TECHNICAL NOTES

Sound Level Meter

NL-62

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Organization of the NL-62 documentation

Documentation for the Sound Level Meter NL-62 comes in three parts, as listed below.

- **Instruction Manual**

  Describes operating procedures for the NL-62, connection and use of peripheral equipment such as a level recorder and printer, and use of the SD memory card.

- **Serial Interface Manual**

  Describes communication with a computer, using the serial interface built into the NL-62. The manual covers the communication protocol, use of control commands for the sound level meter, format of data output by the sound level meter, and other topics.

- **Technical Notes (this document)**

  This document provides in-depth information about sound level meter performance, microphone construction and characteristics, influence of extension cables and windscreen on the measurement, and other topics.

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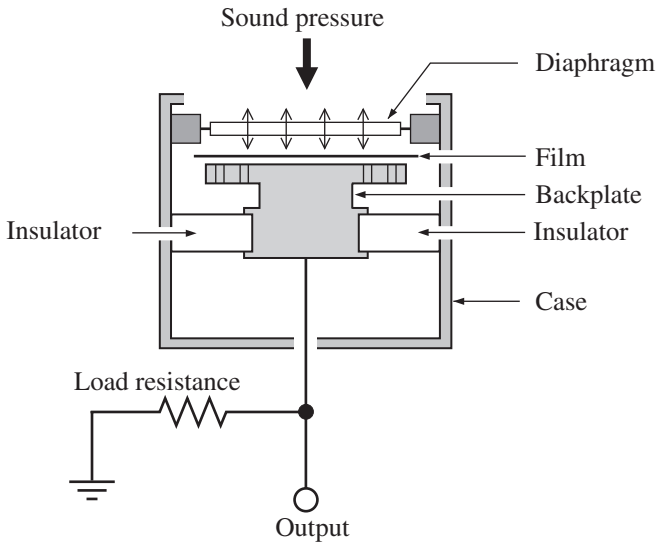
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Microphone

Measurements of sound pressure level can be carried out with a variety of microphone types. The NL-62 employs the prepolarized condenser microphone UC-59L that is compact and delivers stable and reliable response.

Construction and operation principle

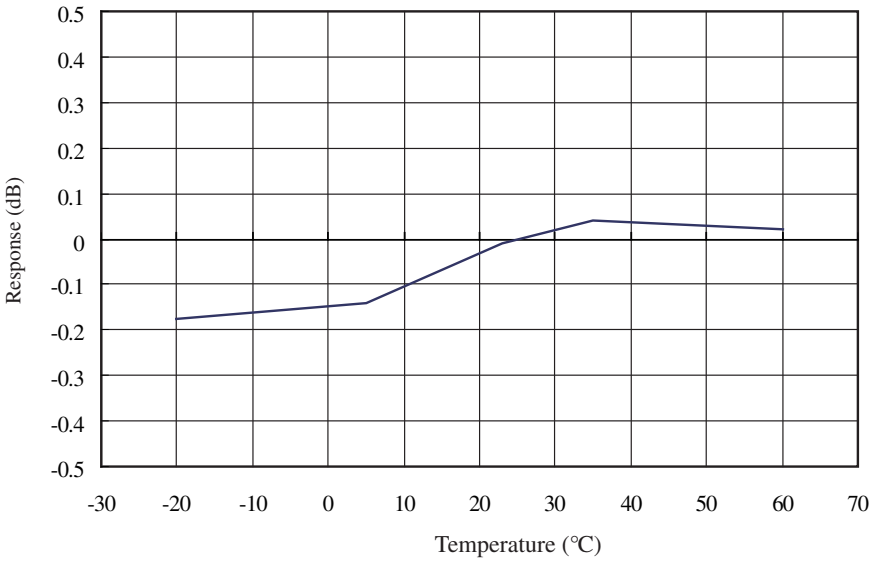
As shown in the illustration below, an electret condenser microphone normally consists of five main parts, namely the diaphragm, film, backplate, insulator, and case. A film with an electrical charge is normally mounted to the back-plate. When sound pressure is applied to the diaphragm, the distance between the diaphragm and the backplate changes, thereby altering the capacitance. Using a load resistor, this change can be turned into a voltage change. The frequency response as well as the temperature and humidity characteristics of an prepolarized condenser microphone depend considerably on the type and properties of the materials used. The high frequency range is determined by the resonance frequency of the diaphragm assembly.



Construction of prepolarized condenser microphone

Thermal characteristics

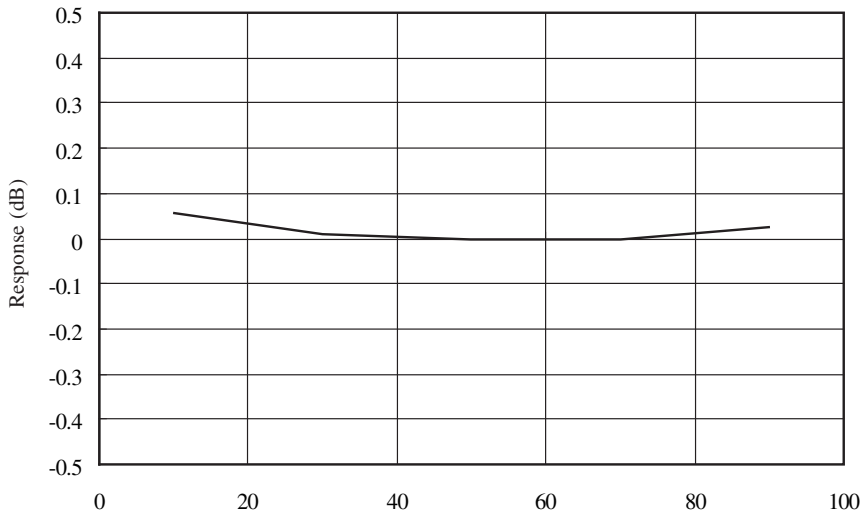
The thermal characteristics of a microphone indicate how sensitivity changes at various temperatures. The diagrams below show the thermal characteristics of the microphone UC-59L.



Thermal characteristics of UC-59L (at 250 Hz)

Humidity characteristics

The humidity characteristics of a microphone indicate how sensitivity changes at various humidity. The diagrams below show the humidity characteristics of the microphone UC-59L.



Humidity characteristics of UC-59L (at 250 Hz)

Specifications of microphone UC-59L

Model	UC-59L
Nominal diameter	1/2 inch
Sensitivity	-27 dB ±2 dB (re. 1 V/Pa)*
Frequency response	1 to 20000 Hz
Capacitance	13 pF ±1.5 pF
Temperature dependent sensitivity level fluctuation	
	±0.35 dB max. from -10 to +50ºC
	referenced to 23ºC (at 1 kHz)
	±0.5 dB max. from -20 to +60ºC
	referenced to 23ºC (at 1 kHz)
Humidity dependent sensitivity level fluctuation	
	±0.14 dB max. referenced to 23ºC, 50%RH
	90%RH max.
	(at 1 kHz no condensation)
Ambient temperature/humidity range for operation	
	-20 to +60ºC, 90%RH max.
	(no condensation)
Ambient temperature range for storage	
	-20 to +60ºC
Dimensions, weight	13.2 dia × approx. 14.3 mm, approx. 4.7 g

*Reference environment conditions

Temperature: 23ºC, Humidity: 50%RH

Atmospheric pressure: 101.325 kPa

Preamplifier

Preamplifier Requirement

Since the condenser microphone is a small-capacity transducer, it has high impedance, especially at low frequencies. Therefore a very high load resistance is required to ensure uniform response extending to the low frequency range. The relationship between the microphone capacitance and the low-range cutoff frequency can be expressed as follows.

$$f_0 = \frac{1}{2\pi \times Z_{in} \times C_m}$$

f_0: Low-range cutoff frequency (Hz)
Z_{in}: Preamplifier input impedance (Ω)
C_m: Capacitance of condenser microphone (F)

If the output of the microphone were directly routed through a long shielded cable, the capacitance between the cable conductors would cause a sharp drop in sensitivity, as is evident from the following equation.

$$M_0 = \frac{C_m}{C_m + C_c} \cdot M_s$$

M_0: Output voltage into directly connected shielded cable (V)
M_s: Output voltage in microphone open condition (V)
C_c: Cable capacitance of shielded cable (F)

For the above reasons, a preamplifier of high input impedance is connected directly after the microphone, to provide a low-impedance output signal.

Preamplifier Specifications

Model name:	NH-26
Input impedance:	Approx. 30 GΩ // 24 pF
Output resistance:	Approx. 50 Ω

Influence of Microphone Extension Cable

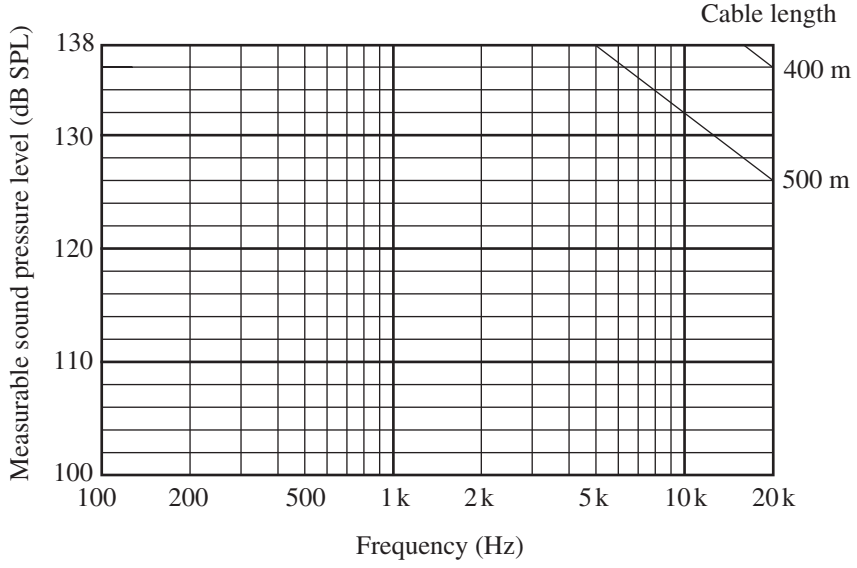
When the output of the microphone/preamplifier is routed through an extension cable, certain limitations regarding measurable sound pressure level and frequency range will apply. This is due to the influence of the cable capacitance. The longer the cable, the lower the measurable sound pressure level and the lower the frequency limit.
Available cables are listed in the table below. Combining multiple cables is also possible.

