



LABORATORI METROLOGICI

DELTA OHM srl 35030 Caselle di Selvazzano (PD)
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RAPPORTO DI TARATURA N. _____
 Calibration Report No. _____

Si riferisce a
 Referring to

Filtri acustici

- Data di emissione <i>date of issue</i>	-----
- destinatario <i>addressee</i>	-----
- richiesta <i>application</i>	-----
- in data <i>Date</i>	-----
- registro di laboratorio <i>laboratory reference</i>	-----
- data delle misure <i>date of measurements</i>	-----
	Strumento – <i>Instrument</i>
	Preamplificatore - <i>Preamplifier</i>
- costruttore <i>manufacturer</i>	Delta Ohm S.r.l.
- modello <i>model</i>	HD2010UC/A
- matricola <i>serial number</i>	-----
	Delta Ohm S.r.l.
	HD2010PNE2

Le incertezze di misura dichiarate in questo documento sono espresse come due volte lo scarto tipo (corrispondente, nel caso di distribuzione normale, a un livello di confidenza di circa 95%).

The measurement uncertainties stated in this document are estimated at the level of twice the standard deviation (corresponding, in the case of normal distribution, to a confidence level of about 95%).

Prova - <i>Test</i>	Campo <i>Range</i>	Incertezza <i>Uncertainty</i>
Att. relativa < 6dB e Linearità <i>Relative att < 6dB and Lin.</i>	1 mHz ÷ 200 kHz	0.06
Att. relativa > 6 dB <i>Relative att. > 6 dB</i>	1 mHz ÷ 256 kHz	0.6
Funzionamento in tempo reale <i>Real-time operation</i>	5 Hz ÷ 60 kHz	0.13
Filtri anti-aliasing <i>Anti-aliasing filters</i>	16 Hz ÷ 8 MHz	0.9
Somma dei segnali d'uscita <i>Summation of output signals</i>	1 mHz ÷ 256 kHz	0.3
Risposta piatta in frequenza <i>Flat frequency response</i>	1 mHz ÷ 200 kHz	0.09

La catena di riferibilità ha inizio dai campioni di prima linea muniti di certificati di taratura:
Traceability is through first line standards validated by certificates of calibration:

Campioni di 1a linea <i>First line standards</i>	Modello <i>Model</i>	Matricola <i>Serial number</i>	Certificato <i>Certificate</i>
Multimetro - <i>Multimeter</i>	-----	-----	-----

Lo sperimentatore
Operator



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Caratteristiche del banco di filtri Filter set specifications

Larghezza di banda: 1/3 ottava
Bandwidth
Frequenze centrali: 25 Hz ÷ 10k Hz
Central frequencies
Freq. di campionamento: 48 kHz
Sampling frequency
Campo di linearità: 80 dB
Linearity range

Freq. [Hz]	25Hz [dB]
4.6	79.3
8.1	77.5
17.5	43.8
19.7	20.7
22.1	2.1
22.8	0.2
24.2	0.0
24.8	-0.1
25.5	0.0
26.2	0.3
27.0	1.0
27.8	2.3
31.1	21.1
35.1	52.1
76.1	80.0
150.0	80.0
CLASSE	1

Condizioni ambientali di misura Environmental measurement condition

Lo strumento è stato posto in equilibrio termico con l'ambiente da almeno 24 h.
The instrument has been held at thermal equilibrium with ambient for at least 24h.

