

Measurement setup Industrial fans / acoustic issues

Fans are measured in a testing room that consists of two chambers: a suction and a pressure side room.

Fan under test is mounted in a frame positioned in the separating wall between the two chambers.

Both rooms are equipped with microphones on an enveloping surface around the fan on one side and around the inlet or outlet opening on the other side.

Two types of fans are tested: a) free-running fans and b) casing fans. With every measurement the sound level of the motor is a part of the measurement data. All fans are tested with free inlet opening.

Common acoustic problems for both type of fans:

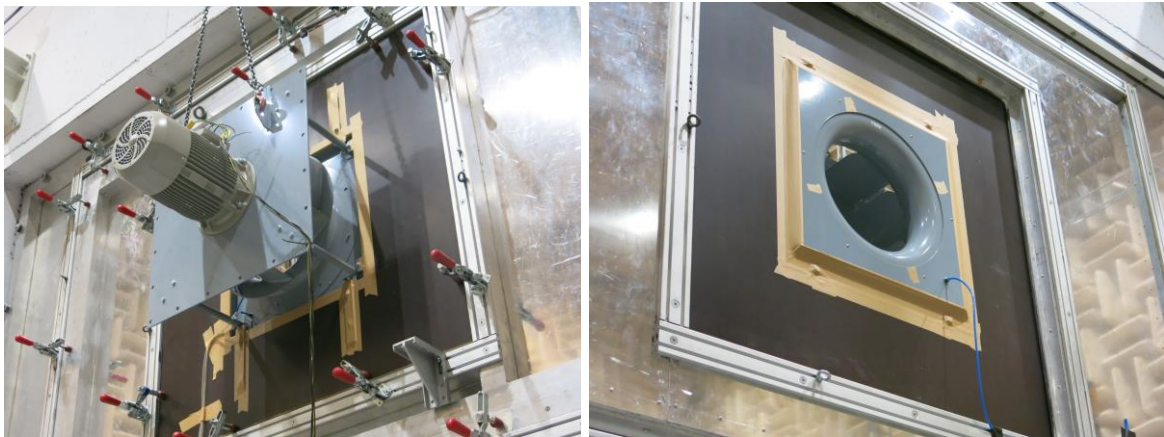
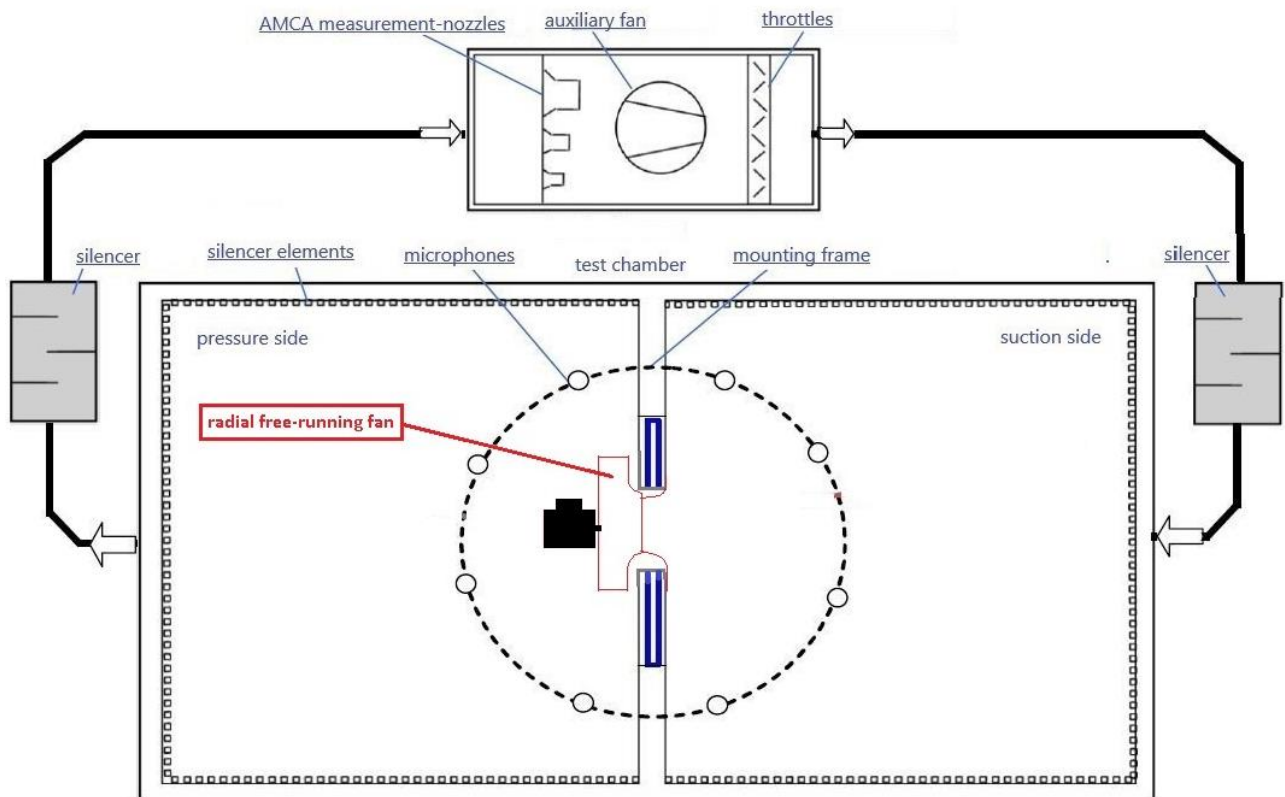
- Same fan range and size can be combined with different motors, depending on operating point, speed, power consumption, efficiency, specified motor manufacturer etc. The motor that was used for the measurements is just one possible specimen for this fan range and size. So, the acoustic motor data cannot be presumed constant for the tested fan.
- Acoustic motor data given by motor manufacturers are just “one-value”-data and show only the total sound power but no octave values (s. example motor data sheet below). In case the motor sound predominates the fans outside sound, it's impossible to show octave values for the fan outside.
- Acoustics for calculated (not measured) diameters of the same fan range shall consider that those fan sizes will be equipped with different motors (motors that were not part of any fan measurement).