Model	Length
EC-04	2 m
EC-04A	5 m
EC-04B	10 m

Model	Length
EC-04C	30 m (reel)+5 m (connection cable)
EC-04D	50 m (reel)+5 m (connection cable)
EC-04E	100 m (reel)+5 m (connection cable)

Extension cable EC-04 series

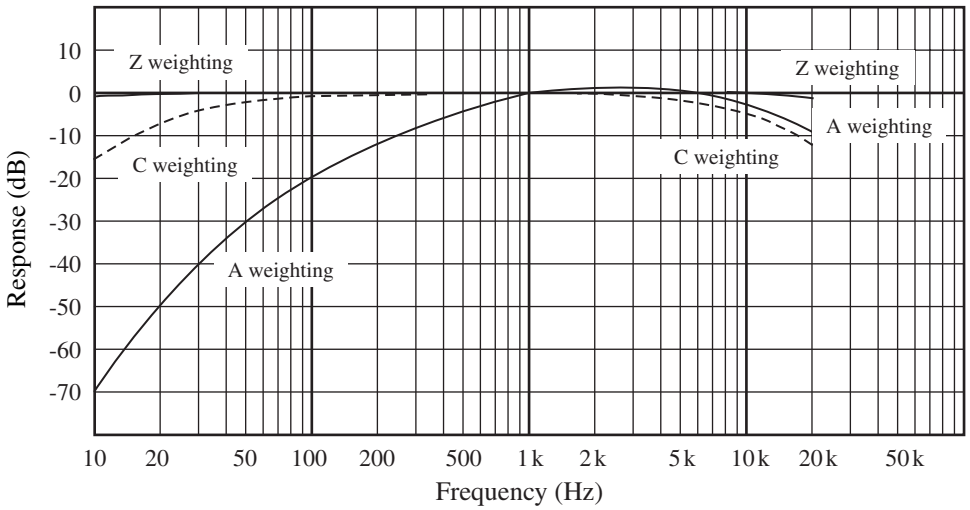
The diagram below shows the relationship among cable length, measurable sound pressure level, and frequency.
If for example a sound pressure level of 132 dB is to be measured up to 10 kHz, an extension cable length of up to 500 meters can be used.



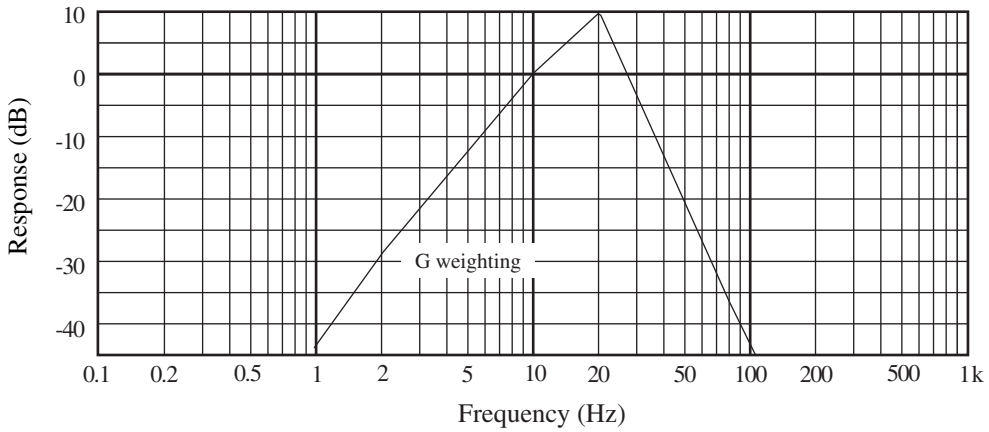
Relationship among cable length, measurable sound pressure level, and frequency

Frequency Weighting Network

The NL-62 provides frequency weightings A, C, Z and G. The electrical characteristics of the weighting network at AC output connector are as shown below.



Frequency weighting (A, C, Z)



Frequency weighting (G)

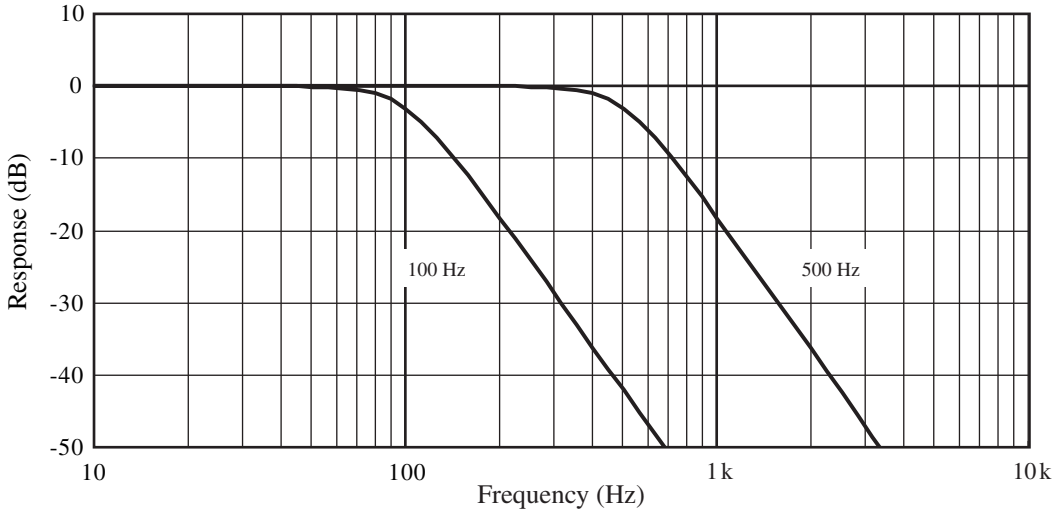
The volume impression (loudness) of a sound depends not only on the sound pressure level, but also on the frequency. At high or low frequencies, a sound is felt to be less loud than a sound of equal level in the midrange. The frequency weighting A compensates for this effect and produces measurement results which are close to the actual impression of loudness. For this reason, this type of frequency weighting is widely used for purposes such as sound level evaluation.

With the frequency weighting Z, frequency response is linear, which is suitable for sound pressure level measurements and for using the sound level meter output for frequency analysis.

The frequency weighting C curve produces almost flat response, but with a roll off below 31.5 Hz and above 8 kHz. This is suitable for sound pressure level measurements in situations with unwanted low-frequency or high-frequency components.

Characteristics of low-pass filter (LPF)

The representative characteristics of the built-in low-pass filter (cut off frequency: 100 Hz, 500 Hz) are shown as below.



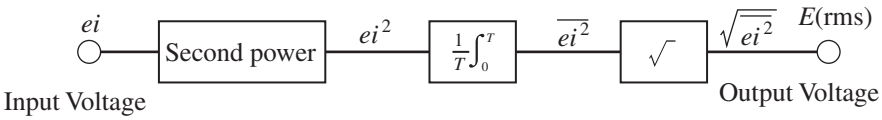
Characteristics of low-pass filter (LPF)

RMS Detection Circuit and Time Weighting

The sound level meter uses rms detection. The rms value *E* (rms) is defined by the following equation.

$$E(\mathrm{rms}) = \sqrt{\frac{1}{T}\int_0^T e^2\,\mathrm{dt}}$$

The voltage e which changes over time is raised to the second power, and integration for the time interval T is performed. The result is divided by T and the square root is extracted. The circuit configuration for performing the above mathematical operation looks as follows.
The NL-62 uses digital processing to determine the rms value.



During sound level measurements, the level often fluctuates drastically, which would make it difficult to evaluate readings if some kind of averaging is not applied. Sound level meters therefore provide the capability for index weighting (index averaging) using the rms circuit. The parameters of this weighting process are called the time weightings, determined by the time constant (see next page).

Sound level meters usually have a F (Fast) and S (Slow) setting for the time weighting. The time range that is considered for averaging is narrow in the F (Fast) setting and wide in the S (Slow) setting. In the F (Fast) setting, the instantaneous level has a larger bearing on the displayed value than in the S (Slow) setting. From the point of view of the measurement objective, the F (Fast) setting is more suitable to situations with swiftly changing sound level, whereas the S (Slow) setting yields a more broadly averaged picture.
The 10 s setting yields a more broadly averaged picture than the S (Slow) setting.

The F (Fast) setting is more commonly used, and sound pressure level values given without other indication are usually made with F (Fast) characteristics.

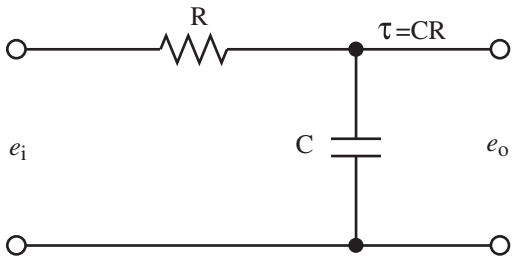
The S (Slow) setting is suitable for measuring the average of sound with fairly constant levels. For example, in Japan aircraft noise and high-speed train noise is usually transient noise with high fluctuation, but the S (Slow) setting is used to determine the maximum level for each noise event.
Low-frequency sound pressure level values given without other indication are usually made with S (Slow) characteristics.

