Test Certificate

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Determination of sound power levels of a noise source using sound pressure with guidance from BS EN ISO 3745

COMPANY NAME & ADDRESS:	Silentair Limited Unit 4, Hanson Lane Enterprise Centre Hanson Lane Halifax HX1 5PG
FOR ATTENTION OF:	Phil Gillat
DESCRIPTION:	Air Conditioning Unit with refrigerant supply / unit attached and running
DIMENSIONS:	31 cm high x 71 cm wide x 131 cm deep
MANUFACTURER:	Silentair
MODEL:	Prototype
SERIAL NUMBER:	-
MODE OF OPERATION:	Low and Max fan settings
YEAR OF MANUFACTURE:	2011
DATE OF TEST:	7 and 10 October 2011

Test Engineer (initial): ..... Name: James Massaglia .....

1 ACOUSTIC ENVIRONMENT AND SOURCE MOUNTING

The source was installed by Silentair Limited in the anechoic chamber at the University of Salford. The source was suspended from the ceiling on chains in the centre of the chamber to replicate its location in practice. The source was connected to the refrigerant unit that was located outside the chamber, by copper tubing which supplied the refrigerant to the unit. 14 vents were connected to the unit and the outlets were present in the chamber (see pictures in Appendix 1 of this report).

The source was powered by standard 230 volt mains power inside the chamber. The refrigerant unit was supplied by 32 Amp single phase power supply located outside the chamber.

2 INSTRUMENTATION

The tests were carried out using the instrumentation below which are traceable to National Standards:-

Type	Manufacturer	Model	Serial Number
Low Noise Microphone	B&K	4179 & associated preamplifier, 2660	2549740
Measuring amplifier	B&K	2610	863718
Analyser	B&K	PULSE	2694924
Calibrator (94dB, 1kHz)	B&K	4231	2393938

No windscreen was used during this test. The 4179 microphone preamplifier was set to '4179 + 20dB'.

The system was calibrated at the start and end of the test with the B&K 4231 calibrator to ensure recorded levels matched the level on the calibrator's current external calibration certificate.

3 DEFINITION OF THE MEASUREMENT SURFACE

A hypothetical reference surface was defined that enveloped the main air conditioning unit under test, excluding the protruding vents. The spherical surface was defined to surround the unit at the largest distance possible from the unit. The radius of the sphere, *d = 1.4m.*

4 MICROPHONE POSITIONS AND ORIENTATION

Ten measurement positions were defined for the measurement. The measurement positions were selected with guidance from BS EN ISO 3745: 2009, and were positioned on the measurement sphere defined above, either in the plane that passed through the horizontal centre of the unit, or in the plane 30 degrees below the centre of the unit. Diagrams showing measurement positions are included in Appendix 2 of this report. Measurements were carried out on only one side of the unit as earlier measurements demonstrated the symmetrical nature of the sound source.

5 ACOUSTICAL DATA

The octave band sound power levels of the source, corrected for background noise and environmental conditions, are provided in the table below:-

Octave Band Centre Frequency, Hz	Unit Setting: Low	Unit Setting: Max
63	41.8	47.2
125	41.3	45.6
250	33.4	39.6
500	28.8	35.6
1000	24.6	33.9
2000	17.1	25.0
4000*	19.4	18.6
8000*	28.8	30.5

The measured sound pressure levels corrected for background noise, L_{pi} at each measurement point, the average surface sound pressure levels, L_{pf}, and the sound power level, L_w of the source in each octave frequency band are given in Appendix 3 of this report.

*Levels at 4kHz and 8kHz are affected by background levels, and therefore levels quoted represent an upper limit for the sound pressure levels of the noise source.

