

Optimus Sound Level Meters User Manual

Part B Technical Information



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This manual should be used in conjunction with the document titled “**User Manual for the optimus sound level meters**”.

This manual refers to optimus sound level meters fitted with firmware version 2.3 or later.

The following table lists sections and tables in this manual where information required by specific sections of IEC 61672-1 2002 can be found.

In certain instances the requested information is not applicable, as noted in the Comments column.

All tabular correction data in this manual is available in electronic spread sheet format on request from Cirrus Research plc. See Page 38 for contact details or visit www.cirrusresearch.co.uk/library/optimus

IEC 61672-1 2002 Section 5		
Section	Reference	Comments
5.1.3	See “User manual for the optimus sound level meters”, page 30	
5.1.4	See “User manual for the optimus sound level meters”, page 10	
5.1.6	See “User manual for the optimus sound level meters”, pages 30 and 10	
5.1.7	See “User manual for the optimus sound level meters”, page 10	
5.1.8		Computer software is not a part of the Sound Level Meter
5.1.10	See “User manual for the optimus sound level meters”, page 31	
5.1.12		The optimus sound level meters have a single measurement range
5.1.13	See sections 9.3a and 9.3b – Pages 20 and 20	
5.1.14	See section 5.1.14 - Page 8	
5.1.15	See section 9.3g – Page 21	
5.1.16	See section 5.1.16 – Page 8 & section 9.3 i – Page 22	
5.1.17		The optimus sound level meters are single-channel instruments.
5.1.18	See section 5.1.18 – Page 8	
5.2.1	See “User manual for the optimus sound level meters”, page 39	
5.2.3	See “User manual for the optimus sound level meters”, page 42, and for general guidance on calibration, page 39.	The microphone should be checked if the calibration offset deviates by more than 1 dB from the previous calibration.
5.2.4	See Appendix 1 – Optimus correction data – Page 24	
5.2.5	See Appendix 1 – Optimus correction data – Page 24	
5.2.7	See section 9.3d – Page 20	
5.2.8	See section 9.3d – Page 20	

5.4.12	See section 9.2.2c – Page 15	There are no optional frequency responses.
5.5.9	See section 9.3e – Page 20	
5.5.10	See section 9.3e – Page 20	
5.5.11	See section 9.3k – Page 22	
5.6.2	See section 9.3h – Page 21	
5.6.3	See section 9.3h – Page 21	
5.6.4	See section 9.3h – Page 21	
5.6.5		No special procedures are required for measuring noise levels close to the noise floor.
5.7.1	See "User manual for the optimus sound level meters", page 31, and Section 9.2.2d – Page 16	
5.10.1	See "User manual for the optimus sound level meters", page 19	
5.11.1	See section 5.11.1 – Page 8	
5.12.1	See section 9.2.2 i – Page 16	
5.13.1	See "User manual for the optimus sound level meters", page 26	
5.14.1	See section 5.14.1 – Page 9	
5.15.2	See "User manual for the optimus sound level meters", page 18	
5.15.3	See "User manual for the optimus sound level meters", Page18	
5.15.4	See "User manual for the optimus sound level meters", page 18	
5.15.5	See section 5.15.5 – Page 9	
5.15.6	See section 5.15.6 – Page 9	
5.15.7	See "User manual for the optimus sound level meters", page 16	
5.15.8		The optimus sound level meters use no alternative display devices
5.16.1	See section 5.16.1 – Page 9	
5.17.1	See "User manual for the optimus sound level meters", page 28	
5.17.1 Note 2	See section 5.17.1 Note 2 – Page 10	
5.17.2	See section 5.17.2 – Page 10	
5.18.1	See section 5.18.1 – Page 10	
5.18.2	See section 9.3n – Page 22	
5.20.2	See section 9.3j – Page 22	
5.20.3	See "User manual for the optimus sound level meters", page 31	
5.20.4	See "User manual for the optimus sound level meters", page 17	
IEC 61672-1 2002 Section 6		
Section	Reference	Comments
6.1.2	See section 9.3 l – Page 22	
6.2.2	See "User manual for the optimus sound level meters", page 13, and Section 6.2.2 – Page 11	
6.5.2	See section 6.5.2 – Page 11	

6.6.1	See section 9.3o – Page 22	
6.6.3	See section 9.3o – Page 22	
6.6.9	See section 9.3o – Page 22	
IEC 61672-1 2002 Section 7		
Section	Reference	Comments
7.1	See section 5.18.1 – Page 10	
7.2	See Appendix 1 – Optimus correction data – Page 24	The UA:237 90mm diameter windshield is the only relevant accessory.
7.4	See “User manual for the optimus sound level meters”, page 32	
IEC 61672-1 2002 Section 9		
9.2.1a	See “User manual for the optimus sound level meters”, page 30	
9.2.1b	See “User manual for the optimus sound level meters”, page 10	
9.2.1c	See “User manual for the optimus sound level meters”, page 30	
9.2.2a	See “User manual for the optimus sound level meters”, page 32	
9.2.2b	See section 9.2.2b – Page 11	
9.2.2c	See section 9.2.2c – Page 15, and “User manual for the optimus sound level meters”, page 31	A-, C- and Z-weightings are provided, and are measured simultaneously.
9.2.2d	See section 9.2.2d – Page 16, and “User manual for the optimus sound level meters”, page 31	Fast, Slow and Impulse are provided, and are measured simultaneously.
9.2.2e		The Optimus has no level range controls.
9.2.2g	See “User manual for the optimus sound level meters”, page 18, and Section 5.15.5 – Page 9	
9.2.2h	See “User manual for the optimus sound level meters”, page 30	
9.2.2i	See section 9.2.2i – Page 16	
9.2.2j		Computer software is not part of the optimus sound level meters.
9.2.2k	See “User manual for the optimus sound level meters”, page 30	
9.2.3a	See “User manual for the optimus sound level meters”, page 31	
9.2.3b	See “User manual for the optimus sound level meters”, page 20	
9.2.3c	See “User manual for the optimus sound level meters”, page 17	
9.2.4a	See “User manual for the optimus sound level meters”, page 39	The following acoustic calibrators may be used with Optimus meters: Class 1: CR:515 Class 2: CR:514
9.2.4b	See “User manual for the optimus	The calibration check frequency is

	sound level meters”, page 41	1 kHz.
9.2.4c	See “User manual for the optimus sound level meters”, page 13	Optimus will accept a new acoustic calibration offset if the level is stable and the new offset is in the range ± 1.5 dB.
9.2.4d	See section 9.2.4d – Page 17	
9.2.5a	See section 9.2.5a – Page 19	
9.2.5b	See section 9.2.5b – Page 19	
9.2.5d	See section 9.3h – Page 21	
9.2.5e	See section 5.1.18 – Page 8	
9.2.5f	See section 5.16.6 – Page 9	
9.2.5i	See section 5.1.14 – Page 8	
9.2.5j	See section 5.1.14 – Page 8	
9.2.5k	See section 5.1.14 – Page 8, 5.10.1 – Page 8, 5.11.1 – Page 8, and “User manual for the optimus sound level meters”, page 19	
9.2.5l	See section 5.14.1 – Page 9	
9.2.5m	See “User manual for the optimus sound level meters”, page 16	
9.2.5n	See section 5.18.1 – Page 10	
9.2.5o	See section 9.2.5o – Page 20	
9.2.5p	See section 5.16.1 – Page 9	
9.2.6a	See Appendix 1 – Optimus correction data – Page 24	
9.2.6b		No correction is required for standard microphone extension cables.
9.2.6c	See “User manual for the optimus sound level meters”, page 32	
9.2.6d	See section 5.18.1 – Page 10	
9.2.7a		No components of the optimus are intended to be operated only in an environmentally controlled enclosure.
9.2.7b	See section 6.5.2 – Page 10	
9.2.7c	See “User manual for the optimus sound level meters”, page 43, and section 9.2.7c – Page 20	
9.3a	See section 9.3a – Page 20	
9.3b	See section 9.3b – Page 20	
9.3c	See section 9.3c – Page 20	
9.3d	See section 9.3d – Page 20	
9.3e	See section 9.3e – Page 20	
9.3f	See section 9.3f – Page 21	
9.3g	See section 9.3g – Page 21	
9.3h	See section 9.3h – Page 21	
9.3i	See section 9.3i – Page 22	
9.3j	See section 9.3j – Page 22	
9.3k	See section 9.3k – Page 22	
9.3l	See section 9.3l – Page 22	
9.3m	See section 9.3m – Page 22	
9.3n	See section 9.3n – Page 22	
9.3o	See section 9.3o – Page 22	

Section 5

5.1.14 Description of 'start', 'stop' and 'reset' functions

These functions control the measurement of LxyMax, LxyMin, Lxeq,t and LxPeak.

'Start' is on the left-hand softkey while the instrument is not yet running a measurement.

'Stop' is available while a measurement is in progress. If Pause Mode is enabled (via the Advanced Menu) hold the right-hand softkey for four seconds then release it, or press it briefly to enter Pause Mode then press it again to stop. The Stop function stores the measurement, suspends accumulation of data then clears the latching overload indicator.

'Reset' is available from the Main Menu: while a measurement is in progress press the centre 'Menu' softkey then select the upper left-hand 'Reset' icon. The Reset function clears all accumulated data and clears the latching overload indicator.

Note that the term 'Hold' means the storage and display of the highest (or lowest) value of a given data type during a measurement period. LMax and LPeak hold the highest value; LMin holds the lowest.

5.1.15 Electrical testing method

Electrical testing is done by removing the microphone capsule by unscrewing it from the top of the preamplifier, and replacing it with a standard 1/2" 60UNS threaded dummy microphone of series capacitance 18 pF (± 2 pF) fed from a signal source of impedance 50 Ω .

The Cirrus Research dummy microphone type KP:66 is recommended. The KP:66 has a standard BNC input socket and capacitance 18 pF.

Other types of dummy microphone may be used, but please take care that the device has a capacitance of 18 pF (± 2 pF).

The input sensitivity is nominally 50 mV/Pa (i.e. a signal of 50 mV_{RMS} at a suitable frequency produces a sound level reading of 94 dB).

Note that the exact sensitivity varies depending on the specific microphone capsule with which the instrument has been calibrated.

All microphone types fitted to the Optimus range share the same electrical substitution method and characteristics.

5.1.16 Highest Sound Pressure Level

Maximum permissible sound pressure level for all microphone types fitted to the Optimus range is 160 dB.

Maximum input voltage at the input to the dummy microphone is 100 V_{pk-pk}.

5.1.18 Start up period

After being switched on, the Optimus is ready to make measurements as soon as the display shows its normal operating view and the date and time are shown in the footer bar (i.e. after the initial boot-up sequence has completed).

This is typically between 5 and 15 seconds after switching on.

5.10.1 Overload indication

Overload is indicated by the word 'overload' (in the chosen language) on the display. On the Sound Level View and Leq View the overload indicator is situated beneath and to the left of the large number.

When a measurement is NOT in progress, the overload indicator is shown for at least 1 second, so that very short transient overload conditions are visible to the operator.

When a measurement IS in progress, the overload indicator stays on until the measurement is stopped or reset.

In some circumstances the overload and underrange indicators will be shown simultaneously. In this case the text will be abbreviated to save space.

The overload indicator can also shown when measurements are recalled from memory in Recall Mode.

5.11.1 Under-range indication

Under-range is indicated by the word 'underrange' (in the chosen language) on the display. On the Sound Level View and Leq View the overload indicator is situated beneath and to the left of the large number.

The under-range indicator is shown for at least 1 second, so that very short transient under-range conditions are visible to the operator.

Under-range is indicated on the Sound Level View and Leq View. The level below which under-range is displayed depends on the frequency weighting shown for the 'big number' on the selected display page:

A-weighting – less than 20.0 dB

C-weighting – less than 35.0 dB

Z-weighting – less than 45.0 dB

In some circumstances the overload and underrange indicators will be shown simultaneously. In this case the text will be abbreviated to save space.

Note that if any displayed decibel value on the Sound Level View or Leq View is below 14.0dB, the value will be replaced by dashes ('---'). These levels are typically below the noise floor of the microphone capsule and so will only be encountered during electrical testing.

5.14.1 User adjustable thresholds

There are no user adjustable thresholds in the Optimus sound level meter, within the scope of IEC 61672-1 2002.

Note: some models include the Dose View, which features adjustable thresholds. These functions conform to IEC 61252 – Personal Sound Exposure Meters.

5.15.5 Display update rate

The display update rate for numerical values is 0.5 seconds for SPL functions and 1 second for Leq functions.

5.15.6 Integration method

The optimus sound level meters display a valid integrated noise level within 2 seconds of the start of a measurement.

5.16.1 Electrical output specifications

AC output is provided for testing purposes only. No electrical outputs are within the scope of IEC 61672:1 2002.

AC output is provided on Pin 4 of the 18-way utility connector (with Ground on Pin 1), and on the tip of the 2.5mm stereo jack connector (with Ground on the outer ring).

The AC output is a buffered amplifier capable of driving loads down to 32 Ω .

The highest maximum output voltage before clipping is 1.7 V_{pk-pk}.

The maximum output power is 35 mW, and short circuit AC current will not exceed 100 mA.

The AC output is terminated internally with a series capacitor of 100 μF that is discharged to ground via 1 $\text{M}\Omega$.

External equipment connected to the AC output should have a load resistance of 100 $\text{k}\Omega$ or greater, and must not have a significant capacitive component.

The AC output has four user-selectable gain settings available via the "Advanced, AC out" Menu: High / Low levels, and +20dB amplifier On/Off.

Voltages and full scale levels are as follows:

High Levels (70-140dB)

0 dB gain: 1.3 $V_{\text{pk-pk}}$ (450 mV_{RMS}) at full scale 140 dB
+20 dB gain: 1.7 $V_{\text{pk-pk}}$ (600 mV_{RMS}) at full scale 132 dB

Low Levels (20-90dB)

0 dB gain: 400 $\text{mV}_{\text{pk-pk}}$ (140 mV_{RMS}) at full scale 90 dB
+20 dB gain: 1.3 $V_{\text{pk-pk}}$ (450 mV_{RMS}) at full scale 90 dB

The ring on the stereo jack socket is configured as a digital input. It is connected internally to +3V3 via a 1 $\text{M}\Omega$ resistor. This input is not used on the Optimus.

5.17.1 NOTE 2

Real-time clock drift is ± 2 seconds per day at temperatures between 20 and 25°C.

5.17.2 Minimum & Maximum Integration Times

The minimum integration time for manual measurements is 5 seconds.

The integration time ranges from 1 minute up to 240 hours in "Timer" mode, and from 5 seconds up to 30 days in manual mode (depending on instrument capabilities and storage settings).

5.18.1 Microphone Extension Cables

The ZL:205 is the standard microphone extension cable, with length 5m.

Section 6

6.2.2 Static Pressure

The MK:224 microphone capsule has a static (barometric) pressure coefficient of -0.0066 dB/kPa. This corresponds to a change of -0.28dB between 108 kPa and 65 kPa. The CR:515 acoustic calibrator uses internal static pressure compensation to keep its output sound level within specified tolerance limits between 108 kPa and 65 kPa static pressure. Therefore no additional correction by the operator is necessary.

6.5.2 Electrostatic discharge

The instrument does not suffer permanent degradation or loss of functions after electrostatic discharges of up to ± 4 kV by contact or ± 8 kV by air discharge. Temporary loss of function may result: the instrument may restart.

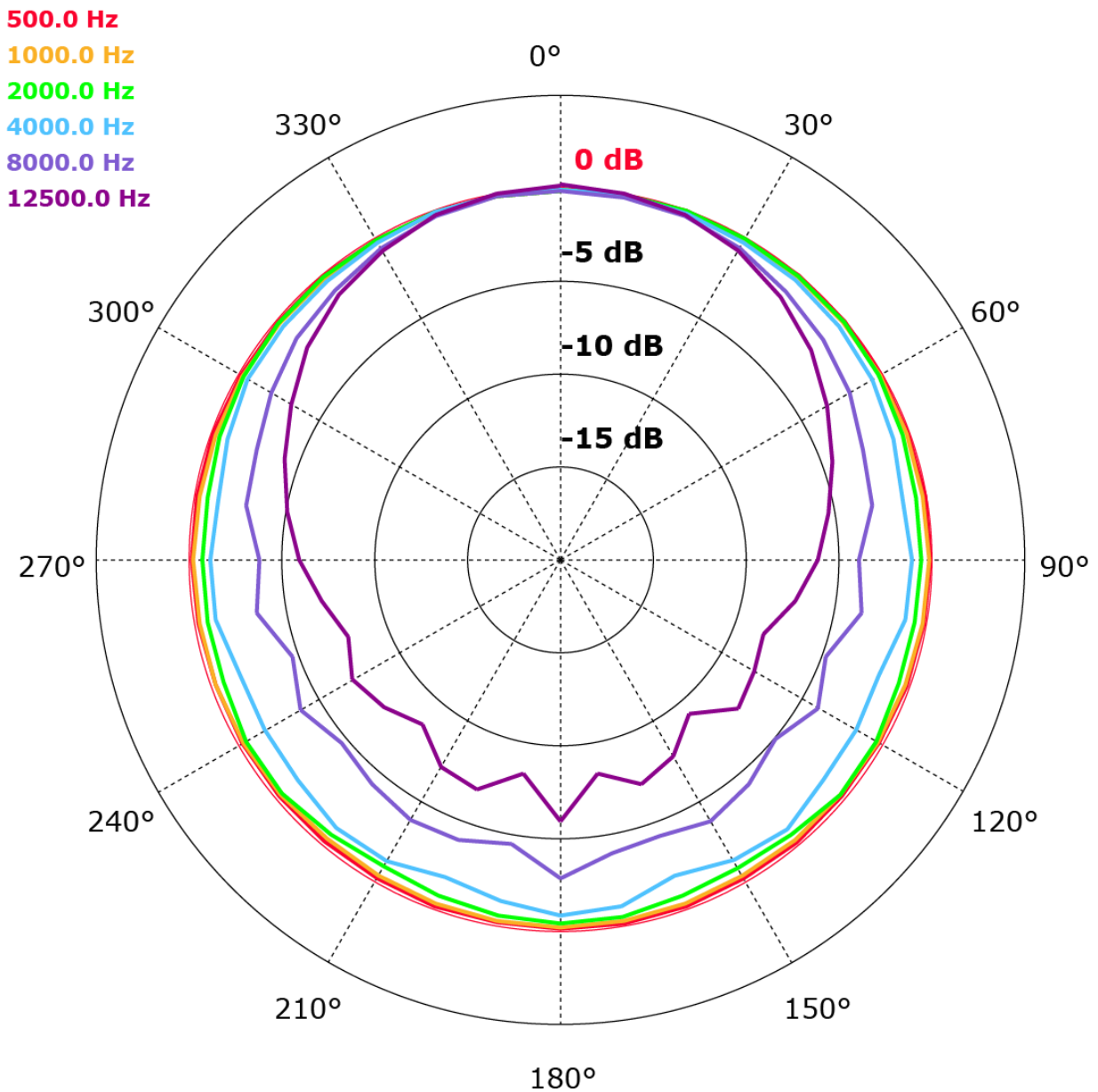
Section 9

9.2.2 b – Directional response

The following polar charts are provided for illustrative purposes. For tabular data please see "Appendix – Optimus adjustment data", page 24.