The I (Impulse) setting enables the meter to track noise bursts of very short duration.

Time weightings and time constant

Time Weighting	Time constant	
	Rise time	Decay time
F (Fast)	125 msec	125 msec
S (Slow)	1 s	1 s
I (Impulse)	35 msec	1.5 sec
10 s	10 s	10 s

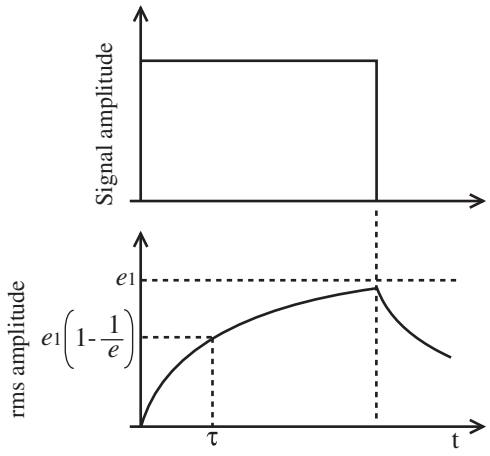
The time weighting network of the sound level meter performs index averaging on the square of the sound pressure signal. The equivalent circuit is shown below. τ is the time constant, which equals CR.



e_i : Input voltage (proportional to square of sound pressure)
e_o : Output voltage

Equivalent electrical circuit

The response of the index averaging circuit to a single burst signal is shown below.



$e1$: Burst signal voltage
e : Logarithm base
τ : Time constant
t : Time

Burst signal response

Measurement Functions

L_{Aeq} (equivalent continuous sound level)

For a sound pressure level signal that changes over time, the L_{Aeq} (equivalent continuous sound level) is a hypothetical constant sound pressure level that has the same energy as the actually measured signal in the measurement interval. It is determined by the following equation.

$$L_{AeqT} = 20 \log_{10} \left\{ \left[\left(\frac{1}{T} \right) \int_{t1}^{t2} p_A^2 (t)\, dt \right]^{1/2} / p_0 \right\}$$

t: Time variable of integration from an arbitrary start time at t_1 to the end of the interval at t_2

T: Time interval $T = t_2 - t_1$

$p_A(t)$: A-weighted instantaneous sound pressure at running time t

p_0: Reference sound pressure (20 μPa)

In sound pressure level meter NL-62, the digital processing to determine L_{Aeq} is carried out according to the following equation.

$$L_{Aeq} = 20 \log_{10} \left\{ \left(\frac{1}{N} \sum_{i=1}^{N} p_A^2 (i) \right)^{1/2} / p_0 \right\}$$

N: Number of samples

In NL-62, the sampling interval is 20.8 μs (48000 samples per second).

L_{AE} (sound exposure level)

The L_{AE} (sound exposure level) is a hypothetical constant 1-second sound pressure level having the same energy as a single-event sound pressure level measured with A weighting. It is determined by the following equation.

$$L_{AE} = 10 \log_{10} \left\{ \left[\int_{t1}^{t2} p_A^2(t)\, dt \right] \Big/ p_0^2 T_0 \right\} = L_{Aeq} + 10 \log_{10}(T / T_0)$$

t: Time variable of integration from an arbitrary start time at t_1 to the end of the interval at t_2

T: Time interval $T = t_2 - t_1$

T_0: Reference time (1 second)

$p_A(t)$: A-weighted instantaneous sound pressure at running time t

p_0: Reference sound pressure (20 μPa)

In NL-62, the digital processing to determined L_{AE} is carried out according to the following equation.

$$L_{AE} = 10 \log_{10} \frac{1}{N_0} \sum_{i=1}^{N} \frac{p_A^2(i)}{p_0^2}$$

N_0: Number of samples per second

In NL-62, the sampling interval is 20.8 μs (48000 samples per second).

L_N (percentile sound level)

The L_N (percentile sound level) is the sound level which was N percent or more of the measurement time. The NL-62 allows the user to select five values for N (from 1 to 99, in 1 steps). The sampling interval for L_N processing is 100 ms (10 samples per second).

L_{max}, L_{min} (maximum and minimum sound level)

L_{max} is the maximum sound level and L_{min} the minimum sound level encountered during a measurement.

In NL-62, the sampling interval is 20.8 μs (48000 samples per second). The maximum and minimum values since the start of the measurement are stored. Therefore the L_{max} and L_{min} readings up to the current point can be displayed already during measurement.

L_{Atm5} (takt-max sound level)

For the duration of the measurement, the maximum level within a 5-second interval is sampled and the power average is determined. L_{Atm} is calculated according to the following equation.

$$L_{Atm} = 10 \log_{10} \frac{1}{N} \sum_{i=1}^{N} 10^{Lm/10}$$

L_m: Maximum level within interval (5 seconds)
N: Number of samples

The number of samples is determine according to the following equation.

For L_{Atm5}: $N = \dfrac{(t_2 - t_1)}{5}$

t_1: Measurement start time
t_2: Measurement end time

L_{peak} (peak sound level)

The peak sound level is a maximum absolute value of frequency weighted instantaneous sound pressure level during the measuring time.

Influence of Background Noise

When measuring a certain sound in a certain location, all other sounds present at that location except the measurement target sound are background noise (also called ambient noise or dark noise). Since the sound level meter will display the combination of target sound and background noise, the amount of background noise must be taken into consideration when determining the level of the target sound.

If the difference between the meter reading in absence of the target sound and the reading with the target sound is 10 dB or more, the influence of background noise is small and may be disregarded. If the difference is less than 10 dB, the values shown in the table below may be used for compensation, to estimate the level of the target sound.

Background noise compensation

Display reading difference with and without target sound (dB)	4	5	6	7	8	9
Compensation value (dB)	- 2		- 1			

If for example the measured sound level when operating a machine is 70 dB, and the background noise level when the machine is not operating is 63 dB, the compensation value for the difference of 7 dB is -1 dB. Therefore the sound level of the machine can be taken to be 70 dB + (-1 dB) = 69 dB.

The above principle for compensating the influence of the background noise assumes that both the background noise and the target sound are approximately constant. If the background noise fluctuates, and especially if it is close in level to the target sound, compensation is difficult and will often be meaningless.

Description for IEC 61672-1

Standard paragraph	Description	See also	Remark NL-62
4	**Reference environmental conditions**	9.1	Ambient temperature: 23°C Static pressure: 101.325 kPa Relative humidity: 50%
5	**Performance specifications**		
5.1	**General**		
5.1.4	Configuration & normal mode of operation	9.2.1 b)	Configuration • NL-62 • WS-10 → Controls and Functions, Preparations
5.1.6	Models of microphone Appropriate procedures for use the sound level meter	9.2.1 c) 9.2.5 b)	UC-59L → Measurement
5.1.7	Mounting of microphone	9.2.1 b)	→ Controls and Functions, Preparations
5.1.8	Identification of computer software		N/A
5.1.10	Description of frequency weightings that are provided	9.2.2 c)	A, C, Z, G
5.1.12	Description of level ranges (@ A-weighted SPL @ 1 kHz) Instruction manual of the level range controls and function. Recommendation for selecting the optimum level range.	9.2.2 h) 9.2.5 c)	25 dB to 138 dB N/A N/A
5.1.13	Reference SPL, reference level range, reference orientation, reference position of microphone.	9.2.5 a), 9.3 a), b), c)	94 dB N/A Reference incidence direction and reference point position (Fig. 1)
5.1.14	Operating of the hold facility and the means for clearing a display that is held.		→ Measurement
5.1.15	Dummy microphone: Design goal and tolerance	9.3 g)	Capacitance of dummy microphone: 13 pF Tolerance: ±1.5 pF
5.1.16	Highest SPL and Peak-Peak input voltage without causing damage.	9.3 i)	148 dB 11 Vp-p
5.1.17	Characteristics of each independent channel to be described		N/A
5.1.18	Initial time interval after switching on power	9.2.5 e)	Less than 90 seconds
5.2	**Adjustment to indicated levels**		
5.2.1	Model of sound calibrator(s)	9.2.4 a)	NC-74 (RION)
5.2.3	Procedure for calibration & adjustment with sound calibrator	9.2.4 c)	→ Calibration

Standard paragraph	Description	See also	Remark NL-62
5.2.4 5.2.5	Data for correction - with and without windscreen - for : - Deviation of average frequency response to uniform frequency response. - Case reflection and microphone diffraction Including values for expanded uncertainties. In 1/3 octave frequencies for 63 Hz to 1 kHz and 1/12 octave frequencies for 1 kHz to 16 kHz	9.2.4 d) 9.2.5 b)	Frequency response of the microphone UC-59L (Fig. 2) Frequency response of the NL-62 (including the case reflection) (Fig. 3) Influence of WS-10 on acoustic performance of NL-62 (Fig. 9) Frequency response with windscreen correction (WS-10) (Fig. 10) Refer to IEC 61672-1 (JIS C 1509-1) frequency response (Tab. 1)
5.2.7	Adjustment data for sound calibrator or electrostatic actuator (for A-weighted sound levels)	9.3 d)	Adjustment data for sound calibrator (Tab. 3)
5.4	**Frequency weightings**		
5.4.12	Frequency response & tolerances of optional frequency responses	9.2.2 c)	N/A
5.5	**Level linearity**		
5.5.9	A, C and Z weighted levels for the lower and upper limit of the linear operating range.	9.3 e)	The lower and upper limits of the linear operating range (Tab. 4)
5.5.10	Starting point for the level linearity error	9.3 f)	The lower and upper limits of the linear operating range (Tab. 4)
5.5.11	How to test level linearity if display range < linearity range	9.3 k)	N/A
5.6	**Self generated noise**		
5.6.1	Self-noise at the more sensitive ranges (including microphone)	9.2.5 o) 9.3 h)	Maximum value A: <17 dB C: <25 dB Z: <42 dB G: <35 dB Typical value A: 13 dB C: 20 dB Z: 35 dB G: 29 dB
5.6.3	Self-noise at the more sensitive ranges with dummy microphone	9.3 h)	Dummy microphone (13 pF) Maximum value Equal to 5.6.1 Typical value A: 11 dB C: 16 dB Z: 28 dB G: 21 dB