Data sheet of the motor used for PR502.4G5.BA.MR and PR502.4G5.GA.MR:

Datenblatt für Drehstrom-Käfigläufermotoren SIMOTICS											
Data sheet for three-phase Squirrel-Cage-Motors											
Motor Typ / Motor type : 1CV3130B						SIMOTICS SD - 132 S - IM B5 - 4					
Kunden-Auftrags-Nr. / Client order no.						Item-Nr. / Item-No.					
Auftrags-Nr. / Order no.						Komm.-Nr. / Consignment no.					
Bemerkung / Remarks											
Elektrische Daten / Electrical data											
U	Δ / Y	f	P	P	I	n	M	η ³⁾			
[V]		[Hz]	[kW]	[hp]	[A]	[1/min]	[Nm]	4/4	3/4	2/4	4
Netzbetrieb (S1) / DOL duty (S1) - 155(F) nach 130(											
400	Δ	50	5,50	-/-	10,80	1470	35,5	89,6	90,0	89,4	0,
690	Y	50	5,50	-/-	6,30	1470	35,5	89,6	90,0	89,4	0,
460	Δ	60	6,30	-/-	10,40	1770	34,0	91,7	92,0	91,3	0,
460	Δ	60	5,50	-/-	9,30	1775	29,5	91,7	91,6	90,5	0,
IM B5 / IM 3001		FS 132 S		IP55		UKCA		IEC/EN 60034		IEC,	
Umgebungsbedingungen / Environmental conditions : -20 °C - +40 °C / 1000 m										Festbremszeit (w	
Mechanische Daten / Mechanical data											
Schallpegel (LpA / LwA) bei 50Hz/60Hz Sound level (SPL / SWL) at 50Hz/60Hz						64 / 76 dB(A) ^{2) 3)}		68 / 80 dB(A) ^{2) 3)}		Schwinggrößenstufe Vibration severity grade	

Test setup of PR502.4G5.BA.MR:

Setup large testing room /free-running fan



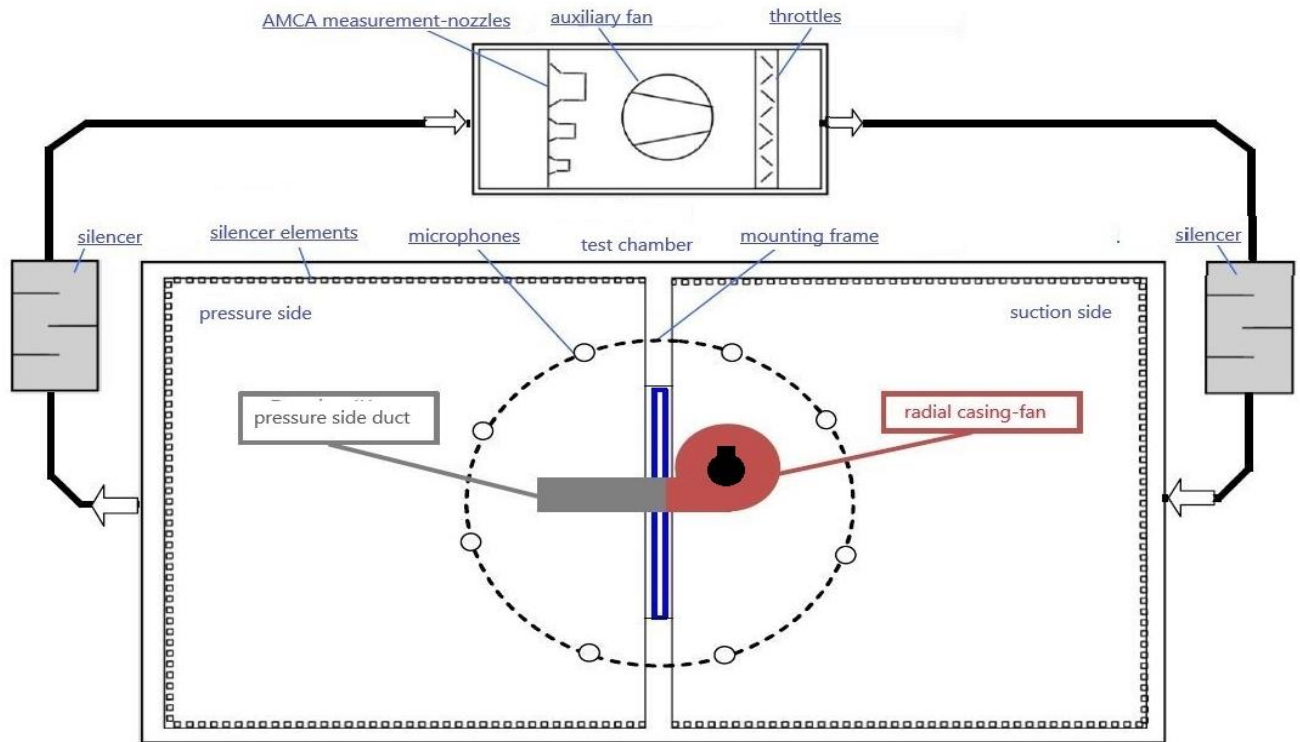
The acoustic measurement data of free-running fans are:

- $L_{w5}^{*1)}$ on the suction side: This is just the sound level coming from the suction side opening of the fan.
- $L_{w6}^{*1)}$ on the pressure side: This sound level is the sum of the discharge side of the fan and the sound of the motor. (They cannot be measured separately). Problem: This type of fan is a plug-in fan: In a customers' machine the impeller is on the inside of the machine, the motor is outside, both separated by the supporting plate of the fan which closes the machine's plug-in opening.

Customers are interested in the acoustic behaviour inside and outside separately, but the measured values are always the sum of both components.

Test setup of PR502.4G5.GA.MR:

Setup large testing room / radial casing fan



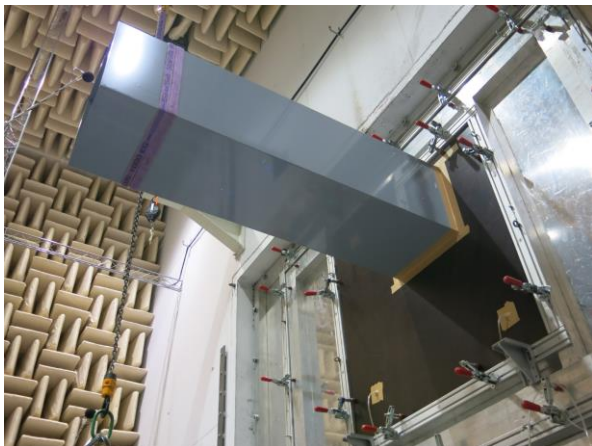
Aerodynamic data:

Klasse 1 für $q_{V1} > 6000 \text{ m}^3/\text{h}$, Klasse 2 für $1000 \text{ m}^3/\text{h}$ bis $6000 \text{ m}^3/\text{h}$, Klasse 3 für $500 \text{ m}^3/\text{h}$ bis $1000 \text{ m}^3/\text{h}$ nach DIN 24166; 0 Pa - 3000 Pa.

Acoustic data:

Klasse 1 gemäß DIN EN ISO 3745 (100 Hz bis 16 kHz); ISO 13347-1 und -3; DIN EN 13487.

Setup acc. to ISO 5801 bzw. AMCA 210-99.