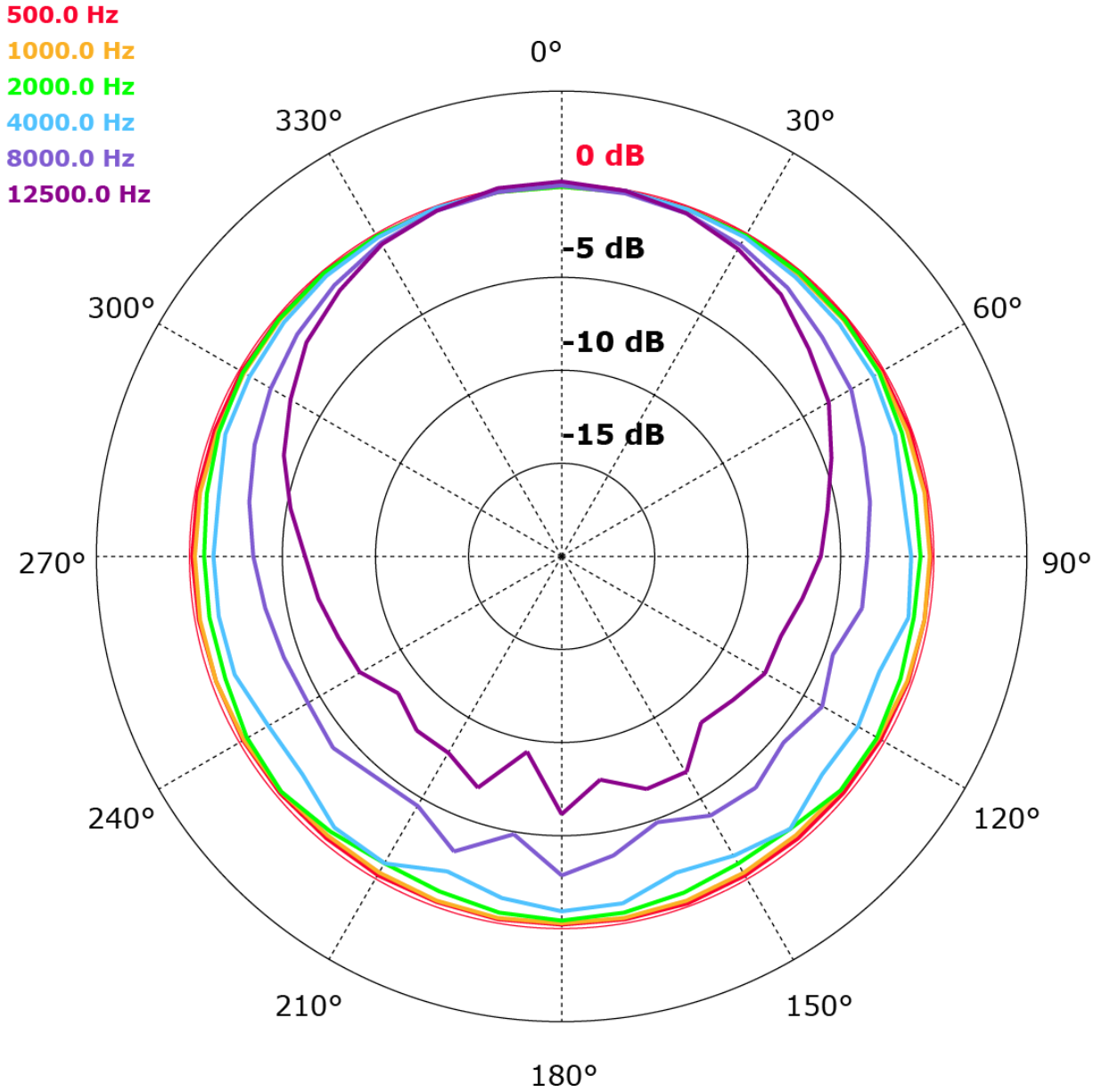
Responses of Optimus with typical MK:224 microphone capsule – influences of microphone frequency response, reflections and diffraction

Incidence direction – plane parallel to instrument display screen (horizontal)



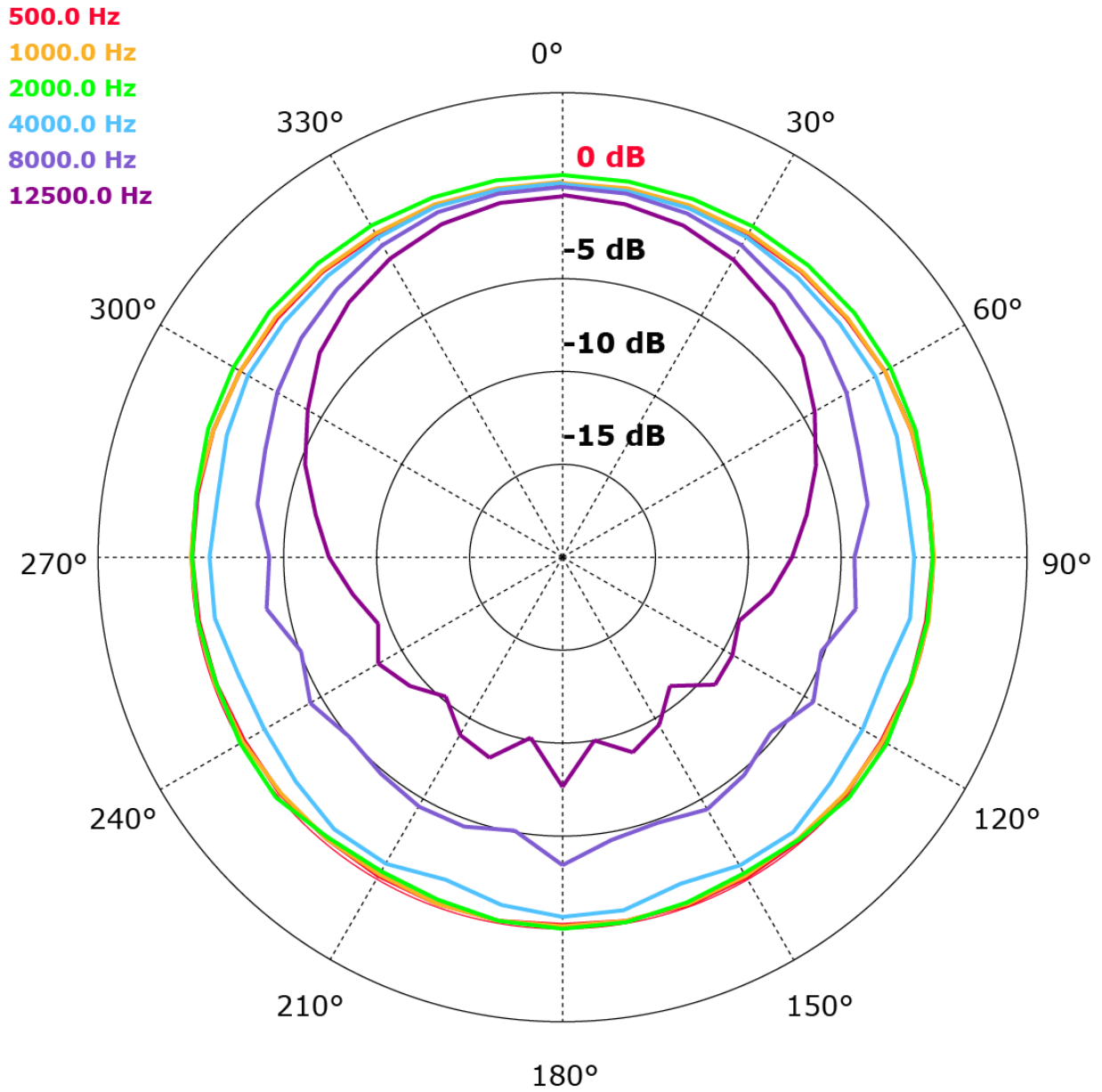
Responses of Optimus with typical MK:224 microphone capsule – influences of microphone frequency response, reflections and diffraction

Incidence direction – plane perpendicular to instrument display screen (vertical)



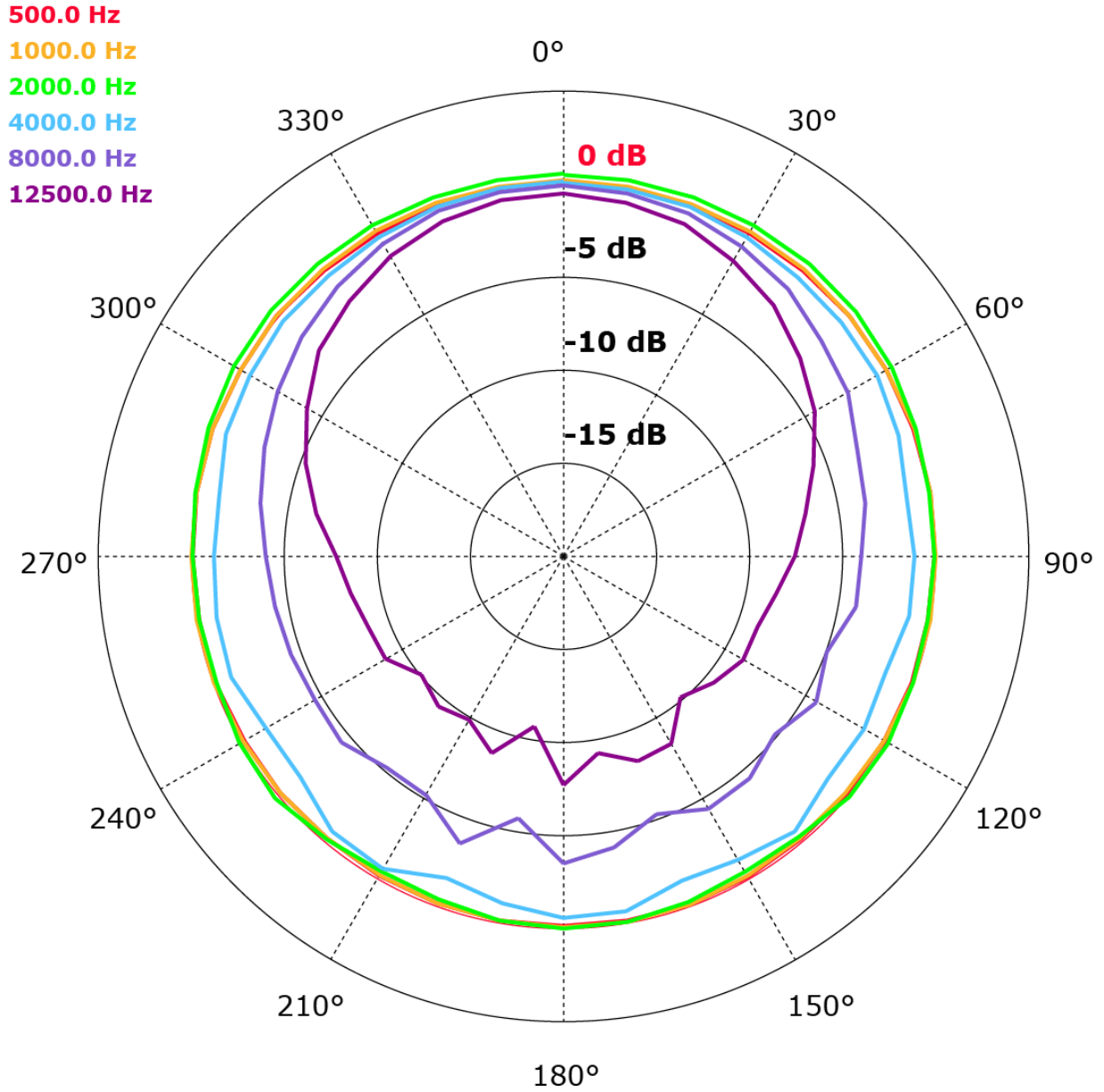
Responses of Optimus with typical MK:224 microphone capsule with UA-237 Windshield – influences of microphone frequency response, reflections and diffraction

Incidence direction – plane parallel to instrument display screen (horizontal)



Responses of Optimus with typical MK:224 microphone capsule with UA-237 Windshield – influences of microphone frequency response, reflections and diffraction

Incidence direction – plane perpendicular to instrument display screen (vertical)



9.2.2 c – Frequency Weightings

Nominal Frequency (Hz)	Frequency weightings (dB)			Tolerance limits (dB)	
				Class	
	A	C	Z	1	2
10	-70,4	-14,3	0.0	+3,5 ; -∞	+5,5 ; -∞
12,5	-63.4	-11.2	0.0	+3,0 ; -∞	+5,5 ; -∞
16	-56.7	-8.5	0.0	+2,5 ; -4,5	+5,5 ; -∞
20	-50.5	-6.2	0.0	±2,5	±3,5
25	-44.7	-4.4	0.0	+2,5 ; -2,0	±3,5
31,5	-39.4	-3.0	0.0	±2,0	±3,5
40	-34.6	-2.0	0.0	±1,5	±2,5
50	-30.2	-1.3	0.0	±1,5	±2,5
63	-26.2	-0.8	0.0	±1,5	±2,5
80	-22.5	-0.5	0.0	±1,5	±2,5
100	-19.1	-0.3	0.0	±1,5	±2,0
125	-16.1	-0.2	0.0	±1,5	±2,0
160	-13.4	-0.1	0.0	±1,5	±2,0
200	-10.9	0.0	0.0	±1,5	±2,0
250	-8.6	0.0	0.0	±1,4	±1,9
315	-6.6	0.0	0.0	±1,4	±1,9
400	-4.8	0.0	0.0	±1,4	±1,9
500	-3.2	0.0	0.0	±1,4	±1,9
630	-1.9	0.0	0.0	±1,4	±1,9
800	-0.8	0.0	0.0	±1,4	±1,9
1000	0	0	0	±1,1	±1,4
1250	0.6	0.0	0.0	±1,4	±1,9
1600	1.0	-0.1	0.0	±1,6	±2,6
2000	1.2	-0.2	0.0	±1,6	±2,6
2500	1.3	-0.3	0.0	±1,6	±3,1
3150	1.2	-0.5	0.0	±1,6	±3,1
4000	1.0	-0.8	0.0	±1,6	±3,6
5000	0.5	-1.3	0.0	±2,1	±4,1
6300	-0.1	-2.0	0.0	+2,1 ; -2,6	±5,1
8000	-1.1	-3.0	0.0	+2,1 ; -3,1	±5,6
10000	-2.5	-4.4	0.0	+2,6 ; -3,6	+5,6 ; -∞
12500	-4.3	-6.2	0.0	+3,0 ; -6,0	+6,0 ; -∞
16000	-6.6	-8.5	0.0	+3,5 ; -17,0	+6,0 ; -∞
20000	-9.3	-11.2	0.0	+4,0 ; -∞	+6,0 ; -∞

9.2.2 d – Time Weightings

	Fast	Slow	Impulse
Time constant	0.125 s	1 s	35 ms

9.2.2 i – Peak measurement ranges

The Optimus measures LAPeak, LCPeak and LZPeak. LCPeak is mandated by the standard IEC 61672-1:2002 and its range is shown in **bold** in the table below.

Frequency	A-weighting	C-weighting	Z-weighting
31.5 Hz	40 – 140 dB	50 – 140 dB	55 – 140 dB
1 kHz	40 – 140 dB	50 – 143 dB	55 – 140 dB
4 kHz	40 – 140 dB	50 – 143 dB	55 – 140 dB
8 kHz	40 – 140 dB	50 – 140 dB	55 – 140 dB
12.5 kHz	40 – 140 dB	50 – 137 dB	55 – 140 dB

Note that the upper limits of the A, C and Z-weighted Peak ranges are 3 dB above the corresponding Sound Level range upper limits as described in section 9.3e below (Page 20). The note in that section regarding the effect of calibration offset also applies to the upper limit of the Peak ranges.

9.2.4 d – Frequency Response Corrections

The values in the table below should be subtracted from the measurement reading to correct for the corresponding effect at the reference direction, 0° angle of incidence for plane-progressive sound waves.

See "Appendix 1 – Optimus correction data", page 24, for detailed correction tables at other angles of incidence.