Standard paragraph	Description	See also	Remark NL-62
5.6.5	Instruction to measure low level sounds with consideration of influence of self-noise	9.2.5 d)	→ Influence of background noise
5.7	**Time weighting F and S**		
5.7.1	Description of time weightings that are provided	9.2.2 d)	F(Fast), S(Slow), 10s
5.10 - 5.11	**Overload and Under-range indication**		
5.10.1	Operation & interpretation of overload indicators	9.2.5 k)	→ Controls and Functions
5.11.1	Operation & interpretation of under-range indicators		→ Controls and Functions
5.12	**Peak C sound level**		
5.12.1	Nominal range of L_{Cpeak} at for each level range	9.2.2 i)	60 dB to 141 dB The lower and upper limits of the linear operating range (Tab. 4)
5.14	**Thresholds**		
5.14	Operation of user-selectable thresholds	9.2.5 l)	N/A
5.15	**Display**		
5.15.2	Description of the indication of displayed quantities	9.2.2 g)	→ Controls and Functions
5.15.3	Description of the display	9.2.2 g)	→ Controls and Functions
5.15.4	Description of the displayed quantities	9.2.2 a)	N/A
5.15.5	Statement of the display update rate	9.2.2 g)	1 second
5.15.6	Time interval for completion of the integration	9.2.5 f)	Less than 1 second
5.15.7	Description of method for transferring data to PC	9.2.5 m)	N/A Refer to serial interface manual
5.16	**Analogue and digital outputs**		
5.16.1	Electric output connector (AC output)	9.2.5 p)	Frequency weighting: A, C, Z, G Output voltage: 1 Vrms (at output level range upper) Output range: 4 Vrms or less Output impedance: 600 Ω Load impedance: >10 kΩ
	Electric output connector (DC output)		Frequency weighting: A, C, Z, G Output voltage: 2.5 V (at output level range upper), 25 mV/dB Output range: 0 to 5 V Output impedance: 50 Ω Load impedance: >10 kΩ
5.17	**Timing facilities**		
5.17.1	Procedure to preset the integration time & time of the day	9.2.5 g)	→ Preparations
5.17.2	Statement of the minimum & maximum integration time	9.2.5 h)	Minimum: 1 second Maximum: 24 hours

Standard paragraph	Description	See also	Remark NL-62
5.18	**RF emissions and power supply disturbance**		
5.18.1	Length & type of interface cable and characteristics of connected devices	9.2.5 n)	Microphone extension cable EC-04 series (up to 35 m) Output cable CC-24 (2.5 m) All cables shielded
5.18.2	Operating mode or highest radio frequency emissions	9.3 n)	Operation mode: normal operation Connection pattern: AC adapter NC-98 (with ferrite cores) Output cable CC-24 (with ferrite cores) Communication cable CC-42R (with ferrite cores) USB cable (with ferrite cores) Microphone extension cable EC-04 series 35 m (with ferrite cores)
5.20	**Power supply**		
5.20.2	Maximum and minimum power supply voltage	9.3 j	Maximum: 7 V Minimum: 4 V
5.20.3	Battery types & battery life	9.2.3 a)	N/A LR6 × 4: approx. 12 hours
5.20.4	Operation from an external power supply	9.2.3 c)	→ Preparations
5.20.5	Public power supply voltage	9.2.3 d)	100 to 240 V AC (tolerance range 90 to 264 V), 50/60 Hz (47 to 63 Hz)
6	**Environmental, electrostatic and radio frequency criteria**		
6.1.2	Time interval for needed to stabilize after environmental changes	9.3 l)	Temperature change: < 1 hour Humidity change: < 1 hour Static pressure change: < 5 minutes
6.2.2 (Note)	Measurement when static pressure is < 85 kPa		Calibration and measurement performed in this environment using Sound Calibrator NC-74
6.5.2	Degradation of functions by electrostatic discharge	9.2.7 b)	Measurement value affected temporarily by electrostatic discharge
6.6.1	Operating mode with least immunity to AC power frequency fields and RF fields	9.3 o)	Fig. 13 Operation mode: normal operation Connection pattern: AC adapter NC-98 (with ferrite cores) Output cable CC-24 (with ferrite cores) Communication cable CC-42R (with ferrite cores) USB cable (with ferrite cores) Microphone extension cable EC-04 series 35 m (with ferrite cores)
6.6.4 (Note)	Field strength for conforming (in case > 10 V/m)	9.3 m)	N/A

Standard paragraph	Description	See also	Remark NL-62
7	**Provisions for use with auxiliary devices**		
7.1	Correction for use of microphone cable	9.2.6 b)	N/A
7.2	Effect of optional accessories (windscreen)	9.2.6 a)	Influence of WS-10 on acoustic performance of NL-62 (Fig. 9)
7.3	Statement of conformance with optional accessories (windscreen)		Compliant with IEC 61672-1 (JIS C 1509-1), with Windscreen WS-10 mounted
7.4	Operation of 1/1 - 1/3 octave band filters	9.2.6 c)	N/A
7.5	Details about connection & effects of auxiliary devices	9.2.6 d)	→ Preparations
9	**Instruction manual**		
9.2.1	**General**		
9.2.1 a)	Description of type, classification (X, Y, Z) and class		Group X, Class 1
9.2.1 b)	Overall configuration, Normal operation configuration (including windscreen)	5.1.4 5.1.7	Refer to 5.1.4 Refer to 5.1.7
9.2.1 c)	Models of microphones	5.1.6	Refer to 5.1.6
9.2.1 d)	Required microphone cable to conform		N/A
9.2.1 e)	Characteristics & operation each channel		N/A
9.2.2	**Design features**		
9.2.2 a)	Description of quantities which can be measured	5.15.4	L_p, L_{eq}, L_{max}, L_{min}, L_E, L_N, L_{peak}, L_{Atm5}
9.2.2 b)	Relative free-field response as function of incidence angle and frequency (detailed tabular description)		Directional Characteristics with Horizontal Direction (Fig. 14, Tab. 5), Vertical Direction (Fig. 15, Tab. 6)
9.2.2 c)	Description of the frequency weightings	5.1.10 5.4.12	Refer to 5.1.10 Refer to 5.4.12
9.2.2 d)	Description of the time weightings	5.7.1	Refer to 5.7.1
9.2.2 e)	Identification of the level ranges (A-weighted @ 1 kHz)	5.1.12	Refer to 5.1.12
9.2.2 f)	Operation of the level range control	5.1.12	Refer to 5.1.12
9.2.2 g)	Description of the display and update rates	5.15.2-3-4-5	Refer to 5.15.2-3-4-5
9.2.2 h)	Total range of A-weighted SPL (@ 1 kHz)	5.1.12	Refer to 5.1.12
9.2.2 i)	Nominal range of L_{Cpeak} at for each level range	5.12.1	Refer to 5.12.1
9.2.2 j)	Computer software to operate the SLM	5.1.8	Refer to 5.1.8
9.2.2 k)	Design goals and tolerances for quantities which are not in the standard (T-weight 10 ms, L_{AIeq})		The lower and upper limits of the linear operating range (Tab. 4)

Standard paragraph	Description	See also	Remark NL-62
9.2.3	**Power supply**		
9.2.3 a)	Battery types & battery life	5.20.3	Refer to 5.20.3
9.2.3 b)	Description of the function of battery check		→ Controls and Functions
9.2.3 c)	Operation from an external power supply	5.20.4	Refer to 5.20.4
9.2.3 d)	Public power supply voltage	5.20.5	Refer to 5.20.5
9.2.4	**Adjustment to indicated levels**		
9.2.4 a)	Model of sound calibrator(s)	5.2.1	Refer to 5.2.1
9.2.4 b)	Calibration check frequency		1 kHz
9.2.4 c)	Procedure for calibration & adjustment with sound calibrator	5.2.3	Refer to 5.2.3
9.2.4 d)	Data for correction - with and without windscreen - for : - Deviation of average frequency response to uniform frequency response. - Case reflection and microphone diffraction Including values for expanded uncertainties. In 1/3 octave frequencies for 63 Hz to 1 kHz and 1/12 octave frequencies for 1 kHz to 16 kHz	5.2.4 - 5.2.5	Refer to 5.2.4 - 5.2.5
9.2.5	**Operating the sound level meter**		
9.2.5 a)	Reference direction	5.1.13	Refer to 5.1.13
9.2.5 b)	Procedure to measure sound, Influence of the instrument case and operator.	5.1.6 5.2.4 5.2.5	Refer to 5.1.6 Refer to 5.2.4 Refer to 5.2.5
9.2.5 c)	Recommendation for selecting optimum level range	5.1.12	Refer to 5.1.12
9.2.5 e)	Initial time interval after switching on power	5.1.18	Refer to 5.1.18
9.2.5 f)	Time interval for completion of the integration	5.15.6	Refer to 5.15.6
9.2.5 g)	Procedure to preset the integration time & time of the day	5.17.1	Refer to 5.17.1
9.2.5 h)	Statement of the minimum & maximum integration time	5.17.2	Refer to 5.17.2
9.2.5 i)	Operation of the “Hold” function		→ Measurement
9.2.5 j)	Operation of the reset function or L_{eq}, L_E, L_{peak} and overload		Measurement results (measurement values, overload indication, under-range indication) are reset when a new measurement is started. Time required for measurement initialization: < 1 second
9.2.5.k)	Operation & interpretation of overload indicators	5.10.1	Refer to 5.10.1