6 ADDITIONAL REQUESTED DATA

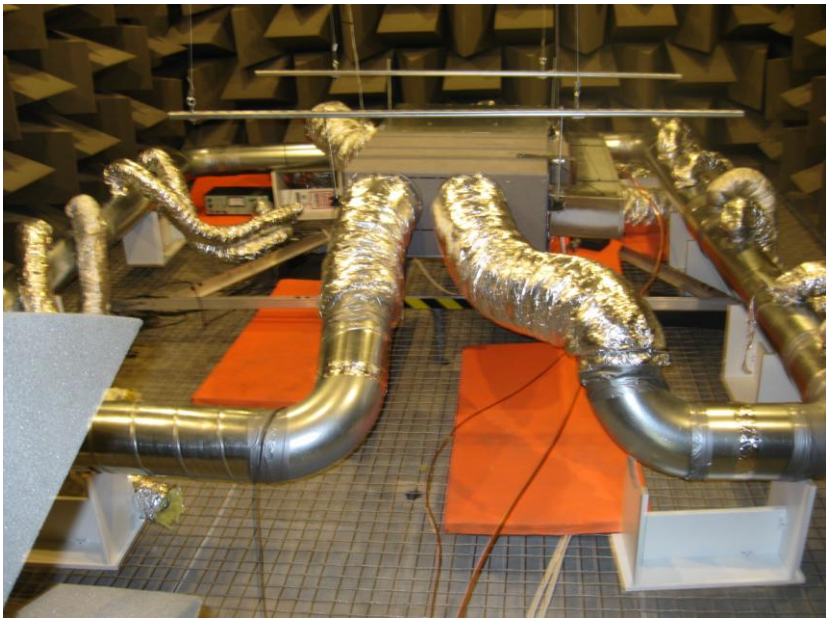
L_{pf} values calculated from the sound power values at 1m, 2m and 5m from the surface of the source are included in the tables in Appendix 3.

Appendix 4 of this report compares the sound emitted from the source to NR15 and NR20 curves.

Appendix 5 of this report provides plots of the time history of the sound pressure levels during change over of the unit between cooling and heating.

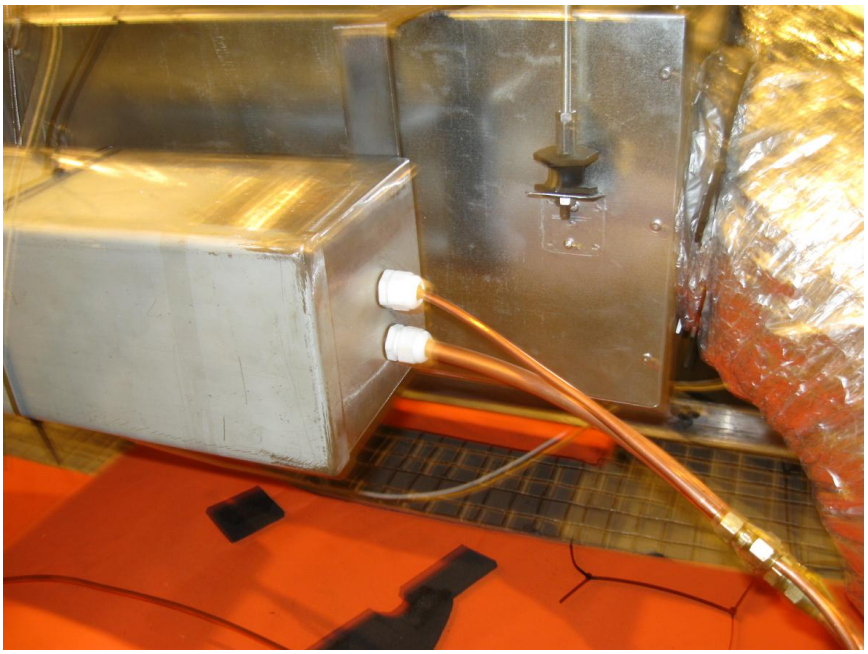
Appendix 6 of this report provides the differences in the sound pressure levels recorded with the unit side cover in place and removed.

Appendix 1 – Installation Photographs



Unit in situ in chamber with all ducting and vents installed.

Ducts entering unit at rear.