Parametri ambientali Environmental parameters		
T [°C]	P [hPa]	U [RH.%]
22.7	1013	55.7

Freq. [Hz]	25Hz [dB]	Freq. [Hz]	40Hz [dB]	Freq. [Hz]	50Hz [dB]
10.2	83.0	7.2	80.0	9.1	80.0
12.1	46.3	12.8	77.5	16.2	80.0
14.8	17.9	17.5	43.8	35.1	56.9
17.8	2.4	31.2	28.3	39.4	39.8
28.7	1.0	35.1	2.3	44.2	2.7
29.6	0.8	36.2	0.8	45.6	0.8
30.4	0.1	37.5	0.2	47.0	0.1
31.3	0.0	38.3	0.0	48.3	0.0
32.1	0.8	40.4	-0.1	49.6	-0.1
33.0	0.2	40.4	0.0	50.9	0.0
34.0	0.8	41.5	0.2	52.4	0.2
35.1	2.3	42.2	0.8	54.0	0.8
39.4	38.1	44.2	2.4	55.7	2.8
44.2	58.4	49.6	40.0	62.5	40.2
95.9	80.0	55.7	60.8	70.2	63.8
167.8	80.0	120.9	80.0	152.3	80.0
		214.0	80.0	269.6	80.0
CLASSE	0	CLASSE	0	CLASSE	0

Risultati delle prove Test results

Le prove sono state eseguite dopo avere messo in punto il fonometro al livello di pressione sonora di riferimento 94 dB nel campo di misura principale:

50 dB ÷ 130 dB

Le misure sono state eseguite sostituendo il microfono con un adattatore capacitivo di impedenza equivalente.

The tests were carried out after sound level meter calibration at the reference sound pressure level 94 dB in the reference range:

50 dB ÷ 130 dB

Measurements were carried out replacing the microphone with a capacitive adapter of equivalent impedance.

Attenuazione relativa Relative attenuation

L'attenuazione relativa dei filtri di un terzo d'ottava è stata verificata applicando un segnale di ampiezza pari al fondo scala diminuito di 1dB, nel campo principale e misurando il livello di pressione sonora.

The relative attenuation of third octave filters has been verified applying a signal 1dB below the full scale level in the reference range and measuring the sound pressure level.

Freq. [Hz]	63Hz [dB]	Freq. [Hz]	80Hz [dB]	Freq. [Hz]	100Hz [dB]
11.5	80.0	14.5	80.0	18.3	80.0
20.0	80.0	25.7	80.0	32.3	80.0
44.2	68.4	55.7	63.8	70.2	69.3
49.6	42.2	62.5	41.3	78.7	53.0
55.7	3.0	70.2	3.0	88.4	2.9
57.5	0.9	72.4	0.8	91.2	0.6
59.2	0.2	74.6	0.1	94.0	0.0
60.9	0.0	76.7	0.0	96.6	-0.1
62.5	-0.1	78.7	-0.1	99.2	-0.1
64.2	-0.1	80.9	-0.1	101.9	-0.1
66.0	0.1	83.2	0.0	104.8	0.1
68.0	0.8	85.7	0.6	107.9	0.5
70.2	3.0	88.4	2.9	111.4	2.9
78.7	45.1	99.2	51.9	125.0	56.9
88.4	70.9	111.4	74.1	140.3	79.8
191.8	80.0	241.7	80.0	304.5	80.0
339.7	80.0	428.0	80.0	539.2	80.0
CLASSE	0	CLASSE	0	CLASSE	0

Freq. [Hz]	125Hz [dB]	Freq. [Hz]	160Hz [dB]	Freq. [Hz]	200Hz [dB]
23.0	80.0	29.0	80.0	36.5	80.0
40.7	80.0	51.3	80.0	64.6	80.0
88.4	73.2	111.4	78.5	140.3	80.0
99.2	55.0	125.0	56.1	157.5	62.2
111.4	2.9	140.3	3.1	176.8	3.1
114.9	0.6	144.8	0.6	182.4	0.6
118.4	0.0	149.1	0.2	187.9	0.0
121.7	-0.1	153.4	0.0	193.3	-0.1
125.0	-0.1	157.5	-0.1	198.4	-0.1
128.3	-0.1	161.7	0.0	203.7	-0.1
132.0	0.0	166.3	0.1	209.5	0.0
136.0	0.5	171.3	0.6	215.8	0.5
140.3	3.0	176.8	3.2	222.7	3.0
157.5	61.2	198.4	65.7	250.0	69.7
176.8	80.0	222.7	80.0	280.6	80.0
383.7	80.0	483.4	80.0	609.1	80.0
679.3	80.0	855.9	80.0	1078.4	80.0
CLASSE	0	CLASSE	0	CLASSE	0