Standard paragraph	Description	See also	Remark NL-62
9.2.5 l)	Operation of user-selectable thresholds	5.14	Refer to 5.14
9.2.5 m)	Description of method for transferring data to PC	5.15.7	Refer to 5.15.7
9.2.5 n)	Length & type of interface cable and characteristics of connected devices	5.18.1	Refer to 5.18.1
9.2.5 o)	Self-noise at the more sensitive ranges (including microphone). Averaging time ≥ 30 s.	5.6.1	Refer to 5.6.1
9.2.5 p)	Characteristics of AC and DC output	5.16.1	Refer to 5.16.1
9.2.6	**Accessories**		
9.2.6 a)	Effect of windscreen (directional response and frequency weighting)	7.2	Refer to 7.2
9.2.6 b)	Corrections for microphone cable	7.1	Refer to 7.1
9.2.6 c)	Use of bandpass filters	7.4	Refer to 7.4
9.2.6 d)	Connection of auxiliary devices	7.5	Refer to 7.5
9.2.7	**Influence of environmental conditions**		
9.2.7 a)	Components intended for operation in controlled environment		None
9.2.7 b)	Degradation of functions by electrostatic discharge	6.5.2	Refer to 6.5.2
9.2.7 c)	Statement for conformance to AC power frequency fields and RF fields		Statement of conforming to the basic statement (Tab. 2)
9.3	**Information for testing**		
9.3 a)	Reference sound pressure level	5.1.13	Refer to 5.1.13
9.3 b)	Reference level range	5.1.13	Refer to 5.1.13
9.3 c)	Microphone reference point	5.1.13	Refer to 5.1.13
9.3 d)	For A-weighted sound levels: Adjustment data for multi-frequency sound calibrator and/or electrostatic actuator	5.2.7	Refer to 5.2.7
9.3 e)	Nominal A-weighted sound levels at the upper and lower limits of the linear operating range on each level range. - For frequencies 31.5 Hz, 1, 4, 8 and 12.5 kHz	5.5.9	Refer to 5.5.9
9.3 f)	Starting point for the level linearity error - For frequencies 31.5 Hz, 1, 4, 8 and 12.5 kHz - At the reference level range	5.5.10	Refer to 5.5.10
9.3 g)	Dummy microphone: Design goal and tolerance	5.1.15	Refer to 5.1.15
9.3 h)	Self-noise at the more sensitive ranges with microphone and with dummy microphone	5.6.1 / 5.6.3	Refer to 5.6.1 / 5.6.3
9.3 i)	Highest SPL and Peak-Peak input voltage to accommodate	5.1.16	Refer to 5.1.16

Standard paragraph	Description	See also	Remark
			NL-62
9.3 j)	Maximum and minimum power supply voltage	5.20.2	Refer to 5.20.2
9.3 k)	How to test level linearity if display range < linearity range	5.5.11	Refer to 5.5.11
9.3 l)	Time interval for needed to stabilize after environmental changes	6.1.2	Refer to 6.1.2
9.3 m)	Field strength for conforming (in case > 10 V/m)	6.6.4	Refer to 6.6.4
9.3 n)	Operating mode or highest radio frequency emissions	5.18.2	Refer to 5.18.2
9.3 o)	Operating mode with least immunity to AC power frequency fields and RF fields	6.6.1	Refer to 6.6.1

IEC 61672-1 (JIS C 1509-1) frequency response

Tab. 1 IEC 61672-1 (JIS C 1509-1) frequency response

Nominal Frequency (Hz)	Exact Frequency (Hz)	UC-59L Frequency Response (dB)	NL-62 Frequency Response (dB)	NL-62 Electrical Response (dB)	Windscreen (WS-10) Effect (dB)	Windscreen (WS-10) Correction (dB)	Total Expanded Uncertainty (dB)
63	63.10	0.0	-0.1	0.0	0.0	0.0	0.3
80	79.43	0.0	-0.1	0.0	0.0	0.0	0.3
100	100.0	0.0	-0.1	0.0	0.0	0.0	0.3
125	125.9	0.0	0.0	0.0	0.0	0.0	0.3
160	158.5	0.0	-0.1	0.0	0.0	0.0	0.3
200	199.5	0.0	0.0	0.0	0.0	0.0	0.2
250	251.2	-0.1	0.0	0.0	0.0	0.0	0.2
315	316.2	0.0	0.0	0.0	0.1	0.0	0.2
400	398.1	0.0	0.0	0.0	0.1	0.0	0.2
500	501.2	0.0	0.1	0.0	0.1	0.0	0.2
630	631.0	0.0	0.1	0.0	0.1	0.0	0.2
800	794.3	0.0	0.1	0.0	0.1	-0.1	0.2
1000	1000	0.0	0.0	0.0	0.1	-0.1	0.2
1250	1259	0.0	-0.2	0.0	0.2	-0.1	0.3
1600	1585	0.1	-0.4	0.0	0.2	-0.2	0.3
2000	1995	0.0	0.0	0.0	0.3	-0.3	0.3
2500	2512	0.1	0.2	0.0	0.4	-0.3	0.3
3150	3162	0.2	0.1	0.0	0.5	-0.4	0.3
4000	3981	0.2	-0.1	0.0	0.3	-0.4	0.4
5000	5012	0.3	0.4	0.0	0.0	-0.4	0.4
6300	6310	0.3	-0.1	0.0	-0.2	-0.3	0.4
8000	7943	0.2	0.0	0.0	0.0	-0.1	0.4
10000	10000	0.1	0.2	0.0	-0.2	0.1	0.6
12500	12589	-0.2	-0.1	0.0	-0.5	0.3	0.6
16000	15849	-1.1	-0.2	0.0	-0.7	0.4	0.6

Reference incidence direction and reference point position

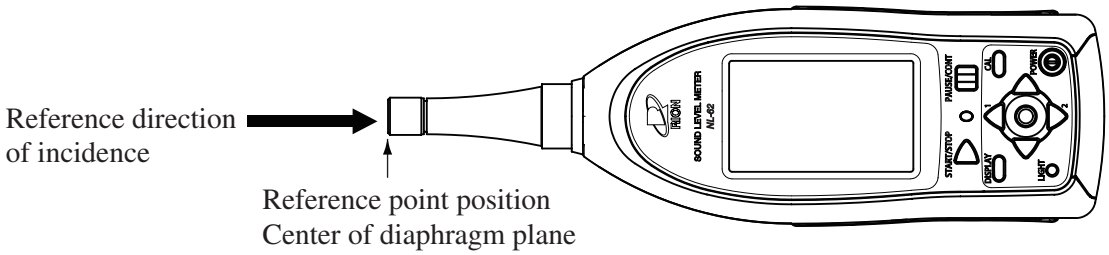


Fig. 1 Reference incidence direction and reference point position

Frequency response

The frequency response of a sound field microphone is expressed as the frequency response in the reference direction of incidence (0°).

The diagram below shows an example for the frequency response of the microphone UC-59L.

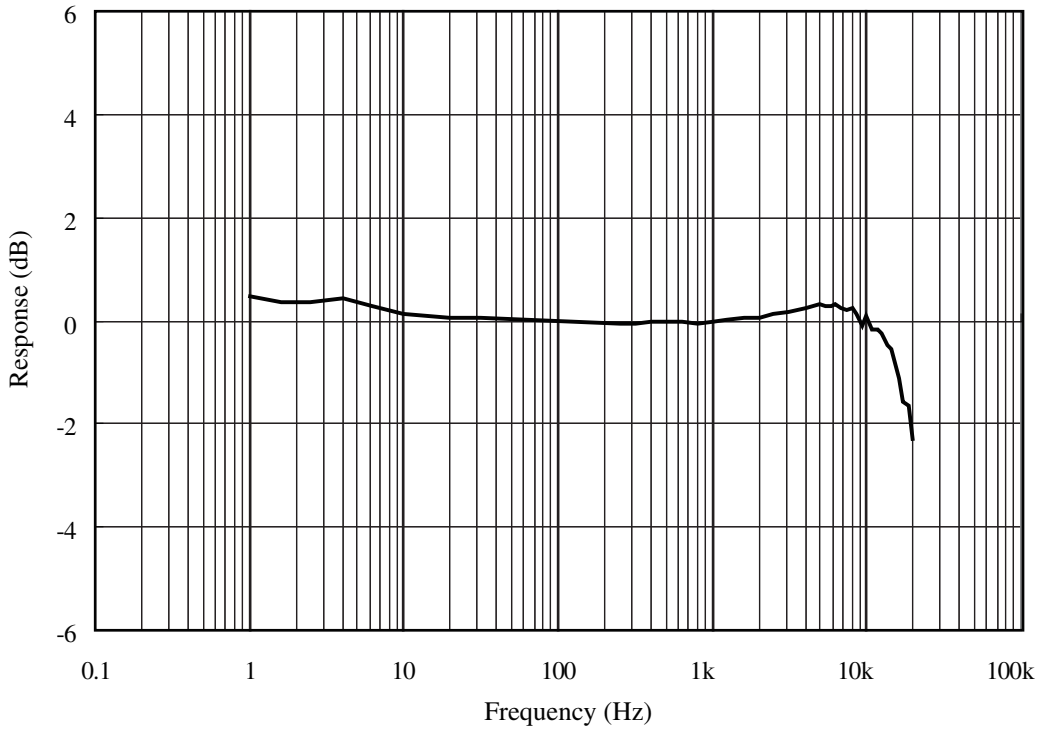


Fig. 2 Frequency response of the microphone UC-59L

Influence of body reflection

The NL-62 is designed to minimize reflections caused by the body of the unit.

