FUZE TEATRO

Acoustic Test Report

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Acoustic measurements for the determination of the sound power level

Elation FUZE Teatro Acoustic Test

Report No. M177342/01

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1 Situation und task

The company Elation Lighting manufactures entertainment lighting products. Recently, a convection-cooled moving light for use in noise sensitive environments has been developed.

The sound power level of the device during operation shall be measured for documentation.

The measurements shall be carried out according to the standards ISO 3744 [1] and ISO 3745 [2].

The results should be summarized in a written report.

2 Standards

[1] Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane (ISO 3744:2010); German version EN ISO 3744:2010

[2] Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Precision methods for anechoic rooms and hemi-anechoic rooms (ISO 3745:2012+Amd 1:2017); German version EN ISO 3745:2012 + A1:201

3 Measurements

3.1 Setup

The measurements were carried out in a semi-anechoic room at the Müller-BBM laboratories. The room has a very low background noise of about 1 dB(A). The device under test was set on the floor in the middle of the room. Then all in all nine microphones were installed at 1 m distance on a box-shaped measurement surface. Figure 1 shows the semi-anechoic measurement room, the device under test FUZE TEATRO and the nine microphone positions.

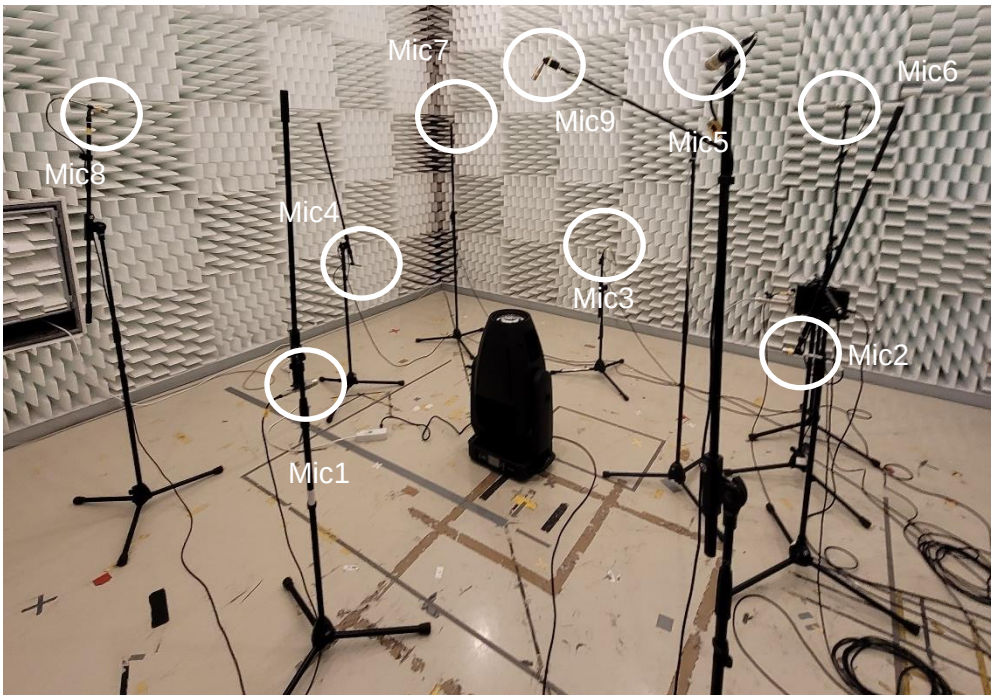


Figure 1. Semi-anechoic measurement room, the device under test (here Elation FUZE TEATRO) and the nine microphone positions.

3.2 Procedure

Date:	2024-04-09
Time:	09:00 – 15:00
Temperature:	24.0 °C
Relative humidity:	34.2 %
Müller-BBM staff:	Otto Martner
Elation staff:	Roger Hamers

The used measurement equipment is listed in Table 1. For each microphone the calibration was checked with an acoustic calibrator before and after the measurement. No significant deviation was found.

Table 1. Measurement equipment.