Nominal Frequency (Hz)	Exact Frequency (Hz)	Typical MK:224 free-field response at 0° (dB)	Free-field influence of optimus case at 0° (dB)	Free-field influence of Windshield UA-237 at 0° (dB)	Expanded uncertainties at 95% coverage, k=2 (dB)
63	63	0.00	0.00	0.00	0.28
80	79	0.00	0.00	0.00	0.28
100	99	0.00	0.00	0.00	0.28
125	125	0.00	0.00	0.00	0.28
160	158	0.00	0.00	0.00	0.28
200	198	0.00	0.00	0.00	0.28
250	251	0.00	0.02	0.03	0.28
315	316	0.00	0.01	0.04	0.28
400	398	0.00	0.01	0.06	0.28
500	501	0.00	0.01	0.07	0.28
630	631	0.00	0.01	0.09	0.27
800	794	0.00	-0.01	0.14	0.27
1000	1000	0.00	-0.03	0.22	0.27
1060	1059	0.00	-0.03	0.25	0.27
1120	1122	0.00	-0.02	0.28	0.27
1180	1189	0.00	-0.01	0.31	0.27
1250	1259	0.00	0.00	0.34	0.27
1320	1334	0.00	0.02	0.37	0.27
1400	1413	0.00	0.05	0.40	0.27
1500	1496	0.00	0.07	0.42	0.27
1600	1585	0.00	0.09	0.46	0.27
1700	1679	0.00	0.10	0.49	0.27
1800	1778	0.00	0.09	0.52	0.27
1900	1884	0.00	0.05	0.56	0.27
2000	1995	0.00	-0.01	0.59	0.27
2120	2113	0.00	-0.06	0.62	0.27
2240	2239	0.00	-0.11	0.64	0.27
2360	2371	0.00	-0.11	0.64	0.28
2500	2512	0.00	-0.05	0.64	0.28
2650	2661	0.00	0.08	0.58	0.31
2800	2818	0.00	0.20	0.41	0.34
3000	2985	0.00	0.14	0.19	0.31
3150	3162	0.00	0.04	0.09	0.28
3350	3350	0.00	-0.03	0.05	0.28
3550	3548	0.00	-0.06	0.06	0.28
3750	3758	0.00	-0.05	0.09	0.30
4000	3981	0.00	-0.03	0.13	0.32
4250	4217	0.00	0.01	0.18	0.31
4500	4467	0.00	0.02	0.25	0.30
4750	4732	0.00	0.01	0.29	0.29
5000	5012	0.00	-0.07	0.31	0.28
5300	5309	0.00	-0.13	0.33	0.28
5600	5623	0.00	0.00	0.19	0.29
6000	5957	0.00	0.08	0.01	0.29
6300	6310	0.00	0.00	-0.01	0.29
6700	6683	0.00	-0.09	0.01	0.29

7100	7079	0.00	-0.10	0.03	0.29
7500	7499	0.00	-0.03	0.06	0.29
8000	7943	0.00	-0.08	0.04	0.30
8500	8414	0.00	-0.21	0.07	0.30
9000	8913	0.00	-0.09	-0.01	0.29
9500	9441	0.00	-0.05	-0.19	0.29
10000	10000	0.10	-0.06	-0.08	0.29
10600	10593	0.15	0.05	-0.10	0.29
11200	11220	0.20	0.03	-0.22	0.33
11800	11885	0.25	-0.07	-0.23	0.30
12500	12589	0.30	-0.08	-0.71	0.29
13200	13335	0.21	-0.02	-0.64	0.30
14000	14125	0.12	-0.01	-0.73	0.29
15000	14962	-0.19	-0.07	-0.79	0.28
16000	15849	-0.51	-0.06	-0.90	0.29
17000	16788	-1.04	-0.03	-0.90	0.29
18000	17783	-1.58	-0.01	-1.15	0.36
19000	18837	-2.33	-0.13	-1.20	0.57
20000	19953	-3.09	0.04	-1.12	0.57

Expanded combined uncertainty of the corrections (95% coverage, k=2)

Nominal Frequency (Hz)	Exact Frequency (Hz)	Expanded combined uncertainty (dB)	Nominal Frequency (Hz)	Exact Frequency (Hz)	Expanded combined uncertainty (dB)
63	63	0.28	3350	3350	0.28
80	79	0.28	3550	3548	0.28
100	99	0.28	3750	3758	0.30
125	125	0.28	4000	3981	0.32
160	158	0.28	4250	4217	0.31
200	198	0.28	4500	4467	0.30
250	251	0.28	4750	4732	0.29
315	316	0.28	5000	5012	0.28
400	398	0.28	5300	5309	0.28
500	501	0.28	5600	5623	0.29
630	631	0.27	6000	5957	0.29
800	794	0.27	6300	6310	0.29
1000	1000	0.27	6700	6683	0.29
1060	1059	0.27	7100	7079	0.29
1120	1122	0.27	7500	7499	0.29
1180	1189	0.27	8000	7943	0.30
1250	1259	0.27	8500	8414	0.30
1320	1334	0.27	9000	8913	0.29
1400	1413	0.27	9500	9441	0.29
1500	1496	0.27	10000	10000	0.29
1600	1585	0.27	10600	10593	0.29
1700	1679	0.27	11200	11220	0.33
1800	1778	0.27	11800	11885	0.30
1900	1884	0.27	12500	12589	0.29
2000	1995	0.27	13200	13335	0.30
2120	2113	0.27	14000	14125	0.29
2240	2239	0.27	15000	14962	0.28
2360	2371	0.28	16000	15849	0.29
2500	2512	0.28	17000	16788	0.29
2650	2661	0.31	18000	17783	0.36
2800	2818	0.34	19000	18837	0.57
3000	2985	0.31	20000	19953	0.57
3150	3162	0.28			

9.2.5 a – Reference direction

The reference direction, or “0°, head-on incidence”, is perpendicular to the microphone diaphragm and parallel to the length of the preamplifier body.

9.2.5b – Observer position

The meter will be either mounted upon a tripod or held in the hand. In order to avoid the effect of sound reflections from the body of the operator interfering with the measurement, the meter should be located as far as possible from the body.

When taking a measurement, the operator should place themselves at a distance behind the tripod-mounted meter, or extend the hand-held meter as far from the body as is possible.

9.2.5o – Noise Floor

The averaging time is at least 30 seconds. It is recommended that Integrated Level (Leq,t) is used for noise floor measurements.

9.2.7c – Influence of variations in environmental conditions

The Optimus range conform to the specifications of IEC 61672-1 2002 for exposure to radio frequency fields at sound levels not less than 74 dB.

9.3a – Reference sound pressure level

The reference sound pressure level is 1 Pa (94.0 dB).

9.3b – Reference level range

The Optimus is a single-range instrument, so the only range is the reference range.

9.3c – Microphone reference point

The microphone reference point is the centre of the diaphragm of the MK:224 microphone.

9.3d – Periodic testing

It is recommended to use multi-frequency acoustic calibrator for Periodic Testing of frequency response. For the B&K Multifunction Acoustic Calibrator type 4226, use the function settings as follows:

Microphone – 'b',

Sound Field – 'Falcon, free field'.

These settings require no additional corrections to obtain A-weighted sound levels equivalent to the response to plane-progressive sound waves from the reference direction at the available frequencies.

9.3e – Linear operating range

Frequency	A-weighting	C-weighting	Z-weighting
31.5 Hz	20 – 100 dB	30 – 137 dB	45 – 140 dB
1 kHz	20 – 140 dB	30 – 140 dB	45 – 140 dB
4 kHz	20 – 140 dB	30 – 140 dB	45 – 140 dB
8 kHz	20 – 139 dB	30 – 137 dB	45 – 139 dB
12.5 kHz	20 – 136 dB	30 – 134 dB	45 – 139 dB

(12.5kHz applies to Class 1 Optimus models only).

Note that the upper limits on the linearity range are affected by the calibration offset. Optimus instruments are factory-adjusted to a zero calibration offset and will have the upper limits shown above. If a different microphone capsule is fitted or the microphone sensitivity changes, resulting in a negative calibration offset, the upper limits will be reduced by the value of the offset. For example: a calibration offset of -2.0 dB will result in an upper limit of 138 dB at 1 kHz.

9.3f – Linear measurement starting level

For testing of level linearity according to IEC 61672-2 and IEC 61672-3 the starting point is not critical and can be selected, within reasonable bounds, at the convenience of the testing laboratory.

Two options are presented in the table below:

Option 1 uses the same electrical signal (input) level at each test frequency;

Option 2 uses the same displayed (output) A-weighted level at each test frequency.

Decibel values in the table below represent the A-weighted Sound Level or Integrated Level shown on the Optimus display at each starting level.

Frequency	Option 1	Option 2
31.5 Hz	54.6 dB	94.0 dB
1 kHz	94.0 dB	94.0 dB
4 kHz	95.0 dB	94.0 dB
8 kHz	92.9 dB	94.0 dB
12.5 kHz	89.7 dB	94.0 dB

Note that decibel levels in Option 1 are stated to a tolerance of ± 0.5 dB when a fixed electrical signal level is used.

9.3g – Electrical insert signals

Electrical testing is done by removing the microphone capsule by unscrewing it from the top of the preamplifier, and replacing it with a standard 1/2" 60UNS threaded dummy microphone of series capacitance 18 pF (± 2 pF) fed from a signal source of impedance 50 Ω .

The Cirrus Research dummy microphone type KP:66 is recommended. The KP:66 has a standard BNC input socket and capacitance 18 pF.

Other types of dummy microphone may be used, but please take care that the device has a capacitance of 18 pF (± 2 pF).

The input sensitivity is nominally 50 mV/Pa (i.e. a signal of 50 mV_{RMS} at a suitable frequency produces a sound level reading of 94 dB).

Note that the exact sensitivity varies depending on the specific microphone capsule with which the instrument has been calibrated.

All microphone types fitted to the Optimus range share the same electrical substitution method and characteristics.

9.3h – Self-generated noise

Highest anticipated self-generated noise in a low-level sound field with microphone capsule type MK:224 fitted:

A-weighted – 18 dB

C-weighted – 25 dB

Z-weighted – 35 dB

Highest anticipated self-generated noise in a low-level sound field with electrical input via 18pF dummy microphone terminated with a 50 Ω load (between signal pin and body):

A-weighted – 15 dB

C-weighted – 24 dB

Z-weighted – 35 dB

Note: the above decibel values are Leq,t measured over 30 seconds.

	Self-generated noise				
	L_{AF}	L_{CF}	L_{ZF}	L_{Aeq}	L_{AE} ($t_{int} = 10s$)
Electric	15 dB	24 dB	35 dB	15 dB	25 dB
Acoustic	18 dB	25 dB	35 dB	18 dB	28 dB

The instrument's connections for data communication are non-reactive, which means that the displayed value cannot be altered by either the hardware or the software. Using the microphone extension cable does not require to apply any correction to the reading.

9.3i – Highest sound pressure level

Maximum permissible sound pressure level for all microphone types fitted to the Optimus range is 160 dB.

Maximum input voltage at the input to the dummy microphone is 100 V_{pk-pk}.

9.3j – Battery voltage range

When powered by 4 x AA primary batteries: maximum 6.8 V, minimum 4.5 V. (The instrument automatically shuts down when the battery voltage drops below 4.5 V).

When powered via USB: maximum 5.3 V, minimum 4.7 V.

9.3k – Display device

The display device will display all levels over the entire linear operating range.

9.3l – Typical Stabilization Time after changes in environmental conditions.

Sudden changes in temperature will affect Optimus measurements. (This is due to temperature differentials between parts of the analog circuit and their stabilized power supply circuits. In particular, the noise floor will rise).

The instrument must be allowed to stabilize for at least 1 hour after a sudden change in temperature of more than 5 °C.

Sudden changes in barometric pressure will also affect measurements. (This is due to pressure equalization in the microphone capsule, which is vented via the preamplifier into the instrument body or cable back-shell. In particular the low frequency response and absolute sensitivity will be affected.)

The instrument must be allowed to stabilize for at least 10 minutes after a sudden change in barometric pressure of more than 5 kPa.

9.3m – Field Strength >10 V/m

Not applicable. The Optimus conforms to the specifications of IEC 61672-1 2002 for electric field strengths up to and including 10 V/m.

9.3n – Radio Frequency Emissions

No mode of operation or configuration produces radio frequency emissions significantly greater than any other. However, for reference purposes the worst-case configuration for testing is with the plane of electric field perpendicular to the centre of the display.

9.3o – AC Power and Radio Frequency Susceptibility

The operating mode of the meter (display mode, storage settings etc) has no effect on susceptibility to radio frequency and AC power frequency fields.

The configuration with the greatest susceptibility to radio frequency fields is with ZL:205 microphone extension cable fitted, USB data cable fitted, the meter case vertical with display facing the radio transmitter, and vertically polarised electrical field. The configuration with the greatest susceptibility to AC power fields is with the axis of the field-generating coil passing through the centre of the meter's display and exiting through the centre of the back of the case.

Appendix 1 – Optimus correction data

The values in the tables below need to be subtracted from the measurement reading to correct for the corresponding effect.

Uncertainty figures for all tables below are as stated above in table “Expanded combined uncertainty of the corrections” - page 19.

**Influence of reflections and diffraction on the frequency response of a typical MK:224 microphone (relative to 0°):
0° to 120°**

Nominal Frequency (Hz)	Exact Frequency (Hz)	Angle from reference direction													
		0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	
63	63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
80	79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
100	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
125	125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
160	158	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
200	198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
250	251	0.00	-0.02	-0.02	-0.02	0.01	0.00	-0.02	-0.03	-0.05	-0.05	-0.06	-0.07	-0.10	
315	316	0.00	-0.02	-0.02	-0.02	0.01	0.00	-0.02	-0.03	-0.05	-0.05	-0.07	-0.08	-0.12	
400	398	0.00	-0.03	-0.02	-0.02	0.00	-0.01	-0.02	-0.03	-0.05	-0.06	-0.08	-0.09	-0.13	
500	501	0.00	-0.02	-0.02	-0.02	0.00	-0.01	-0.03	-0.04	-0.06	-0.07	-0.09	-0.11	-0.13	
630	631	0.00	-0.02	-0.01	-0.02	-0.02	-0.03	-0.04	-0.06	-0.08	-0.09	-0.11	-0.12	-0.13	
800	794	0.00	-0.01	-0.01	-0.02	-0.03	-0.05	-0.06	-0.09	-0.11	-0.13	-0.14	-0.15	-0.14	
1000	1000	0.00	-0.01	-0.01	-0.02	-0.04	-0.07	-0.09	-0.12	-0.14	-0.17	-0.19	-0.20	-0.21	
1060	1059	0.00	-0.01	-0.02	-0.03	-0.04	-0.07	-0.10	-0.13	-0.15	-0.18	-0.21	-0.21	-0.24	
1120	1122	0.00	-0.01	-0.02	-0.03	-0.04	-0.07	-0.10	-0.13	-0.16	-0.19	-0.22	-0.22	-0.26	
1180	1189	0.00	-0.01	-0.03	-0.03	-0.04	-0.08	-0.10	-0.14	-0.16	-0.20	-0.23	-0.24	-0.29	
1250	1259	0.00	-0.01	-0.03	-0.04	-0.05	-0.08	-0.11	-0.14	-0.17	-0.21	-0.25	-0.25	-0.31	
1320	1334	0.00	-0.02	-0.03	-0.04	-0.05	-0.09	-0.12	-0.15	-0.19	-0.22	-0.26	-0.27	-0.33	
1400	1413	0.00	-0.02	-0.04	-0.05	-0.05	-0.09	-0.13	-0.16	-0.20	-0.24	-0.28	-0.29	-0.35	
1500	1496	0.00	-0.01	-0.04	-0.05	-0.06	-0.10	-0.14	-0.18	-0.22	-0.26	-0.30	-0.31	-0.37	
1600	1585	0.00	-0.01	-0.04	-0.05	-0.07	-0.12	-0.15	-0.19	-0.24	-0.28	-0.32	-0.33	-0.39	
1700	1679	0.00	-0.01	-0.04	-0.06	-0.09	-0.13	-0.17	-0.22	-0.26	-0.30	-0.35	-0.36	-0.41	
1800	1778	0.00	-0.01	-0.04	-0.06	-0.10	-0.15	-0.20	-0.24	-0.29	-0.33	-0.38	-0.40	-0.44	
1900	1884	0.00	-0.02	-0.04	-0.07	-0.11	-0.17	-0.22	-0.27	-0.32	-0.37	-0.41	-0.44	-0.48	
2000	1995	0.00	-0.02	-0.04	-0.08	-0.13	-0.19	-0.25	-0.30	-0.36	-0.40	-0.45	-0.48	-0.52	
2120	2113	0.00	-0.02	-0.05	-0.08	-0.14	-0.22	-0.28	-0.34	-0.39	-0.44	-0.49	-0.52	-0.56	
2240	2239	0.00	-0.02	-0.04	-0.09	-0.16	-0.24	-0.31	-0.37	-0.43	-0.48	-0.54	-0.57	-0.61	
2360	2371	0.00	-0.01	-0.04	-0.09	-0.17	-0.26	-0.34	-0.41	-0.47	-0.53	-0.58	-0.61	-0.65	
2500	2512	0.00	0.00	-0.03	-0.08	-0.18	-0.28	-0.37	-0.45	-0.51	-0.57	-0.62	-0.65	-0.70	
2650	2661	0.00	0.03	-0.02	-0.06	-0.19	-0.30	-0.41	-0.49	-0.55	-0.61	-0.68	-0.69	-0.75	
2800	2818	0.00	0.04	-0.01	-0.06	-0.21	-0.32	-0.45	-0.54	-0.63	-0.70	-0.79	-0.78	-0.85	
3000	2985	0.00	0.01	-0.05	-0.11	-0.23	-0.35	-0.48	-0.60	-0.72	-0.82	-0.92	-0.93	-0.98	
3150	3162	0.00	-0.03	-0.08	-0.16	-0.25	-0.37	-0.50	-0.64	-0.79	-0.92	-1.01	-1.06	-1.09	
3350	3350	0.00	-0.05	-0.09	-0.18	-0.27	-0.40	-0.53	-0.67	-0.84	-0.99	-1.09	-1.15	-1.17	
3550	3548	0.00	-0.06	-0.10	-0.20	-0.29	-0.43	-0.56	-0.71	-0.88	-1.05	-1.16	-1.23	-1.25	
3750	3758	0.00	-0.06	-0.11	-0.20	-0.30	-0.46	-0.61	-0.76	-0.92	-1.11	-1.23	-1.31	-1.33	
4000	3981	0.00	-0.05	-0.10	-0.21	-0.32	-0.50	-0.66	-0.81	-0.98	-1.18	-1.31	-1.39	-1.42	
4250	4217	0.00	-0.04	-0.10	-0.21	-0.33	-0.54	-0.73	-0.89	-1.06	-1.26	-1.42	-1.50	-1.52	
4500	4467	0.00	-0.03	-0.10	-0.22	-0.36	-0.57	-0.80	-1.00	-1.16	-1.36	-1.55	-1.63	-1.65	
4750	4732	0.00	-0.02	-0.11	-0.24	-0.40	-0.62	-0.87	-1.11	-1.30	-1.49	-1.70	-1.79	-1.80	
5000	5012	0.00	-0.02	-0.13	-0.27	-0.46	-0.69	-0.96	-1.23	-1.47	-1.65	-1.86	-1.98	-1.99	
5300	5309	0.00	-0.02	-0.15	-0.32	-0.55	-0.80	-1.06	-1.36	-1.64	-1.83	-2.04	-2.21	-2.21	
5600	5623	0.00	-0.01	-0.14	-0.34	-0.62	-0.91	-1.18	-1.49	-1.81	-2.05	-2.26	-2.46	-2.47	
6000	5957	0.00	-0.03	-0.14	-0.33	-0.61	-0.97	-1.27	-1.57	-1.90	-2.20	-2.43	-2.66	-2.73	
6300	6310	0.00	-0.05	-0.18	-0.36	-0.62	-1.01	-1.37	-1.68	-2.02	-2.37	-2.63	-2.85	-2.99	
6700	6683	0.00	-0.07	-0.23	-0.45	-0.72	-1.11	-1.51	-1.87	-2.21	-2.59	-2.89	-3.09	-3.30	
7100	7079	0.00	-0.07	-0.24	-0.52	-0.84	-1.23	-1.65	-2.07	-2.43	-2.82	-3.18	-3.36	-3.60	
7500	7499	0.00	-0.07	-0.24	-0.50	-0.90	-1.35	-1.76	-2.25	-2.64	-3.04	-3.45	-3.64	-3.91	
8000	7943	0.00	-0.08	-0.28	-0.53	-0.92	-1.48	-1.91	-2.42	-2.89	-3.30	-3.75	-3.95	-4.22	
8500	8414	0.00	-0.09	-0.33	-0.63	-1.00	-1.59	-2.11	-2.60	-3.15	-3.57	-4.05	-4.28	-4.51	
9000	8913	0.00	-0.07	-0.30	-0.67	-1.13	-1.68	-2.30	-2.81	-3.40	-3.87	-4.35	-4.64	-4.86	
9500	9441	0.00	-0.07	-0.29	-0.62	-1.14	-1.78	-2.36	-3.03	-3.58	-4.16	-4.64	-5.00	-5.22	
10000	10000	0.00	-0.10	-0.38	-0.73	-1.19	-1.96	-2.54	-3.30	-3.86	-4.53	-5.03	-5.44	-5.69	
10600	10593	0.00	-0.09	-0.39	-0.80	-1.34	-2.09	-2.81	-3.52	-4.20	-4.89	-5.43	-5.87	-6.10	
11200	11220	0.00	-0.08	-0.35	-0.75	-1.41	-2.19	-2.97	-3.70	-4.57	-5.19	-5.87	-6.33	-6.58	
11800	11885	0.00	-0.11	-0.44	-0.87	-1.56	-2.46	-3.22	-4.16	-4.95	-5.70	-6.43	-6.86	-7.16	
12500	12589	0.00	-0.12	-0.44	-0.95	-1.69	-2.60	-3.52	-4.48	-5.36	-6.28	-7.06	-7.52	-7.90	
13200	13335	0.00	-0.16	-0.54	-1.03	-1.83	-2.81	-3.81	-4.79	-5.86	-6.82	-7.61	-8.14	-8.58	
14000	14125	0.00	-0.17	-0.57	-1.18	-1.98	-3.10	-4.10	-5.25	-6.40	-7.35	-8.24	-8.89	-9.39	
15000	14962	0.00	-0.21	-0.66	-1.25	-2.22	-3.32	-4.46	-5.71	-6.87	-7.93	-8.94	-9.72	-10.14	
16000	15849	0.00	-0.23	-0.72	-1.41	-2.38	-3.65	-4.88	-6.10	-7.45	-8.70	-9.81	-10.63	-10.96	
17000	16788	0.00	-0.27	-0.82	-1.56	-2.66	-3.99	-5.27	-6.66	-8.14	-9.50	-10.70	-11.52	-11.86	
18000	17783	0.00	-0.28	-0.89	-1.69	-2.87	-4.37	-5.82	-7.35	-8.80	-10.18	-11.45	-12.34	-12.93	
19000	18837	0.00	-0.38	-0.93	-1.87	-3.17	-4.72	-6.27	-7.95	-9.59	-11.13	-12.52	-13.56	-14.14	
20000	19953	0.00	-0.38	-0.95	-1.90	-3.21	-4.87	-6.46	-8.21	-9.92	-11.51	-13.00	-14.11	-14.74	

