LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO –
CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Technical Note	LIGO-T030075-00-D	4/25/2003

Notes on the Acoustic Emission of VME Crates at LIGO

Szabolcs Márka

! First DRAFT !

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Abstract

Various acoustic noise sources can affect the noise levels of LIGO. Among the significant noise sources are the cooling fans within the VME crates. I measured the ambient sound level increase due to the cooling fans for the available (Knuerr, Elma and Dawn) crates. I also collected spectral information to characterize the acoustic signature of each crate. I found that the presently used Knuerr crate is significantly quieter than the other two. The Dawn is much noisier than the Elma. The measured results are consistent with the specifications of the manufacturers and the airflow requirements of the various crates. In the light of these findings, we must consider the acoustic emission as one of the selection criteria when purchasing new crates. We cannot take it granted that fewer new crates will produce less acoustic problems than larger number of Knuerr crates.

Introduction

Acoustic mitigation became one of the priorities for LIGO. When considering the acoustic pollution within the "quiet" zones of the observatories, we should learn about the sources. The cooling fans installed in the LVEA are among the significant sources. Among the various cooling fans, probably the most significant noise sources are the ones located in the VME crates. These sources are also important since we are considering the replacement of our VME crates due to RFI/EMI contamination problems. The new crates will require stronger airflow to provide the required cooling power due to their intricate interior. As we recently received samples of VME crates considered by the RFI/EMI mitigation team, I was able to perform some simple comparative acoustic emission measurements. I measured the ambient sound level increase due to the cooling fans within the available (Knuerr, Elma and Dawn) crates. I also collected spectral information to characterize the acoustic signature of each crate. These measurements can help us to select the best solution, to understand the acoustic environment we will face and give us a starting point for the mitigation effort. As a side product of this investigation I also collected relevant information, which is attached to this short note in the Appendices. Appendix A provides technical details about the various fans used in the VME crates considered. Appendix B gives the relevant specifications on the sound level meter used for the measurements. Appendix C gives you a feeling about what does "quiet" mean on human terms. Appendix D provides some insight on the industrial process of measuring fan noise. It also helps with the understanding of the often misleading and/or hard to compare specifications. In Appendix E, I show some interesting pictures of our VME crates.

Measurement details

To be consistent with previous measurements, I used the Radio Shack Sound Level Meter to collect the data. I did not trust a calibration of any single unit so I used 4 of them (3 analogs and 1 digital) to obtain the data. I placed the VME crates and microphones on separate tables to mitigate direct coupling through the surface of the table. I also placed the microphones on a thick book. Microphone #3 was placed on a dry board eraser to further decrease the non-air coupling. However, I did not observe significant difference between #3 and the other microphones. The sensors were placed ~12" behind and ~12" below the fans of each crate. This geometry lets us take close-by measurements, while avoiding the direct flow from the fans. The same sensors were used for each measurement and I tried to preserve the geometry as much as possible. The sound level meters were set to dB(C) (see Appendix B) and "slow response". The ambient noise level (without crate noise) was measured before and after each crate noise measurement. It was consistent from measurement to measurement within the accuracy of the readout. The sensor also provides an amplified microphone signal output, which can be used for spectral studies. Since the Knuerr crate has a variable speed fan, I also measured the noise levels close to a loaded/hot Knuerr unit in the LVEA. This in-LVEA measurement is likely to be contaminated by other noise sources, so it can only be viewed as an upper bound. The two measurements differ by ~2 dB(C).

Figure 1 Measurement geometry

Results and opinions

Table 1 summarizes the results of the raw sound level measurements.

	Knuerr[1]	Elma	Dawn	Ambient[2] level
Mic #1 [dB(C)]	63 (65)	71	74	61
Mic #2 [dB(C)]	62 (64)	71	73	60
Mic #3 [dB(C)]	62	70	73	60
Mic #4 [dB(C)]	62	70	73	60
Flow [CFM]	22.4-82.4	118	150	
RPM	1150-2300	3200	3250	
Noise Rating dB(A)	22-39	46.5	53.6	

Table 1. Measured sound levels and fan specifications from the literature. For the Knuerr crate the measured noise levels in () are the results of measurement in the LVEA.

Based on these measurements, it is clear that the new crates have significantly higher acoustic emission than the presently used model (Knuerr). Also, the emission of the Dawn unit is higher than the emission of the Elma crate. The order of noisiness agrees with the expected order inferred from the parameters supplied by the fan manufacturers. Fans with higher flow rating/RPM produce more noise.

All the fans were connected to the chassis directly. There were no (polymer) isolating elements installed at the mounting points of the fans.

A cursory web search for “ultra quiet” fans indicated that there are available and geometrically/electrically compatible quiet fans on the market. However, it is very suspicious that those so-called “ultra quiet” fans have low flow rating and RPM. I had the impression that these “quiet” fans are just like any other fan with low performance specs. Of course a more systematic search can uncover the “hidden gold”.

When disassembling, the Dawn crate proved to be annoying, due to the very loose and flimsy RFI seals.

Conclusion: My first impression is that the Elma crate is a better unit both mechanically and acoustically than the Dawn crate.

[1] The manufacturer’s specification indicates that the fan used in the Knuerr crate has variable flow. It means that the lab measurement could have underestimated the noise emission, since the electrical load of the crate’s power supply was low. As a cross check, I measured the sound level behind and below ~12” of a loaded/hot Knuerr crate in the LVEA. As expected, I got a higher reading, ~2 dB above the level measured in the laboratory. However, it is not clear whether the difference can be fully attributed to noisier fans.

[2] Note that LIGO buildings are quite noisy due to the air conditioning system.

