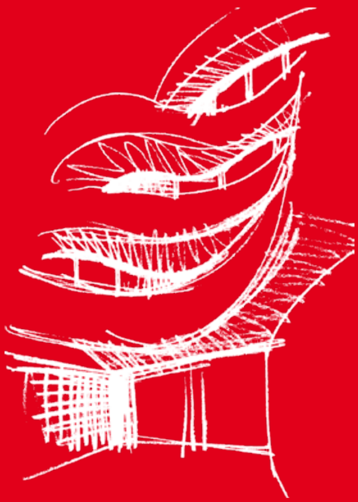

Planning manual part 1.0

emcoair **ventilation components**

Basics and Product summary

emcobad | emcobau | emcoklima

EMCO

emcoair **ventilation components**

More than 40 years ago emco klima was launched to produce a series of best quality air diffusers. Continuous development of products for various different air delivery systems and their ‚on-time' despatch, gradually secured the creation of well earned trust between emco and the consultant specifiers, contractors and end users.
emco klima also offers ‚In-house' services that include laboratory testing, computer analysis and product selection during the planning process, to provide functional dependability and optimum economic efficiency for the entire range of air and water based systems.
emco klima has noticed a significant change in clients requirements. The reason being increased sales of other products such as emco therm Floor Convectors for heating and emco klima chilled ceiling system, where water is the means of energy transportation.
Reduced electrical energy for water circulation is one of the major driving forces behind market changes, in addition to changes in construction methods and artistic challenges.

emcoair **swirl diffusers**

emcoair **ceiling air diffusers**

emcoair **linesr diffusers**

emcoair **circular pipe diffusers**

emcoair **tower diffusers**

emcoair **industrial air diffusers**

emcoair **spaecialist air diffusers**

emcoair **floor diffusers**

emcoair **grilles and flow regulators**

emcoair **weather protection grids**

emcoair **multi-blade dampers**

emcoair **dampers**

emcoair **Regelkomponenten**

emcoair **electronic control components**








contents

Index of symbols

Symbol	Description	Unit
A	Surface	m²
A_{eff}	Geometrically free cross section of stream	m² bzw. m²/m
B	Width	mm
C	Induktions-Korrekturfaktor bei verändertem Gitteröffnungswinkel α	-
D, d	Diameter	mm, m
D_{min}	Abstand der Gitter, bzw. der Gitter von der Decke	m
F	Power	N
f	Korrekturfaktor für vertikale Strahlgeschwindigkeit	-
f_m	Mittenfrequenz	Hz
g	Acceleration due to gravity	ms^{-2}
H, h	Height	mm, m
i	Induction ratio	-
K	Korrekturfaktor für v_{eff} bei geändertem Lamellenanstellwinkel β	-
k	Height of roughness	mm
L, l	Length (of the room), length of the course of the stream	mm, m
L_W	Sound power level	dB
L_{WA}	A-grade Sound-Intensity Level	dB (A)
L_p	Sound pressure level	dB
L_{PA}	A-grade Sound Pressure Level	dB (A)
ΔL	Raumdämpfungs- bzw. Absorptionsmaß	dB
$\Delta L_{Okt.}$	Sound power per Okt.	dB/Okt.
m	Masse	kg
ṁ	Mass Flow Rate Water	$kg\,s^{-1}$
n	Number (quantity)	-
P	Sound power	W
p	Sound pressure	Pa
p_d	Dynamic pressure	Pa
p_0	External pressure (air pressure)	Pa
p_{st}	Static pressure	Pa
p_t	Total pressure	Pa
Δ_p	Pressure difference	Pa
Δp_R	Drop in pressure through friction	Pa
Δp_t	Total pressure difference	Pa
R, r	Radius	mm, m