130° to 250°

Nominal Frequency (Hz)	Exact Frequency (Hz)	Angle from reference direction												
		130°	140°	150°	160°	170°	180°	190°	200°	210°	220°	230°	240°	250°
63	63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	158	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200	198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	251	-0.07	-0.06	-0.09	-0.08	-0.09	-0.09	-0.09	-0.10	-0.10	-0.14	-0.11	-0.14	-0.09
315	316	-0.08	-0.06	-0.10	-0.07	-0.09	-0.10	-0.10	-0.11	-0.11	-0.16	-0.12	-0.16	-0.11
400	398	-0.08	-0.06	-0.10	-0.08	-0.09	-0.10	-0.10	-0.10	-0.12	-0.12	-0.17	-0.13	-0.12
500	501	-0.09	-0.08	-0.10	-0.08	-0.10	-0.11	-0.11	-0.12	-0.13	-0.17	-0.14	-0.17	-0.14
630	631	-0.11	-0.10	-0.11	-0.10	-0.11	-0.11	-0.12	-0.13	-0.14	-0.16	-0.15	-0.17	-0.16
800	794	-0.14	-0.14	-0.13	-0.13	-0.13	-0.12	-0.14	-0.15	-0.16	-0.17	-0.18	-0.18	-0.19
1000	1000	-0.18	-0.18	-0.18	-0.16	-0.17	-0.15	-0.17	-0.19	-0.21	-0.21	-0.23	-0.24	-0.24
1060	1059	-0.20	-0.19	-0.19	-0.17	-0.17	-0.16	-0.18	-0.20	-0.22	-0.22	-0.25	-0.26	-0.26
1120	1122	-0.21	-0.20	-0.21	-0.18	-0.18	-0.18	-0.19	-0.21	-0.24	-0.25	-0.27	-0.28	-0.28
1180	1189	-0.22	-0.21	-0.22	-0.19	-0.19	-0.19	-0.20	-0.23	-0.25	-0.27	-0.29	-0.30	-0.29
1250	1259	-0.24	-0.22	-0.24	-0.20	-0.20	-0.20	-0.21	-0.24	-0.27	-0.29	-0.31	-0.32	-0.31
1320	1334	-0.25	-0.23	-0.25	-0.21	-0.21	-0.21	-0.22	-0.25	-0.28	-0.31	-0.33	-0.34	-0.32
1400	1413	-0.27	-0.25	-0.27	-0.22	-0.22	-0.22	-0.23	-0.27	-0.30	-0.32	-0.35	-0.36	-0.34
1500	1496	-0.30	-0.27	-0.28	-0.24	-0.23	-0.23	-0.24	-0.28	-0.31	-0.34	-0.37	-0.39	-0.36
1600	1585	-0.32	-0.30	-0.30	-0.25	-0.25	-0.23	-0.26	-0.29	-0.33	-0.36	-0.39	-0.41	-0.38
1700	1679	-0.35	-0.33	-0.32	-0.28	-0.27	-0.24	-0.27	-0.31	-0.36	-0.39	-0.42	-0.44	-0.41
1800	1778	-0.39	-0.36	-0.35	-0.30	-0.29	-0.26	-0.29	-0.34	-0.39	-0.42	-0.46	-0.47	-0.45
1900	1884	-0.43	-0.40	-0.38	-0.33	-0.31	-0.29	-0.31	-0.37	-0.42	-0.45	-0.50	-0.51	-0.48
2000	1995	-0.47	-0.44	-0.41	-0.36	-0.33	-0.33	-0.33	-0.40	-0.46	-0.49	-0.54	-0.56	-0.52
2120	2113	-0.52	-0.49	-0.45	-0.39	-0.36	-0.36	-0.36	-0.43	-0.50	-0.54	-0.59	-0.60	-0.56
2240	2239	-0.57	-0.54	-0.49	-0.43	-0.39	-0.38	-0.39	-0.47	-0.54	-0.58	-0.64	-0.64	-0.60
2360	2371	-0.62	-0.59	-0.54	-0.47	-0.42	-0.40	-0.43	-0.51	-0.59	-0.62	-0.69	-0.68	-0.65
2500	2512	-0.67	-0.64	-0.59	-0.51	-0.45	-0.43	-0.47	-0.55	-0.63	-0.66	-0.75	-0.71	-0.71
2650	2661	-0.73	-0.72	-0.65	-0.56	-0.49	-0.48	-0.52	-0.59	-0.69	-0.68	-0.81	-0.73	-0.78
2800	2818	-0.84	-0.84	-0.76	-0.65	-0.58	-0.58	-0.60	-0.68	-0.79	-0.77	-0.91	-0.80	-0.88
3000	2985	-0.99	-0.97	-0.88	-0.76	-0.68	-0.68	-0.71	-0.80	-0.92	-0.95	-1.04	-0.98	-0.98
3150	3162	-1.10	-1.05	-0.96	-0.83	-0.74	-0.75	-0.79	-0.90	-1.02	-1.11	-1.14	-1.13	-1.07
3350	3350	-1.18	-1.11	-1.03	-0.89	-0.79	-0.80	-0.85	-0.97	-1.10	-1.23	-1.22	-1.24	-1.15
3550	3548	-1.25	-1.16	-1.09	-0.93	-0.84	-0.86	-0.90	-1.05	-1.18	-1.33	-1.30	-1.33	-1.24
3750	3758	-1.32	-1.23	-1.16	-0.99	-0.89	-0.91	-0.96	-1.12	-1.26	-1.41	-1.38	-1.41	-1.33
4000	3981	-1.40	-1.31	-1.24	-1.06	-0.94	-0.96	-1.03	-1.19	-1.35	-1.50	-1.47	-1.49	-1.43
4250	4217	-1.51	-1.43	-1.34	-1.15	-1.01	-1.02	-1.11	-1.29	-1.46	-1.60	-1.57	-1.59	-1.55
4500	4467	-1.64	-1.58	-1.48	-1.27	-1.11	-1.12	-1.21	-1.41	-1.60	-1.73	-1.71	-1.72	-1.69
4750	4732	-1.81	-1.77	-1.63	-1.42	-1.22	-1.23	-1.33	-1.54	-1.76	-1.88	-1.88	-1.89	-1.85
5000	5012	-2.00	-1.98	-1.82	-1.60	-1.36	-1.36	-1.48	-1.72	-1.95	-2.07	-2.07	-2.09	-2.04
5300	5309	-2.22	-2.21	-2.04	-1.80	-1.53	-1.55	-1.67	-1.92	-2.17	-2.27	-2.28	-2.31	-2.23
5600	5623	-2.49	-2.49	-2.31	-2.04	-1.75	-1.74	-1.89	-2.17	-2.42	-2.51	-2.54	-2.57	-2.44
6000	5957	-2.70	-2.67	-2.55	-2.23	-1.94	-1.97	-2.08	-2.40	-2.66	-2.75	-2.77	-2.81	-2.64
6300	6310	-2.91	-2.86	-2.77	-2.41	-2.12	-2.14	-2.28	-2.63	-2.90	-2.99	-3.02	-3.05	-2.85
6700	6683	-3.19	-3.12	-3.05	-2.67	-2.35	-2.37	-2.52	-2.91	-3.20	-3.28	-3.34	-3.35	-3.12
7100	7079	-3.51	-3.41	-3.35	-2.95	-2.60	-2.60	-2.78	-3.22	-3.50	-3.58	-3.66	-3.63	-3.39
7500	7499	-3.83	-3.70	-3.65	-3.23	-2.84	-2.84	-3.04	-3.52	-3.81	-3.88	-4.00	-3.92	-3.68
8000	7943	-4.19	-4.02	-3.99	-3.54	-3.11	-3.08	-3.32	-3.85	-4.14	-4.20	-4.36	-4.23	-4.00
8500	8414	-4.56	-4.37	-4.32	-3.86	-3.40	-3.35	-3.61	-4.17	-4.47	-4.53	-4.71	-4.54	-4.34
9000	8913	-4.95	-4.72	-4.68	-4.21	-3.70	-3.69	-3.96	-4.57	-4.89	-4.95	-5.13	-4.93	-4.74
9500	9441	-5.33	-5.06	-5.03	-4.55	-3.98	-4.02	-4.28	-4.94	-5.24	-5.32	-5.48	-5.28	-5.05
10000	10000	-5.83	-5.52	-5.51	-5.02	-4.38	-4.38	-4.72	-5.41	-5.69	-5.81	-5.92	-5.73	-5.43
10600	10593	-6.32	-6.00	-5.94	-5.48	-4.78	-4.72	-5.14	-5.88	-6.17	-6.30	-6.39	-6.20	-5.88
11200	11220	-6.77	-6.51	-6.41	-5.95	-5.27	-5.19	-5.69	-6.46	-6.72	-6.91	-6.94	-6.76	-6.37
11800	11885	-7.31	-7.08	-6.90	-6.48	-5.72	-5.78	-6.30	-7.18	-7.39	-7.65	-7.58	-7.43	-7.00
12500	12589	-8.02	-7.82	-7.58	-7.16	-6.28	-6.33	-6.96	-7.86	-8.01	-8.33	-8.16	-8.04	-7.48
13200	13335	-8.69	-8.54	-8.21	-7.76	-6.79	-6.76	-7.49	-8.39	-8.49	-8.85	-8.64	-8.51	-7.94
14000	14125	-9.49	-9.43	-8.96	-8.53	-7.44	-7.37	-8.16	-9.04	-9.12	-9.54	-9.27	-9.17	-8.59
15000	14962	-10.30	-10.32	-9.73	-9.32	-8.13	-8.08	-8.90	-9.75	-9.84	-10.32	-10.04	-9.86	-9.22
16000	15849	-11.17	-11.22	-10.56	-10.14	-8.81	-8.75	-9.66	-10.47	-10.54	-11.06	-10.79	-10.46	-9.76
17000	16788	-12.17	-12.18	-11.45	-11.05	-9.57	-9.44	-10.43	-11.18	-11.34	-11.68	-11.54	-11.14	-10.34
18000	17783	-13.41	-13.39	-12.68	-12.33	-10.59	-10.19	-11.26	-11.98	-12.24	-12.58	-12.50	-12.12	-11.26
19000	18837	-14.65	-14.35	-13.97	-13.53	-12.03	-11.61	-12.72	-13.43	-13.94	-14.13	-14.03	-13.88	-12.94
20000	19953	-15.14	-14.80	-14.42	-13.97	-12.44	-11.88	-13.17	-13.84	-14.35	-14.54	-14.34	-14.24	-13.23

260° to 350°

Nominal Frequency (Hz)	Exact Frequency (Hz)	Angle from reference direction									
		260°	270°	280°	290°	300°	310°	320°	330°	340°	350°
63	63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	158	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200	198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	251	-0.12	-0.08	-0.06	-0.05	-0.06	-0.03	-0.01	-0.04	-0.03	-0.01
315	316	-0.13	-0.09	-0.06	-0.05	-0.07	-0.02	0.00	-0.04	-0.03	-0.01
400	398	-0.15	-0.10	-0.08	-0.06	-0.07	-0.02	-0.01	-0.05	-0.03	-0.01
500	501	-0.15	-0.12	-0.10	-0.08	-0.08	-0.04	-0.02	-0.05	-0.03	-0.02
630	631	-0.16	-0.14	-0.12	-0.11	-0.10	-0.06	-0.04	-0.05	-0.03	-0.03
800	794	-0.18	-0.18	-0.16	-0.14	-0.12	-0.09	-0.07	-0.05	-0.04	-0.04
1000	1000	-0.23	-0.22	-0.20	-0.17	-0.14	-0.11	-0.09	-0.06	-0.05	-0.05
1060	1059	-0.25	-0.23	-0.21	-0.17	-0.15	-0.11	-0.08	-0.07	-0.05	-0.05
1120	1122	-0.27	-0.24	-0.21	-0.18	-0.16	-0.11	-0.08	-0.07	-0.05	-0.05
1180	1189	-0.29	-0.25	-0.22	-0.18	-0.16	-0.11	-0.08	-0.07	-0.05	-0.05
1250	1259	-0.31	-0.26	-0.23	-0.19	-0.17	-0.11	-0.08	-0.07	-0.05	-0.04
1320	1334	-0.32	-0.27	-0.24	-0.19	-0.17	-0.12	-0.08	-0.07	-0.05	-0.04
1400	1413	-0.34	-0.28	-0.25	-0.20	-0.18	-0.12	-0.08	-0.08	-0.05	-0.04
1500	1496	-0.35	-0.30	-0.26	-0.22	-0.19	-0.13	-0.09	-0.08	-0.05	-0.04
1600	1585	-0.37	-0.32	-0.28	-0.24	-0.21	-0.15	-0.10	-0.09	-0.06	-0.05
1700	1679	-0.39	-0.35	-0.31	-0.26	-0.22	-0.17	-0.12	-0.09	-0.06	-0.05
1800	1778	-0.42	-0.38	-0.34	-0.29	-0.25	-0.19	-0.14	-0.10	-0.07	-0.06
1900	1884	-0.45	-0.41	-0.37	-0.32	-0.27	-0.21	-0.15	-0.11	-0.07	-0.06
2000	1995	-0.49	-0.45	-0.40	-0.35	-0.29	-0.22	-0.16	-0.11	-0.07	-0.06
2120	2113	-0.53	-0.49	-0.44	-0.38	-0.32	-0.24	-0.18	-0.11	-0.07	-0.06
2240	2239	-0.57	-0.53	-0.48	-0.42	-0.34	-0.26	-0.19	-0.12	-0.07	-0.05
2360	2371	-0.61	-0.57	-0.52	-0.46	-0.37	-0.29	-0.21	-0.12	-0.07	-0.05
2500	2512	-0.65	-0.61	-0.58	-0.50	-0.40	-0.32	-0.23	-0.11	-0.06	-0.05
2650	2661	-0.69	-0.67	-0.65	-0.56	-0.42	-0.36	-0.28	-0.11	-0.06	-0.06
2800	2818	-0.77	-0.77	-0.74	-0.62	-0.45	-0.41	-0.33	-0.12	-0.08	-0.07
3000	2985	-0.91	-0.88	-0.79	-0.65	-0.49	-0.40	-0.31	-0.15	-0.09	-0.07
3150	3162	-1.04	-0.96	-0.83	-0.67	-0.53	-0.39	-0.28	-0.18	-0.10	-0.05
3350	3350	-1.14	-1.02	-0.86	-0.69	-0.57	-0.38	-0.26	-0.19	-0.10	-0.04
3550	3548	-1.23	-1.07	-0.91	-0.73	-0.61	-0.39	-0.25	-0.20	-0.09	-0.02
3750	3758	-1.32	-1.12	-0.96	-0.78	-0.65	-0.41	-0.25	-0.20	-0.08	-0.01
4000	3981	-1.40	-1.18	-1.02	-0.83	-0.69	-0.44	-0.27	-0.19	-0.07	0.00
4250	4217	-1.48	-1.26	-1.10	-0.91	-0.75	-0.49	-0.30	-0.20	-0.07	-0.01
4500	4467	-1.59	-1.38	-1.21	-1.01	-0.81	-0.55	-0.36	-0.23	-0.11	-0.04
4750	4732	-1.71	-1.52	-1.35	-1.13	-0.89	-0.63	-0.44	-0.28	-0.16	-0.10
5000	5012	-1.85	-1.69	-1.50	-1.24	-0.97	-0.71	-0.52	-0.32	-0.19	-0.11
5300	5309	-2.01	-1.87	-1.65	-1.35	-1.05	-0.79	-0.59	-0.35	-0.19	-0.10
5600	5623	-2.21	-2.09	-1.81	-1.47	-1.16	-0.89	-0.64	-0.35	-0.16	-0.06
6000	5957	-2.43	-2.24	-1.92	-1.56	-1.25	-0.91	-0.60	-0.32	-0.13	-0.03
6300	6310	-2.66	-2.41	-2.06	-1.69	-1.37	-0.95	-0.61	-0.37	-0.18	-0.06
6700	6683	-2.94	-2.63	-2.26	-1.88	-1.51	-1.04	-0.72	-0.47	-0.25	-0.10
7100	7079	-3.21	-2.84	-2.47	-2.06	-1.62	-1.15	-0.83	-0.51	-0.24	-0.08
7500	7499	-3.46	-3.05	-2.68	-2.20	-1.72	-1.27	-0.86	-0.50	-0.23	-0.09
8000	7943	-3.73	-3.31	-2.93	-2.36	-1.90	-1.39	-0.90	-0.56	-0.32	-0.16
8500	8414	-4.01	-3.59	-3.19	-2.56	-2.11	-1.49	-1.02	-0.68	-0.39	-0.19
9000	8913	-4.33	-3.93	-3.43	-2.80	-2.26	-1.58	-1.15	-0.69	-0.33	-0.13
9500	9441	-4.59	-4.19	-3.54	-2.96	-2.25	-1.64	-1.07	-0.59	-0.27	-0.07
10000	10000	-4.96	-4.51	-3.81	-3.12	-2.44	-1.73	-1.08	-0.66	-0.30	-0.05
10600	10593	-5.39	-4.85	-4.21	-3.34	-2.72	-1.86	-1.27	-0.74	-0.31	-0.04
11200	11220	-5.92	-5.19	-4.61	-3.67	-2.88	-2.04	-1.35	-0.72	-0.29	-0.02
11800	11885	-6.51	-5.82	-5.01	-4.18	-3.21	-2.38	-1.60	-0.96	-0.49	-0.18
12500	12589	-6.86	-6.29	-5.32	-4.29	-3.45	-2.41	-1.65	-0.97	-0.47	-0.17
13200	13335	-7.19	-6.54	-5.64	-4.48	-3.52	-2.48	-1.62	-0.94	-0.44	-0.09
14000	14125	-7.80	-6.92	-6.00	-4.86	-3.76	-2.66	-1.75	-1.04	-0.45	-0.10
15000	14962	-8.50	-7.54	-6.39	-5.19	-4.10	-2.85	-1.91	-1.10	-0.52	-0.14
16000	15849	-8.97	-8.12	-6.86	-5.52	-4.30	-3.04	-1.98	-1.17	-0.51	-0.11
17000	16788	-9.47	-8.59	-7.38	-5.95	-4.64	-3.23	-2.16	-1.26	-0.57	-0.15
18000	17783	-10.34	-9.25	-7.94	-6.42	-5.10	-3.60	-2.37	-1.39	-0.64	-0.17
19000	18837	-11.83	-10.68	-9.15	-7.44	-5.88	-4.14	-2.77	-1.70	-0.84	-0.27
20000	19953	-12.09	-10.93	-9.36	-7.57	-5.98	-4.14	-2.69	-1.62	-0.68	-0.05