Refrigerant coupled to unit via copper pipes

Appendix 2 – Diagrams showing measurement positions

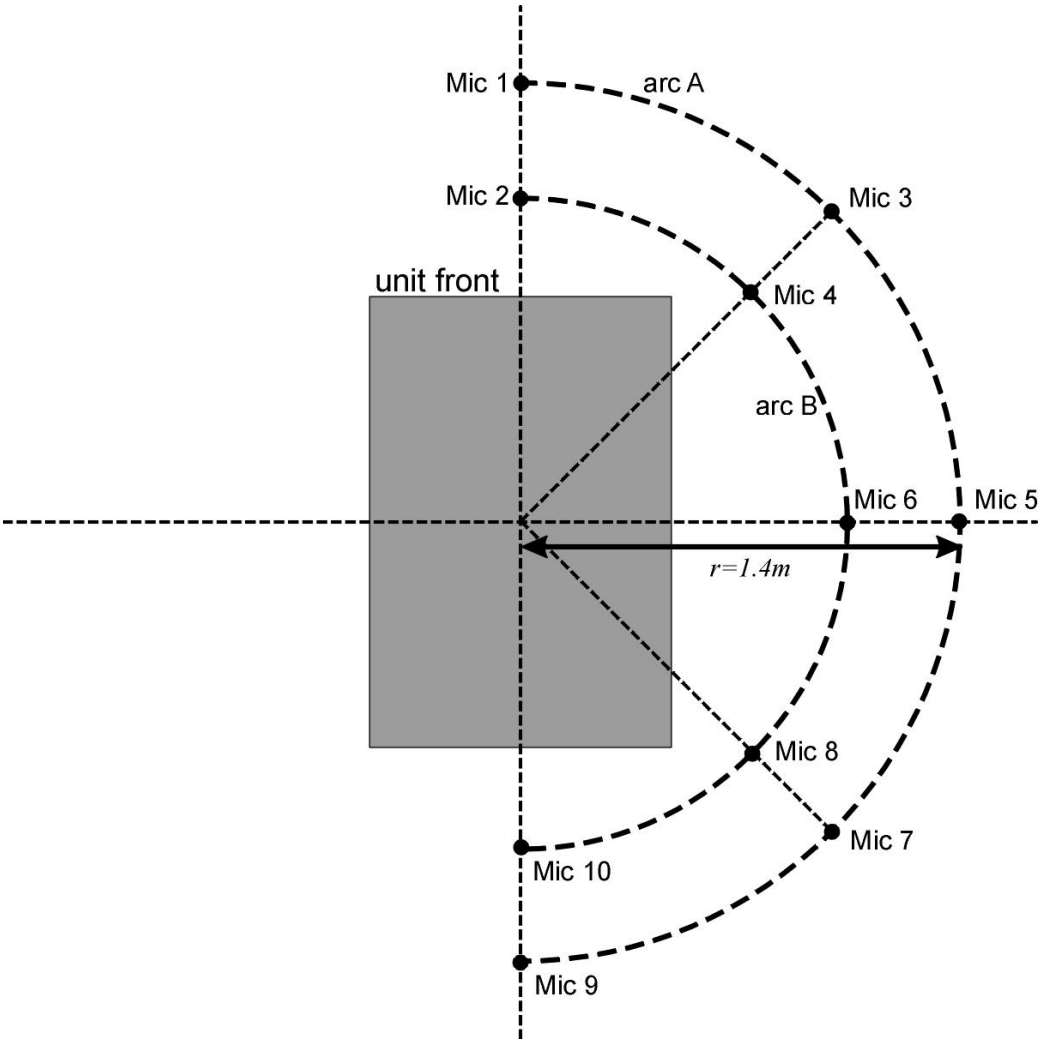


Figure A2.1 – Horizontal View

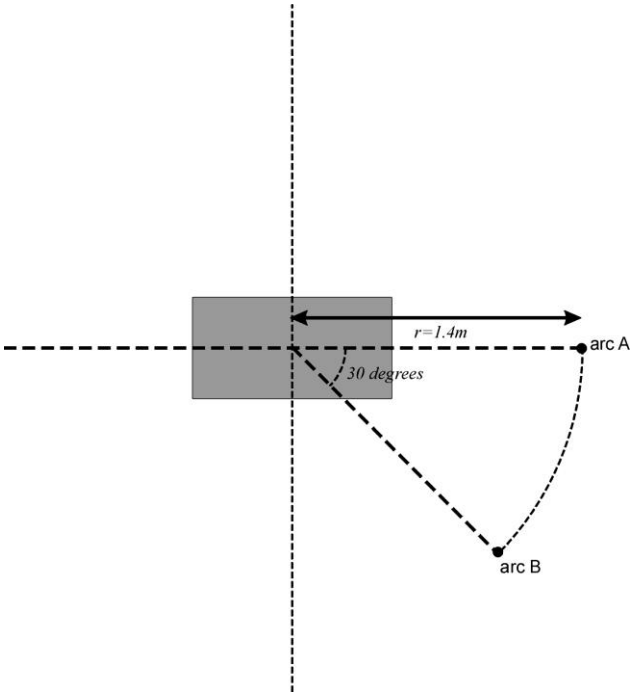


Figure A2.2 – Vertical View

Appendix 3 – Acoustical Data

The following data is included in each table below in each third octave frequency bands:-