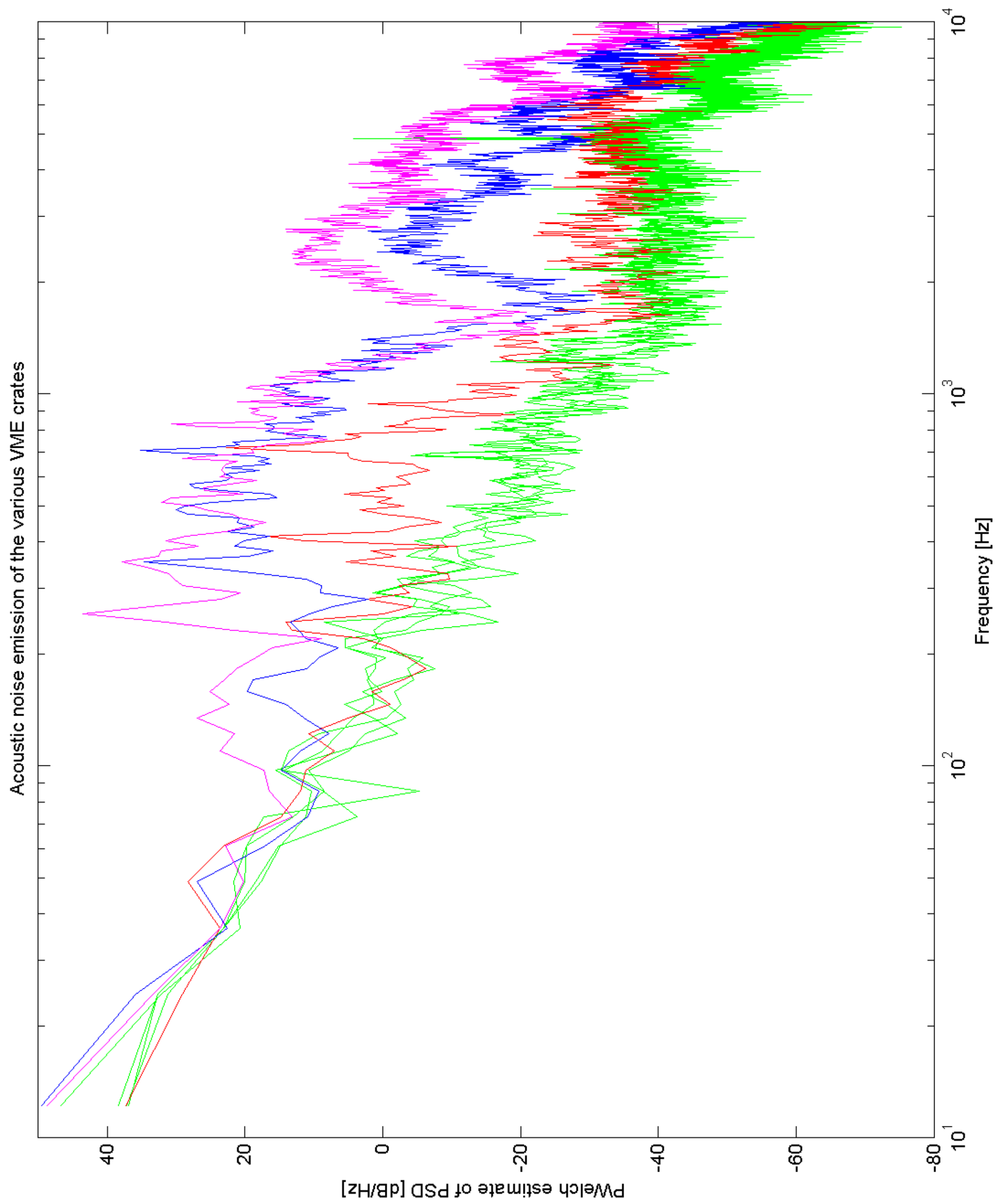
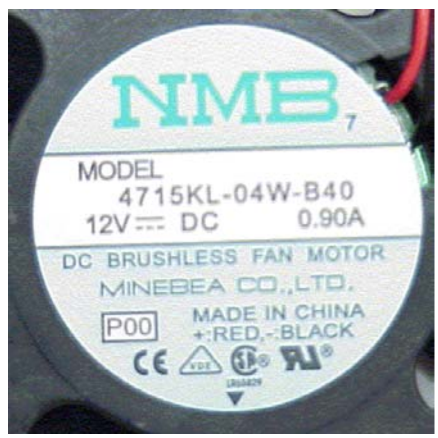


Figure 2 Acoustic emissions of the VME crates as a function of frequency. The green lines are the representative ambient noise spectra. The red line is the Knuerr spectrum. The blue line is the Elma spectrum. The magenta line is the Dawn spectrum.

Appendix A - VME cooling fans and their datasheets

Knuerr Crate :

Elma Crate:



Dawn Crate:

home shop silentguide service faq reseller contact

pc silent.de
it's a quiet case

Status:
101 of 116 articles available now!