Name	Description	Manufacturer	Type	Serial No.
Mic 1 to Mic 9	1“ condenser microphone	Brüel & Kjaer	4145	1584867
	Preamplifier	Brüel & Kjaer	2669C	2159784
	1“ condenser microphone	Brüel & Kjaer	4145	1584822
	Preamplifier	Brüel & Kjaer	2669C	2159776
	1“ condenser microphone	Brüel & Kjaer	4145	1223230
	Preamplifier	Brüel & Kjaer	2669C	2159777
	½“ condenser microphone	Brüel & Kjaer	4190	2150422
	Preamplifier	Brüel & Kjaer	2669C	2159778
	1“ condenser microphone	Brüel & Kjaer	4145	633215
	Preamplifier	Brüel & Kjaer	2669C	2159779
	1“ condenser microphone	Brüel & Kjaer	4145	1503339
	Preamplifier	Brüel & Kjaer	2669C	2159780
	1“ condenser microphone	Brüel & Kjaer	4145	415541
	Preamplifier	Brüel & Kjaer	2669C	2159782
	1“ condenser microphone	Brüel & Kjaer	4145	1009422
	Preamplifier	Brüel & Kjaer	2669C	2159783
	1“ condenser microphone	Brüel & Kjaer	4179	2577859
	Preamplifier	Brüel & Kjaer	2660	1540613
	Power supply	Brüel & Kjaer	2807	1620133
Acoustic calibrator	Sound pressure	Brüel & Kjaer	4230	1511269
Multichannel measurement system	Controller	Mecalc	PQ12	0921M2169
	Input card	Mecalc	SC42S G2	0322M5066
	Input card	Mecalc	SC427	1110M1641
	MIC-module	Mecalc	MIC42X7 G2	0222M4357
	MIC-module	Mecalc	MIC42X7 G2	1108M5973
	MIC-module	Mecalc	MIC42X7 G2	0222M4381
	MIC-module	Mecalc	MIC42X7 G2	1122M9701
	MIC-module	Mecalc	MIC42X5	0512M0760
Software	Measurement and evaluation software	Müller-BBM VibroAkustik Systeme GmbH	PAK 6.1	Service Release 1

The device was controlled by Roger Hamers via a control board outside of the measurement room. Also, the acoustic measurements were controlled from outside of the room.

Each action was set for about one minute. The different actions such as LED on/off, Tilt, Pan, Zoom and many more were defined by Elation before the tests.

3.3 Evaluation

In the evaluation the A-weighted sound pressure level L_{Aeq} of all nine measurement positions was energetically averaged. In addition, a correction of the background noise was carried out. For this, the background noise level $L_{Aeq,BGN}$ was energetically subtracted from the averaged sound pressure level $L_{Aeq,m}$:

$$L_{Aeq} = 10 \log (10^{LAeq,m/10} - 10^{LAeq,BGN/10}) \text{ dB}.$$

The A-weighted sound power level L_{WA} was calculated according to [1] with

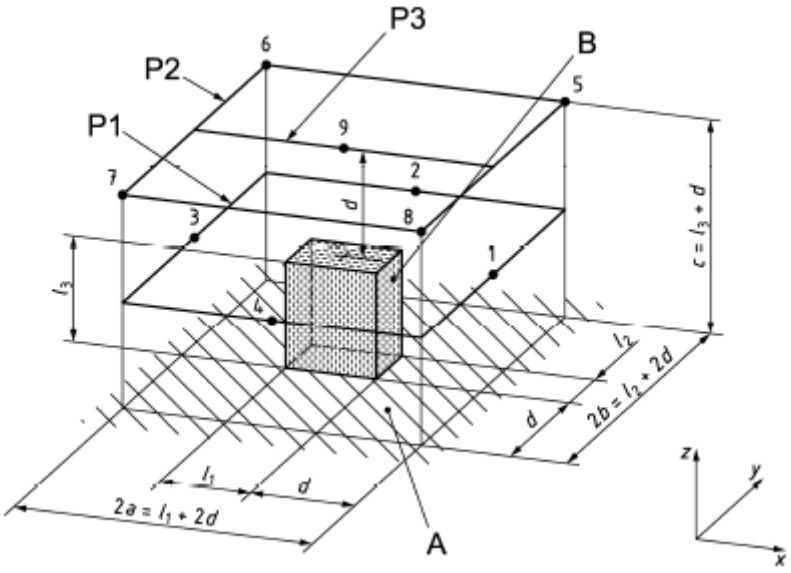
$$L_{WA} = L_{Aeq} + 10 \log (S/S_0) \text{ dB}$$

L_{WA} A-weighted sound power level, dB re 1 pW,

L_{Aeq} energetic average value of the A-weighted sound pressure level at the nine microphone positions, dB re 20 µPa,

S measurement surface, here S = 22.25 m², 10 log (S/S_0) dB = 13.5 dB,

S_0 reference surface, S_0 = 1 m².