- measured sound pressure level at each microphone position (at 1.4m from the source) corrected for background noise, L_{pi} (dB re 20μPa)
- average measured sound pressure level over measurement surface (at 1.4m from source) corrected for background noise, L_{pf} (dB re 20μPa)
- average sound power level corrected for environmental conditions, L_w (dB re 1pW)
- average surface sound pressure level at 1m from the source, $L_{pf\,(1m)}$ (dB re 20μPa)
- average surface sound pressure level at 1m from the source, $L_{pf\,(2m)}$ (dB re 20μPa)
- average surface sound pressure level at 1m from the source, $L_{pf\,(5m)}$ (dB re 20μPa)

Table A3-1 – Acoustical Data for sound power measurements (Low Setting)

Freq, Hz	L_{p1}	L_{p2}	L_{p3}	L_{p4}	L_{p5}	L_{p6}	L_{p7}	L_{p8}	L_{p9}	L_{p10}	$L_{pf\,(1.4m)}$	L_W	$L_{pf\,(1m)}$	$L_{pf\,(2m)}$	$L_{pf\,(5m)}$
63	31.4	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5	32.7	28.3	41.8	25.2	20.5	13.4
125	30.5	28.2	28.9	27.4	26.4	23.5	27.7	27.3	24.6	29.2	27.8	41.3	24.7	19.9	12.9
250	20.9	20.2	21.8	21.2	19.7	15.9	19.5	19.6	17.8	19.6	19.9	33.4	16.8	12.0	4.9
500	14.6	14.1	17.5	12.8	13.5	11.3	14.0	13.7	12.9	20.4	15.3	28.8	12.2	7.5	0.4
1000	8.4	10.5	12.1	9.8	12.8	10.9	11.0	11.4	11.8	10.8	11.1	24.6	8.0	3.2	-3.8
2000	1.8	5.1	5.5	3.4	3.1	2.0	3.0	3.3	2.0	4.7	3.6	17.1	0.5	-4.3	-11.4
4000*	3.7	4.9	6.8	6.6	6.9	3.5	8.6	4.9	3.9	6.1	5.9	19.4	2.8	-2.0	-9.0
8000*	9.0	21.2	21.3	8.5	10.3	10.2	9.4	9.6	10.3	8.8	15.3	28.8	12.2	7.4	0.4

Table A3-2 – Acoustical Data for sound power measurements (Max Setting)

Freq, Hz	L_{p1}	L_{p2}	L_{p3}	L_{p4}	L_{p5}	L_{p6}	L_{p7}	L_{p8}	L_{p9}	L_{p10}	$L_{pf\,(1.4m)}$	L_W	$L_{pf\,(1m)}$	$L_{pf\,(2m)}$	$L_{pf\,(5m)}$
63	36.1	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	36.9	33.7	47.2	30.6	25.9	18.8
125	35.2	31.8	33.8	31.8	27.7	26.1	28.3	30.4	30.0	35.8	32.1	45.6	29.0	24.3	17.2
250	28.2	26.3	27.8	27.2	22.8	23.4	24.6	24.6	24.5	27.7	26.1	39.6	23.0	18.2	11.2
500	23.0	21.2	23.9	21.6	21.9	19.8	21.8	20.1	21.5	24.2	22.1	35.6	19.0	14.3	7.2
1000	19.2	19.0	21.6	19.9	22.7	19.3	19.5	19.2	20.2	21.7	20.4	33.9	17.3	12.5	5.5
2000	10.0	10.6	12.8	10.0	12.7	10.6	10.9	10.0	12.8	13.1	11.5	25.0	8.4	3.7	-3.4
4000*	3.7	4.9	6.8	2.9	6.8	4.7	4.4	5.5	3.2	6.5	5.2	18.6	2.0	-2.7	-9.8
8000*	8.9	21.3	21.4	9.0	9.8	12.5	12.5	12.4	12.5	21.1	17.0	30.5	13.9	9.1	2.0

*Levels at 4kHz and 8kHz are affected by background levels, and therefore levels quoted represent an upper limit for the sound pressure levels of the noise source.