Symbol	Description	Unit
T	Thermodynamic temperature	K
T_R	Thermodynamic temperature of the room	K
T_{ab}	Thermodynamic temperature of the outgoing air	K
T_{zu}	Thermodynamic temperature of the supply air	K
t	Time	s
t_0, t_R	Supply air temp. /Room air temperature	°C
$t_{x\,max}$	maximale Temperatur im Strahlquerschnitt nach dem Strahlweg x	°C
ΔT_0, Δt_0	emperature difference between supply air and room air	K
ΔT_{xy}	Temperature difference between stream and room air after point x or x+y in the length of the course of a stream	K
$\Delta t_{x\,max}$	max. temperature difference between stream and room air	K
V, V_{geo}	Room Volume	m³
$\dot{V}$	Air Flow Volume	$m^3\,h^{-1}$
$\dot{V}_x$	Total volume flow at coordinate x	$m^3\,h^{-1}$
$\dot{V}_0$	Volume flow of supply air	$m^3\,h^{-1}$ bzw. $m^3\,(hm)^{-1}$
v	Velocity	ms^{-1}
v_{eff}	effektive Ausblasgeschwindigkeit am Gitteraustritt	ms^{-1}
vβ	effektive Ausblasgeschwindigkeit am Gitteraustritt bei Lamellenanstellwinkel β	ms^{-1}
v_{max}	Maximum average velocity after point x or x+y in the length of the course of a stream	ms^{-1}
X, x	Length of a stream's course	mm, m
x_{krit}	Critical airflow distance	m
y	Vertical length of a stream's course after the blast	m
y_{max}	Vertical penetration depth	m
Y, y	Vertical deflection of the non-isothermal stream	m
$Y_{0,2}$, $y_{0,2}$	Abstand von der Strahlachse, bei dem die Strahlgeschwindigkeit v=0,2 m/s beträgt	m
α, β, γ, δ	Angle, airstream diffusion angle	°
ζ	Resistance coefficient	-
λ	Friction coefficient	-
ρ	Density	$kg\,m^{-3}$

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Basic terms

Coanda Effect
The coanda effect is the property of flowing mediums, where they are flowing in parallel or even in divergent directions, to align themselves with level surfaces or even other streams, or to attract such streams.

Critical airflow distance

When there is a difference between the room temperature and the airflow temperature, then, depending on whether its temperature is lower or higher than the room temperature, in addition to the change in elevation brought about by diffusion, the effect will be for the airflow to rise or fall. If supply air at a lower temperature is blown into a room horizontally, then the axis of the current of such a free airstream will follow a course that immediately curves downward. With ceiling streams (wall streams), the Coanda effect will cause the stream to cling to the ceiling for a certain distance in spite of the lower temperature; the stream does not start to drop off until a later time point. This distance from the air diffuser to the point where the colder stream unsticks from the ceiling is called the “critical airflow distance”.

Temperature ratio

The temperature ratio is the ratio of the temperature difference at a point x and the temperature difference at the air diffuser. The temperature ratio is a nondimensional quantity. The smaller the temperature ratio is after a certain length of a stream’s course, the faster temperature differences will be reduced, and the greater the airflow induction will be.

Induction ratio
The induction ratio is the ratio from the total volume flow in motion at a point x and the volume flow of the supply air. As the induction ratio cannot be determined experimentally, it is calculated indirectly from the temperature ratio.

Airflow distance x and y
Airflow distance x is:

- the distance from the geometric center of a diffuser to a junction with an airstream flowing in the opposite direction;
- the length of the course of an airstream from the geometric center of the diffuser along a horizontal and vertical wall to a point for which the parameters relevant to the stream are to be determined.

Airflow distance y is:

- the vertical distance of a vertical airstream created by the meeting of two horizontal streams flowing toward one another, from their junction point to the point for which the parameters relevant to the stream are to be determined.

The definitions for x and y also apply when, owing to their geometry, diffusers are not flush with the ceiling or are suspended. In such cases one must take into account the fact that after the airflow distance (x + y), the following interrelationship between the velocities applies with and without any ceiling influence:

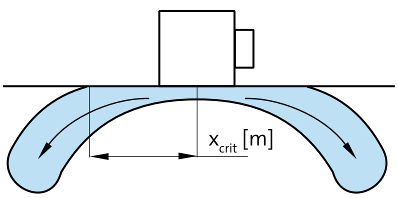
$v_{\text{max (mit Decke)}} = 1{,}4 \text{ x } v_{\text{max (ohne Decke)}}$

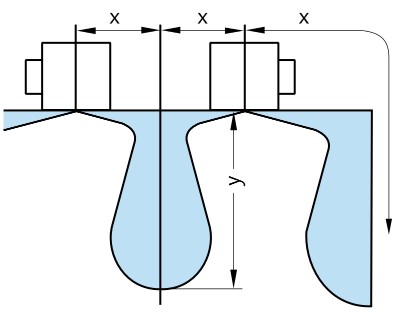
bzw.