Legend:

1 to 9	measurement positions
A	reflecting plane
B	reference cuboid
2*a*	length of the measurement surface
2*b*	width of the measurement surface
c	height of the measurement surface
d	measurement distance, here d = 1 m
l_1	length of the reference cuboid, here l_1 = 0.44 m
l_2	width of the reference cuboid, here l_2 = 0.32 m
l_3	height of the reference cuboid, here l_3 = 0.90 m
P1 to P3	path 1 to path 3

Figure 2. Scheme of the measurement setup with the device under test, the nine microphone positions according to ISO 3744 [1] and the measurement surface.

No additional corrections were considered for

K_1 background noise correction,

K_2 room influence correction,

C_1, C_2 meteorological influence according to temperature and relative humidity

4 FUZE TEATRO – A-weighted sound pressure levels and sound power levels

No	Test Name	Description	Energetic average of A-weighted sound pressure level L_{pAm} (1m distance, 9 microphone positions dB re 20 µPa, incl. background noise correction)		A-weighted sound power level L_{WA}, dB re 1 pW	
			Ultra Quiet Mode	Best Speed	Ultra Quiet Mode	Best Speed
0	Background noise			13		
1	Reset Sequence	Power on fixture and wait till display shows reset completed		32		45
2	LED off	Fixture powered on, All controls idle		-5		9
3	LED 100%	LED 100%, 900 Hz		6		19
4	LED 100%	LED 100%, 15 kHz		-1		13
5	LED 50%	LED 50%, 900 Hz		19		33
6	LED 50%	LED 50%, 15 kHz		5		19
7	LED 10%	LED 10%, 900 Hz		15		29
8	LED 10%	LED 10%, 15 kHz		3		16
9	Pan	-90° to +90°, 3 sec fades. LED off	15	15	29	29
10	Tilt	-135° (head down) to 0° (head straight up), 3 sec fades, LED off	29	31	43	45
11	Zoom Slow	0-100% Zoom, 5s fades, LED off	28	29	42	43
12	Zoom Fast	0-100% Zoom, 0s bumps, LED off	33	41	47	54
13	Focus	0-100% Focus Lens, 0s fades, LED off	29	39	43	53
14	Gobo Rotation	100% CW Rotation Gobo, LED on	23	29	36	43
15	Gobo Wheel Spin	100% Gobo Wheel 1 Spin, LED on	30	34	43	48
16	Iris	Continuous Iris 0-100%, 0s fades	19	24	32	38
17	Frost	Continuous Frost 0-100%, 0s fades	19	21	32	34
18	Prism	Prism 100% CW Rotation, LED on	22	28	36	41
19	Framing Slow	Continuous Framing Moves, 2s fades, LED on	16	18	29	31
20	Framing Fast	Continuous Framing Moves, 1s fades, LED on	18	18	31	31
21	All functions Slow	Continuous move of all functions, 5s fades, LED on	31	32	44	45
22	All functions Fast	Continuous move of all functions, 1s fades, LED on	33	41	46	55

Figure 3. A-weighted sound pressure and sound power levels during various operation conditions of the tested FUZE TEATRO device. Note: Sound pressure levels below 20 dB(A) are in general inaudible under real conditions.

5 Conclusion

Sound pressure levels on a surface at 1 m distance to the device under test were carried out. Level values were found in the range of the background noise with 13 dB(A) up to 41 dB(A) during the Fast Zoom Sequence.

The noise emission for the 15 kHz control frequency shows much lower values than the 900 Hz control frequency.

In the Ultra Quiet Mode the noise emission can be reduced by up to 10 dB compared to the Normal Mode.

Some of the tested configurations show sound pressure levels below 20 dB(A). These low levels are supposed to be inaudible under normal conditions in a theatre or concert hall.

The sound power level values can be used for the prediction of the sound pressure distribution in rooms based on simulations and calculation models.

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