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Freq. [Hz]	250Hz [dB]	Freq. [Hz]	315Hz [dB]	Freq. [Hz]	400Hz [dB]
46.0	80.0	58.0	80.0	73.0	80.0
81.4	80.0	102.6	80.0	129.3	80.0
176.8	80.0	222.7	53.7	280.6	57.2
198.4	66.2	250.0	28.5	315.0	40.0
222.7	3.0	280.6	2.4	353.6	2.7
229.8	0.5	289.6	0.9	364.8	0.8
236.8	0.0	298.3	0.3	375.8	0.1
243.5	-0.1	306.8	0.1	386.5	0.0
250.0	-0.1	315.0	0.0	396.9	0.0
256.7	0.0	323.4	0.0	407.5	0.0
264.0	0.0	332.6	0.2	419.1	0.2
271.9	0.6	342.6	0.7	431.7	0.9
280.6	3.2	353.6	2.3	445.4	2.9
315.0	80.0	396.8	39.9	500.0	40.4
353.6	80.0	445.4	60.7	561.2	63.9
767.4	80.0	966.8	80.0	1218.2	80.0
1358.7	80.0	1711.8	80.0	2156.8	80.0
CLASSE	0	CLASSE	0	CLASSE	0

Freq. [Hz]	4kHz [dB]	Freq. [Hz]	5kHz [dB]	Freq. [Hz]	6.3kHz [dB]
736.0	80.0	927.3	80.0	1168.3	80.0
1303.0	80.0	1641.8	80.0	2069.6	80.0
2828.4	58.3	3583.6	63.9	4489.9	69.3
3174.8	3.1	4000.0	41.6	5039.7	53.0
3535.6	2.9	4489.9	3.1	5636.9	2.9
3677.3	0.8	4633.1	0.9	5837.3	0.6
3788.1	-0.2	4777.2	0.1	6013.2	0.1
3895.8	0.0	4908.4	0.0	6184.1	-0.1
4069.0	-0.1	5039.7	-0.1	6349.4	-0.1
4107.0	0.0	5154.5	0.0	6519.6	0.0
4223.8	0.1	5321.6	0.1	6704.8	0.1
4351.0	0.8	5482.0	0.8	6866.8	0.7
4489.8	2.9	5656.8	3.1	7127.2	3.0
4939.7	45.0	6349.7	53.1	8000.0	56.9
5636.9	79.8	7127.2	74.3	8979.7	79.6
12278.0	80.0	15469.6	80.0	19490.4	80.0
21739.0	80.0	27899.4	80.0	34508.4	80.0
CLASSE	0	CLASSE	0	CLASSE	0

Freq. [Hz]	500Hz [dB]	Freq. [Hz]	630Hz [dB]	Freq. [Hz]	800Hz [dB]
92.0	80.0	115.9	80.0	146.0	80.0
162.9	80.0	205.2	80.0	258.6	80.0
353.6	58.3	445.5	63.8	561.2	69.3
396.9	42.1	500.0	41.5	630.0	53.1
445.5	2.8	561.2	3.0	707.1	3.0
459.7	0.8	579.1	0.8	729.7	0.7
473.5	0.1	596.6	0.1	751.7	0.1
487.0	-0.1	613.5	0.0	773.0	0.0
500.0	-0.1	630.0	-0.1	793.7	-0.1
513.4	0.0	646.8	-0.1	814.9	0.0
528.0	0.1	665.2	0.1	838.1	0.1
543.9	0.8	685.2	0.7	863.4	0.8
561.2	2.8	707.1	3.1	890.9	3.1
630.0	45.0	793.7	52.0	1000.0	56.9
707.1	70.8	890.9	74.2	1122.2	72.8
1534.8	80.0	1933.7	80.0	2436.3	80.0
2717.4	80.0	3423.7	80.0	4313.6	80.0
CLASSE	0	CLASSE	0	CLASSE	0

Freq. [Hz]	8kHz [dB]	Freq. [Hz]	10kHz [dB]	Freq. [Hz]	12.5kHz [dB]
472.0	80.0	1881.6	80.0	2336.7	80.0
566.2	80.0	3283.3	80.0	4137.1	80.0
5656.9	74.3	7127.2	78.2	8979.7	80.0
6349.6	55.2	8000.0	56.0	10079.4	62.4
6747.2	3.1	8979.7	3.1	11313.7	3.1
7354.0	0.8	9266.2	0.6	11674.6	0.6
7576.2	0.2	9545.4	0.1	12026.4	0.1
7991.5	0.8	9816.0	0.0	12368.3	0.0
8000.0	-0.1	10079.4	-0.1	12699.2	0.0
8214.1	0.0	10349.1	0.0	13039.0	0.1
8447.5	0.1	10643.2	0.1	13409.6	0.3
8762.1	0.7	10963.9	0.6	13813.7	0.8
8979.7	3.1	11313.7	3.1	14254.4	3.3
10079.4	61.4	12699.2	65.7	16000.0	69.9
11313.7	80.0	14254.3	80.0	17959.3	80.0
24536.4	80.0	30939.1	80.0	38980.9	80.0
43477.9	80.0	54778.7	80.0	69016.9	80.0
CLASSE	0	CLASSE	0	CLASSE	0

Freq. [Hz]	1kHz [dB]	Freq. [Hz]	1.25kHz [dB]	Freq. [Hz]	1.6kHz [dB]
184.0	80.0	231.8	80.0	292.1	80.0
325.8	80.0	410.5	80.0	517.1	80.0
707.1	73.2	890.9	78.4	1122.5	80.0
793.7	55.1	1000.0	55.0	1259.9	62.5
890.9	3.1	1122.2	3.0	1414.2	3.2
919.3	0.7	1157.5	0.6	1459.3	0.6
947.0	0.1	1193.2	0.1	1503.3	0.1
973.9	0.0	1227.1	0.0	1546.0	0.0
1000.0	-0.1	1259.9	-0.1	1587.4	-0.1
1026.8	-0.1	1293.6	0.0	1629.9	0.1
1055.9	0.1	1328.4	0.1	1676.2	0.2
1087.8	0.6	1370.0	0.6	1726.7	0.7
1122.5	3.0	1414.2	3.1	1781.8	3.3
1259.9	61.4	1587.4	65.5	2000.0	69.9
1414.2	80.0	1781.8	80.0	2244.9	80.0
3069.6	80.0	3867.4	80.0	4872.6	80.0
5434.7	80.0	6847.3	80.0	8627.1	80.0
CLASSE	0	CLASSE	0	CLASSE	0

Freq. [Hz]	2kHz [dB]	Freq. [Hz]	2.5kHz [dB]	Freq. [Hz]	3.15kHz [dB]
368.0	80.0	463.7	80.0	584.2	80.0
651.6	80.0	820.9	80.0	1034.3	80.0
1414.2	80.0	1781.8	53.6	2244.9	57.1
1587.4	66.2	2000.0	28.5	2519.8	40.1
1793.8	3.1	2244.9	2.3	2814.4	2.8
1938.6	0.6	2316.5	0.8	2948.7	0.9
1994.0	0.1	2363.3	0.2	3066.6	0.2
1997.9	0.0	2354.2	0.0	3092.1	0.0
2000.0	-0.1	2319.8	-0.1	3174.8	0.0
2053.5	0.0	2387.5	0.0	3259.8	0.1
2141.8	0.2	2460.8	0.1	3352.4	0.2
2175.5	0.7	2541.1	0.7	3454.4	0.9
2244.9	3.2	2628.4	2.3	3563.6	3.0
2519.8	80.0	3174.8	39.9	4000.0	40.4
2828.4	80.0	3563.6	60.7	4489.8	63.9
6139.1	80.0	7933.8	80.0	9745.2	80.0
10869.5	80.0	13694.7	80.0	17254.2	80.0
CLASSE	0	CLASSE	0	CLASSE	0



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Somma dei segnali d'uscita
Summation of output signals

La verifica che la somma dei segnali di uscita è pari al segnale di ingresso è stata eseguita utilizzando le misure effettuate nella prova di "Attenuazione relativa". Le frequenze scelte sono le due frequenze di taglio e la frequenza centrale per tutti i filtri esclusi gli estremi.

Verification that the summation of output signals is equal to the input signal has been carried out using the measurements of "Relative attenuation" test. The frequencies chosen are the bandedge and the central ones of all the filters except the ends.

Filtro [Hz]	Frequenza [Hz]	$\Delta\Sigma$ [dB]	Filtro [Hz]	Frequenza [Hz]	$\Delta\Sigma$ [dB]
	24.8	0.6		500.0	0.0
31.5	30.4	0.0	630	613.5	0.1
	34.0	0.5		685.2	-0.0
	31.2	0.5		630.0	-0.0
40	38.3	0.1	800	773.0	0.1
	42.8	0.5		863.4	-0.1
	39.4	0.5		793.7	-0.1
50	48.3	0.1	1000	973.9	0.0
	54.0	0.1		1087.8	0.0
	49.6	0.1		1000.0	0.0
63	60.9	0.1	1250	1227.0	0.1
	68.0	0.0		1370.5	-0.1
	62.5	0.0		1259.9	-0.1
80	76.7	0.1	1600	1546.0	0.1
	85.7	0.1		1726.7	-0.2
	78.7	0.1		1587.4	-0.2
100	96.6	0.1	2000	1947.9	0.1
	107.9	0.1		2125.3	0.3
	99.2	0.1		2000.0	0.3
125	121.7	0.1	2500	2454.2	0.1
	136.0	-0.0		2741.0	0.5
	125.0	-0.0		2519.8	0.5
160	153.4	0.1	3150	3092.1	0.0
	171.3	-0.1		3453.4	0.1
	157.5	-0.1		3174.8	0.1
200	193.3	0.1	4000	3895.8	0.1
	215.8	0.0		4351.0	0.0
	198.4	0.1		4000.0	0.0
250	243.5	0.1	5000	4708.4	0.1
	271.9	0.2		5382.0	0.0
	250.0	0.2		5039.7	0.0
315	306.8	0.0	6300	6184.1	0.1
	342.6	0.5		6906.8	-0.1
	315.0	0.0		6349.6	-0.1
400	386.5	0.0	8000	7791.5	0.1
	431.7	0.2		8742.1	-0.1
	396.9	0.2		8000.0	-0.1
500	487.0	0.1	10000	9816.7	0.0
	547.8	0.1		10963.9	-0.1

carried out at 5 dB steps up to 5 dB from scale ends and at 1 dB steps near them.

Leq in [dB]	ΔLeq 25 Hz [dB]	ΔLeq 10k Hz [dB]
136	-0.0	0.0
129	0.0	0.0
128	-0.0	-0.0
127	0.0	0.0
126	-0.0	-0.0
125	-0.0	0.0
120	0.0	0.0
115	0.0	0.0
110	-0.0	0.0
105	0.0	-0.0
100	0.0	0.0
98	0.1	0.0
90	0.0	0.0
85	-0.0	-0.0
80	0.0	0.0
75	0.0	-0.0
70	-0.0	-0.0
65	-0.0	0.0
60	0.0	0.1
55	0.0	0.0
54	0.0	0.0
53	0.0	0.0
52	0.0	0.0
51	0.1	-0.0
50	-0.0	0.0

Linearità dei campi di misura
Linearity of measurement ranges

La linearità dei filtri, è stata verificata in tutti i campi di misura misurando il Leq. La frequenza del segnale di prova applicato è pari alla frequenza centrale nominale del filtro in esame. Per ogni campo di misura sono state eseguite 2 misure, a 2 dB dalle estremità della scala, comunque 16 dB oltre il valore di misura del rumore autogenerato.

Sound level meter linearity has been verified in all measurement ranges measuring the Leq. The frequency of the applied test signal was equal to the nominal central frequency of filter under test. For each measurement range 2 measurements have been carried out, at 2 dB from scale ends, in any case 16 dB above the self generated noise level.

Campo di misura Measurement range [dB]	Leq in [dB]	ΔLeq 25 Hz [dB]	ΔLeq 10k Hz [dB]
60÷ 140	138	0.1	0.0
	62	0.0	0.0
40÷ 120	118	-0.2	-0.0
	42	-0.2	0.0
30÷ 110	108	-0.2	-0.1
	42	-0.3	-0.1
20÷ 100	98	-0.3	-0.1
	42	-0.2	-0.1

Campo di funzionamento lineare
Linear operating range

La verifica della linearità dei filtri è stata eseguita per i filtri con frequenze centrali pari a 16Hz e 20kHz misurando il Leq. La frequenza del segnale di prova applicato è pari alla frequenza centrale nominale del filtro in esame. Le misure sono state eseguite a passi di 5 dB sino a 5 dB dagli estremi della scala ed a passi di 1 dB vicino ad essi.

Verification of filters linearity has been carried out for filters of central frequency equal to 16Hz and 20kHz measuring the Leq. The frequency of the applied test signal was equal to the nominal central frequency of filter under test. The measurements have been



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Report of calibration no

Funzionamento in tempo reale
Real-time operation

Il funzionamento in tempo reale è stato verificato per tutti i filtri, nel campo principale, utilizzando un segnale di ingresso vobulato in frequenza nell'intervallo:

6 Hz ÷ 50000 Hz

Il tempo di vobulazione è pari a 55.0 s e per ciascun filtro viene misurato il Leq su 60.0 s.

Real-time operation has been verified for all the filters, in the reference range, using a swept-frequency input signal in the range:

6 Hz ÷ 50000 Hz

The sweep time is equal to 55.0 s and for every filter the Leq is measured during 60.0 s.

Filtro [Hz]	ΔLEQ [dB]	Filtro [Hz]	ΔLEQ [dB]
25	0.3	630	0.0
31.5	0.2	800	0.0
40	0.2	1k	0.0
50	0.1	1.25k	0.1
63	0.0	1.6k	0.0
80	0.1	2k	0.0
100	0.1	2.5k	0.2
125	0.1	3.15k	0.0
160	0.0	4k	0.1
200	0.1	5k	0.0
250	0.1	6.3k	0.1
315	0.1	8k	0.0
400	0.0	10k	0.0
500	0.1	12.5k	0.0

Filtri anti-aliasing
Anti-aliasing filters

L'efficacia dei filtri anti-aliasing è stata verificata misurando la risposta di ciascun filtro ad un segnale in ingresso di frequenza pari alla frequenza di campionamento meno la frequenza centrale nominale e di livello pari al fondo scala del campo principale. La frequenza di campionamento è pari a 48 kHz.

The effectiveness of anti-aliasing filters has been verified measuring the filter response to an input signal of frequency equal to the sampling frequency minus the nominal center frequency and of level equal to the reference range full scale. The sampling frequency of each filter is equal 48 kHz.

Filtro [Hz]	Att.Rel. [dB]	Filtro [Hz]	Att.Rel. [dB]
25	74.7	630	76.7
31.5	74.3	800	78.9
40	74.3	1k	80.0
50	74.2	1.25k	80.0
63	74.1	1.6k	80.0
80	74.1	2k	75.1
100	74.2	2.5k	73.1
125	74.1	3.15k	75.2
160	74.1	4k	80.0
200	74.3	5k	77.3
250	74.2	6.3k	72.8
315	74.6	8k	80.0
400	74.9	10k	74.3
500	75.5	12.5k	80.0