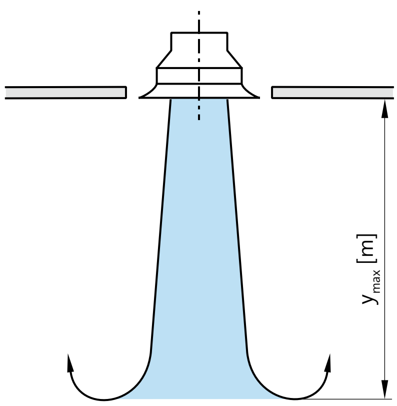
$v_{\text{max (ohne Decke)}} = 0{,}71 \text{ x } v_{\text{max (mit Decke)}}$

Vertical penetration depth

Vertical penetration depth, y_{max}, is understood to be the vertical distance of an airstream at a higher temperature, introduced into a room from the diffuser to its reversal point.







Acoustics

Sound causes vibrations in the air, which alternately compress and expand. These changes in pressure overlay the existing air pressure and reproduce sinusoidally in the air. If these pressure variations reach the human ear, the air pressure waves are converted into mechanical vibrations by the ear drums. The hearing process has been started. The human ear perceives only an airborne sound, whereby the following two parameters are decisive:

a. **Sound pressure**
b. **Frequency**

1. Sound pressure
Sound pressure is the pressure change in the air which is generated by an acoustic source. These variations in pressure are measured in N/m² and identified with p. Sound pressure represents a gauge for volume. It depends on the distance between the acoustic source and the measurement point as well as the condition of the room.
Sound pressure as a pure parameter is not suited to calculate sound propagation. The sound power of the acoustic source must be determined..

2. Sound power
Sound power is energy emitted from an acoustic source and transformed into sound. Sound power is fed to the air in the form of pressure fluctuations. Sound power is a parameter that cannot be measured directly. It is determined when the acoustic pressure surrounds the acoustic source.
Sound power is thus a parameter not dependent upon the room and distance. It will be used for all further calculations, and will be specified in watts [W].
For practical reasons, non-dimensional operational figures are adpoted, which go back to A.G. Bell.

3. Sound pressure level
The logarithmic ratio of sound pressure p to the reference value p_o is identified as sound pressure level L_p and is measured in decibels [dB].

$$L_p = 10\log \left(\frac{p}{p_0}\right)^2 \text{ in dB}$$

The reference value is $p_0 = 2 * 10^{-5}$ N/m² and is the minimum sound power that humans perceive. It is identified as the auditory threshold. The acous-tic range (auditory threshold – pain threshold) therefore lies between 0 and 120 dB.

4. Sound power level
The logarithmic ratio of sound power (W) to reference value (W_0) is identified as the sound power level and is also measured in decibels [dB].

$$L_W = 10\log \frac{W}{W_0} \text{ in dB}$$

The reference value is $W_0 = 10^{-12}$ W.
Although the sound pressure level and sound power levels are both expressed in decibels (dB), they are two different things. The sound power level is the sound generated at the source and the sound pressure level is a sound perceived at a certain distance from the sound source. Thus the sound power level is generally higher than the sound pressure level.

5. Frequency weighting
When the frequencies vary, humans perceive equal acoustic pressure levels differently. Generally an acoustic pressure level at a low frequency is perceived to be softer and less disruptive than at a high frequency. In order to accommodate this subjective sense, objectively measured acoustic pressure levels are adapted to the perception of volume. This is referred to as weighting acoustic pressure.
The weighting is done as follows:

A certain value from the gauged sound pressure level is subtracted from the frequencies to which humans are less sensitive, at the same time a certain value is added to other frequency ranges. The a-weighting has established itself as the primary type of weighting.
Here the statement is a singular designation, referred to as an A-weighted sound pressure level or A-weighted sound power level. It is indicated in dB(A).

6. Sound level addition
If there are several acoustic sources, the respective energies (sound power level) and sound intensity (sound pressure level) must be added to make a total sound level. The same principles are valid for both the sound power level and the sound pressure level. The following relation is valid for multiple acoustic sources with the same level:

$$L_{ges} = L_1 + 10 * \log n \text{ [dB]}$$

In this equation, **n** is the number of acoustic sources. The function is illustrated in graph 1.
If there are acoustic sources with varying levels, a level increase of ΔL is added to the higher level, the increase being dependent on the level difference and calculated according to the following equation:

$$\Delta L = 10 * \log (1 + 10^{(L_1 - L_2/10)})$$

This correlation is also valid for $L_2 > L_1$ and illustrated in graph 2.