19 Customers online

Shop > Product details

Basket
0 Articles: 0.00 €

Papst Vario 4312MV

PAPST

Recommend product

Papst-fan variofan 4312 MV
Measurements 119*119*32mm
Air-flow 22.4-82.4 CFM / 38-140 m³/h
5.25" Y-power-connector (12 volt) with connected thermal-resistor

Noise-level: 22-39 db(A)

39.95 €
article awaited for 5/2/2003

1 Order

Technical datasheet >
as PDF-Document

Gerneral information

- Quiet operating
- High class ball bearing
- Glass fibre strengthened plastics fan
- External-motor with electronic commutation
- Connections are safe of wrong polarity; blockage- and overload guard

Technical Data

Dimensions: 119*119*32mm
Distance between Installation holes: 104.8mm
Diameter of Installation hole: 4.3mm
Weight: 220g

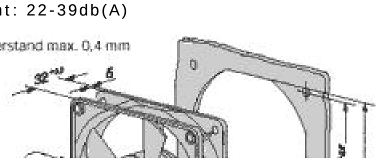
Speed: 1,150-2,300 rpm.
Air-flow m³/h: 38-140
Air-flow CFM: 22.4-82.4
Bearing: ball bearing
Supply voltage: 12V
Consumption: 1.5-3W
Temperature sensing devise: integrated into connection cable

Life span 40°C/65°C: 70,000 / 40,000 hours

Connection:


5.25" Power connection (Y-connector)

Noise development: 22-39db(A)



silentfinder

Your personal assistant for product choice: Find the right products for your system with a mouse click!

to the Silentfinder >

silentguide

Do you want more information about noise sources, right airflow, etc. ?

to the SilentGuide >>

Be sure to shop safely

You have a right of return for two weeks and a warranted SSL-secure transmission of personal data.

Pay by

Schutz gegen Missbrauch
AMERICAN EXPRESS
VISA
MasterCard

or Cash On Delivery or pre payment

Shipping costs

Germany

GLS (German Parcel):
5,- € Standard
9,- € C.O.D.

Deutsche Post AG:
7,- € Standard
11,- € C.O.D.
(excl. 1,53€ fee)

Other countries
Worldwide delivery starting at only 10 € depending on country

questions

Read our FAQ or write us an email to:

These products might be also interesting for you

Fan vibration-damping

4 rubber-pins to fasten fan with discontinued screw-holes

article in repeat order
1.60 €

1 Order

Fan-Screws

i.e. to mount 80mm fans into case
4 pcs. per set

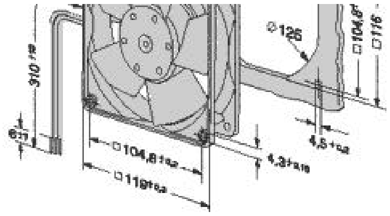
available now
0.75 €

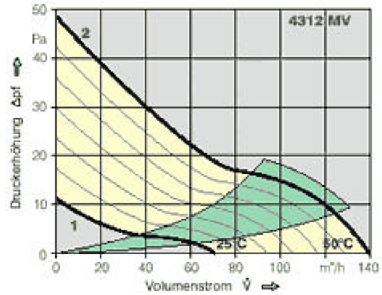
1 Order

Scotch connector for 3 cables

Mount your new power-supply-fan without soldering
Just cut the cables, put the connector (for up to 3 cables) on the cables and press it together.

info@pcsilent.de

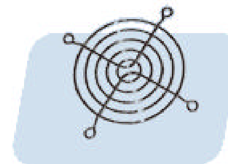




Important: to mount a fan you need a **minimum of 2 connectors** (+ AND -). Easy, fast and secure...

available now
0.65 €

1 Order



Fan-protection for 119*119mm fans

available now
1.60 €

1 Order

Imprint - General conditions - PCSilent.de® is a registered trademark of Hiller&Hinken GmbH

4715KL (119□ x 38L)

General Specifications

Motor Protection:
Auto Restart/Polarity Protection

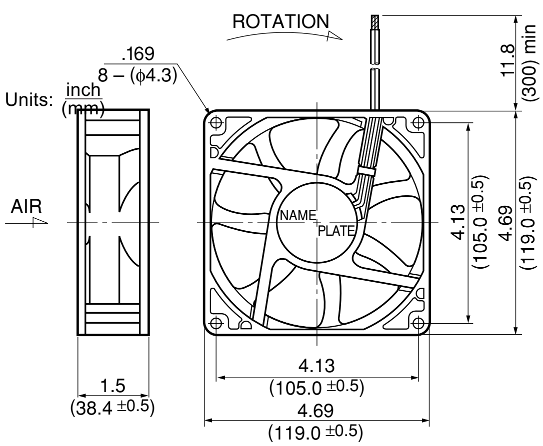
Insulation Resistance: 10M Ω or over with a DC500V Megger

Dielectric Withstand Voltage: AC 700V 1s

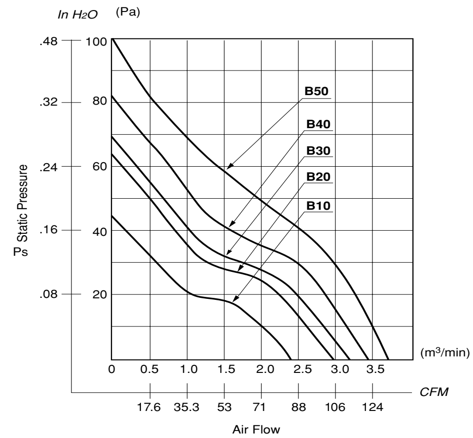
Allowable Ambient Temperature Range:

B50 Class: -10°C ~ +40°C (Operating)
B40 Class: -10°C ~ +50°C (Operating)
B10 ~ B30 Class: -10°C ~ +70°C (Operating)
All Class: -40°C ~ +70°C (Storage)
(non-condensing environment)

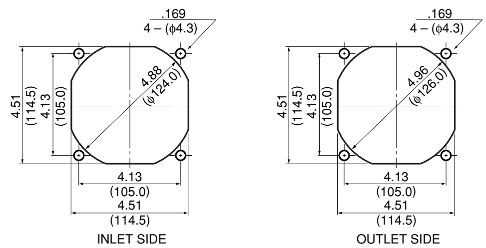
Outline



Characteristic Curves



Panel Cut-outs



Material

Casing : Plastic (Black) 94V-0
Impeller : Plastic (Black) 94V-0
Bearing : Ball Bearing
Lead Wire: UL1007, AWG24, +Red, -Black