Influence of the Optimus case on frequency response – plane parallel to the display screen (Horizontal)

0° to 120°

Nominal Frequency (Hz)	Exact Frequency (Hz)	Angle from reference direction												
		0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°
63	63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	158	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200	198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	251	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	-0.03
315	316	0.01	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	-0.04
400	398	0.01	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.00	-0.04	-0.01
500	501	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	-0.04	-0.02
630	631	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.01	-0.04	-0.04
800	794	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.02	0.03	0.04	0.03	-0.02	-0.04
1000	1000	-0.03	-0.03	-0.03	-0.03	-0.04	-0.03	-0.03	-0.01	0.01	0.04	0.06	0.02	0.00
1060	1059	-0.03	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.02	-0.01	0.03	0.07	0.03	0.01
1120	1122	-0.02	-0.02	-0.02	-0.03	-0.04	-0.05	-0.05	-0.03	-0.03	0.02	0.07	0.04	0.03
1180	1189	-0.01	-0.01	-0.01	-0.03	-0.04	-0.05	-0.06	-0.04	-0.04	0.01	0.06	0.04	0.05
1250	1259	0.00	0.01	0.00	-0.02	-0.04	-0.06	-0.06	-0.05	-0.06	-0.01	0.05	0.05	0.08
1320	1334	0.02	0.03	0.02	0.00	-0.03	-0.06	-0.07	-0.06	-0.07	-0.02	0.04	0.06	0.10
1400	1413	0.05	0.05	0.05	0.02	-0.01	-0.05	-0.07	-0.07	-0.08	-0.04	0.03	0.06	0.12
1500	1496	0.07	0.07	0.08	0.05	0.01	-0.04	-0.08	-0.09	-0.09	-0.06	0.00	0.06	0.15
1600	1585	0.09	0.10	0.10	0.08	0.05	-0.02	-0.07	-0.10	-0.11	-0.07	-0.02	0.05	0.16
1700	1679	0.10	0.10	0.12	0.11	0.08	0.02	-0.06	-0.11	-0.13	-0.09	-0.05	0.03	0.18
1800	1778	0.09	0.09	0.12	0.12	0.12	0.07	-0.02	-0.11	-0.15	-0.11	-0.08	0.00	0.19
1900	1884	0.05	0.06	0.09	0.11	0.14	0.12	0.04	-0.08	-0.18	-0.13	-0.10	-0.04	0.19
2000	1995	-0.01	0.01	0.04	0.08	0.13	0.16	0.11	-0.03	-0.20	-0.16	-0.12	-0.08	0.18
2120	2113	-0.06	-0.05	-0.02	0.02	0.09	0.16	0.16	0.06	-0.17	-0.19	-0.12	-0.12	0.15
2240	2239	-0.11	-0.10	-0.08	-0.05	0.03	0.13	0.19	0.14	-0.12	-0.23	-0.12	-0.14	0.10
2360	2371	-0.11	-0.13	-0.12	-0.11	-0.05	0.07	0.18	0.21	-0.03	-0.26	-0.14	-0.14	0.03
2500	2512	-0.05	-0.10	-0.12	-0.15	-0.13	-0.01	0.14	0.25	0.08	-0.29	-0.20	-0.13	-0.05
2650	2661	0.08	-0.01	-0.04	-0.13	-0.20	-0.14	0.07	0.24	0.21	-0.26	-0.32	-0.10	-0.15
2800	2818	0.20	0.10	0.11	0.02	-0.14	-0.27	-0.09	0.14	0.25	-0.09	-0.45	-0.10	-0.19
3000	2985	0.14	0.10	0.14	0.12	0.03	-0.17	-0.22	-0.01	0.17	0.12	-0.34	-0.18	-0.12
3150	3162	0.04	0.05	0.08	0.11	0.10	-0.02	-0.20	-0.13	0.09	0.20	-0.15	-0.28	-0.05
3350	3350	-0.03	0.01	0.03	0.06	0.11	0.08	-0.12	-0.20	0.02	0.22	-0.01	-0.35	-0.03
3550	3548	-0.06	-0.01	-0.01	0.02	0.09	0.13	-0.04	-0.20	-0.06	0.22	0.09	-0.38	-0.05
3750	3758	-0.05	-0.01	-0.02	-0.02	0.04	0.15	0.05	-0.16	-0.16	0.21	0.17	-0.39	-0.09
4000	3981	-0.03	0.00	-0.01	-0.03	-0.01	0.13	0.12	-0.07	-0.24	0.17	0.22	-0.35	-0.16
4250	4217	0.01	0.01	0.00	-0.03	-0.06	0.03	0.15	0.04	-0.30	0.07	0.25	-0.27	-0.26
4500	4467	0.02	0.01	0.01	-0.03	-0.09	-0.10	0.07	0.14	-0.29	-0.14	0.25	-0.17	-0.42
4750	4732	0.01	-0.01	0.01	-0.02	-0.09	-0.19	-0.12	0.18	-0.19	-0.38	0.20	-0.07	-0.56
5000	5012	-0.07	-0.10	-0.03	0.00	0.00	-0.15	-0.25	0.06	0.02	-0.51	0.08	0.04	-0.58
5300	5309	-0.13	-0.18	-0.13	-0.08	0.03	0.02	-0.22	-0.15	0.21	-0.44	-0.15	0.17	-0.46
5600	5623	0.00	-0.07	-0.08	-0.11	-0.08	0.09	0.02	-0.25	0.18	-0.16	-0.37	0.33	-0.29
6000	5957	0.08	0.05	0.04	0.00	-0.06	-0.05	0.14	-0.13	-0.10	0.14	-0.46	0.31	-0.14
6300	6310	0.00	-0.01	0.02	0.01	-0.03	-0.09	-0.02	0.01	-0.33	0.19	-0.49	0.16	-0.03
6700	6683	-0.09	-0.09	-0.04	-0.01	-0.03	-0.07	-0.13	0.05	-0.41	0.11	-0.37	-0.01	0.13
7100	7079	-0.10	-0.11	-0.06	-0.02	0.01	-0.03	-0.10	-0.01	-0.26	-0.05	-0.09	-0.16	0.29
7500	7499	-0.03	-0.06	-0.07	-0.09	-0.02	0.00	-0.08	-0.11	-0.06	-0.32	0.14	-0.44	0.33
8000	7943	-0.08	-0.07	-0.01	-0.08	-0.16	-0.04	-0.08	-0.21	0.00	-0.56	0.26	-0.79	0.28
8500	8414	-0.21	-0.22	-0.12	-0.02	-0.12	-0.13	-0.04	-0.18	-0.07	-0.51	0.27	-0.88	0.28
9000	8913	-0.09	-0.14	-0.15	-0.16	0.00	-0.11	-0.07	-0.06	-0.33	-0.14	-0.12	-0.61	0.25
9500	9441	-0.05	-0.06	0.00	-0.06	-0.13	0.04	-0.15	-0.04	-0.38	0.14	-0.55	-0.37	-0.10
10000	10000	-0.06	-0.09	-0.03	0.02	-0.03	-0.05	-0.05	-0.12	-0.23	-0.03	-0.68	0.03	-0.55
10600	10593	0.05	-0.02	-0.02	-0.07	0.02	-0.08	0.01	-0.17	-0.08	-0.42	-0.57	0.38	-0.94
11200	11220	0.03	-0.03	0.03	-0.01	-0.08	0.04	-0.18	-0.12	-0.28	-0.60	0.14	0.15	-1.23
11800	11885	-0.07	-0.14	-0.13	-0.19	-0.12	-0.17	-0.15	-0.18	-0.38	-0.29	0.05	-0.54	-1.19
12500	12589	-0.08	-0.12	-0.10	-0.11	-0.10	-0.06	-0.14	-0.19	-0.28	-0.16	-0.34	-1.08	-0.29
13200	13335	-0.02	-0.01	0.06	0.02	0.09	0.09	0.09	0.09	0.06	-0.03	-0.39	-0.91	0.54
14000	14125	-0.01	0.01	0.06	0.08	0.16	0.21	0.18	0.22	0.16	0.02	0.02	-0.07	1.08
15000	14962	-0.07	-0.02	0.09	0.08	0.20	0.21	0.28	0.26	0.14	0.17	0.55	0.92	0.97
16000	15849	-0.06	0.01	0.10	0.12	0.24	0.33	0.31	0.31	0.25	0.43	0.74	1.14	0.48
17000	16788	-0.03	0.04	0.15	0.16	0.31	0.31	0.32	0.39	0.43	0.57	0.46	0.63	-0.53
18000	17783	-0.01	0.04	0.16	0.14	0.30	0.35	0.36	0.37	0.23	0.22	0.21	-1.06	-1.83
19000	18837	-0.13	0.02	0.06	0.12	0.29	0.26	0.26	0.28	0.22	0.45	0.52	0.82	1.42
20000	19953	0.04	0.22	0.27	0.29	0.49	0.47	0.41	0.43	0.33	0.60	0.73	1.14	1.90

130° to 250°

Nominal Frequency (Hz)	Exact Frequency (Hz)	Angle from reference direction												
		130°	140°	150°	160°	170°	180°	190°	200°	210°	220°	230°	240°	250°
63	63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	158	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200	198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	251	-0.03	-0.03	-0.03	-0.04	-0.01	-0.02	-0.03	-0.03	-0.03	-0.03	-0.04	-0.02	-0.03
315	316	-0.04	-0.04	-0.03	-0.05	-0.01	-0.02	-0.04	-0.03	-0.03	-0.03	-0.04	-0.01	-0.03
400	398	-0.04	-0.04	-0.03	-0.05	-0.02	-0.02	-0.04	-0.03	-0.03	-0.03	-0.04	-0.02	-0.03
500	501	-0.05	-0.05	-0.04	-0.05	-0.02	-0.02	-0.04	-0.03	-0.04	-0.05	-0.05	-0.02	-0.03
630	631	-0.07	-0.06	-0.05	-0.05	-0.03	-0.03	-0.04	-0.04	-0.05	-0.07	-0.07	-0.04	-0.03
800	794	-0.08	-0.08	-0.08	-0.06	-0.04	-0.04	-0.05	-0.06	-0.08	-0.10	-0.09	-0.05	-0.01
1000	1000	-0.09	-0.12	-0.12	-0.09	-0.05	-0.04	-0.06	-0.09	-0.12	-0.14	-0.09	-0.02	0.03
1060	1059	-0.09	-0.14	-0.13	-0.10	-0.05	-0.04	-0.06	-0.10	-0.13	-0.15	-0.08	-0.01	0.04
1120	1122	-0.08	-0.15	-0.14	-0.11	-0.05	-0.04	-0.07	-0.11	-0.14	-0.15	-0.07	0.01	0.05
1180	1189	-0.08	-0.16	-0.15	-0.12	-0.05	-0.04	-0.07	-0.11	-0.15	-0.16	-0.06	0.03	0.06
1250	1259	-0.07	-0.17	-0.16	-0.14	-0.05	-0.04	-0.07	-0.12	-0.17	-0.17	-0.04	0.05	0.07
1320	1334	-0.06	-0.18	-0.18	-0.15	-0.05	-0.03	-0.08	-0.13	-0.18	-0.17	-0.02	0.07	0.07
1400	1413	-0.04	-0.19	-0.20	-0.16	-0.05	-0.03	-0.08	-0.15	-0.20	-0.18	-0.01	0.10	0.07
1500	1496	-0.02	-0.20	-0.22	-0.18	-0.05	-0.03	-0.09	-0.16	-0.22	-0.19	0.01	0.12	0.06
1600	1585	0.00	-0.20	-0.25	-0.19	-0.06	-0.03	-0.09	-0.19	-0.25	-0.20	0.04	0.13	0.04
1700	1679	0.03	-0.21	-0.28	-0.22	-0.07	-0.03	-0.10	-0.22	-0.28	-0.20	0.07	0.15	0.02
1800	1778	0.07	-0.21	-0.32	-0.25	-0.08	-0.03	-0.12	-0.26	-0.32	-0.20	0.11	0.16	-0.02
1900	1884	0.12	-0.21	-0.37	-0.29	-0.09	-0.03	-0.14	-0.30	-0.37	-0.20	0.15	0.15	-0.07
2000	1995	0.18	-0.19	-0.42	-0.34	-0.11	-0.04	-0.16	-0.35	-0.41	-0.17	0.20	0.14	-0.12
2120	2113	0.22	-0.14	-0.43	-0.36	-0.11	-0.04	-0.16	-0.37	-0.42	-0.12	0.23	0.09	-0.15
2240	2239	0.26	-0.09	-0.43	-0.37	-0.11	-0.04	-0.16	-0.39	-0.42	-0.06	0.25	0.03	-0.16
2360	2371	0.29	-0.03	-0.43	-0.38	-0.11	-0.02	-0.15	-0.41	-0.42	0.00	0.26	-0.04	-0.15
2500	2512	0.31	0.03	-0.42	-0.37	-0.11	-0.01	-0.13	-0.44	-0.43	0.06	0.25	-0.14	-0.13
2650	2661	0.30	0.10	-0.42	-0.37	-0.12	0.01	-0.10	-0.49	-0.44	0.13	0.20	-0.27	-0.11
2800	2818	0.22	0.22	-0.41	-0.41	-0.15	0.01	-0.10	-0.57	-0.44	0.21	0.07	-0.33	-0.18
3000	2985	0.09	0.33	-0.35	-0.53	-0.15	0.02	-0.16	-0.61	-0.34	0.28	-0.05	-0.19	-0.33
3150	3162	0.01	0.37	-0.28	-0.63	-0.14	0.05	-0.21	-0.61	-0.23	0.33	-0.08	-0.06	-0.40
3350	3350	-0.03	0.38	-0.22	-0.70	-0.13	0.07	-0.24	-0.61	-0.14	0.36	-0.08	0.01	-0.40
3550	3548	-0.06	0.37	-0.16	-0.75	-0.12	0.09	-0.26	-0.60	-0.06	0.37	-0.06	0.02	-0.36
3750	3758	-0.06	0.35	-0.10	-0.78	-0.12	0.10	-0.27	-0.60	0.02	0.37	-0.04	-0.01	-0.29
4000	3981	-0.05	0.33	-0.04	-0.79	-0.13	0.11	-0.28	-0.61	0.10	0.35	0.00	-0.10	-0.19
4250	4217	-0.03	0.29	0.01	-0.80	-0.14	0.12	-0.30	-0.64	0.17	0.30	0.03	-0.24	-0.07
4500	4467	-0.02	0.21	0.05	-0.85	-0.19	0.11	-0.35	-0.70	0.22	0.21	0.03	-0.40	0.06
4750	4732	-0.03	0.10	0.07	-0.92	-0.26	0.07	-0.42	-0.77	0.25	0.08	-0.02	-0.51	0.14
5000	5012	-0.05	-0.01	0.13	-0.96	-0.32	0.10	-0.46	-0.81	0.30	-0.02	-0.13	-0.47	0.23
5300	5309	-0.13	-0.06	0.21	-0.97	-0.37	0.14	-0.49	-0.80	0.36	-0.03	-0.29	-0.29	0.32
5600	5623	-0.26	-0.01	0.30	-0.92	-0.42	0.19	-0.53	-0.74	0.41	0.07	-0.48	-0.11	0.36
6000	5957	-0.41	0.10	0.36	-0.86	-0.45	0.22	-0.62	-0.59	0.46	0.22	-0.53	0.08	0.27
6300	6310	-0.54	0.12	0.34	-0.85	-0.51	0.18	-0.72	-0.46	0.45	0.28	-0.53	0.24	0.12
6700	6683	-0.62	0.09	0.29	-0.81	-0.57	0.19	-0.80	-0.36	0.41	0.26	-0.52	0.39	-0.06
7100	7079	-0.64	0.07	0.30	-0.70	-0.59	0.26	-0.84	-0.22	0.40	0.22	-0.47	0.49	-0.26
7500	7499	-0.67	-0.02	0.30	-0.65	-0.65	0.29	-0.93	-0.12	0.38	0.12	-0.37	0.47	-0.51
8000	7943	-0.70	-0.15	0.25	-0.63	-0.83	0.30	-1.09	-0.07	0.32	0.00	-0.20	0.41	-0.61
8500	8414	-0.56	-0.20	0.17	-0.51	-1.01	0.34	-1.26	0.04	0.25	-0.06	0.01	0.41	-0.46
9000	8913	-0.25	-0.30	0.09	-0.32	-1.12	0.39	-1.47	0.26	0.20	-0.20	0.27	0.20	-0.14
9500	9441	-0.09	-0.44	0.12	-0.24	-1.21	0.34	-1.56	0.37	0.32	-0.31	0.45	-0.30	0.36
10000	10000	0.06	-0.52	0.19	-0.13	-1.36	0.37	-1.51	0.45	0.45	-0.24	0.63	-0.40	0.67
10600	10593	0.17	-0.60	0.24	-0.01	-1.56	0.38	-1.61	0.54	0.60	-0.26	0.84	-0.41	0.69
11200	11220	0.41	-1.04	0.14	0.00	-1.85	0.39	-1.75	0.66	0.71	-0.52	1.18	-0.39	0.34
11800	11885	0.43	-1.65	-0.29	-0.17	-2.13	0.23	-1.84	0.63	0.63	-0.64	0.86	0.07	-0.30
12500	12589	0.22	-1.59	-0.49	-0.26	-2.31	0.15	-1.62	0.74	0.58	-0.33	0.28	0.70	-0.63
13200	13335	0.15	-1.14	-0.35	-0.14	-2.42	0.26	-1.56	0.81	0.52	-0.19	-0.22	0.89	-0.25
14000	14125	-0.05	-0.60	-0.18	-0.02	-2.56	0.32	-1.67	0.66	0.35	-0.18	-0.98	0.81	0.34
15000	14962	-0.52	-0.20	0.04	0.16	-2.67	0.35	-1.66	0.52	0.27	-0.09	-1.54	0.11	0.18
16000	15849	-0.85	0.21	0.22	0.40	-2.76	0.38	-1.58	0.47	-0.09	0.30	-1.18	-1.11	-0.64
17000	16788	-1.04	0.65	0.14	0.59	-3.03	0.39	-1.44	0.42	-0.46	0.56	-0.61	-1.70	-1.51
18000	17783	-0.76	1.41	-0.24	0.92	-3.39	0.52	-1.42	0.19	-0.87	0.56	0.09	-1.29	-1.20
19000	18837	1.85	1.33	-0.95	0.43	-3.26	-0.30	-1.10	-0.41	-1.29	0.45	0.53	0.67	-0.14
20000	19953	1.99	1.54	-0.62	0.42	-2.81	-0.30	-0.94	-0.22	-1.09	0.32	0.20	0.47	-0.38