Appendix 4 – Comparison with Noise Reduction Curves

Figure A4.1 - the measured noise compared with NR15 and NR20 curves for Max setting

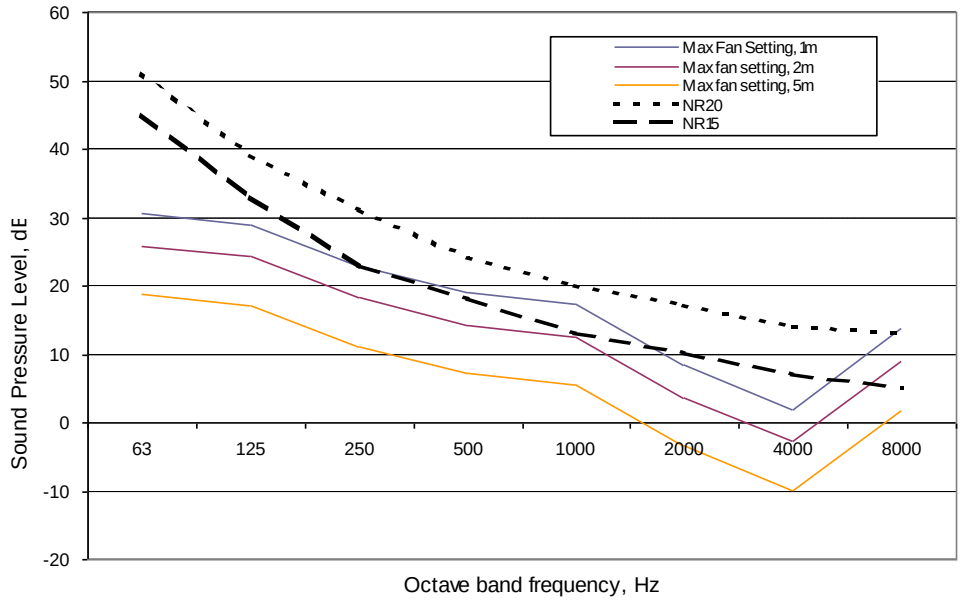
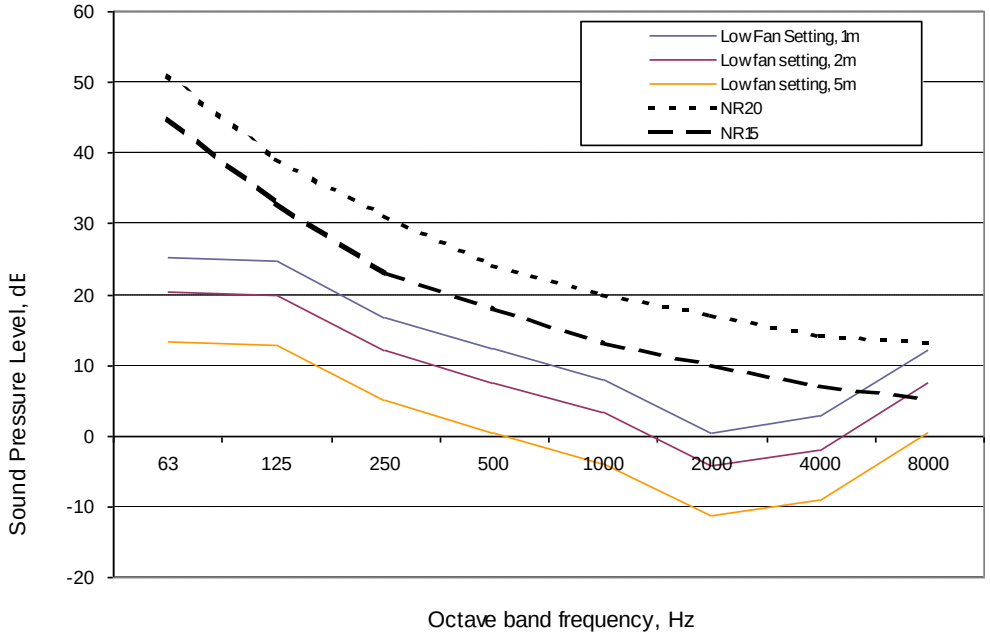
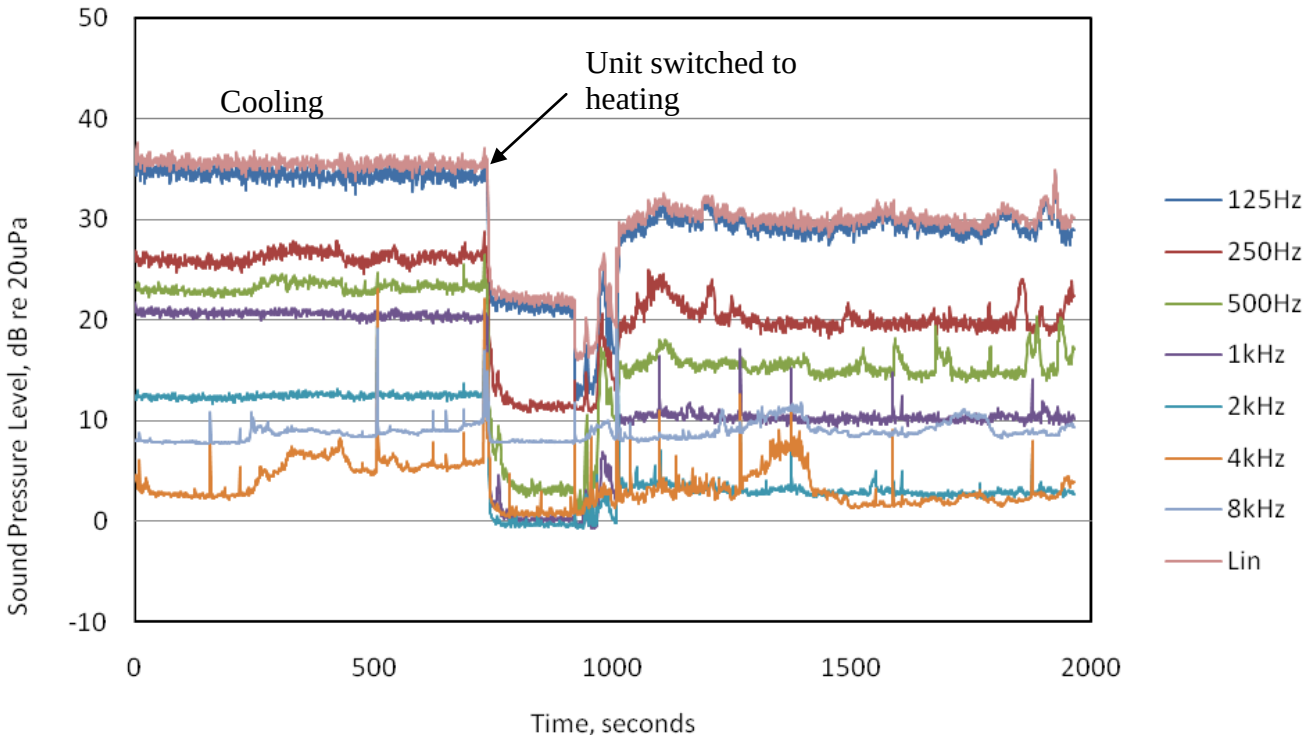


Figure A4.2 - the measured noise compared with NR15 and NR20 curves for Low setting



*Levels at 4kHz and 8kHz are affected by background levels, and therefore levels quoted represent an upper limit for the sound pressure levels of the noise source.

Appendix 5 – Time history with unit set to cooling and then switched to heating. Unit set on Max setting.



Appendix 6 – Comparison between the sound pressure levels recorded with the unit side cover in place and removed

All the measurements presented in this report were taken with the side cover of the unit in place. Three additional measurements were carried out at microphone positions 5, 6, and 7 (which represent the positions closest to the side cover) at the Max setting with the side cover removed. The average difference between the levels with the side cover in place / removed at these positions are presented in table A6.1 below.

Table A6.1

Octave Band Centre Frequency, Hz	Average difference in Sound Pressure Level, dB
63	0.0
125	0.1
250	-1.7
500	-0.8
1000	0.0
2000	0.8
4000	-0.4
8000	1.6