Specifications

MODEL		Rated Voltage	Operating Voltage	Current	Input Power	Speed	Max. Air Flow		Max. Static Pressure		Noise	Mass
	Product No.	(V)	(V)	(A)*1	(W)*1	(min⁻¹)*1	CFM*1	(m³/min)*1	in H2O	(Pa)*1	(dB)*1	(g)
4715KL-04W-**B10**-	X00	12	6.0 ~ 13.8	0.27	3.24	2300	83.6	2.37	.17	44.1	37.0	260
4715KL-04W-**B20**-	X00	12	6.0 ~ 13.8	0.40	4.80	2650	97.0	2.75	.22	55.9	41.0	260
4715KL-04W-**B30**-	X00	12	6.0 ~ 13.8	0.55	6.60	2950	108.0	3.07	.27	68.2	42.5	260
4715KL-04W-**B40**-	X00	12	6.0 ~ 13.8	0.70	8.40	3200	118.0	3.34	.33	81.4	46.5	260
4715KL-04W-**B50**-	X00	12	8.0 ~ 12.6	1.00	12.00	3600	130.0	3.68	.44	110.0	50.0	260
4715KL-05W-**B10**-	X00	24	10.0 ~ 27.6	0.15	3.60	2300	83.6	2.37	.17	44.1	37.0	260
4715KL-05W-**B20**-	X00	24	10.0 ~ 27.6	0.21	5.04	2650	97.0	2.75	.22	55.9	41.0	260
4715KL-05W-**B30**-	X00	24	10.0 ~ 27.6	0.31	7.44	2950	108.0	3.07	.27	68.2	42.5	260
4715KL-05W-**B40**-	X00	24	10.0 ~ 27.6	0.35	8.40	3200	118.0	3.34	.33	81.4	46.5	260
4715KL-05W-**B50**-	X00	24	18.0 ~ 25.0	0.50	12.00	3600	130.0	3.68	.44	110.0	50.0	260
4715KL-07W-**B10**-	X00	48	25.0 ~ 55.2	0.08	3.84	2300	83.6	2.37	.17	44.1	37.0	260
4715KL-07W-**B20**-	X00	48	25.0 ~ 55.2	0.11	5.28	2650	97.0	2.75	.22	55.9	41.0	260
4715KL-07W-**B30**-	X00	48	25.0 ~ 55.2	0.16	7.68	2950	108.0	3.07	.27	68.2	42.5	260
4715KL-07W-**B40**-	X00	48	25.0 ~ 55.2	0.20	9.60	3200	118.0	3.34	.33	81.4	46.5	260

Rotation: Clockwise Airflow Outlet: Air Out Over Struts *1: Average Values in Free Air

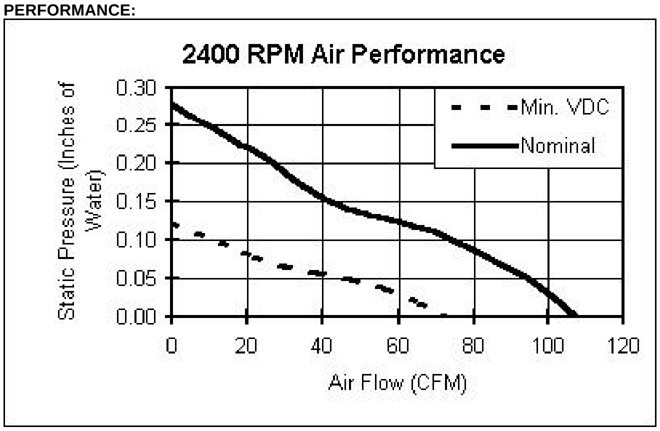
Galaxy® DC

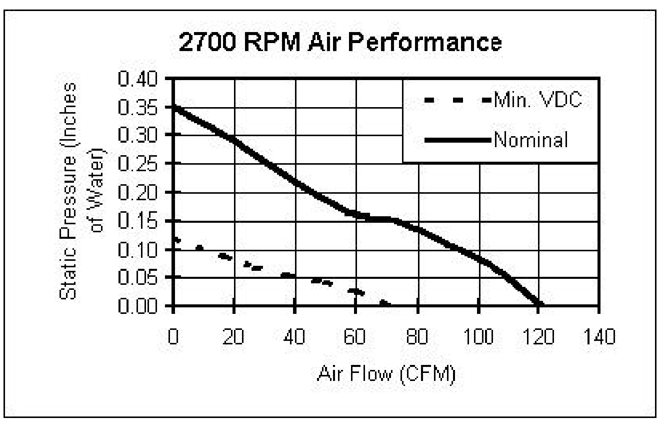
Brushless DC Tubeaxial Fan

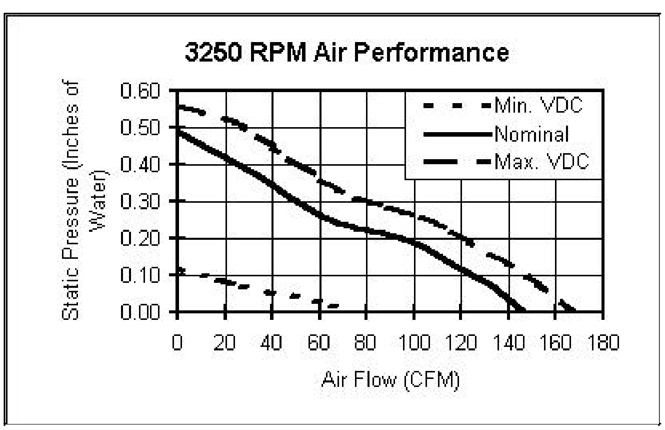
FEATURES:

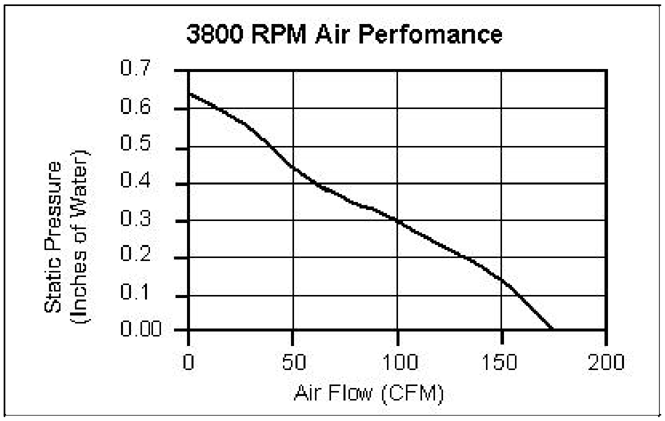
- Size: 5.0" sq. x 1.5" deep (127mm x 38.1mm)
- Air Flow: 110 to 190 CFM
- Voltage: 12, 24, & 48 VDC
- Operating Temperature Range: -10°C to +70°C
- Storage Temperature Range: -40°C to +85°C
- Feathered Edge™ for Lower Noise
- Ball Bearings
- 12" Leadwires, 22 AWG, or Terminals
- Weight: 22 oz (.62 Kg)

PERFORMANCE:









SPECIFICATIONS:

Model No.	Part No.	VDC	Watts	Running Current (Amps)	Locked Rotor Current (Amps)	RPM	CFM	dBA	Features
GL12H4V	031080	12	9.0	0.750	3.100	2400	110	45.8	2, 3
GL12C4V	031077	12	11.0	0.920	2.900	2700	125	48.2	2, 3
GL12B3	031711	12	15.0	1.250	3.000	3250	150	53.6	1, 3
GL12B4	031074	12	15.0	1.250	3.000	3250	150	53.6	2, 3
GL12B7	031200	12	15.0	1.250	3.000	3250	150	53.6	1, 3 5
GL12K3	039193	12	27.6	2.300	5.100	3800	175	59.0	1, 3
GL24H4V	031081	24	9.0	0.380	1.150	2400	110	45.8	2, 3
GL24C4V	031078	24	11.0	0.460	1.150	2700	125	48.2	2, 3
GL24B3	031757	24	15.0	0.625	1.350	3250	150	53.6	1, 3
GL24B4	031075	24	15.0	0.625	1.350	3250	150	53.6	2, 3
GL24B7	031636	24	15.0	0.625	1.350	3250	150	53.6	1, 3 5
GL24K3	039151	24	22.8	0.095	2.000	3800	175	59.0	1, 3
GL24Z3	039773	24	30.0	1.24	2.000	4250	190	61.0	1, 3
GL48C4V	031079	48	11.0	0.230	0.930	2700	125	48.2	2, 3
GL48H4V	031082	48	9.0	0.190	0.930	2700	125	45.8	2, 3
GL48B4	031076	48	15.0	0.310	0.930	3250	150	53.6	2, 3
GL48K3	039285	48	21.6	0.450	0.700	3800	175	59.0	1, 3
GL48Z3	039773	48	30.0	0.620	1.200	4250	190	61.0	1, 3

Click here to view diagram - Galaxy.gif (76K)

FEATURES:

1. Leadwires
2. Terminals
3. Ball Bearings
4. Sleeve Bearings
5. Tachometer Output
6. Thermal Speed Control
7. Programmable Speed Control
8. Fan Performance Sensor

MOTOR:

- Brushless Electronic Commutation Provided By Dependable Solid State Circuitry
- Ball Bearings
- 100% Dielectric Tested
- Electronic Locked Rotor Protection
- Polarity Protected

CONSTRUCTION:

- Venturi - Die Cast Zinc Alloy, Black
- Propeller - Polycarbonate, Black, UL94V-0

LIFE EXPECTANCY:

- L10 Data - 82,500 hrs, @ 50°C

EMI:

- These products have been tested and complies with FCC Part 15 Class B of:

EN55022 - 1994 Class B Conducted Emissions.
EN55022 - 1995 Class B Radiated Emissions.

