmBUS; RS A

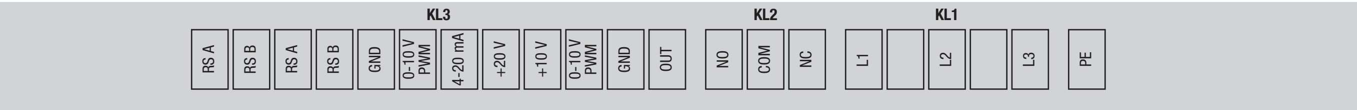
L2) EC motors (size 112, three-phase mains-powered)



Connector	Connection	Assignment / function
PE	PE	Protective earth
KL1	L3	Mains; L3
	L2	Mains; L2
	L1	Mains; L1
KL2	NC	Alarm relay, break for failure
	COM	Alarm relay, COMMON (2A, 250 VAC, AC1)
	NO	Alarm relay, make for failure

Connector	Connection	Assignment / function
KL3	OUT	Master output 0-10 V max. 3 mA
	GND	GND
	0-10 V / PWM	Control / Actual value input (Impedance 100 kΩ)
	+10 V	Supply for external potentiometer,
		10 VDC (+10 %) @ 10 mA
	+20 V	Supply for external sensor,
		20 VDC (±20 %) @ 50 mA
	4-20 mA	Control / Actual value input
	0-10 V / PWM	Control / Actual value input
	GND	GND
	RSB	RS485 interface for ebmBUS; RS B
	RSA	RS485 interface for ebmBUS; RS A
	RSB	RS485 interface for ebmBUS; RS B
	RSA	RS485 interface for ebmBUS; RS A

M) EC motors (size 150, three-phase mains-powered)



Connector	Connection	Assignment / function
PE	PE	Protective earth
KL1	L3	Mains; L3
	L2	Mains; L2
	L1	Mains; L1
KL2	NC	Alarm relay, break for failure
	COM	Alarm relay, COMMON (2A, 250 VAC, AC1)
	NO	Alarm relay, make for failure

Connector	Connection	Assignment / function
KL3	OUT	Master output 0-10 V max. 3 mA
	GND	GND
	0-10 V / PWM	Control / Actual value input (Impedance 100 kΩ)
	+10 V	Supply for external potentiometer,
		10 VDC (+10 %) @ 10 mA
	+20 V	Supply for external sensor,
		20 VDC (±20 %) @ 50 mA
	4-20 mA	Control / Actual value input
	0-10 V / PWM	Control / Actual value input
	GND	GND
	RSB	RS485 interface for ebmBUS; RS B
	RSA	RS485 interface for ebmBUS; RS A
	RSB	RS485 interface for ebmBUS; RS B
	RSA	RS485 interface for ebmBUS; RS A

Connection diagram: Condensing pressure control with master-slave fans