The chart below shows the influence on the measurement.

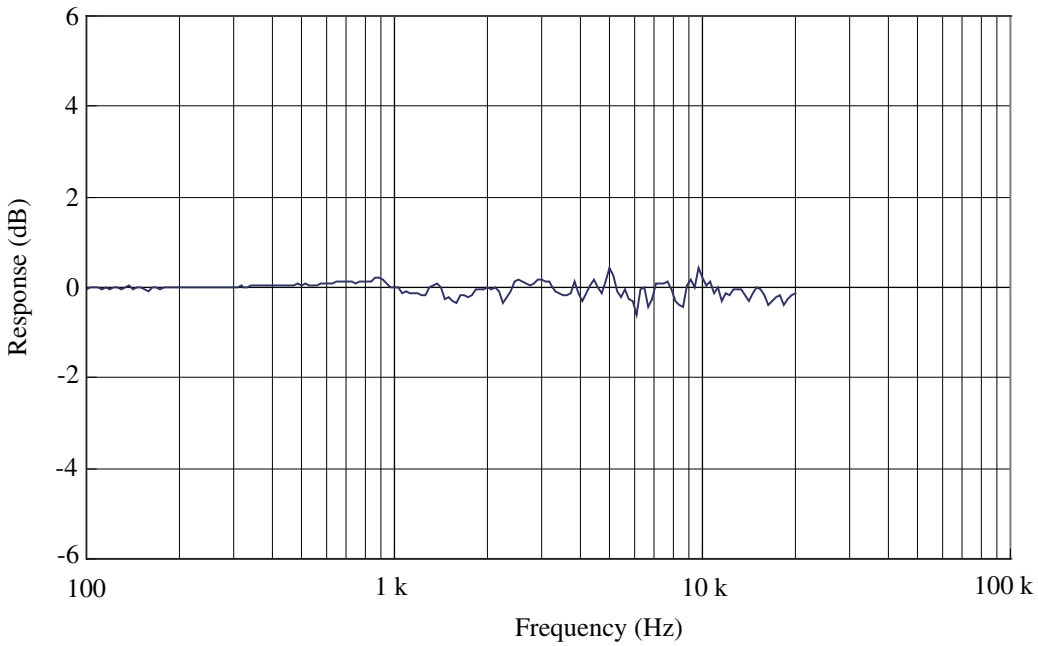


Fig. 3 Influence of Body reflection

Acoustical influence of operator

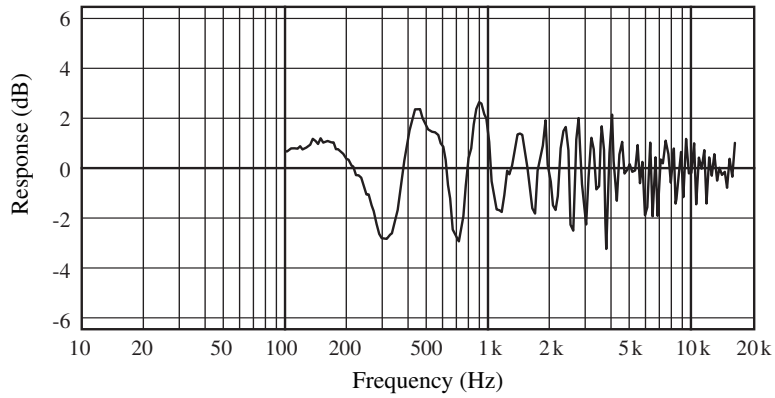


Fig. 4 Acoustical influence of operator (the distance from the top of the microphone to the operator is approx. 40 cm)

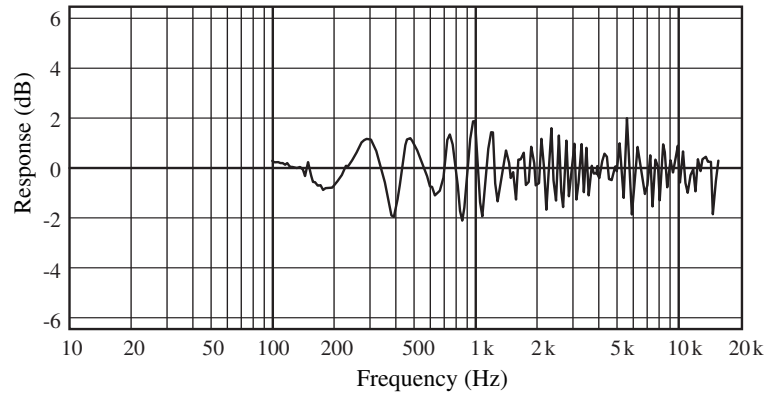


Fig. 5 Acoustical influence of operator (the distance from the top of the microphone to the operator is approx. 70 cm)

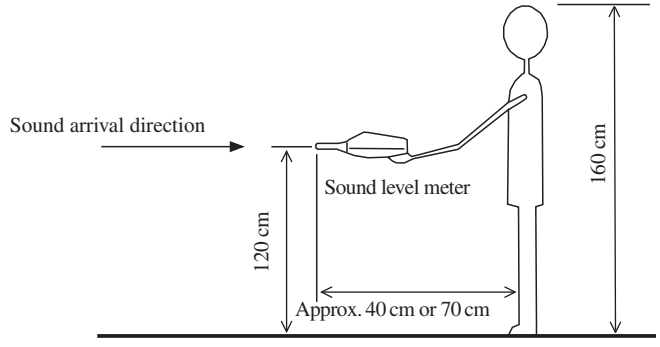


Fig. 6 Measurement conditions for acoustical influence of operator

Reduction of wind noise by windscreen

During outdoor measurements or measurement of ventilation devices, wind noise can falsify measurement results. To counter such problems, the supplied windscreen WS-10 should be mounted on the microphone. The characteristics of the WS-10 are shown below. The attenuation of wind noise produced by the windscreen is about 25 dB with frequency weighting A and 15 dB with frequency weighting C.

The influence of the windscreen WS-10 on the acoustic performance of the microphone is within ±1.0 dB up to 12.5 kHz, as shown in the diagram on the next page.

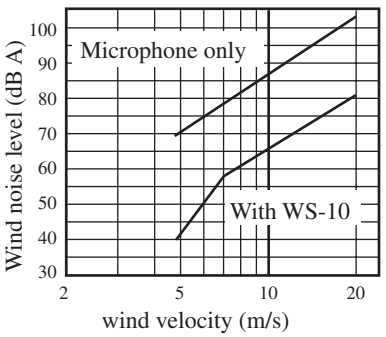


Fig. 7-1 Frequency weighting A

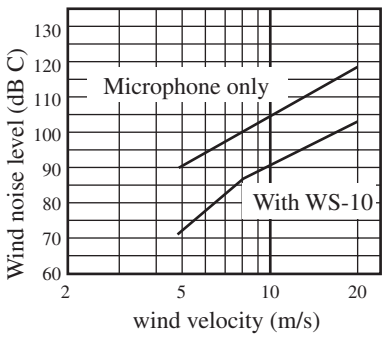


Fig. 7-2 Frequency weighting C

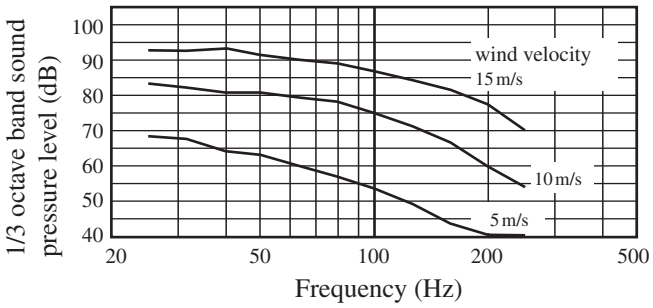


Fig. 8 Frequency response of wind noise measured with windscreen WS-10 mounted microphone

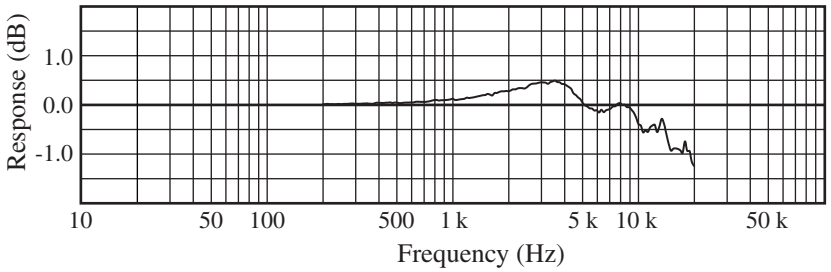


Fig. 9 Influence of windscreen WS-10 on acoustical properties of microphone (referred to microphone response without windscreen)

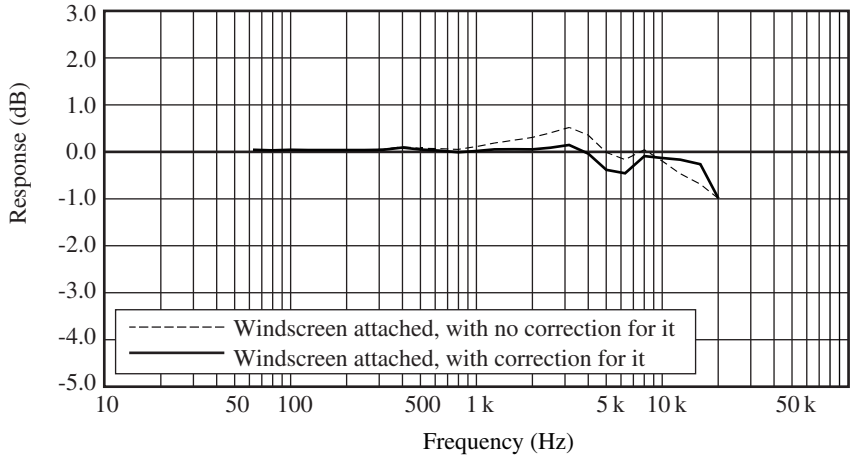


Fig. 10 Frequency response with windscreen correction (WS-10)

Effect of Windscreen for outdoor WS-15

The windscreen WS-15 not only reduces measurement errors due to wind noise, it also protects the microphone from rain.