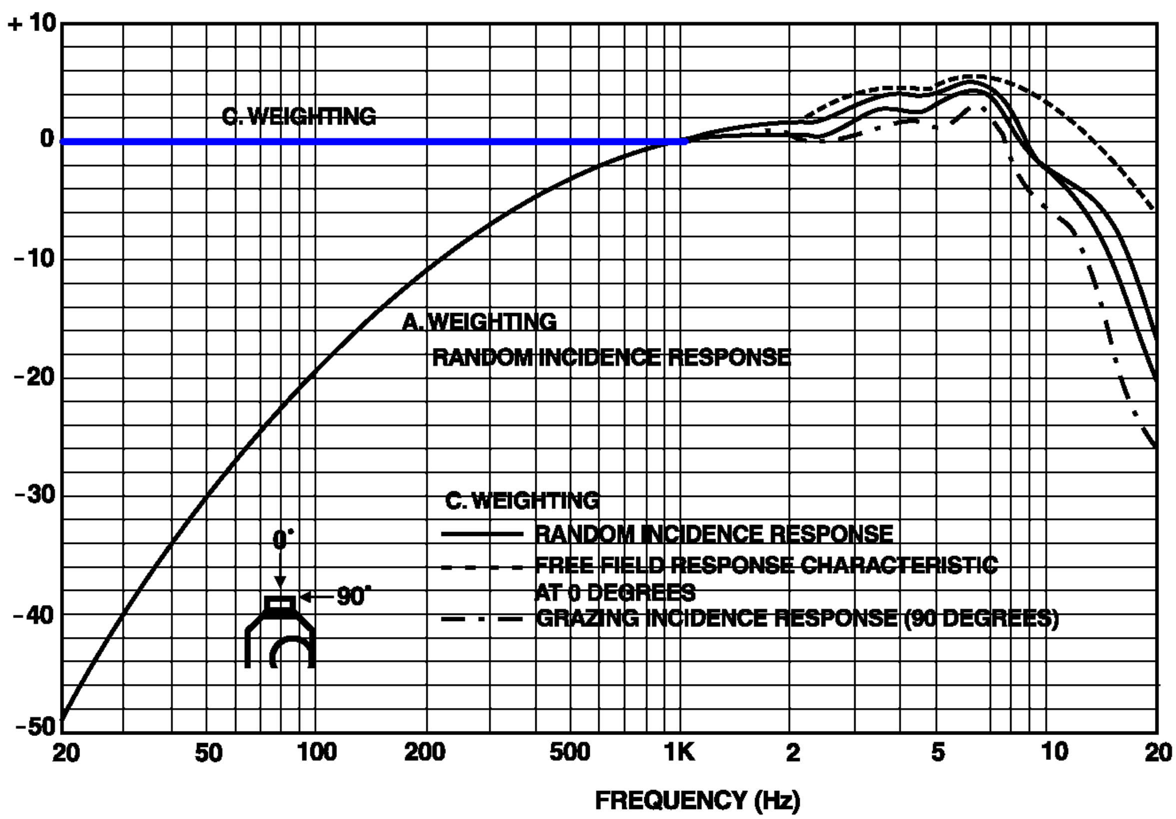
OPTIONS:

- Tachometer Output - square wave output equal to 2 pulses per revolution
- Fan Performance Sensors (FPS)
- Thermal Speed Control
- Programmable Speed Control
- Customized Harness Assemblies
- Threaded Mounting Holes Available

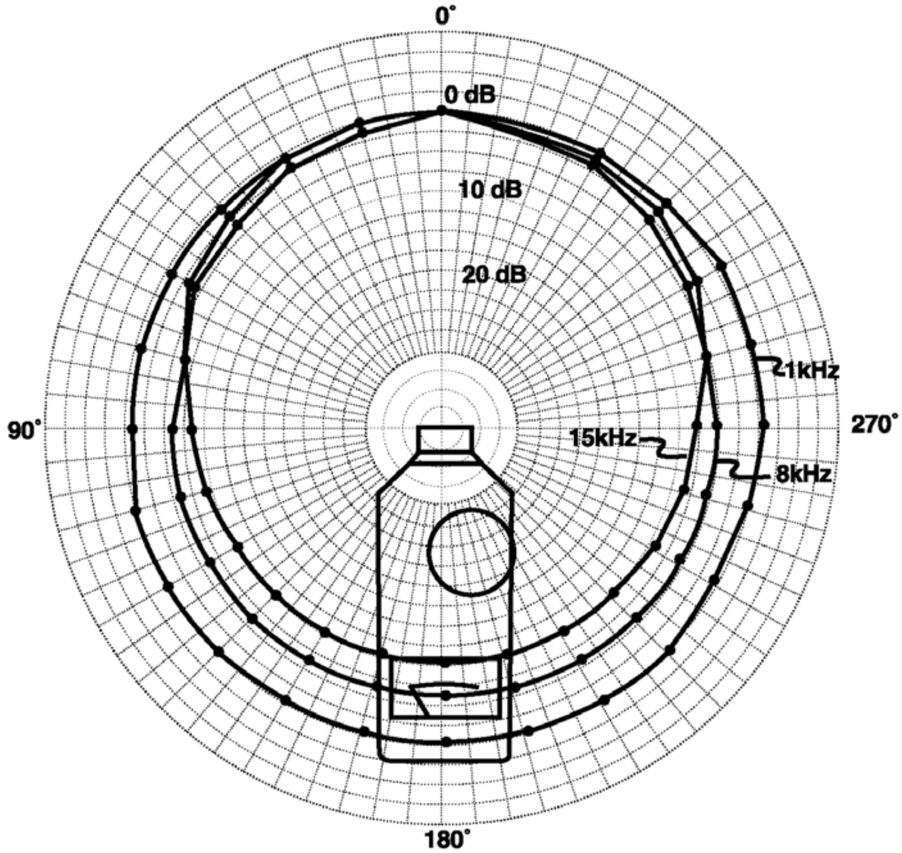
Appendix B – Sound Level Meter Data

Versions of the Radio Shack Sound Level Meter (a general consensus is that it is better than the name of the manufacturer…)

Pictorial representation of the dB (A) and dB (C) standard definition:



Directional sensitivity of the microphone:



Specifications as provided by the manufacturer:

Accuracy .... ± 2 dB @ 114 dB

Standard .... 0 dB = 0.0002 µbar

Weighting .... A and C

Response .... Fast and Slow

Signal Output .... 1.0V (peak) minimum into open circuit, with full-scale meter, deflection at 1 kHz

Load Impedance ....10k Ohm minimum

Distortion .... Less than 2% at 1 kHz, 0.5V

Microphone .... Electret condenser omnidirectional becoming slightly directional with increase in frequency

Appendix C – How Quiet Is Quiet ?