260° to 350°

Nominal Frequency (Hz)	Exact Frequency (Hz)	Angle from reference direction									
		260°	270°	280°	290°	300°	310°	320°	330°	340°	350°
63	63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	158	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200	198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	251	-0.02	-0.02	-0.01	-0.01	0.01	-0.01	-0.01	0.01	0.01	0.00
315	316	-0.02	-0.02	-0.01	-0.01	0.01	-0.01	-0.01	0.01	0.01	0.00
400	398	-0.01	-0.02	-0.01	-0.01	0.02	-0.01	-0.01	0.01	0.01	0.00
500	501	-0.01	-0.01	0.00	0.00	0.01	-0.01	-0.01	0.01	0.01	-0.01
630	631	0.00	0.00	0.01	0.00	0.01	-0.01	-0.02	-0.01	-0.01	-0.01
800	794	0.02	0.02	0.01	0.00	-0.02	-0.03	-0.03	-0.04	-0.04	-0.03
1000	1000	0.03	0.01	-0.02	-0.04	-0.05	-0.06	-0.07	-0.07	-0.06	-0.04
1060	1059	0.04	0.00	-0.03	-0.06	-0.06	-0.07	-0.08	-0.07	-0.06	-0.05
1120	1122	0.03	-0.02	-0.04	-0.07	-0.07	-0.08	-0.08	-0.07	-0.05	-0.04
1180	1189	0.03	-0.03	-0.06	-0.09	-0.08	-0.09	-0.09	-0.06	-0.04	-0.03
1250	1259	0.02	-0.05	-0.07	-0.10	-0.09	-0.10	-0.09	-0.05	-0.03	-0.02
1320	1334	0.00	-0.07	-0.09	-0.12	-0.10	-0.10	-0.08	-0.04	-0.01	0.00
1400	1413	-0.02	-0.09	-0.10	-0.13	-0.10	-0.10	-0.06	-0.01	0.02	0.02
1500	1496	-0.05	-0.11	-0.12	-0.15	-0.11	-0.08	-0.04	0.01	0.04	0.05
1600	1585	-0.07	-0.12	-0.14	-0.16	-0.11	-0.05	0.00	0.04	0.07	0.07
1700	1679	-0.10	-0.14	-0.17	-0.17	-0.10	-0.01	0.04	0.06	0.08	0.08
1800	1778	-0.13	-0.16	-0.20	-0.17	-0.06	0.04	0.07	0.07	0.08	0.07
1900	1884	-0.16	-0.19	-0.23	-0.15	0.00	0.08	0.08	0.06	0.05	0.04
2000	1995	-0.18	-0.23	-0.25	-0.09	0.07	0.11	0.07	0.02	0.00	-0.02
2120	2113	-0.18	-0.26	-0.23	0.00	0.12	0.10	0.02	-0.04	-0.07	-0.08
2240	2239	-0.20	-0.29	-0.17	0.09	0.13	0.07	-0.04	-0.12	-0.14	-0.12
2360	2371	-0.23	-0.31	-0.06	0.16	0.10	0.02	-0.10	-0.19	-0.18	-0.14
2500	2512	-0.29	-0.29	0.07	0.20	0.03	-0.04	-0.16	-0.24	-0.20	-0.09
2650	2661	-0.39	-0.18	0.19	0.20	-0.10	-0.11	-0.18	-0.25	-0.14	0.03
2800	2818	-0.43	0.04	0.21	0.09	-0.30	-0.16	-0.07	-0.13	-0.03	0.16
3000	2985	-0.27	0.16	0.11	-0.09	-0.34	-0.11	0.04	0.00	0.04	0.11
3150	3162	-0.09	0.16	0.04	-0.21	-0.23	-0.05	0.05	0.05	0.03	0.00
3350	3350	0.04	0.15	-0.01	-0.26	-0.10	-0.01	0.03	0.04	0.01	-0.06
3550	3548	0.14	0.14	-0.08	-0.24	0.02	0.02	-0.01	0.02	-0.01	-0.09
3750	3758	0.21	0.12	-0.15	-0.18	0.11	0.03	-0.05	-0.01	-0.01	-0.08
4000	3981	0.26	0.08	-0.22	-0.08	0.17	0.01	-0.09	-0.03	0.00	-0.05
4250	4217	0.28	-0.02	-0.25	0.04	0.18	-0.05	-0.10	-0.03	0.01	-0.01
4500	4467	0.27	-0.20	-0.20	0.15	0.08	-0.12	-0.08	-0.01	0.04	0.05
4750	4732	0.18	-0.37	-0.07	0.18	-0.11	-0.13	-0.01	0.03	0.06	0.09
5000	5012	-0.02	-0.41	0.12	0.06	-0.23	-0.05	0.09	0.04	0.02	0.02
5300	5309	-0.26	-0.26	0.27	-0.16	-0.19	0.12	0.09	-0.07	-0.10	-0.07
5600	5623	-0.44	0.03	0.18	-0.27	0.02	0.11	-0.05	-0.15	-0.11	-0.02
6000	5957	-0.41	0.26	-0.08	-0.11	0.13	-0.07	-0.05	-0.05	0.00	0.04
6300	6310	-0.26	0.27	-0.25	0.07	0.00	-0.08	-0.01	0.00	0.03	0.02
6700	6683	-0.04	0.16	-0.27	0.11	-0.09	-0.06	0.00	0.00	0.00	-0.03
7100	7079	0.20	-0.03	-0.11	0.00	-0.08	-0.03	0.03	-0.02	-0.05	-0.05
7500	7499	0.34	-0.31	0.08	-0.13	-0.06	0.00	-0.02	-0.10	-0.04	0.02
8000	7943	0.35	-0.42	0.13	-0.19	-0.05	-0.04	-0.12	-0.05	0.05	0.04
8500	8414	0.19	-0.30	0.01	-0.14	-0.02	-0.14	-0.03	0.01	-0.07	-0.09
9000	8913	-0.34	0.12	-0.27	-0.02	-0.11	-0.10	0.04	-0.15	-0.10	-0.01
9500	9441	-0.47	0.32	-0.18	0.01	-0.14	0.08	-0.07	-0.02	0.08	0.06
10000	10000	-0.23	0.09	0.09	-0.05	0.11	-0.03	0.08	0.10	0.06	0.01
10600	10593	0.27	-0.12	0.29	-0.01	0.20	0.05	0.18	0.03	0.06	0.09
11200	11220	0.77	-0.03	0.14	0.20	0.01	0.20	0.12	0.09	0.09	0.04
11800	11885	0.32	0.36	0.04	0.15	0.09	0.07	0.18	-0.01	-0.03	0.05
12500	12589	-0.33	0.09	-0.01	-0.14	-0.04	-0.03	0.01	-0.05	-0.04	-0.04
13200	13335	-0.40	-0.19	-0.05	-0.10	-0.08	-0.09	-0.01	-0.05	-0.01	-0.01
14000	14125	-0.08	-0.41	-0.28	-0.25	-0.21	-0.20	-0.09	-0.12	-0.07	-0.01
15000	14962	-0.16	-0.43	-0.55	-0.43	-0.35	-0.34	-0.22	-0.23	-0.16	-0.10
16000	15849	-0.76	-0.50	-0.46	-0.56	-0.43	-0.39	-0.24	-0.27	-0.16	-0.11
17000	16788	-0.86	-0.54	-0.45	-0.44	-0.31	-0.34	-0.20	-0.16	-0.11	-0.04
18000	17783	-0.62	-0.72	-0.57	-0.50	-0.36	-0.32	-0.14	-0.18	-0.11	-0.06
19000	18837	-0.67	-0.51	-0.51	-0.59	-0.38	-0.49	-0.28	-0.20	-0.08	-0.07
20000	19953	-0.69	-0.58	-0.50	-0.59	-0.29	-0.45	-0.21	-0.09	0.02	-0.06

Influence of the Optimus case on frequency response – plane perpendicular to the display screen (vertical):

0° to 120°

Nominal Frequency (Hz)	Exact Frequency (Hz)	Angle from reference direction												
		0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°
63	63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	158	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200	198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	251	-0.01	0.00	-0.01	0.00	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.05	-0.05	-0.04
315	316	-0.01	0.00	-0.01	0.01	-0.02	-0.02	-0.02	-0.03	-0.04	-0.04	-0.05	-0.05	-0.04
400	398	-0.01	0.00	-0.01	0.01	-0.02	-0.02	-0.02	-0.03	-0.04	-0.04	-0.05	-0.05	-0.05
500	501	-0.02	-0.01	-0.02	0.00	-0.02	-0.03	-0.02	-0.03	-0.04	-0.03	-0.05	-0.05	-0.06
630	631	-0.03	-0.03	-0.03	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.04	-0.06	-0.08
800	794	-0.06	-0.06	-0.06	-0.06	-0.06	-0.05	-0.05	-0.03	-0.03	-0.02	-0.03	-0.06	-0.10
1000	1000	-0.08	-0.08	-0.08	-0.09	-0.10	-0.09	-0.09	-0.07	-0.06	-0.02	-0.01	-0.03	-0.09
1060	1059	-0.08	-0.09	-0.09	-0.10	-0.11	-0.11	-0.10	-0.09	-0.07	-0.03	-0.01	-0.02	-0.07
1120	1122	-0.08	-0.08	-0.08	-0.09	-0.12	-0.12	-0.12	-0.10	-0.09	-0.04	-0.01	0.00	-0.05
1180	1189	-0.07	-0.07	-0.07	-0.08	-0.13	-0.13	-0.13	-0.11	-0.11	-0.06	-0.01	0.01	-0.03
1250	1259	-0.05	-0.06	-0.06	-0.07	-0.13	-0.14	-0.14	-0.13	-0.13	-0.08	-0.02	0.02	-0.01
1320	1334	-0.03	-0.04	-0.04	-0.06	-0.12	-0.15	-0.15	-0.14	-0.15	-0.10	-0.03	0.03	0.02
1400	1413	-0.01	-0.02	-0.02	-0.03	-0.11	-0.15	-0.16	-0.16	-0.16	-0.12	-0.05	0.04	0.04
1500	1496	0.01	0.00	0.00	-0.01	-0.09	-0.14	-0.17	-0.18	-0.18	-0.15	-0.07	0.04	0.07
1600	1585	0.02	0.02	0.02	0.02	-0.06	-0.12	-0.18	-0.21	-0.20	-0.18	-0.10	0.03	0.09
1700	1679	0.02	0.03	0.04	0.04	-0.03	-0.09	-0.17	-0.23	-0.23	-0.20	-0.14	0.01	0.11
1800	1778	0.00	0.01	0.03	0.05	0.01	-0.04	-0.14	-0.24	-0.27	-0.23	-0.18	-0.03	0.13
1900	1884	-0.04	-0.03	0.01	0.04	0.03	0.01	-0.09	-0.23	-0.31	-0.26	-0.22	-0.07	0.14
2000	1995	-0.10	-0.08	-0.05	0.00	0.03	0.06	-0.02	-0.19	-0.34	-0.30	-0.25	-0.13	0.15
2120	2113	-0.16	-0.14	-0.11	-0.06	-0.01	0.08	0.06	-0.09	-0.33	-0.33	-0.25	-0.18	0.13
2240	2239	-0.20	-0.19	-0.17	-0.14	-0.07	0.06	0.11	0.02	-0.28	-0.36	-0.25	-0.21	0.09
2360	2371	-0.20	-0.21	-0.21	-0.23	-0.15	0.00	0.11	0.12	-0.18	-0.40	-0.25	-0.24	0.04
2500	2512	-0.16	-0.19	-0.21	-0.30	-0.25	-0.09	0.07	0.19	-0.04	-0.42	-0.29	-0.25	-0.03
2650	2661	-0.05	-0.11	-0.12	-0.32	-0.34	-0.25	-0.05	0.19	0.14	-0.37	-0.40	-0.26	-0.13
2800	2818	0.04	-0.02	0.00	-0.21	-0.27	-0.39	-0.30	0.03	0.23	-0.14	-0.59	-0.29	-0.25
3000	2985	0.01	-0.02	0.02	-0.06	-0.09	-0.27	-0.43	-0.21	0.11	0.09	-0.57	-0.35	-0.30
3150	3162	-0.06	-0.05	-0.03	0.00	-0.02	-0.12	-0.34	-0.35	-0.03	0.16	-0.38	-0.40	-0.27
3350	3350	-0.09	-0.07	-0.07	0.02	-0.01	-0.04	-0.20	-0.38	-0.13	0.15	-0.17	-0.44	-0.24
3550	3548	-0.09	-0.06	-0.09	0.01	-0.03	0.00	-0.09	-0.34	-0.23	0.12	0.00	-0.47	-0.20
3750	3758	-0.06	-0.03	-0.07	0.01	-0.05	0.02	0.00	-0.24	-0.32	0.09	0.15	-0.46	-0.18
4000	3981	-0.02	0.00	-0.03	0.02	-0.08	0.00	0.06	-0.10	-0.38	0.03	0.25	-0.41	-0.17
4250	4217	0.02	0.02	0.00	0.04	-0.09	-0.06	0.07	0.02	-0.36	-0.08	0.29	-0.28	-0.23
4500	4467	0.03	0.01	-0.02	-0.01	-0.08	-0.14	-0.03	0.07	-0.24	-0.31	0.25	-0.08	-0.40
4750	4732	-0.01	-0.02	-0.03	-0.08	-0.13	-0.13	-0.22	0.05	-0.09	-0.56	0.15	0.12	-0.67
5000	5012	-0.10	-0.09	-0.02	-0.03	-0.14	-0.12	-0.22	-0.10	0.01	-0.51	0.04	0.26	-0.87
5300	5309	-0.17	-0.20	-0.14	-0.05	-0.02	-0.15	-0.11	-0.31	0.11	-0.21	-0.25	0.24	-0.75
5600	5623	-0.05	-0.12	-0.17	-0.21	-0.02	0.00	-0.17	-0.15	0.00	-0.04	-0.64	0.21	-0.27
6000	5957	0.07	0.03	-0.01	-0.09	-0.18	0.06	-0.10	-0.08	-0.33	0.09	-0.51	0.27	0.16
6300	6310	0.01	0.00	0.02	0.02	-0.16	-0.14	0.02	-0.20	-0.28	0.12	-0.27	0.11	0.22
6700	6683	-0.07	-0.09	-0.08	0.01	-0.07	-0.21	-0.05	-0.17	-0.19	-0.14	-0.21	-0.27	0.16
7100	7079	-0.06	-0.07	-0.07	-0.05	-0.02	-0.06	-0.21	0.03	-0.21	-0.31	-0.07	-0.55	0.24
7500	7499	0.02	-0.04	-0.08	-0.04	-0.15	0.03	-0.19	-0.02	-0.28	-0.23	0.17	-0.56	0.40
8000	7943	-0.06	-0.06	-0.05	-0.12	-0.18	-0.17	-0.09	-0.31	-0.22	-0.22	0.16	-0.49	0.46
8500	8414	-0.20	-0.22	-0.14	-0.07	-0.24	-0.21	-0.06	-0.34	-0.05	-0.27	-0.13	-0.47	0.32
9000	8913	-0.04	-0.10	-0.17	-0.14	-0.07	-0.11	-0.22	-0.09	-0.19	-0.33	-0.38	-0.29	-0.18
9500	9441	0.03	0.01	0.02	-0.03	-0.15	-0.07	-0.09	0.03	-0.35	-0.11	-0.29	0.24	-0.56
10000	10000	0.02	-0.03	-0.02	0.10	-0.16	0.00	-0.15	-0.19	-0.34	0.07	-0.14	0.47	-0.52
10600	10593	0.13	0.03	0.00	-0.03	0.00	-0.11	-0.02	-0.06	-0.02	-0.09	-0.05	0.10	-0.55
11200	11220	0.09	0.03	-0.01	-0.07	-0.16	0.00	-0.13	-0.27	-0.23	-0.42	-0.37	-0.45	-0.96
11800	11885	-0.03	-0.14	-0.18	-0.17	-0.22	-0.19	-0.32	-0.10	-0.40	-0.35	-0.08	-0.44	-0.25
12500	12589	-0.10	-0.17	-0.19	-0.25	-0.24	-0.26	-0.17	-0.32	-0.39	-0.04	-0.07	-0.19	0.29
13200	13335	0.03	-0.02	-0.04	-0.01	-0.14	-0.06	-0.14	-0.14	-0.15	-0.15	0.00	0.02	0.44
14000	14125	0.03	-0.01	-0.05	-0.01	-0.07	-0.04	-0.06	0.07	-0.02	-0.08	-0.22	-0.15	0.24
15000	14962	-0.06	-0.09	-0.09	-0.08	-0.12	-0.09	-0.13	-0.05	-0.16	0.00	-0.01	0.04	-0.22
16000	15849	-0.03	-0.05	-0.06	0.00	-0.09	-0.07	-0.03	-0.09	0.03	0.06	0.56	0.67	-0.12
17000	16788	-0.07	-0.08	-0.09	0.01	-0.08	-0.02	0.05	0.02	0.15	0.30	0.19	0.95	0.48
18000	17783	-0.24	-0.27	-0.28	-0.21	-0.27	-0.13	-0.18	-0.14	-0.08	-0.13	0.20	-0.08	0.64
19000	18837	-0.23	-0.22	-0.33	-0.16	-0.36	-0.41	-0.43	-0.38	-0.47	0.00	-0.48	0.69	-0.99
20000	19953	0.00	0.01	-0.15	0.02	-0.18	-0.25	-0.25	-0.21	-0.21	-0.26	-0.05	0.75	0.09