The WS-15 characteristics are shown below.

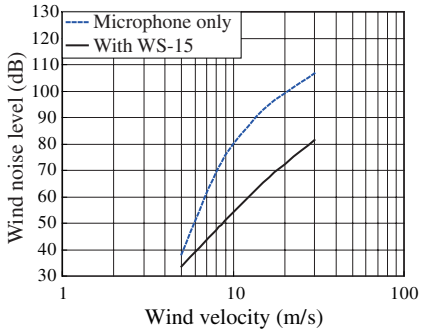


Fig. 11-1 Frequency weighting A

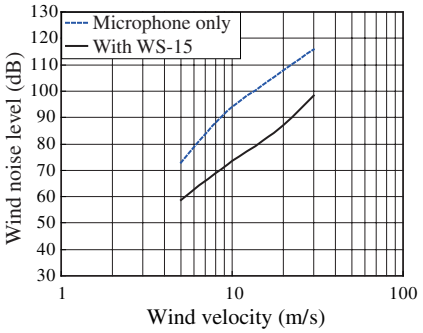


Fig. 11-2 Frequency weighting C

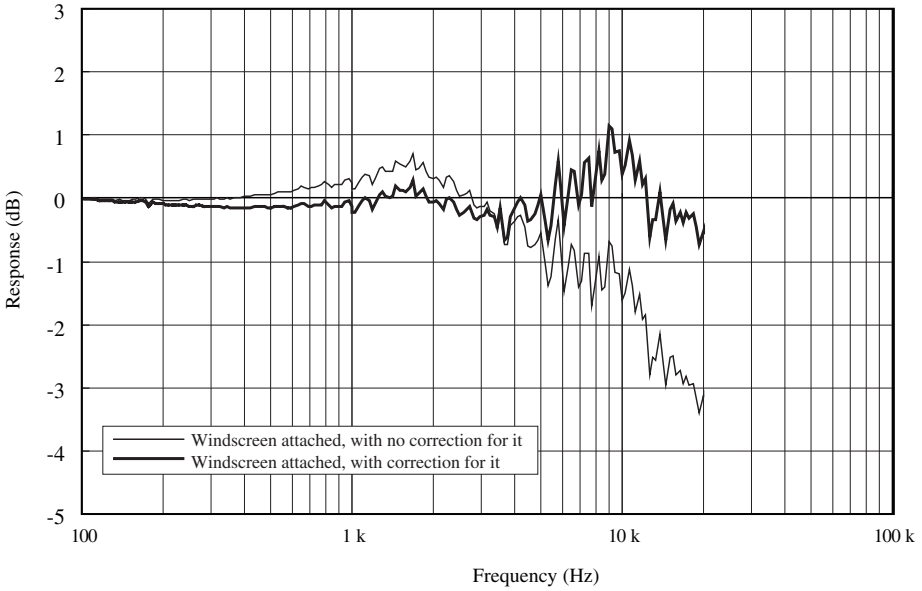


Fig. 12 Frequency response with windscreen correction (WS-15)

The greatest susceptibility configuration for radio frequency fields

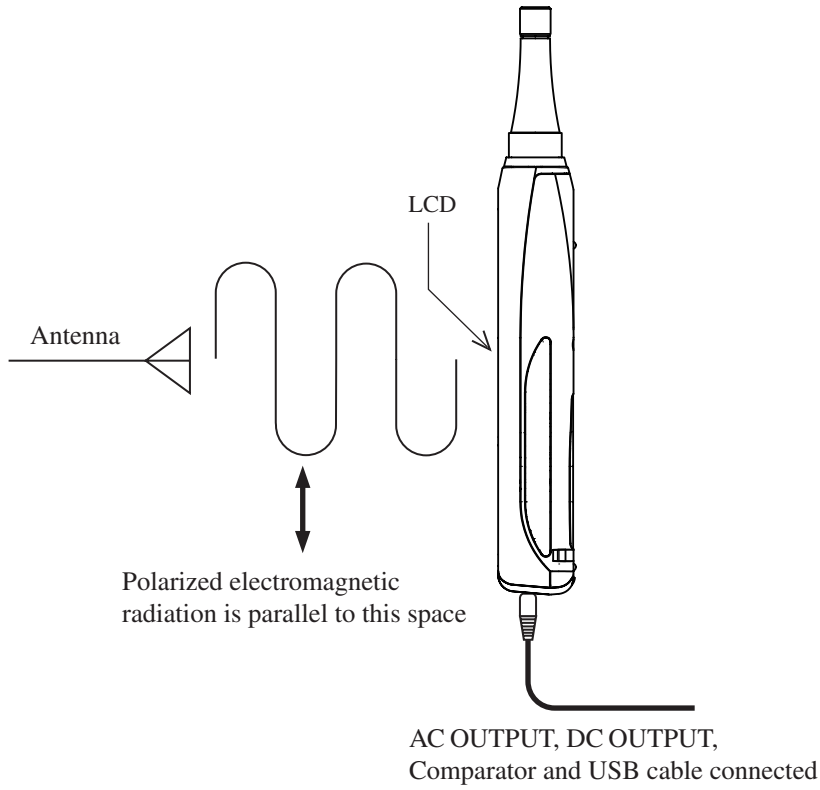


Fig. 13 The greatest susceptibility configuration for radio frequency fields

Statement of conforming to the basic statement

Tab. 2 Statement of conforming to the basic statement

	NL-62
Immunity (AC power frequency magnetic field)	The specification of IEC 61672-1 Class 1 is satisfied
Immunity (Radio frequency electromagnetic field)	The specification of IEC 61672-1 Class 1 is satisfied
Emissions	The specification of IEC 61672-1 Class 1 is satisfied

Adjustment data for sound calibrator

Tab. 3 Adjustment data for sound calibrator

Frequency (Hz)	NL-62 Correction (dB)
31.5	0.0
63	0.0
125	0.0
250	0.0
500	0.0
1000	0.0
2000	0.2
4000	0.9
8000	3.0
12500	5.9
16000	7.3

The lower and upper limits of the linear operating range

Tab. 4 The lower and upper limits of the linear operating range

A weighting

	31.5 Hz	1 kHz	4 kHz	8 kHz	12.5 kHz
Upper	98.0	138.0	138.0	136.0	133.0
Start	94.0	94.0	94.0	94.0	94.0
Lower	25.0	25.0	25.0	25.0	25.0

C weighting

	31.5 Hz	1 kHz	4 kHz	8 kHz	12.5 kHz
Upper	135.0	138.0	137.0	135.0	131.0
Start	94.0	94.0	94.0	94.0	94.0
Lower	33.0	33.0	33.0	33.0	33.0

Z weighting

	31.5 Hz	1 kHz	4 kHz	8 kHz	12.5 kHz
Upper	138.0	138.0	138.0	138.0	138.0
Start	94.0	94.0	94.0	94.0	94.0
Lower	50.0	50.0	50.0	50.0	50.0

Measurement range

	L_A (dB)	L_C (dB)	L_Z (dB)	L_{Cpeak} (dB)	L_{Zpeak} (dB)
Upper	138.0	138.0	138.0	141.0	141.0
Lower	25.0	33.0	50.0	60.0	65.0

Directional Characteristics

The directional characteristics of a microphone is a measure of its differing sensitivity for sound waves arriving from various angles. Since the prepolarized condenser microphone used in the NL-62 is a pressure-sensitive type, it should be equally sensitive in all directions. However, refraction and cavity effects cause a certain microphone directional response at high frequencies.
The diagrams below shows the directional characteristics for the NL-62.