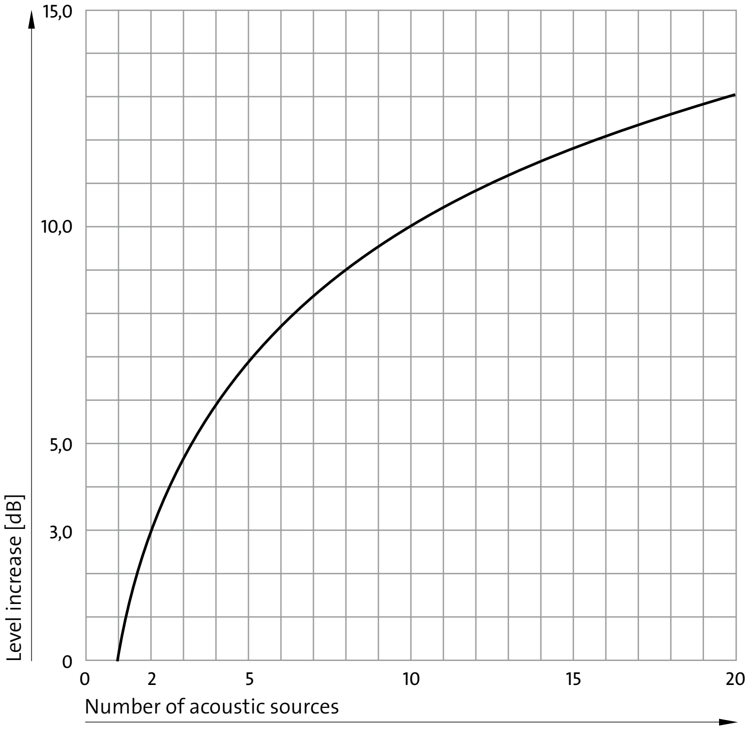
If there are several acoustic sources with varying levels, the addition should be done in steps. First the sum level should be calculated from two levels. The sum level is then added to a third and so on. Each individual addition is done according to the equation stated or the graph. The order of the calculation is not important, as the result is always the same.

Thus the following conclusion can be made:

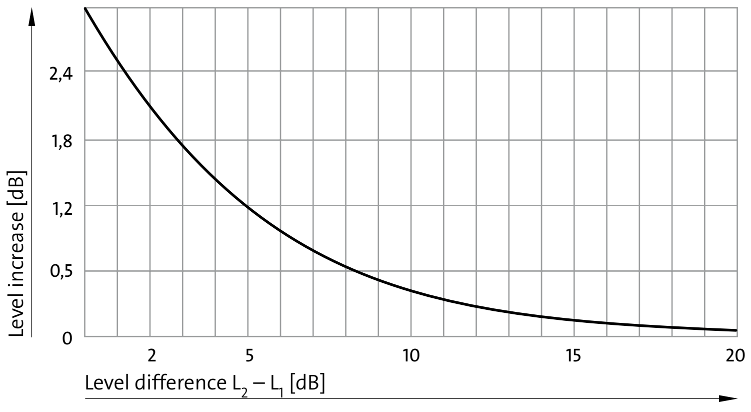
The addition of two sound sources with the same level results in an increase of 3 dB.

If the level difference is greater than 10 dB, there is practically no addition. Formally there is an increase of 0,4 dB, but this is not taken into consideration because the human ear can only perceive changes of at least 3 dB.

Grafik 1:
Increase in level with equally loud acoustic sources



Grafik 2:
Increase in level with unequally loud acoustic sources



Acoustics

7. Determining the sound pressure level in the room

To determine the sound pressure level in a room, the acoustic source and its sound power level must be known. The sound power level generated and emitted by an acoustic source creates a certain sound pressure level, which is independent of the distance to the sound's source, its direction gain and the room absorption.