130° to 250°

Nominal Frequency (Hz)	Exact Frequency (Hz)	Angle from reference direction												
		130°	140°	150°	160°	170°	180°	190°	200°	210°	220°	230°	240°	250°
63	63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	158	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200	198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	251	-0.06	-0.04	-0.04	-0.05	-0.04	-0.04	-0.03	-0.04	-0.03	-0.04	-0.04	-0.03	-0.04
315	316	-0.07	-0.05	-0.04	-0.06	-0.05	-0.05	-0.03	-0.04	-0.03	-0.04	-0.04	-0.02	-0.03
400	398	-0.08	-0.06	-0.04	-0.07	-0.05	-0.05	-0.03	-0.05	-0.03	-0.05	-0.05	-0.02	-0.03
500	501	-0.09	-0.07	-0.05	-0.07	-0.06	-0.05	-0.04	-0.05	-0.04	-0.06	-0.06	-0.03	-0.03
630	631	-0.11	-0.08	-0.07	-0.07	-0.06	-0.05	-0.05	-0.06	-0.06	-0.08	-0.08	-0.04	-0.03
800	794	-0.13	-0.12	-0.10	-0.08	-0.08	-0.06	-0.06	-0.08	-0.09	-0.11	-0.09	-0.05	-0.01
1000	1000	-0.16	-0.17	-0.15	-0.11	-0.09	-0.07	-0.08	-0.11	-0.13	-0.15	-0.08	-0.02	0.03
1060	1059	-0.17	-0.19	-0.16	-0.13	-0.10	-0.07	-0.08	-0.12	-0.14	-0.16	-0.07	0.00	0.04
1120	1122	-0.17	-0.20	-0.17	-0.14	-0.10	-0.07	-0.08	-0.13	-0.15	-0.16	-0.06	0.02	0.05
1180	1189	-0.18	-0.22	-0.18	-0.15	-0.10	-0.07	-0.09	-0.14	-0.16	-0.17	-0.04	0.04	0.06
1250	1259	-0.18	-0.23	-0.19	-0.17	-0.10	-0.07	-0.09	-0.14	-0.17	-0.17	-0.03	0.06	0.06
1320	1334	-0.17	-0.25	-0.21	-0.18	-0.10	-0.07	-0.09	-0.16	-0.18	-0.18	-0.01	0.08	0.06
1400	1413	-0.16	-0.26	-0.23	-0.19	-0.10	-0.07	-0.09	-0.17	-0.20	-0.19	0.01	0.10	0.05
1500	1496	-0.14	-0.28	-0.25	-0.21	-0.11	-0.07	-0.10	-0.19	-0.23	-0.19	0.04	0.11	0.03
1600	1585	-0.12	-0.30	-0.29	-0.22	-0.11	-0.07	-0.10	-0.21	-0.26	-0.20	0.07	0.13	0.00
1700	1679	-0.09	-0.32	-0.33	-0.25	-0.12	-0.07	-0.12	-0.24	-0.29	-0.21	0.10	0.14	-0.03
1800	1778	-0.05	-0.34	-0.38	-0.28	-0.13	-0.07	-0.13	-0.28	-0.34	-0.21	0.14	0.14	-0.08
1900	1884	0.00	-0.35	-0.44	-0.32	-0.15	-0.08	-0.15	-0.33	-0.38	-0.20	0.20	0.14	-0.14
2000	1995	0.06	-0.35	-0.50	-0.36	-0.16	-0.09	-0.18	-0.38	-0.43	-0.17	0.26	0.12	-0.21
2120	2113	0.13	-0.31	-0.51	-0.37	-0.16	-0.08	-0.19	-0.41	-0.43	-0.11	0.30	0.07	-0.25
2240	2239	0.19	-0.26	-0.53	-0.38	-0.16	-0.08	-0.19	-0.43	-0.44	-0.04	0.34	-0.01	-0.28
2360	2371	0.25	-0.21	-0.54	-0.39	-0.14	-0.06	-0.19	-0.45	-0.44	0.04	0.36	-0.11	-0.29
2500	2512	0.31	-0.16	-0.57	-0.38	-0.13	-0.02	-0.20	-0.48	-0.46	0.12	0.36	-0.24	-0.27
2650	2661	0.36	-0.10	-0.62	-0.38	-0.12	0.02	-0.22	-0.54	-0.50	0.21	0.33	-0.42	-0.26
2800	2818	0.31	0.00	-0.66	-0.43	-0.14	0.03	-0.27	-0.64	-0.50	0.34	0.16	-0.55	-0.35
3000	2985	0.12	0.17	-0.60	-0.56	-0.16	0.00	-0.30	-0.72	-0.33	0.47	-0.10	-0.45	-0.46
3150	3162	-0.04	0.28	-0.50	-0.66	-0.16	-0.02	-0.29	-0.75	-0.14	0.56	-0.25	-0.29	-0.45
3350	3350	-0.16	0.35	-0.41	-0.71	-0.15	-0.02	-0.28	-0.75	0.02	0.61	-0.33	-0.19	-0.36
3550	3548	-0.25	0.39	-0.33	-0.76	-0.14	-0.01	-0.28	-0.75	0.16	0.64	-0.36	-0.15	-0.21
3750	3758	-0.29	0.43	-0.26	-0.78	-0.12	0.01	-0.29	-0.75	0.30	0.64	-0.35	-0.16	-0.03
4000	3981	-0.30	0.45	-0.18	-0.80	-0.10	0.04	-0.30	-0.75	0.44	0.61	-0.30	-0.23	0.19
4250	4217	-0.27	0.47	-0.10	-0.81	-0.09	0.07	-0.34	-0.75	0.57	0.52	-0.23	-0.38	0.41
4500	4467	-0.24	0.42	-0.02	-0.88	-0.11	0.08	-0.42	-0.78	0.68	0.34	-0.15	-0.51	0.52
4750	4732	-0.16	0.30	0.05	-0.98	-0.17	0.06	-0.52	-0.83	0.76	0.07	-0.12	-0.52	0.38
5000	5012	-0.04	0.12	0.19	-1.08	-0.20	0.10	-0.60	-0.83	0.88	-0.26	-0.17	-0.19	0.08
5300	5309	0.02	-0.12	0.36	-1.18	-0.23	0.14	-0.67	-0.77	0.98	-0.56	-0.37	0.32	-0.11
5600	5623	-0.13	-0.36	0.56	-1.26	-0.29	0.16	-0.77	-0.63	1.00	-0.71	-0.71	0.65	-0.05
6000	5957	-0.56	-0.40	0.69	-1.30	-0.32	0.15	-0.88	-0.37	0.91	-0.46	-0.77	0.48	-0.05
6300	6310	-0.90	-0.35	0.69	-1.32	-0.34	0.11	-1.01	-0.11	0.75	-0.17	-0.44	0.13	-0.31
6700	6683	-1.01	-0.22	0.63	-1.33	-0.37	0.13	-1.13	0.15	0.52	0.04	0.07	-0.03	-0.47
7100	7079	-0.80	0.02	0.54	-1.27	-0.36	0.20	-1.21	0.43	0.25	0.15	0.53	0.11	-0.27
7500	7499	-0.48	0.19	0.37	-1.22	-0.41	0.22	-1.33	0.67	-0.05	0.05	0.67	0.23	-0.04
8000	7943	-0.23	0.28	0.13	-1.24	-0.54	0.22	-1.50	0.78	-0.31	-0.22	0.46	0.05	-0.04
8500	8414	-0.04	0.28	-0.12	-1.16	-0.66	0.27	-1.73	0.94	-0.51	-0.50	0.19	-0.31	-0.02
9000	8913	-0.03	0.03	-0.37	-0.97	-0.70	0.28	-2.11	1.36	-0.75	-0.90	0.11	-0.54	0.27
9500	9441	-0.07	-0.38	-0.51	-0.79	-0.69	0.24	-2.21	1.63	-0.44	-0.91	0.41	-0.29	0.29
10000	10000	0.23	-0.80	-0.50	-0.58	-0.75	0.28	-2.08	1.70	-0.04	-0.47	0.57	-0.09	0.24
10600	10593	0.82	-1.31	-0.40	-0.30	-0.90	0.30	-2.27	1.85	0.34	-0.03	0.52	0.12	0.03
11200	11220	0.90	-1.30	0.30	0.14	-1.25	0.28	-2.61	1.84	0.84	0.63	0.22	0.43	-0.09
11800	11885	0.00	-0.70	0.68	0.36	-1.65	0.07	-2.90	1.38	0.65	0.58	-0.15	0.27	0.05
12500	12589	-0.18	-0.77	0.71	0.23	-1.78	-0.09	-2.62	0.82	-0.07	0.26	-0.59	0.30	-0.05
13200	13335	-0.24	-0.77	0.95	0.40	-1.91	0.06	-2.39	0.65	-0.40	0.34	-0.56	0.08	0.05
14000	14125	-0.68	-0.74	0.76	0.54	-2.18	0.08	-2.44	0.19	-0.92	0.40	-0.26	-0.43	-0.13
15000	14962	-1.04	-0.39	0.24	0.42	-2.39	0.00	-2.32	-0.54	-1.37	0.43	-0.19	-0.37	-0.57
16000	15849	-0.41	0.38	-0.23	0.26	-2.57	-0.04	-1.79	-0.75	-1.08	0.23	-0.13	-0.75	-0.58
17000	16788	0.70	1.35	-0.83	0.20	-2.79	0.00	-1.31	-0.58	-0.85	-0.01	0.16	-0.46	-0.53
18000	17783	1.51	2.05	-1.28	-0.15	-3.39	0.20	-1.26	-0.56	-1.00	0.33	0.03	-0.41	-0.38
19000	18837	0.18	1.92	-0.06	-1.23	-5.90	-0.74	0.48	0.68	-0.13	-0.86	-0.15	0.12	-0.07
20000	19953	0.12	1.74	-0.51	-0.33	-6.33	-0.55	0.47	0.61	0.22	-0.51	-0.15	0.18	0.09

260° to 350°

Nominal Frequency (Hz)	Exact Frequency (Hz)	Angle from reference direction									
		260°	270°	280°	290°	300°	310°	320°	330°	340°	350°
63	63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	158	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200	198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	251	-0.03	-0.03	-0.04	-0.03	-0.01	-0.01	-0.01	0.01	0.00	-0.01
315	316	-0.04	-0.03	-0.04	-0.03	-0.01	-0.01	-0.01	0.01	0.01	-0.01
400	398	-0.03	-0.03	-0.03	-0.02	-0.01	-0.01	-0.01	0.01	0.01	-0.01
500	501	-0.03	-0.01	-0.02	-0.02	-0.01	-0.01	-0.01	0.00	0.00	-0.02
630	631	-0.02	0.00	-0.01	-0.02	-0.01	-0.02	-0.02	-0.01	-0.02	-0.03
800	794	0.00	0.02	-0.01	-0.04	-0.03	-0.04	-0.04	-0.04	-0.05	-0.05
1000	1000	0.01	0.00	-0.04	-0.08	-0.07	-0.07	-0.07	-0.07	-0.07	-0.06
1060	1059	0.01	-0.02	-0.06	-0.09	-0.08	-0.08	-0.08	-0.07	-0.07	-0.06
1120	1122	0.00	-0.04	-0.08	-0.11	-0.09	-0.09	-0.08	-0.07	-0.07	-0.06
1180	1189	-0.02	-0.06	-0.09	-0.12	-0.10	-0.09	-0.08	-0.06	-0.05	-0.05
1250	1259	-0.04	-0.09	-0.11	-0.13	-0.11	-0.09	-0.08	-0.04	-0.04	-0.03
1320	1334	-0.06	-0.11	-0.13	-0.14	-0.11	-0.09	-0.06	-0.03	-0.02	-0.01
1400	1413	-0.08	-0.13	-0.14	-0.15	-0.12	-0.08	-0.05	0.00	0.01	0.01
1500	1496	-0.11	-0.15	-0.16	-0.16	-0.12	-0.06	-0.02	0.02	0.03	0.04
1600	1585	-0.14	-0.17	-0.17	-0.17	-0.10	-0.03	0.01	0.05	0.05	0.06
1700	1679	-0.18	-0.19	-0.19	-0.17	-0.07	0.01	0.05	0.07	0.06	0.06
1800	1778	-0.21	-0.21	-0.21	-0.16	-0.03	0.06	0.07	0.07	0.05	0.05
1900	1884	-0.24	-0.24	-0.22	-0.11	0.04	0.10	0.08	0.06	0.02	0.02
2000	1995	-0.26	-0.27	-0.22	-0.04	0.10	0.11	0.06	0.01	-0.03	-0.03
2120	2113	-0.26	-0.28	-0.16	0.05	0.14	0.08	0.01	-0.05	-0.09	-0.09
2240	2239	-0.27	-0.28	-0.05	0.13	0.13	0.03	-0.05	-0.11	-0.14	-0.13
2360	2371	-0.28	-0.24	0.08	0.17	0.09	-0.03	-0.10	-0.17	-0.18	-0.14
2500	2512	-0.30	-0.14	0.24	0.15	0.03	-0.08	-0.14	-0.21	-0.19	-0.10
2650	2661	-0.35	0.07	0.37	0.07	-0.03	-0.13	-0.15	-0.21	-0.14	0.01
2800	2818	-0.30	0.32	0.30	-0.08	-0.15	-0.17	-0.06	-0.11	-0.05	0.10
3000	2985	-0.07	0.30	0.04	-0.20	-0.26	-0.11	0.04	0.00	-0.01	0.05
3150	3162	0.12	0.14	-0.10	-0.27	-0.22	-0.04	0.04	0.03	-0.01	-0.03
3350	3350	0.22	0.02	-0.17	-0.26	-0.11	-0.01	0.01	0.03	-0.02	-0.07
3550	3548	0.25	-0.05	-0.22	-0.18	-0.02	0.00	-0.02	0.03	-0.01	-0.08
3750	3758	0.23	-0.06	-0.26	-0.06	0.05	0.01	-0.03	0.03	0.00	-0.06
4000	3981	0.17	-0.07	-0.27	0.07	0.10	0.01	-0.05	0.02	0.02	-0.01
4250	4217	0.10	-0.13	-0.17	0.16	0.12	-0.03	-0.05	0.04	0.06	0.05
4500	4467	0.05	-0.29	0.03	0.17	0.06	-0.10	-0.01	0.09	0.11	0.12
4750	4732	-0.01	-0.37	0.18	0.13	-0.10	-0.09	0.08	0.14	0.13	0.14
5000	5012	-0.20	-0.12	0.20	-0.04	-0.15	0.04	0.15	0.09	0.04	0.06
5300	5309	-0.46	0.18	0.18	-0.23	0.00	0.11	0.08	-0.03	-0.07	-0.03
5600	5623	-0.33	0.21	0.01	-0.15	0.11	0.02	-0.04	-0.09	-0.07	-0.01
6000	5957	0.08	0.15	-0.18	0.03	0.08	-0.08	-0.03	0.02	0.02	0.04
6300	6310	0.15	0.09	-0.14	0.10	0.01	-0.07	0.06	0.06	0.05	0.04
6700	6683	0.10	-0.07	-0.05	0.08	-0.07	0.01	0.06	0.07	0.04	0.02
7100	7079	0.20	-0.18	0.06	0.02	-0.02	0.05	0.08	0.06	0.02	0.00
7500	7499	0.18	-0.19	0.12	-0.09	0.05	0.03	0.05	0.04	0.05	0.08
8000	7943	-0.04	-0.11	0.04	-0.04	0.01	-0.03	0.01	0.05	0.08	0.08
8500	8414	-0.20	0.03	-0.08	0.02	-0.02	-0.04	0.01	0.07	0.00	-0.04
9000	8913	-0.23	0.15	-0.08	0.03	0.04	-0.03	0.16	0.04	0.00	0.08
9500	9441	0.02	0.10	0.11	0.10	0.05	0.16	0.11	0.15	0.21	0.18
10000	10000	0.25	0.01	0.17	0.18	0.16	0.15	0.22	0.29	0.16	0.10
10600	10593	0.45	0.13	0.23	0.17	0.31	0.14	0.36	0.17	0.19	0.22
11200	11220	0.24	0.30	0.17	0.17	0.19	0.28	0.19	0.28	0.17	0.08
11800	11885	0.02	0.17	0.18	0.20	0.18	0.11	0.32	0.12	0.14	0.16
12500	12589	-0.13	-0.17	-0.13	-0.12	0.01	0.03	0.02	0.08	0.00	-0.03
13200	13335	-0.11	-0.04	-0.01	0.00	-0.04	0.02	0.19	0.12	0.13	0.08
14000	14125	-0.14	-0.27	-0.11	-0.02	0.05	0.01	0.09	0.14	0.09	0.09
15000	14962	-0.34	-0.40	-0.39	-0.22	-0.14	-0.11	0.05	0.03	0.04	0.01
16000	15849	-0.36	-0.23	-0.19	-0.06	-0.16	-0.13	-0.01	0.02	0.01	0.00
17000	16788	-0.45	-0.38	-0.27	-0.22	-0.17	-0.17	0.04	0.08	0.07	0.04
18000	17783	-0.56	-0.56	-0.34	-0.22	-0.15	-0.20	-0.04	-0.08	-0.06	-0.14
19000	18837	-0.04	-0.08	-0.19	0.02	0.05	0.03	0.16	0.21	0.19	0.02
20000	19953	-0.01	-0.03	-0.04	0.19	0.22	0.14	0.29	0.42	0.32	0.08

Influence of the UA-237 windshield on frequency response.