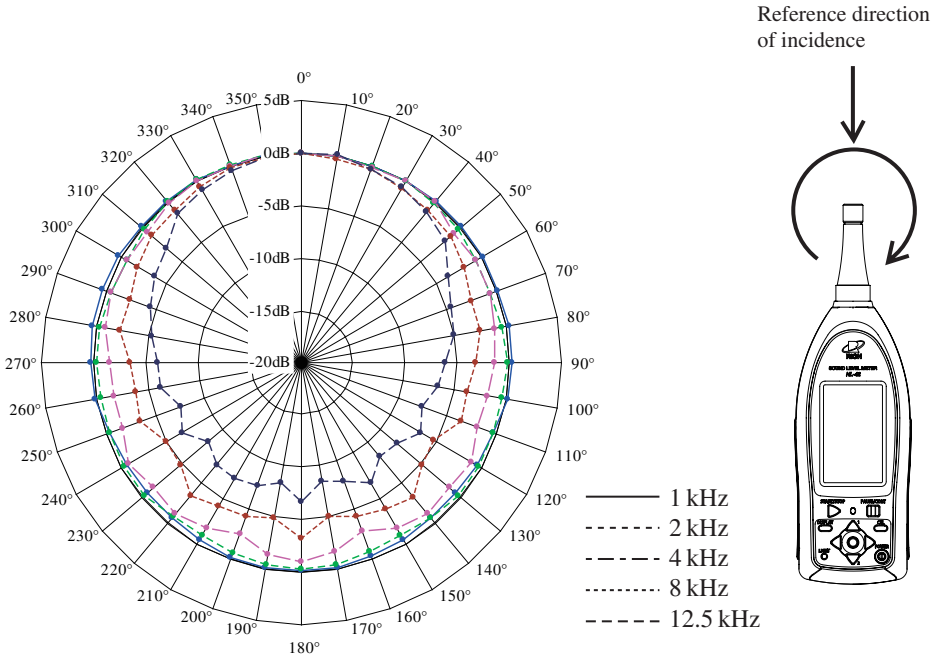


Fig. 14 Directional Characteristics of NL-62 (Rotated horizontal)

Tab. 5 Directional Characteristics of NL-62 (Rotated horizontal)

Angle	Frequency (Hz)				
	1k	2k	4k	8k	12.5k
0	0.00	0.00	0.00	0.00	0.00
10	-0.02	-0.02	-0.06	-0.38	0.12
20	-0.03	-0.03	-0.11	-0.40	-0.31
30	0.01	-0.05	0.02	-0.83	-0.79
40	0.07	-0.12	-0.04	-1.03	-1.28
50	0.07	-0.35	-0.83	-1.25	-2.04
60	0.13	-0.63	-0.64	-1.98	-3.64
70	0.17	-0.68	-0.71	-2.64	-4.61
80	0.19	-0.43	-1.10	-2.59	-5.11
90	0.19	-0.21	-1.38	-3.22	-6.13
100	0.07	-0.41	-1.79	-3.78	-6.67
110	-0.24	-0.50	-1.93	-3.66	-7.69
120	-0.52	-0.27	-1.08	-5.37	-6.73
130	-0.62	-0.24	-1.43	-4.78	-7.94
140	-0.57	-0.68	-1.18	-3.20	-8.21
150	-0.38	-1.01	-1.74	-4.00	-6.69
160	-0.29	-0.80	-2.95	-4.30	-7.96
170	-0.17	-0.46	-1.71	-4.99	-8.53
180	-0.11	-0.29	-1.05	-3.24	-6.72
190	-0.11	-0.40	-1.42	-4.92	-8.36
200	-0.21	-0.75	-2.63	-4.32	-7.56
210	-0.41	-1.03	-1.86	-4.17	-7.35
220	-0.58	-0.82	-1.18	-3.36	-7.32
230	-0.72	-0.35	-1.41	-4.71	-8.26
240	-0.60	-0.25	-0.91	-5.11	-6.70
250	-0.29	-0.49	-1.66	-3.55	-7.68
260	0.04	-0.49	-1.71	-3.81	-6.26
270	0.24	-0.27	-1.54	-3.49	-6.10
280	0.42	-0.27	-0.84	-2.24	-5.28
290	0.35	-0.61	-0.64	-2.35	-4.51
300	0.27	-0.58	-0.62	-1.83	-3.70
310	0.18	-0.31	-0.69	-1.21	-2.95
320	0.12	-0.06	-0.14	-1.01	-1.44
330	0.09	0.05	0.03	-0.55	-1.02
340	0.04	0.04	-0.06	-0.15	-0.59
350	0.05	0.07	0.09	-0.11	-0.17

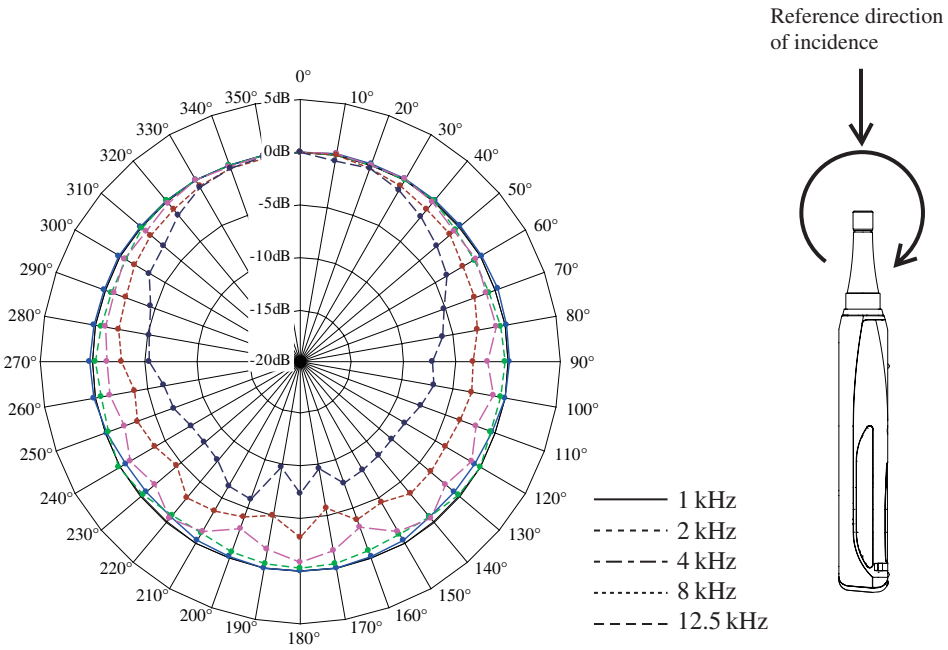


Fig. 15 Directional Characteristics of NL-62 (Rotated vertical)

Tab. 6 Directional Characteristics of NL-62 (Rotated vertical)

Angle	Frequency (Hz)				
	1k	2k	4k	8k	12.5k
0	0.00	0.00	0.00	0.00	0.00
10	0.05	0.01	0.05	-0.08	-0.65
20	0.05	0.02	-0.07	-0.36	-0.39
30	0.08	0.02	0.15	-0.77	-1.14
40	0.10	-0.09	-0.11	-1.03	-1.99
50	0.16	-0.40	-0.61	-1.14	-2.75
60	0.17	-0.73	-0.42	-1.92	-3.70
70	0.18	-0.72	-0.94	-2.19	-5.40
80	0.18	-0.48	-0.85	-2.63	-6.00
90	0.07	-0.25	-1.93	-3.38	-7.31
100	-0.01	-0.50	-1.19	-3.21	-6.97
110	-0.31	-0.63	-1.95	-3.61	-7.77
120	-0.62	-0.06	-1.00	-3.99	-8.44
130	-0.67	-0.21	-1.74	-3.69	-8.48
140	-0.58	-0.72	-0.45	-3.50	-8.26
150	-0.36	-1.07	-1.25	-4.52	-8.11
160	-0.18	-0.91	-3.28	-3.97	-7.65
170	-0.05	-0.47	-1.77	-5.79	-9.68
180	0.01	-0.29	-0.93	-3.26	-7.41
190	-0.07	-0.44	-1.85	-5.11	-9.82
200	-0.18	-0.79	-3.15	-4.27	-5.99
210	-0.34	-1.16	-1.29	-3.56	-6.27
220	-0.52	-0.88	-0.41	-3.16	-7.78
230	-0.72	-0.31	-1.82	-4.44	-8.04
240	-0.54	0.08	-1.15	-3.82	-7.79
250	-0.19	-0.33	-2.04	-3.32	-7.06
260	0.09	-0.57	-1.36	-3.80	-6.66
270	0.23	-0.37	-1.43	-2.77	-5.44
280	0.13	-0.63	-1.07	-2.22	-5.22
290	0.08	-0.66	-1.07	-2.16	-4.62
300	0.06	-0.52	-0.46	-1.62	-3.30
310	0.02	-0.23	-0.71	-1.27	-2.81
320	-0.02	-0.09	-0.27	-1.06	-1.64
330	0.02	-0.03	-0.05	-0.74	-0.88
340	-0.05	-0.03	-0.15	-0.43	-0.30
350	0.01	-0.02	0.02	-0.27	-0.13

Random incidence response

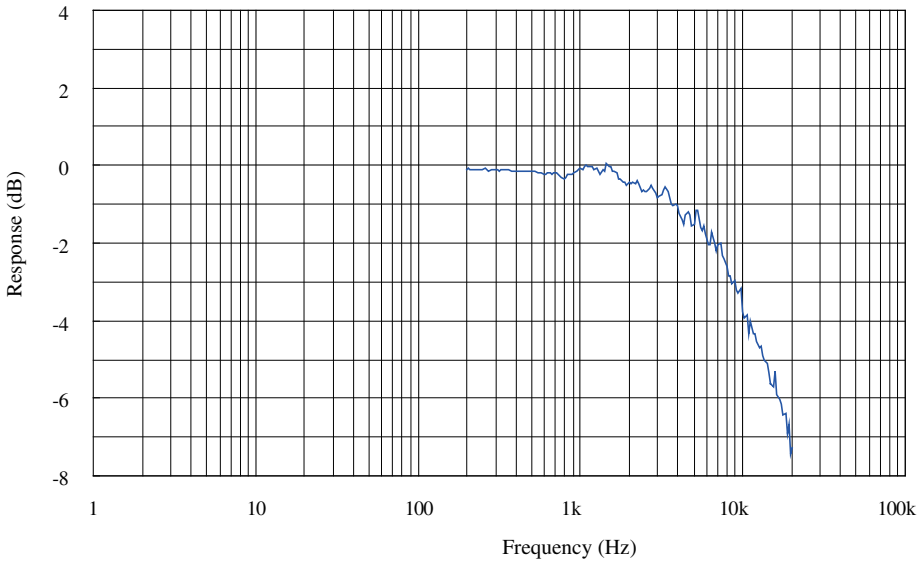


Fig. 16 Random incidence response

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