This leads to a overlapping of the direct and diffuse acoustic field and is described with the following equation:

$$L_p = L_W + 10\log\left(\frac{Q}{4\pi r^2} + \frac{4}{A}\right) \text{ in dB}$$

Q: directivity factor

r: distance from the acoustic source in m

A: absorption area in m² Sabin

Differentiation is made between the following directivity factors:

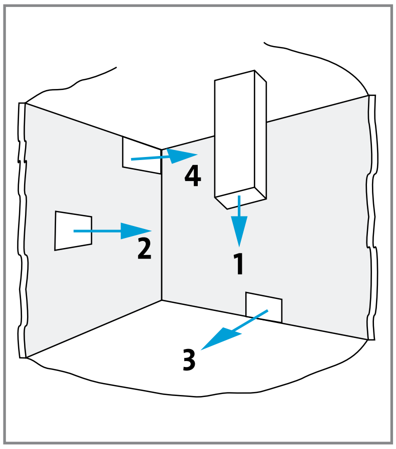
1 In the middle of the room

2 In the middle of the wall

3 In the middle of the room angle

4 In the corner of the room

Directivity factors



The value of the directivity factor is between 1 and 8 and is dependent on the angular distribution.

For practical calculation, set the directivity factor – independent of all other parameters - to 8 and the angular distribution to 0°. For all other cases, use a directivity factor of 4.

Absorption area: the equivalent absorption area can be determined from reverberation time T.

$$A = 0{,}163 \frac{V}{T} \text{ in m}^2$$

V: Space (volume) in m³

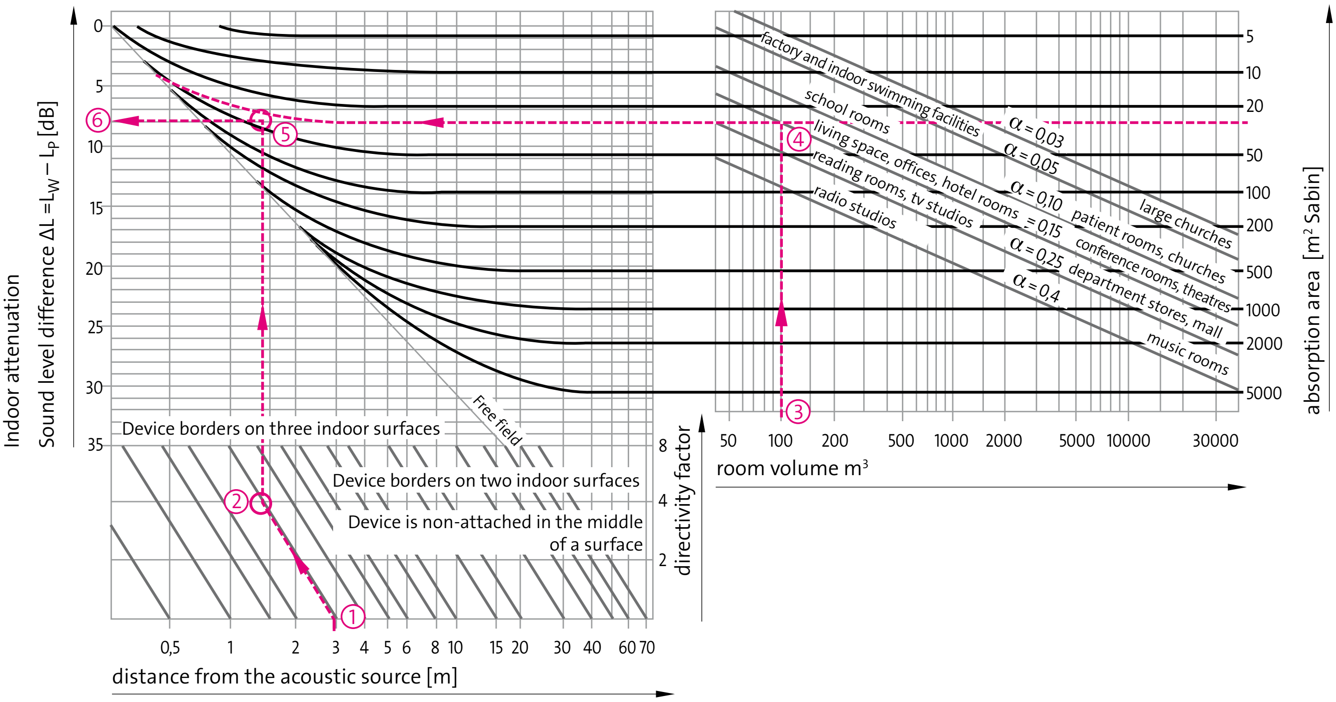
T: Reverberation Time s

Reverberation time can be determined experimentally. During planning, reverberation time can be determined according to VDI 2081 using the following chart.