Note that the UA:237 is spherically symmetrical, angles 350°~190° are equivalent to 10°~170°.
0° to 90°

Nominal Frequency (Hz)	Exact Frequency (Hz)	Angle from reference direction									
		0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
63	63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	158	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200	198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	251	0.03	0.04	0.07	0.07	0.02	0.01	0.04	0.04	-0.02	-0.01
315	316	0.04	0.05	0.09	0.09	0.04	0.01	0.05	0.04	0.01	-0.01
400	398	0.06	0.06	0.09	0.10	0.06	0.02	0.06	0.05	0.03	-0.01
500	501	0.07	0.08	0.10	0.10	0.07	0.03	0.06	0.05	0.05	0.01
630	631	0.09	0.10	0.11	0.11	0.10	0.06	0.08	0.06	0.08	0.04
800	794	0.14	0.15	0.14	0.14	0.13	0.12	0.12	0.10	0.11	0.09
1000	1000	0.22	0.23	0.23	0.22	0.21	0.20	0.19	0.17	0.17	0.16
1060	1059	0.25	0.26	0.26	0.25	0.23	0.22	0.22	0.19	0.19	0.18
1120	1122	0.28	0.29	0.29	0.27	0.25	0.24	0.24	0.22	0.21	0.20
1180	1189	0.31	0.32	0.32	0.30	0.28	0.27	0.27	0.24	0.23	0.22
1250	1259	0.34	0.34	0.35	0.34	0.30	0.30	0.29	0.27	0.26	0.25
1320	1334	0.37	0.37	0.38	0.37	0.33	0.32	0.32	0.29	0.28	0.27
1400	1413	0.40	0.40	0.41	0.40	0.35	0.36	0.35	0.33	0.31	0.30
1500	1496	0.42	0.43	0.44	0.43	0.38	0.39	0.38	0.36	0.34	0.34
1600	1585	0.46	0.46	0.46	0.46	0.41	0.43	0.42	0.39	0.37	0.38
1700	1679	0.49	0.50	0.49	0.49	0.45	0.47	0.46	0.44	0.41	0.42
1800	1778	0.52	0.53	0.53	0.52	0.49	0.50	0.50	0.48	0.46	0.47
1900	1884	0.56	0.57	0.56	0.55	0.52	0.54	0.54	0.53	0.51	0.51
2000	1995	0.59	0.60	0.59	0.59	0.56	0.57	0.58	0.57	0.55	0.56
2120	2113	0.62	0.63	0.62	0.61	0.59	0.60	0.61	0.61	0.60	0.61
2240	2239	0.64	0.65	0.63	0.62	0.61	0.62	0.63	0.63	0.64	0.65
2360	2371	0.64	0.66	0.63	0.63	0.62	0.64	0.64	0.64	0.67	0.70
2500	2512	0.64	0.66	0.61	0.61	0.63	0.66	0.64	0.63	0.70	0.75
2650	2661	0.58	0.62	0.53	0.53	0.59	0.68	0.62	0.60	0.71	0.81
2800	2818	0.41	0.45	0.35	0.35	0.43	0.59	0.50	0.48	0.61	0.75
3000	2985	0.19	0.22	0.18	0.19	0.23	0.35	0.31	0.31	0.41	0.53
3150	3162	0.09	0.10	0.11	0.13	0.12	0.17	0.21	0.21	0.28	0.35
3350	3350	0.05	0.05	0.09	0.11	0.07	0.06	0.14	0.16	0.20	0.23
3550	3548	0.06	0.05	0.09	0.11	0.05	0.00	0.10	0.12	0.15	0.14
3750	3758	0.09	0.08	0.11	0.12	0.04	-0.04	0.06	0.08	0.10	0.06
4000	3981	0.13	0.12	0.14	0.14	0.05	-0.05	0.02	0.04	0.06	-0.01
4250	4217	0.18	0.18	0.17	0.16	0.06	-0.03	-0.02	0.00	0.01	-0.09
4500	4467	0.25	0.24	0.23	0.21	0.11	0.03	-0.04	-0.04	-0.02	-0.17
4750	4732	0.29	0.29	0.27	0.25	0.17	0.13	-0.01	-0.08	-0.05	-0.20
5000	5012	0.31	0.31	0.28	0.26	0.19	0.21	0.08	-0.10	-0.09	-0.19
5300	5309	0.33	0.33	0.29	0.25	0.17	0.20	0.14	-0.06	-0.17	-0.16
5600	5623	0.19	0.20	0.17	0.17	0.09	0.09	0.06	-0.02	-0.29	-0.20
6000	5957	0.01	0.02	0.02	0.04	0.01	0.04	-0.03	-0.01	-0.20	-0.26
6300	6310	-0.01	-0.01	-0.01	0.00	-0.02	0.04	0.00	0.00	-0.03	-0.21
6700	6683	0.01	0.01	-0.01	-0.03	-0.08	-0.03	-0.02	-0.05	0.06	-0.17
7100	7079	0.03	0.03	-0.01	-0.05	-0.15	-0.13	-0.12	-0.15	-0.01	-0.21
7500	7499	0.06	0.06	0.03	-0.01	-0.16	-0.19	-0.23	-0.27	-0.17	-0.29
8000	7943	0.04	0.04	0.03	0.03	-0.11	-0.18	-0.29	-0.36	-0.37	-0.37
8500	8414	0.07	0.07	0.03	0.00	-0.10	-0.15	-0.31	-0.42	-0.55	-0.49
9000	8913	-0.01	0.02	0.01	0.00	-0.12	-0.10	-0.28	-0.42	-0.59	-0.64
9500	9441	-0.19	-0.16	-0.14	-0.08	-0.16	-0.15	-0.20	-0.38	-0.45	-0.79
10000	10000	-0.08	-0.07	-0.15	-0.21	-0.28	-0.25	-0.23	-0.34	-0.40	-0.85
10600	10593	-0.10	-0.07	-0.12	-0.16	-0.34	-0.27	-0.34	-0.31	-0.42	-0.64
11200	11220	-0.22	-0.22	-0.29	-0.30	-0.44	-0.54	-0.57	-0.62	-0.64	-0.59
11800	11885	-0.23	-0.23	-0.29	-0.29	-0.39	-0.41	-0.60	-0.76	-0.76	-0.80
12500	12589	-0.71	-0.70	-0.73	-0.70	-0.79	-0.76	-0.90	-1.07	-1.27	-1.48
13200	13335	-0.64	-0.63	-0.70	-0.71	-0.85	-0.78	-0.83	-0.98	-1.22	-1.45
14000	14125	-0.73	-0.69	-0.71	-0.73	-0.97	-0.95	-1.01	-1.06	-1.21	-1.35
15000	14962	-0.79	-0.76	-0.81	-0.81	-1.00	-1.07	-1.18	-1.22	-1.29	-1.44
16000	15849	-0.90	-0.88	-0.88	-0.85	-1.07	-1.09	-1.21	-1.37	-1.53	-1.62
17000	16788	-0.90	-0.88	-0.93	-0.94	-1.16	-1.08	-1.24	-1.42	-1.70	-1.80
18000	17783	-1.15	-1.15	-1.16	-1.18	-1.48	-1.51	-1.55	-1.61	-1.87	-2.18
19000	18837	-1.20	-1.19	-1.18	-1.13	-1.45	-1.52	-1.72	-1.86	-2.16	-2.33
20000	19953	-1.12	-1.15	-1.09	-1.05	-1.44	-1.49	-1.64	-1.80	-2.22	-2.39

100° to 180°

Nominal Frequency (Hz)	Exact Frequency (Hz)	Angle from reference direction								
		100°	110°	120°	130°	140°	150°	160°	170°	180°
63	63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
125	125	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	158	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200	198	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	251	-0.04	0.04	-0.02	0.05	0.00	0.03	0.06	-0.02	-0.06
315	316	-0.03	0.07	-0.01	0.07	0.01	0.03	0.09	-0.01	-0.07
400	398	-0.02	0.09	0.00	0.08	0.02	0.03	0.10	0.00	-0.06
500	501	0.01	0.11	0.02	0.08	0.03	0.03	0.10	0.01	-0.04
630	631	0.04	0.12	0.04	0.08	0.05	0.04	0.08	0.03	0.00
800	794	0.10	0.14	0.08	0.09	0.08	0.08	0.08	0.06	0.06
1000	1000	0.16	0.20	0.14	0.15	0.14	0.13	0.14	0.11	0.11
1060	1059	0.17	0.22	0.16	0.17	0.16	0.15	0.17	0.13	0.12
1120	1122	0.19	0.24	0.18	0.20	0.18	0.17	0.20	0.15	0.12
1180	1189	0.20	0.26	0.20	0.22	0.20	0.19	0.23	0.17	0.13
1250	1259	0.22	0.27	0.22	0.24	0.22	0.21	0.25	0.19	0.15
1320	1334	0.25	0.29	0.25	0.27	0.25	0.23	0.28	0.20	0.16
1400	1413	0.27	0.31	0.27	0.29	0.27	0.26	0.30	0.22	0.18
1500	1496	0.31	0.34	0.30	0.32	0.29	0.29	0.32	0.25	0.21
1600	1585	0.35	0.37	0.33	0.35	0.32	0.32	0.34	0.28	0.24
1700	1679	0.39	0.41	0.37	0.39	0.36	0.36	0.37	0.31	0.27
1800	1778	0.44	0.45	0.42	0.43	0.40	0.40	0.40	0.35	0.31
1900	1884	0.49	0.50	0.47	0.47	0.45	0.45	0.45	0.39	0.36
2000	1995	0.54	0.55	0.51	0.52	0.50	0.50	0.49	0.43	0.40
2120	2113	0.59	0.59	0.56	0.57	0.54	0.55	0.54	0.48	0.44
2240	2239	0.64	0.64	0.61	0.61	0.59	0.59	0.57	0.52	0.49
2360	2371	0.68	0.68	0.66	0.64	0.64	0.63	0.60	0.56	0.54
2500	2512	0.74	0.72	0.72	0.66	0.69	0.67	0.60	0.61	0.61
2650	2661	0.79	0.74	0.77	0.66	0.75	0.69	0.58	0.67	0.71
2800	2818	0.75	0.68	0.75	0.62	0.75	0.69	0.54	0.68	0.77
3000	2985	0.55	0.55	0.61	0.56	0.64	0.65	0.57	0.62	0.64
3150	3162	0.40	0.47	0.49	0.54	0.54	0.61	0.62	0.55	0.49
3350	3350	0.31	0.43	0.42	0.52	0.48	0.57	0.65	0.51	0.40
3550	3548	0.24	0.39	0.36	0.49	0.43	0.54	0.66	0.47	0.34
3750	3758	0.19	0.35	0.31	0.45	0.39	0.49	0.64	0.44	0.30
4000	3981	0.13	0.28	0.24	0.37	0.34	0.43	0.57	0.39	0.27
4250	4217	0.04	0.16	0.13	0.25	0.25	0.34	0.45	0.31	0.22
4500	4467	-0.07	0.01	-0.01	0.08	0.12	0.21	0.29	0.19	0.13
4750	4732	-0.19	-0.16	-0.18	-0.12	-0.06	0.04	0.07	0.02	0.00
5000	5012	-0.32	-0.35	-0.38	-0.38	-0.31	-0.21	-0.22	-0.22	-0.22
5300	5309	-0.42	-0.52	-0.56	-0.65	-0.59	-0.50	-0.55	-0.52	-0.50
5600	5623	-0.50	-0.72	-0.76	-0.94	-0.93	-0.85	-0.96	-0.89	-0.86
6000	5957	-0.45	-0.69	-0.79	-1.00	-1.07	-1.08	-1.13	-1.11	-1.13
6300	6310	-0.30	-0.51	-0.66	-0.87	-0.99	-1.08	-1.10	-1.10	-1.16
6700	6683	-0.21	-0.36	-0.53	-0.70	-0.86	-0.98	-1.01	-1.03	-1.10
7100	7079	-0.22	-0.29	-0.45	-0.57	-0.72	-0.84	-0.89	-0.91	-0.98
7500	7499	-0.30	-0.27	-0.40	-0.47	-0.58	-0.70	-0.71	-0.74	-0.80
8000	7943	-0.42	-0.36	-0.43	-0.44	-0.50	-0.59	-0.60	-0.55	-0.61
8500	8414	-0.59	-0.58	-0.57	-0.55	-0.57	-0.60	-0.60	-0.47	-0.53
9000	8913	-0.86	-0.87	-0.88	-0.81	-0.81	-0.76	-0.70	-0.53	-0.64
9500	9441	-1.03	-1.02	-1.19	-1.08	-1.13	-1.02	-0.93	-0.81	-0.90
10000	10000	-1.00	-1.10	-1.40	-1.31	-1.45	-1.39	-1.29	-1.24	-1.32
10600	10593	-0.82	-1.13	-1.37	-1.44	-1.66	-1.69	-1.65	-1.60	-1.68
11200	11220	-0.94	-1.19	-1.29	-1.57	-1.84	-2.00	-2.00	-2.00	-2.09
11800	11885	-0.92	-1.00	-1.07	-1.46	-1.59	-1.81	-1.83	-1.73	-1.86
12500	12589	-1.51	-1.54	-1.50	-1.73	-1.82	-1.80	-1.71	-1.65	-1.74
13200	13335	-1.68	-1.71	-1.71	-1.86	-1.85	-1.75	-1.59	-1.52	-1.59
14000	14125	-1.81	-1.96	-2.16	-2.35	-2.19	-2.14	-2.01	-1.92	-2.00
15000	14962	-1.87	-2.18	-2.54	-2.72	-2.64	-2.76	-2.83	-2.70	-2.88
16000	15849	-1.88	-2.09	-2.36	-2.48	-2.82	-3.03	-3.05	-3.05	-3.41
17000	16788	-1.92	-2.02	-2.03	-2.20	-2.70	-2.87	-2.71	-2.62	-3.05
18000	17783	-2.51	-2.47	-2.48	-2.48	-2.81	-3.01	-2.53	-2.32	-2.69
19000	18837	-2.84	-3.04	-3.27	-3.20	-3.49	-3.35	-2.97	-3.00	-3.45
20000	19953	-2.76	-2.93	-3.34	-3.38	-3.73	-3.53	-3.20	-3.45	-4.11

Appendix 2 – Influence of mechanical vibrations

Mechanical vibrations with an acceleration of 1 m/s^2 perpendicular to the plane of the membrane of the microphone at frequencies of 31.5 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 630 Hz, 800 Hz and 1000 Hz will increase the lower limit of the linear operating range of the A-weighting to 75 dB. Mechanical vibrations with an acceleration of 1 m/s^2 parallel to the plane of the membrane increases the lower limit of the linear working range of the A-weighting to 64 dB.

Appendix 3 – Instructions for legal applications

Only calibrated instruments should be used when measurements are made for legal purposes. The Optimus sound level meter has been designed according to the IEC 61672-1 standard and can therefore be approved.

Information for performing electrical tests

The Cirrus Research dummy microphone type KP:66 is recommended. The KP:66 has a capacitance 18 pF and an input sensitivity is nominally 50 mV/Pa (see section 9.3g – Page 21). The maximum input voltage at the input to the dummy microphone is 100 V_{pk-pk} (see section 9.3i – Page 22).

	L _A (dB)	L _C (dB)	L _Z (dB)	L _{Aeq,T} (dB)	L _{AE} (dB) (t _{int} = 10s)	L _{Cpeak} (dB)
31,5 Hz	from 20 to 100 start 94	from 30 to 137 start 94	from 45 to 140 start 94	from 20 to 100 start 94	from 30 to 110 start 104	
1 kHz	from 20 to 140 start 94	from 30 to 140 start 94	from 45 to 140 start 94	from 20 to 140 start 94	from 30 to 150 start 104	from 50 to 143
12, 5 kHz	from 20 to 136 start 94	from 30 to 134 start 94	from 45 to 139 start 94	from 20 to 136 start 94	from 30 to 146 start 104	

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