Comparison between Audiometric Bone Conduction Transducer BC-2LD (BHM-Tech) and B71 (RadioEar)

BC-2LD **B71**

Figure 1. Symbolic photos of the Audiometric Bone Conduction Transducers BC-2LD (left) from BHM-Tech and B71 (right) from RadioEar.

This document compares the performance of the BC-2LD (BHM-Tech) and B71 (RadioEar) audiometric bone conduction transducers. All data for the BC-2LD are average data from measurements of 10 pieces BC-2LD transducers, measured in the laboratory of BHM-Tech. Measured at the Artificial Mastoid Brüel & Kjaer 4930 with a static force of 5.4 N. All data for the B71 from RadioEar were taken from the data sheet or from the referenced publications, unless otherwise stated.

Blue curves represent the BC-2LD and the black curves represent the B71.

Output Vibratory Force Level (OVFL) @ 1 V_{RMS} Input

equivalent to 10 mW @ 1 kHz Input

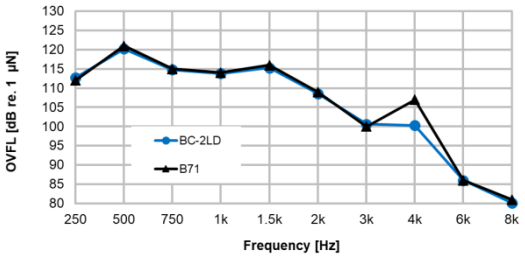

Figure 2. The mean frequency response of the BC2-LD in comparison with the frequency response of the B71, respectively, obtained at an input voltage of 1 V_{RMS}. The B71 data up to 4 kHz is taken from the data sheet (1). B71 data for 6 kHz and 8 kHz are mean values of 3 measured B71. The magnitude is given in decibels relative the 1 µN.

No important differences were found in the output vibratory force level (OVFL) between the BC-2LD and the B71, except at 4000 Hz. The BC-2LD provides a 5-6 dB lower output vibratory force level at 4000 Hz. On the one hand, the calibration data can be corrected by these 6 dB factor at 4000 Hz (see Audiometric Calibration Table at Figure 6) to target artificial mastoid force level. On the other hand, the calibration data can be left according to the standard RETVFLs to counteract the well-known problem of the air-bone gap at 4000 Hz. A number of studies over many years (e.g. (2)) have reported false air-bone gaps, particularly at 4000 Hz, attributed at least partly to calibration standards.

THD @ 1 V_{RMS} Input

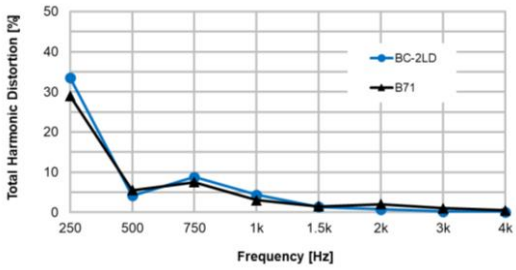

Figure 3. The mean value of the total harmonic distortion (THD) of the BC-2LD in comparison with the total harmonic distortion (THD) of the B71, respectively, when the bone conduction transducers are driven by an input voltage of 1 V_{RMS}. The B71 data is taken from the conference paper (3). The magnitude is given in percent.

No important differences were found in the total harmonic distortion (THD) between the BC-2LD and the B71, measured by an input voltage of 1 V_{RMS}.

THD acc. IEC 60645-1 and ISO 389-3

BC-2LD

TOTAL HARMONIC DISTORTION				
Frequency [Hz]	250	500 - 750	1k	1.5k - 4k
Hearing Level [dB]	20	50	60 (50)	60 (50)
THD [%] typ.	2.5	<1.1	<1.1 (<0.3)	<0.3 (<0.3)
THD [%] max.	5.0	2.0	2.0 (1.0)	1.0 (1.0)

B71

HARMONIC DISTORTION			
Frequency Hz	250	500 & 750	1K-4K
Hearing Level	20	50	50
T.H.D.% Typical	2.3	<1.1	<0.3
T.H.D.% Maximum	5.0	5.0	5.0

Figure 4. Total harmonic distortion (THD) acc. IEC 60645-1:2012 (4) and ISO 389-3:2016 (5) for the BC2-LD and B71. The B71 data is taken from the data sheet (1).