LEAGUE FOR THE HARD OF HEARING
NEW YORK • FLORIDA
Since 1910

New York:
[71 West 23rd Street, New York, NY 10010-4162]
917-305-7700 (Voice) ·917-305-7999 (TTY) · 917-305-7888 (Fax)

Florida:
[2800 W. Oakland Park Blvd., Suite 306, Oakland Park, FL 33311]
954-731-7200 (Voice) · 954-731-7208 (TTY) · 954-485-6336

Noise Center

NOISE CENTER OF THE LEAGUE

1 888 NOISE 88

NOISE LEVELS IN OUR ENVIRONMENT FACT SHEET

How Loud is Too Loud? Experts agree that continued exposure to noise above 85 dBA over time, will cause hearing loss. To know if a sound is loud enough to damage your ears, it is important to know both the loudness level (measured in decibels, dBA) and the length of exposure to the sound. In general, the louder the noise, the less time required before hearing loss will occur. According to the National Institute for Occupational Safety and Health (1998), the maximum exposure time at 85 dBA is 8 hours. At 110 dBA, the maximum exposure time is one minute and 29 seconds. If you must be exposed to noise, it is recommended that you limit the exposure time and/or wear hearing protection.

Measure Up and Turn it Down: Decibel Levels Around Us The following are decibel levels of common noise sources around us. These are typical levels, however, actual noise levels may vary depending on the particular item. Remember noise levels above 85 dBA will harm hearing over time. Noise levels above 140dBA can cause damage to hearing after just one exposure.

Points of Reference *measured in dBA or decibels

- 0 The softest sound a person can hear with normal hearing
- 10 normal breathing
- 20 whispering at 5 feet
- 30 soft whisper
- 50 rainfall
- 60 normal conversation
- 110 shouting in ear
- 120 thunder

Home

- 50 refrigerator
- 50 - 60 electric toothbrush
- 50 - 75 washing machine
- 50 - 75 air conditioner
- 50 - 80 electric shaver
- 55 coffee percolator
- 55 - 70 dishwasher
- 60 sewing machine
- 60 - 85 vacuum cleaner
- 60 - 95 hair dryer

Work

- 40 quiet office, library
- 50 large office
- 65 - 95 power lawn mower
- 80 manual machine, tools
- 85 handsaw
- 90 tractor
- 90 - 115 subway
- 95 electric drill
- 100 factory machinery
- 100 woodworking class

Recreation

- 40 quiet residential area
- 70 freeway traffic
- 85 heavy traffic, noisy restaurant
- 90 truck, shouted conversation
- 95 - 110 motorcycle
- 100 snowmobile
- 100 school dance, boom box
- 110 disco
- 110 busy video arcade
- 110 symphony concert

- 65 - 80 alarm clock
- 70 TV audio
- 70 - 80 coffee grinder
- 70 - 95 garbage disposal
- 75 - 85 flush toilet
- 80 pop-up toaster
- 80 doorbell
- 80 ringing telephone
- 80 whistling kettle
- 80 - 90 food mixer or processor
- 80 - 90 blender
- 80 - 95 garbage disposal
- 110 baby crying
- 110 squeaky toy held close to the ear
- 135 noisy squeeze toys

- 105 snow blower
- 110 power saw
- 110 leafblower
- 120 chain saw, hammer on nail
- 120 pneumatic drills, heavy machine
- 120 jet plane (at ramp)
- 120 ambulance siren
- 125 chain saw
- 130 jackhammer, power drill
- 130 air raid
- 130 percussion section at symphony
- 140 airplane taking off
- 150 jet engine taking off
- 150 artillery fire at 500 feet
- 180 rocket launching from pad

- 110 car horn
- 110 -120 rock concert
- 112 personal cassette player on high
- 117 football game (stadium)
- 120 band concert
- 125 auto stereo (factory installed)
- 130 stock car races
- 143 bicycle horn
- 150 firecracker
- 156 capgun
- 157 balloon pop
- 162 fireworks (at 3 feet)
- 163 rifle
- 166 handgun
- 170 shotgun

LEAGUE HOMEPAGE || Noise Center ||| EMail

Appendix D – A relevant note on noise measurements

IMPORTANT FACTORS TO CONSIDER WHEN COMPARING ACCOUSTICAL DATA

By Application Engineering

INTRODUCTION

When forced convection cooling is required, acoustical noise can often be a determining factor on which product or supplier is chosen. It is because of this that it is important to know that the acoustic data being compared was obtained using similar testing parameters. There are several factors that can affect the noise value:

a. Measurement method (e.g. ANSI S12.11-1987 vs. Freely Suspended)
b. Operating point (e.g. Free delivery vs. Impeded point)
c. Distance from the source (e.g. 1meter vs. 3 feet)

Each of these factors can make a product seem more or less appealing, depending on how it is used.

MEASUREMENT METHOD

The industry standard method for measuring acoustical noise is ANSI S12.11-1987. In this standard the fan is mounted to a specified chamber and the acoustic measurement is taken. Because it is mounted to a chamber, there will be some noise due to structure bourn vibration. In order to "pad" their data, some companies will test their product "freely suspended". In this procedure the fan is hung by springs; thus, the fan is isolated from any vibrational influences on the noise. This will make the acoustical noise seem less than it actually is. An example of this is a Patriot DC (Quiet) PQ24B4, a 6.75" fan. Per ANSI at 3 feet the Sound Pressure Level (SPL) is 54.7 dBA and freely suspended at 3 feet it is 52.0 dBA, a difference of 2.7 dBA.

OPERATING POINT

The fan's operating point can also play and important role when taking acoustical measurements. A fan's acoustic level when measure at free delivery or in the stall region will be much louder than a fan in the efficiency zone of the curve (Figure 1).