The acoustic measurement data of casing fans are:

- Lw5 ^{*1)} on the suction side: This sound level is the sum of 3 components: 1. the suction side of the fan, 2. the sound that is emitted over the casing walls and 3. the sound of the motor. (They also cannot be measured separately).

Problems: In case the customer wants to connect a pipe to the inlet opening these data are not valid as they contain the sound levels that are emitted from the motor and over the casing walls as well (also s. remark below).

The fans outside sound level (casing + motor) can be different if the fan is equipped with a different motor.

- Lw6 ^{*1)} on the pressure side: This is just the sound level coming from the outlet opening of the fan.

Problem: With this special setup a duct is used on the outlet opening to measure the total pressure difference acc. to cat. B. Therefore the sound level cannot be measured because the outlet opening (of the duct) is too far outside of the centre of the enveloping surface of the microphones. So, the lab does not record the outlet values at all.

Remark: Three fan ranges (L, D and M) are equipped with identical impellers, both in free-running and casing versions which were measured separately because of different performance characteristics. So perhaps it can be assumed that the “actual / correct” suction side sound level of the casing version is the same as with the free-running version which was measured directly (?).

If the fan on site is installed acc. to installation type D (inlet + outlet duct) which is the “correct” value of the sound level that the fan emits into the environment? (It cannot be assumed that this is always identical to the sound level of the motor as the sound that is emitted over the casing walls by the impeller is unknown / cannot be measured separately.)

Is it possible to calculate the outlet sound values based on theoretical or empirical values or formulas? (Otherwise, more tests with free outlet (without duct) would be necessary – which should be avoided.)

*1) The designations Lw5 and Lw6 refer to the data column designations given in ZA measurement data tables, s. example:

	Lw(L)6 [dB]	Lw(L)5 [dB]	Lw(A)6 [dB]	Lw(A)5 [dB]
2	93,5	91,5	90,2	86,8
L	93,6	91,8	89,6	85,5
2	93,4	91,7	88,8	84,4
L	93,0	91,5	87,0	82,4

This is not identical with all combinations of tested fans and installations acc. to ISO 13347-1:

3.2 Fan sound power levels

Considering all possible combinations for installation conditions specified in Clause 4, twelve different sound power level (L_W) descriptions are defined in Table 1, for example $L_W(A, in)$.

Table 1 — Sound power levels

Number	Suffix	Description
1	(A, in)	free-inlet sound power level; type A installation.
2	(A, out)	free-outlet sound power level; type A installation.
3	(A, tot)	total sound power level of a fan type A installation (includes the contributions from the inlet, outlet, fan casing and drive).
4	(B, in)	free-inlet sound power level; type B installation.
5	(B, in+cas)	free-inlet sound power level plus casing-radiated noise; type B installation.
6	(B, out)	ducted outlet sound power level; type B installation.
7	(C, in)	ducted inlet sound power level; type C installation.
8	(C, out)	free-outlet sound power level; type C installation.
9	(C, out+cas)	free-outlet sound power level plus casing-radiated noise; type C installation.
10	(D, in)	ducted inlet sound power level; type D installation.
11	(D, out)	ducted outlet sound power level; type D installation.
12	(D, cas)	casing-radiated sound power level; type D installation.

NOTE 1 All of these symbols may be used to indicate levels in one-third octave or octave frequency bands as well as overall sound power levels and A-weighted sound power levels, provided that the sound power to which the symbols relate is clearly defined.

Where noise from the drive may contribute to the noise radiated from a casing then this should be clearly stated by the addition of +dr e.g., $L_W(D, cas + dr)$.

NOTE 2 Not all of the above levels need to be measured for a particular fan.

Informative: Installation types acc. to ANSI/AMCA 214-21 (which is identical to definitions given in ISO 13347-3):

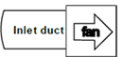
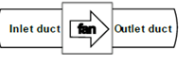
Test Configuration	Duct Configuration	
A	Free inlet, free outlet with partition	
B	Free inlet, ducted outlet	
C	Ducted inlet, free outlet	
D	Ducted inlet, ducted outlet	
E	Free inlet, free outlet without partition	

Figure 7.1 – Test configurations

ISO 13347-3:2004(E)

3 Acoustic environment and ducting

3.1 General

The fan installation conditions conform to the four categories of installation types specified in ISO 5801:

- type A: free inlet, free outlet;
- type B: free inlet, ducted outlet;
- type C: ducted inlet, free outlet;
- type D: ducted inlet, ducted outlet, (casing breakout noise may also be determined for type D ducted inlet, ducted outlet).