Type of room	Example	Average reverberation time [s]
Workspace	Single office	0.5
	Open-plan office	0.5
	Workshops	1.5
Assembly rooms	Concert halls. Opera houses	1.5
	Theaters. Cinemas.	1.0
	Conference rooms	1.0
Housing	Hotel rooms	0.5
Social rooms	Break rooms	0.5
Classrooms	Reading rooms	1.0
	Lecture halls	1.0
	Classrooms/seminar rooms	1.0
Hospital	Operating theatre (room)	2.0
	Patient rooms	1.0
	Spas and swimming pools	2.0
Public areas	Museums	1.5
	Restaurants	1.0
	Showrooms	1.0
Sport facilities	Gymnasiums. Swimming pools	2.0
Other	Radio and TV Studios	0.5
	Computer rooms	1.5

Chart: Reverberation time (From VDI 2081)

Conversion graph sound power in sound pressure level



Indoor attenuation, subject to the absorption area, directivity and distance from the acoustic source can be seen in the above showing graph.

Absorption factor α

A wall which absorbs all incoming acoustic waves, has an absorption factor of α = 1. The above mentioned α_m-values are the ratio of actual absorption to an ideally absorbing wall. They represent a average value.

Absorption area m² Sabin

This is the area which completely absorbs all sound waves. It is **not identical** with the **entire room area**.

Example acoustics:

Fact: *Device with a sound pressure level of 40 dB(A) installed in a conference room with a volume of 100 m³*

Question: *How high is the sound pressure level at a distance of 3 m from the device?*

For practical reasons assume: *Directivity factor is 4*

1. *Starting at point ① follow the parallel line distance 3 m to the intersection point with the horizontal line of directivity factor 4 (point ②).*
2. *From there draw a perpendicular line upwards.*
3. *New start at point ③ Room volume 100 m³ (left side) then follow perpendicular line upwards to the intersection point ④ with the absorption factor line for conference rooms.*
4. *From this point, follow the both the subsidiary line of the left graph to intersection point ⑤*
5. *From point ⑤ follow the horizontal line to the ordinate, which results in a room attenuation of 8 dB (point ⑥).*

Thus the sound pressure level is $L_p = L_W - \Delta L$ = 40 dB(A) – 8 dB(A) = 32 dB(A)
This value of 8 dB(A) indoor attenuation is kept in mind when specifying the sound pressure level.

Product summary emcoair **air diffusers:**
Perfect air conditioning for all comfort and industrial sectors.

1.1.1 emcoair **swirl diffusers · ceiling air diffusers**

DRS

LDK

LSA

DAL 359

DAL 358 R

1.1.2 emcoair **linear diffusers**

SAL 50, SAL 35, SAL 15

SAL-V

SAL-S

1.1.4 emcoair **tower diffusers**

QAL-R, QAL-H, QAL-V, QAL-L

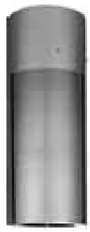
QAL-K

HDQ

1.1.5 emcoair **industrial air diffusers**

VVA

ILV

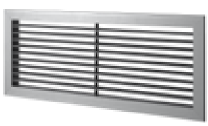


LUWIRO

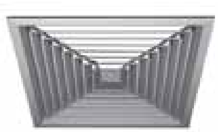
WKD 380

WKD 381

1.1.6 emcoair **grilles · flow regulators · weather louvres**

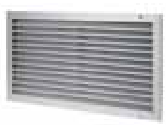


G 311



G 352

ALV



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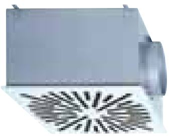
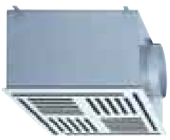

DAL 358


DAL 382


MSA, MSA-V


VAL


DIA


SVL

1.1.3 emcoair **circular pipe diffusers**


RRA, RRA-V

1.1.5 emcoair **spezialist air diffusers**


KSD


INDUCTO

1.1.5 emcoair **floor diffusers**


BD


BQ


NTK


VLD

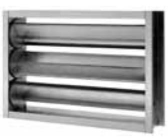

VLV


LDI

1.2 emcoair **SKG air conditioning system**


SKG

1.3 emcoair **multi-blade dampers · dampers · regulation components**


JK 481


DK


BVR


IBL


EVR


VRJK

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