No important differences were found in the total harmonic distortion (THD) between the BC-2LD and the B71, measured according IEC 60645-1:2012 (4) and ISO 389-3:2016 (5). The table for the B71 only gives the data for a hearing level of 50 dB from a frequency of 1 kHz upwards. In order to be able to compare the values, these values are also additional given in the table for the BC-2LD and can be found written in brackets. A maximum THD of 5 % over the entire frequency range is specified for the B71, which is quite high in comparison to the BC-2LD.

Max. Output Force Level acc. IEC 60645-1

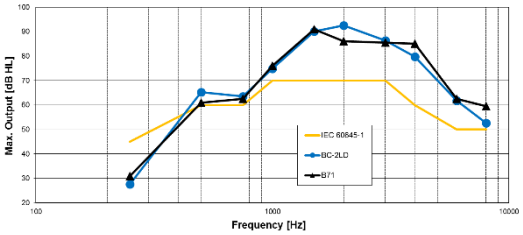

Figure 5. The mean value of the maximum hearing level in decibels for the BC-2LD and in comparison with the value of the maximum hearing level in decibels for the B71, respectively, without exceeding a THD of 6% or at a maximum input voltage of 6 V_{RMS}, whichever comes first. The B71 data is taken from the conference paper (6). The yellow line shows the minimum hearing level required in compliance with IEC 60645-1:2012 (4).

There are slight differences in the measurement of the maximum output force level according to IEC 60645-1 (4) at some frequencies. Both audiometric bone conduction transducers, the BC-2LD and the B71, are above the required minimum hearing level from 500 Hz upwards and below the required minimum hearing level at the frequency of 250 Hz.

Audiometric Calibration

The Audiometric Calibration table shows the required input voltage to provide force levels 40 dB HL ±3.0 dB above threshold (RETVFL) based on ISO and ANSI standards.

BC-2LD

AUDIOMETRIC CALIBRATION		
Frequency [Hz]	**Voltage [mV]**	**dB [re. 1 mV]**
250	460.1	53.3
500	68.8	36.8
750	45.7	33.2
1k	26.6	28.5
1.5k	11.1	20.9
2k	12.3	21.8
3k	26.4	28.4
4k	51.6	34.3

B71

Audiometric Calibration		
Frequency Hz	**mV**	**dB re 1.0mV**
250	515.9	54.3
500	69.0	36.8
750	43.9	32.9
1000	25.5	28.1
1500	10.1	20.1
2000	11.8	21.4
3000	31.5	30.0
4000	27.2	28.7

Figure 6. Comparison of the audiometric calibration table for the BC-2LD and the B71. The B71 data up is taken from the data sheet (1).

The deviations in the audiometric calibration values between the two audiometric bone conduction transducers are within 1.6 dB, except at the frequency of 4000 Hz. The calibration value at this frequency is about 5-6 dB higher for the BC-2LD. See also statement above under section *Output Vibratory Force Level*.

References

1. RadioEar. Bone Transducers - RadioEar. [Online] April 2020. [Cited: 3 February 2021.] https://wdh02.azureedge.net/-/media/radio-ear/main/datasheets/datasheet_b71_04_20.pdf?la=en&rev=4B21&hash=DB59C347E0AA99D06096CFD364A25465.

2. Margolis Robert H., Eikelboom Robert H., Johnson Chad, Ginter Samantha M., Swanepoel De Wet, Moore Brian C. J. False air-bone gaps at 4 kHz in listeners with normal hearing and sensorineural hearing loss. *International Journal of Audiology.* 2013, 52(8), S. 526-532.

3. *A New Audiometric Bone Vibrator - Radioear B81 for more accurate hearing diagnostics.* Jansson Karl Johan Fredén, Håkansson Bo, Johannsen Leif, Tengstrand Tomas. Chalmers, Gothenburg, Sweden : s.n., 2013. S2 workshop.

4. IEC 60645-1:2012 - Electroacoustics - Audiometric equipment. *Part 1: Equipment for pure-tone audiometry.*

5. ISO 389-3:2016 - Acoustics - Reference zero for the calibration of audiometric equipment. *Part 3: Reference equivalent threshold force levels for pure tones and bone vibrators.*

6. Jansson Karl Johan Fredén, Håkansson Bo, Johannsen Leif, Tengstrand Tomas. Electro-acoustic performance of the new bone vibrator Radioear B81: A comparison with the conventional Radioear B71. *International Journal of Audiology.* 2014.