

The transparent Earpiece Technical Documentation

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Version 0.1: November 13, 2019

1 Devices

1.1 General Description

This document describes the technical details for the *Acoustically Transparent Earpieces*. It is a one-size-fits-all earpiece with integrated microphones and drivers for use in research on hearing devices. Details on the design and acoustic performance is provided in this paper:

F. Denk, M. Lettau, H. Schepker, S. Doclo, R. Roden, M. Blau, J. Bach, J. Wellmann, and B. Kollmeier (2019). “A one-size-fits-all earpiece with multiple microphones and drivers for hearing device research”. *Proc. AES Conference on Headphone Technology*. Paper 13. San Francisco, USA, pp. 1–9

Please cite this reference when reporting on your work with the earpieces. The earpieces are available from InEar at <https://www.inear-monitoring.eu/de/transparent-earpiece.htm>.

Figures 1-3 include images and schematics of the device, including the placement and nomenclature of the transducers.

1.2 Included Items

Each unit includes one pair of earpieces, and 16 silicone domes in 4 sizes. The device is functional with other domes, but for comparability we recommend to use the ones supplied. Additional earplugs can be ordered at InEar, Germany. Replacement Cerumen Filters (type HF4) are not included, but can be reordered.



Figure 1: Image of earpieces, including distances between microphones (centres of ports) and assigned microphone names.

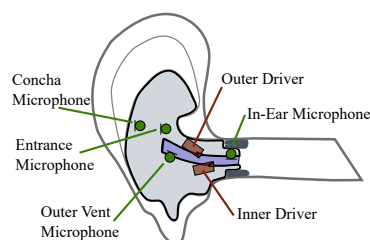


Figure 2: Schematic layout of earpiece.

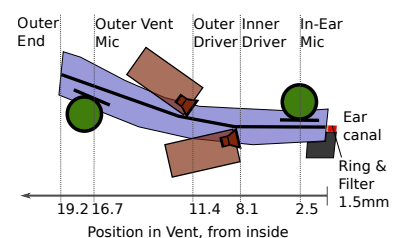


Figure 3: Transducer placement in vent. Note that the cerumen filter is not considered a part of the vent.

1.3 Versions and Serial Number

Different versions and customizations are available and listed in Table 1. Further options may be available on request. For more details on the versions with and without microphone preamplifier, see below.

Each earpiece has a printed serial number. The keys of the serial number are explained in Table 2.

Table 1: Earpiece Versions

Electronics	Venting	Color
Direct Connection Mic. Preamplifiers	Vented Closed	White Black

Table 2: Serial Number Declaration

Template: XY-####-S

X: Electronic Configuration	D: Direct Connection. A: Mic. Amplifiers included.
Y: Venting	V: Vented C: Closed
####	Ongoing Number
S: Side Indicator	L: Left R: Right

2 Connections

The earpieces come with a multicore cable (length: 1m) and a D-Sub DE9 connector. Each earpiece is wired individually. The first 10 cm of cable at the earpiece are plastically bendable to improve the fit in the individual ear. To reduce cable noise, we recommend to tape the cable to the neck of the user.

The electronic connections are listed in Table 3. The cable colors indicate the color of the appropriate strand of the multicore cable.

Table 3: Electronic Connections

Name	Sub-D9 Pin No.	Cable Color
Mic 1 In-Ear Mic	1	gray
Mic 3 Concha Mic	2	yellow
Microphone Supply Vdd	3	red
Inner Driver	4	light blue
Outer Driver	5	green
Mic 2a Entrance Mic	6	pink
Mic 2b Outer Vent Mic	7	brown
Microphone Ground	8	black
Driver Ground	9	white

3 Microphones

The general data of the microphones is listed in Table 4. All microphones are Knowles SPH1642HT5H-1 top-port MEMS microphones. The manufacturer's details can be found at <https://www.knowles.com/docs/default-source/model-downloads/sph1642ht5h-1-rev-b.pdf>.

All microphones share a common ground and Vdd. In the version without preamplifiers, the microphones are directly connected to the multicore cable. The preamplifiers are simple single-stage inverting amplifiers based on two dual-channel OPA1662-Q1 amplifiers.

Table 4: Typical Microphone Specs

	Direct Connection	With Preamps	Unit
Sensitivity @1 kHz	-38	-28	dB V/Pa
Sensitivity Variation	± 1	± 1	dB
Microphone Supply Vdd	2.5 - 3.6	3.1 - 3.6	V
Output impedance	max. 500	<10	Ω
Polarity	Positive	Negative	re Pressure
DC output	1.3	0	V
Input Overload Point	124	122	dB SPL
Signal-to-Noise Ratio	65	65	dB A-weighted

4 Drivers

The general data for the two drivers can be listed in Table 5. In all cases, they are connected directly to the multicore cable. It is recommended to drive them via a headphone amplifier with less than 10Ω output impedance and appropriate output level. Note that the two drivers have a sensitivity offset of about 8 dB. The given maximum output levels are very conservative, and relate to 5% THD at 1 kHz. Using broadband stimuli and accepting some distortions, higher levels can be created.

Table 5: Typical Driver Specs

	Driver Position				Unit
	Inner		Outer		
	Vented	Closed	Vented	Closed	
Type	WBFK-30042		FK-26768		by Knowles
Sensitivity @ 1kHz	108	112	100	106	dB SPL/V IEC711 coupler
max. Output	102	107	103	110	dB SPL @5% THD 1kHz, IEC711 coupler
Input Impedance	124		1000		Ω