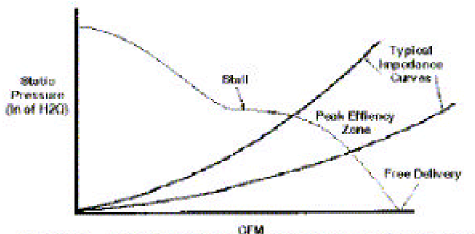


Figure 1 - Accoustic Measurements At Different Loads

Looking at our example from before, a PQ24B4 fan, tested per ANSI standards at free delivery is 54.7 dBA. Under the same testing conditions, except at a static pressure point of .251" of water, the noise level is 52.0 dBA. Thus, acoustical values for a fan at an impeded point in the efficiency zone will appear to be quieter than values for the same fan at free delivery. Please note that when testing freely suspended, the acoustical value given is at free delivery. In order to test a fan at a static pressure it must be mounted to a chamber.

MEASURING DISTANCE

The third consideration when comparing acoustical data is distance from the source. This will only be a concern when dealing with the SPL because, the sound pressure is dependent on the radius from the source. In our industry, this distance is typically either three feet or one meter. Though this difference may appear small, its impact on a sound pressure value is significant. The formula for the SPL is:

$SPL = LwA - 20\log r - 0.6 + C$

SPL "A" weighted Sound Pressure Level (dBA re 20 Pa)

LwA "A" weighted Sound Power Level (dBA re 1 pW)

r Radius from noise source, feet6

C Correction term for temperature and pressure

The "A" weighted scale is used in the industry to compensate for the fact that the ear is not equally sensitive at all frequencies. When comparing two separate noise sources, even thought the SPL values may be the same, one may appear to be noisier if the sound power is centered around a frequency in which the ear is more sensitive. It is because of this that sound level meters us the "A" weighting scale.

The sound power level attempts to describe the acoustic energy emitted from the source. It is also referred to as Noise Power Emission Level (NPEL), as expressed in our catalog. This number is essentially independent of the measurement environment, so it doesn't require the measurement distance to be noted.

Solving for LwA:

$LwA = SPL + 20\log r + 0.6 - C$

Since LwA is independent of the distance from the source:

LwA (at 3 feet) = LwA (at 1 meter)

Therefore:

$SPL_{ft} + 20\log_{10} r_{ft} + 0.6 – C = SPL_m + 20\log_{10} r_m + 0.6 - C$

SPL_{ft} - SPL at 3 feet

SPL_m - SPL at 1 meter (1meter = 3.281 feet)

Canceling out like terms and solving for SPL:

$SPL_{ft} = SPL_m + 20\log_{10} (3.281) - 20\log_{10} (3)$

$SPL = SPL + 10.3201 - 9.5424$

$SPL_{ft} = SPL_m + 0.778$ dB

From this equation it can be seen that the sound pressure level at 1 meter is 0.8 dB less than it is at 3 feet. As noted in our first example and in the Acoustics Ratings chart, a PQ24B4 fan freely suspended at 1 meter is 51.2 dbA and at 3 feet will be 52.0 dbA. Therefore, SPL values at 1 meter will appear to be quieter. It can also be noted that as a general rule, as the distance from the source is doubled, the SPL decreases by 6 dBA.

As can be seen, it is important that when comparing two quantities or values that you are comparing "Apples to Apples". In acoustics it is important that the measurement method, operating point and distance from the source is taken into consideration when comparing two values. Each of these factors can affect the end acoustical value and make a product seem more appealing. Some companies will only give the best acoustical pint such as freely suspended at 1 meter or per ANSI at one meter and at an impeded point. These are all acceptable methods, but unless you compare them to an equivalent value obtained from the same method, they do not provide an accurate comparison. To make it easy, we have posted in our catalog both measurement methods, at free delivery and an impeded point, and with the above-mentioned conversion, the SPL at different distances can be easily calculated.

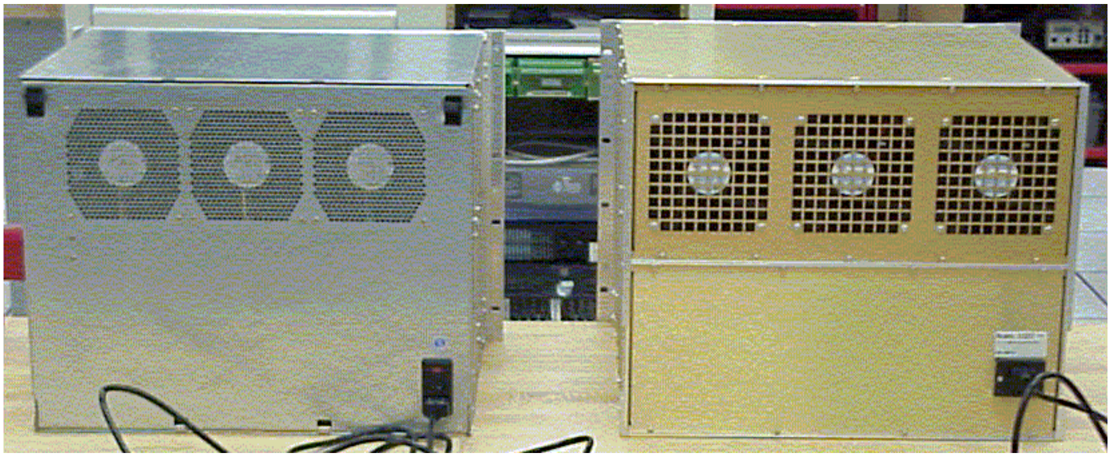
References:

Cyril M. Harris, Handbook of Acoustical Measurements and Noise Control, 3rd ed., (New York: McGraw-Hill, Inc., 1991), p.1.13

To Engineering Notes

Appendix E – Pictures of VME cooling fans and locations

Rear view of the Knuerr and Elma crates:



The Elma crate open:

Rear views of the Dawn crate: