Receivers for IEM design

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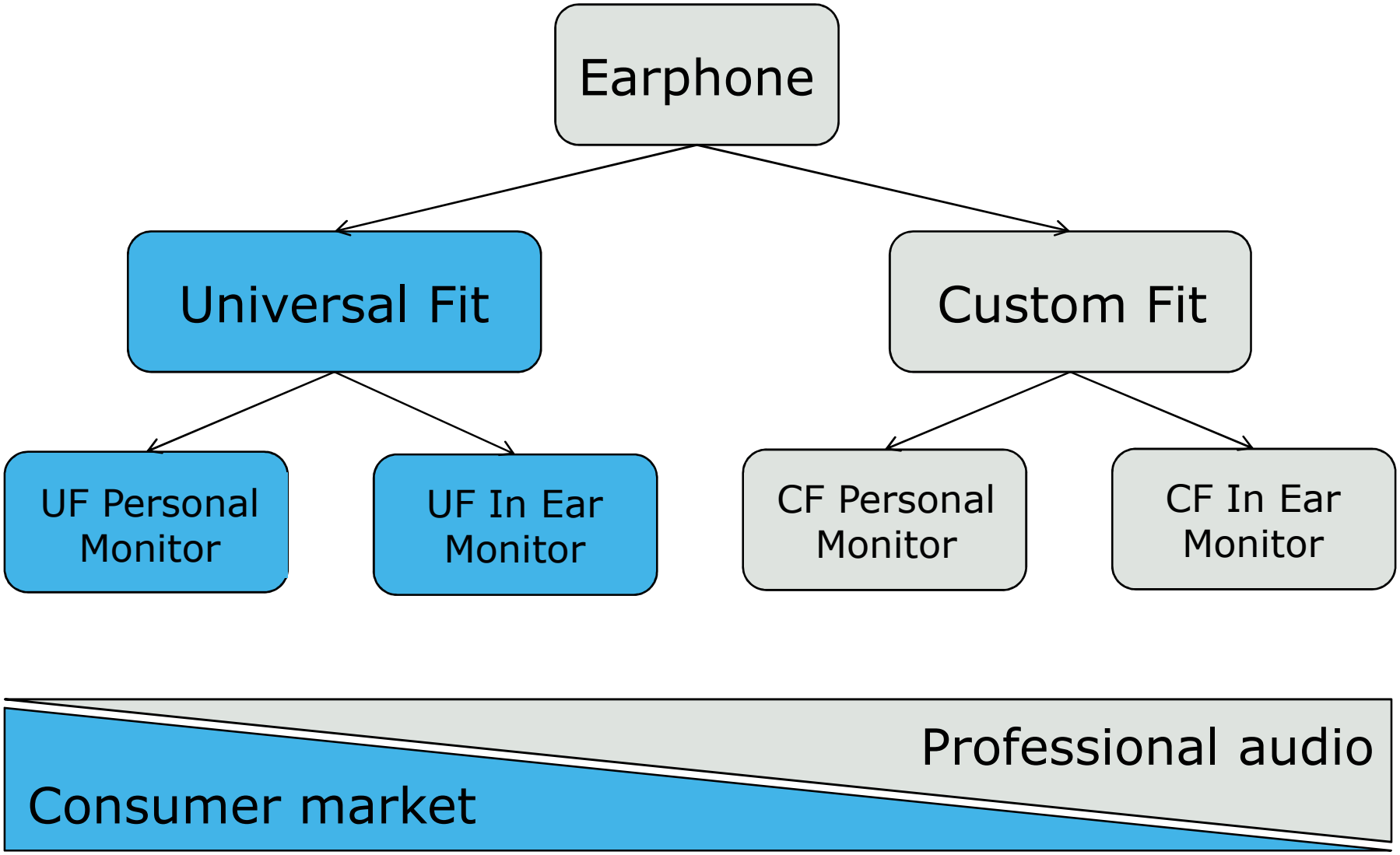
Agenda

- Types of in ear products and their application
- Short Introduction of Sonion receivers suited for audio applications
- Measuring receivers for advanced audio
- Detailed receiver information
- Short introduction of Sonion SSD dampers
- Notes on monitor design

Types of in Ear Phones and Application

Basic types of In Ear Phones



Basic types of In Ear Phones

UF Personal Monitor	UF In Ear Monitor	CF Personal Monitor	CF In Ear Monitor
•Moving Coil •Single BA •Mostly Occluded •MP3	•BA •Multi way BA •Occluded •MP3 / HiFi •Semi pro stage	•BA •Multi way BA •Occluded •MP3 / HiFi •Semi pro Stage	•BA •Multi way BA •Occluded
•Entrylevel	•advanced listeners	•advanced listeners	•Stage
•Limited noise reduction	•Passive noise reduction	•Passive noise reduction	•Passive noise reduction

Professional audio

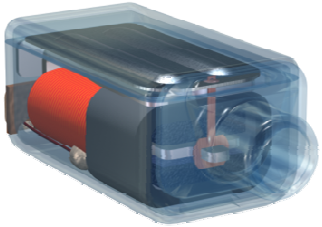
Consumer market

BA or MC and how does it work

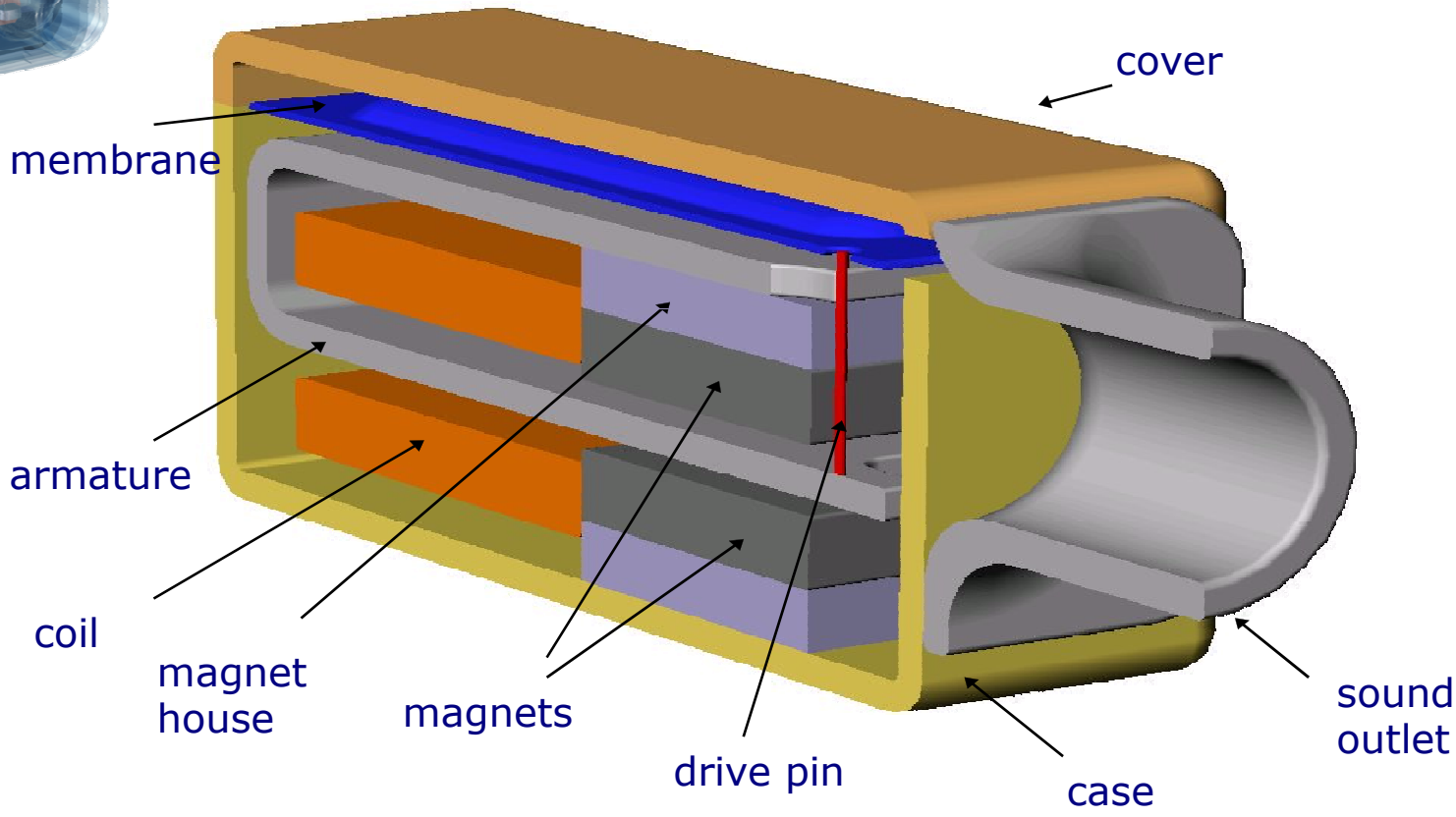
BA or MC, what is the difference ?

- Balanced Armature Receiver
  - Small Size High Efficiency High output devices
  - Suited for occluded applications only
  - Suited for custom products:
    - Sound depends on design of acoustic load
    - Sound does not depend on internal acoustics of shell (volume)
  - Soundquality:
    - Detail
    - Punch
    - Good overall response possible
- Moving Coil
  - Needs well defined acoustic environment: not suited for custom.
  - Good linearity
  - In general soft and forgiving, less tiring, but less detail
  - large

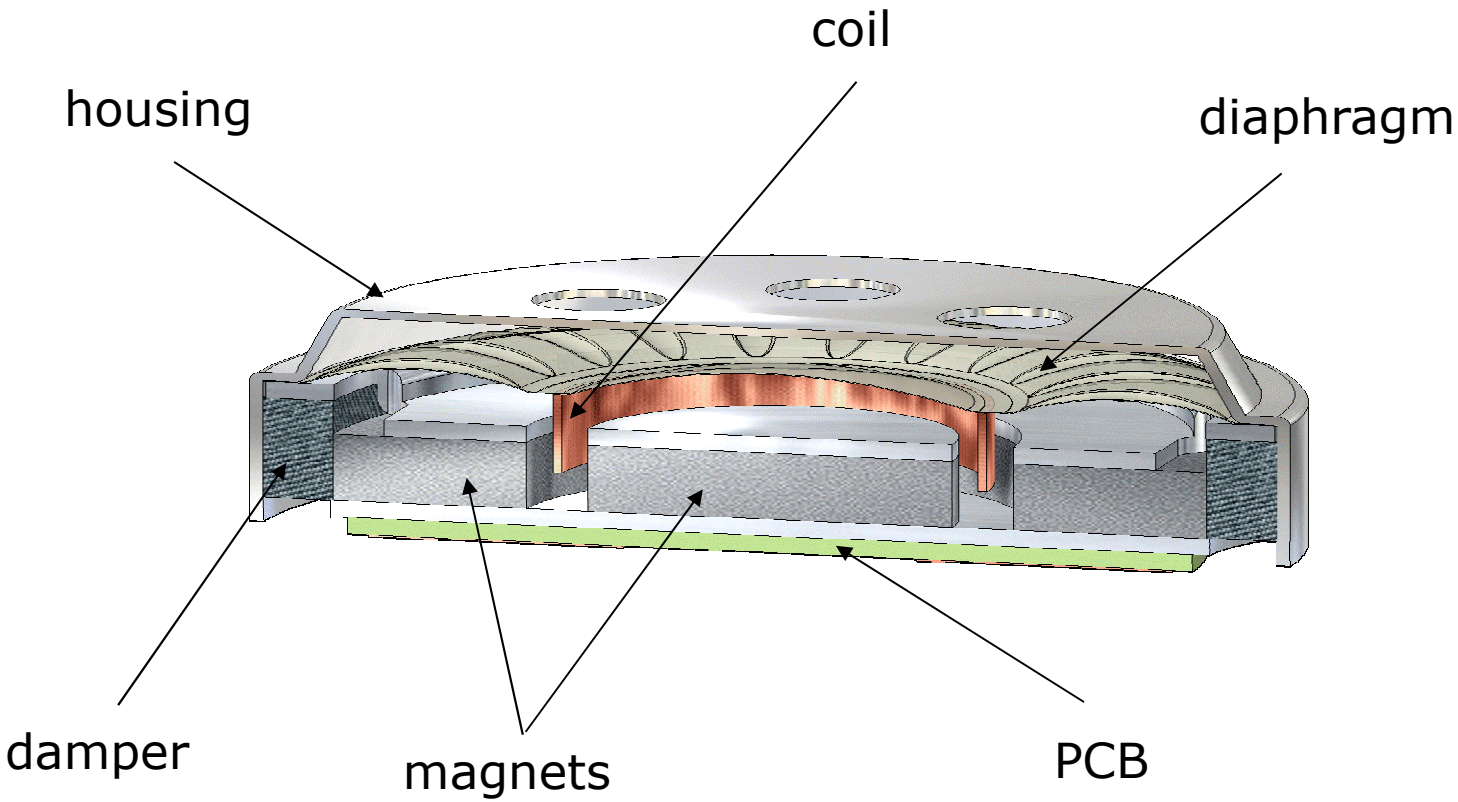
BA principle: cross-section and parts



2600 Receiver

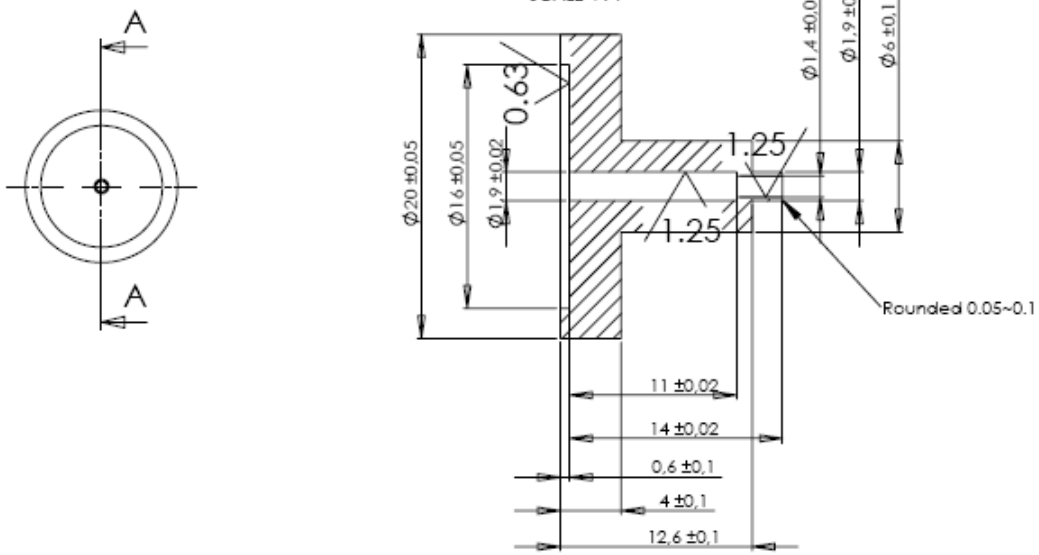


Moving coil: cross section and parts



Acoustic Test Standard

- Hearing Instrument standards not very usefull:
- Sonion has introduced the PA coupler:
  - in the industry accepted coupler that represents application sufficiently
  - Used in combination with IEC 711 earsimulator



What can Sonion offer?

Sonion Pro Audio portfolio

- BA receivers
  - ITE type receivers with a broad bandwidth
  - ***Typical for single or tweeter applications***
  - BTE type receivers with a large headroom and sensitivity
  - ***Typical for woofer in multiway applications***
- Modules (upcoming Q3 2012)
  - ***Plug and play solutions***
- Acoustic Dampers & Application Expertise, Custom Design
  - ***Ask for information***

Some BA receivers and how they are used:

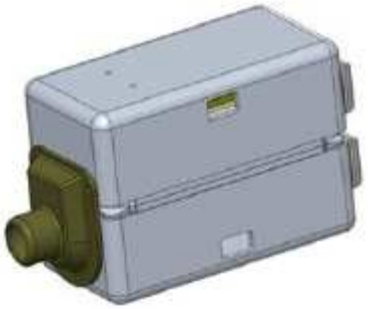
- Popular Broad Band Receivers:
  - 1700 Adequate broad band, optimized headroom
  - 2300 Widest response, accurate sound
  - 2400 High volume alternative for 2300
  - 2600 Warm sounding broad band with small size
  - 3200 Alternative for communication devices

2300

Some BA receivers and how they are used:

- Popular Woofers
  - 2000 excellent PA big sounding woofer
  - 3800 most powerful vented woofer today
  - 3300 excellent PA acurate sounding woofer
  - 3100 smallest true woofer
  - 1700 excellent sounding woofer

Bigger is better !



3800

Some BA receivers and how they are used:

- Popular Tweeters
  - 2300 industry standard tweeter
  - 2400 alternative for 2300
  - 2600 offers nice trade off in size and performance.

2600

Some BA receivers and how they are used:

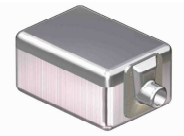
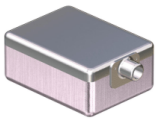
- Popular Midrange for 3 way systems
  - 1700 in combination with a “supertweeter”
  - 3300 in combination with standard tweeter
  - 3500 in combination with standard tweeter

Some BA receivers and how they are used:

- Receiver modules
  - Acupass technology low pass on woofer
  - Combination 1700 woofer and 2300 tweeter with **one spout**
  - Optimized bandwidth, easy to use.
  - Available Q3 2012

1723WT03

BA Receivers by Size overview

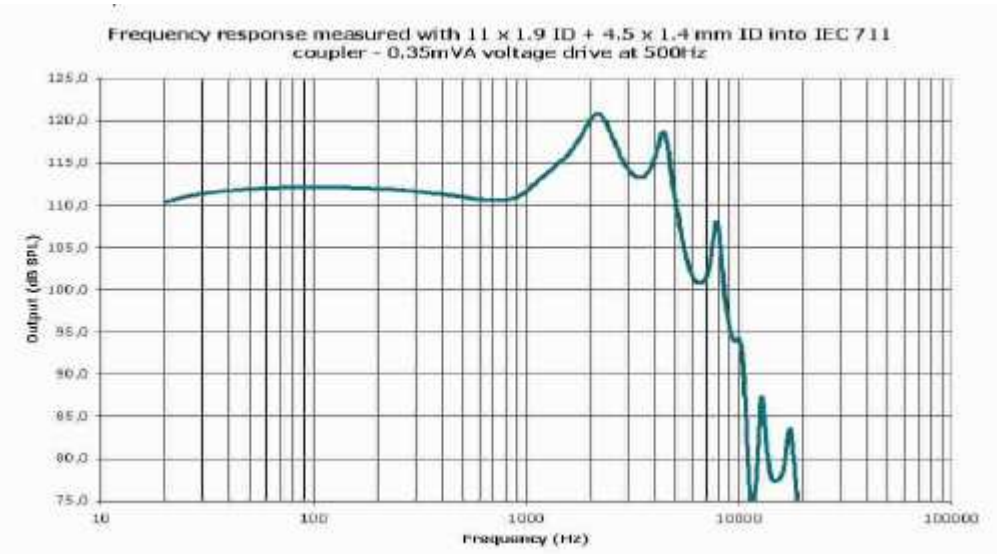
Receiver	Length (mm)	Width (mm)	Height (mm)	
1700	8.0	5.65	4.12	
3300/3800	7.87	5.6	4.09	
2000	9.45	7.13	4.10	
3200	7.87	4.09	2.8	
2300	6.35	4.34	3.02	
2600	5.3	3.1	2.6	

1700 receiver

- Largest size broadband
- Features:
  - Optimized headroom
  - Smooth sound

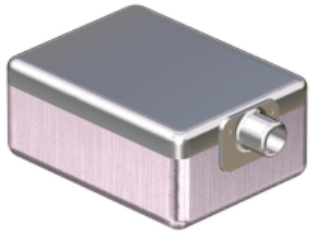
- Typical applications:
  - Entry level PM
  - Communication equipment

- Backvent option for increased bass



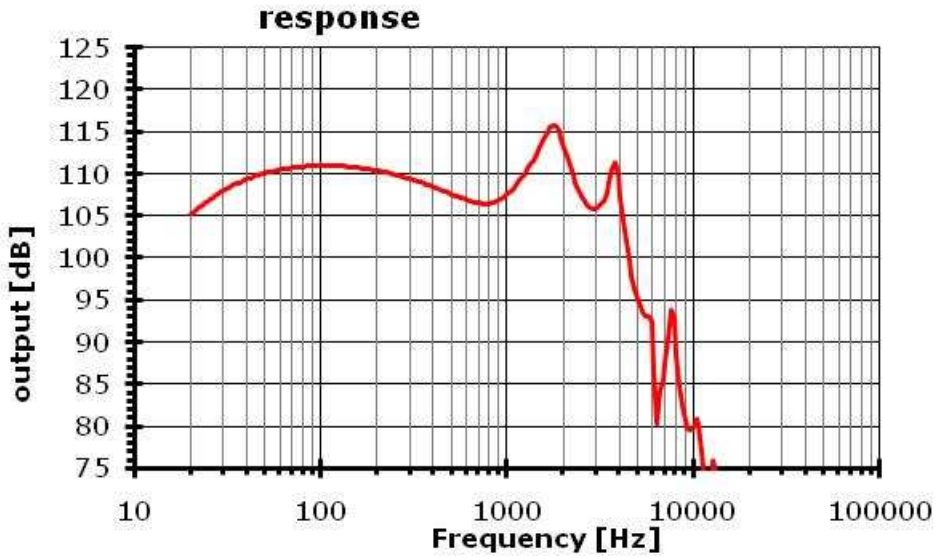
2000 receiver

- Woofer, Largest BA receiver



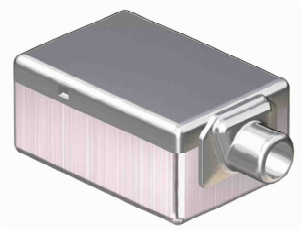
- Features:
  - Natural roll off, easy to use
  - Vintage design, limited shockperformance

- Typical applications:
  - High End PM and IEM as part of a 2 or 3-way

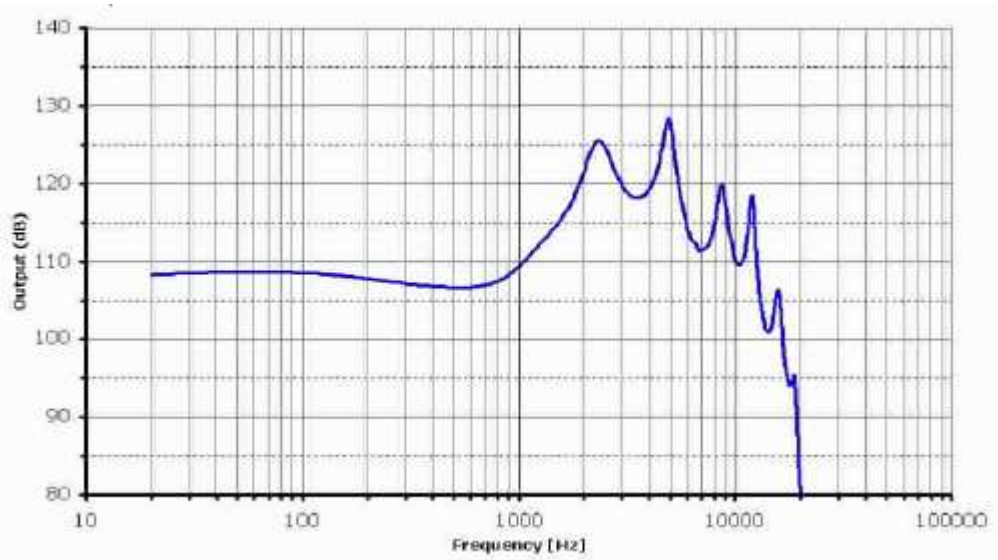


2300 receiver

- Medium size broadband
- Features:
  - Widest response
  - Acurate sound



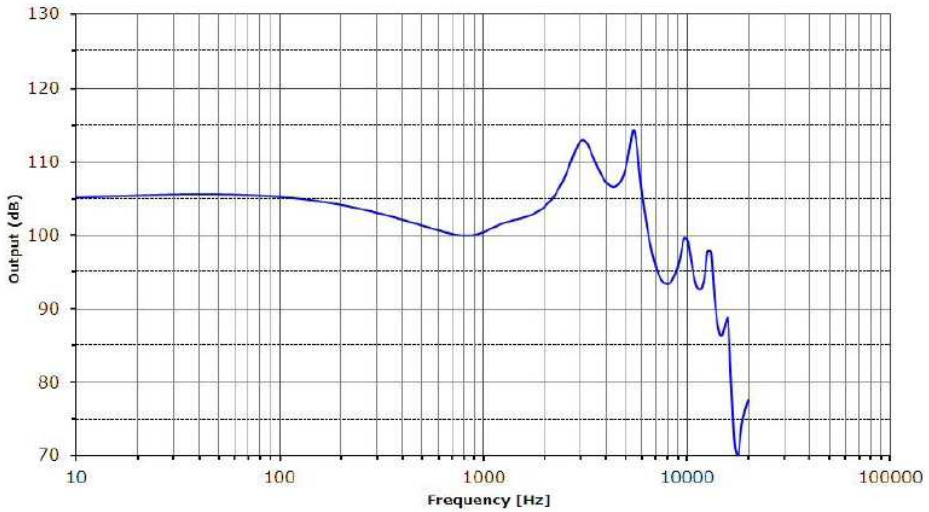
- Typical applications:
  - Medium and High end PM
  - First choice High end tweeter



- Backvent option for increased bass

2600 receiver

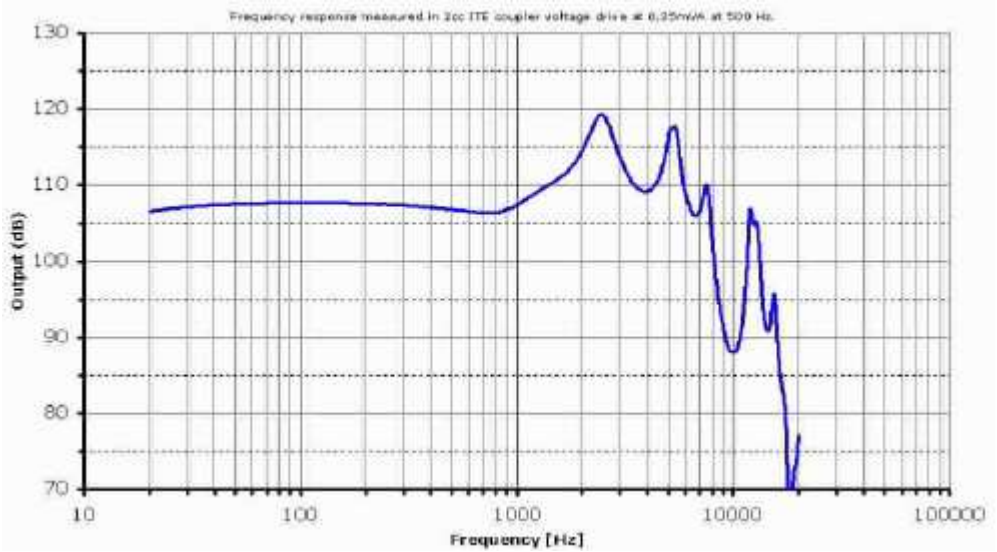
- Small size broadband
- Features:
  - Wide response
  - Smooth sound
- Typical applications:
  - Single full range
  - Small designs
- Backvent option for increased bass



3200 receiver

- Medium size broadband

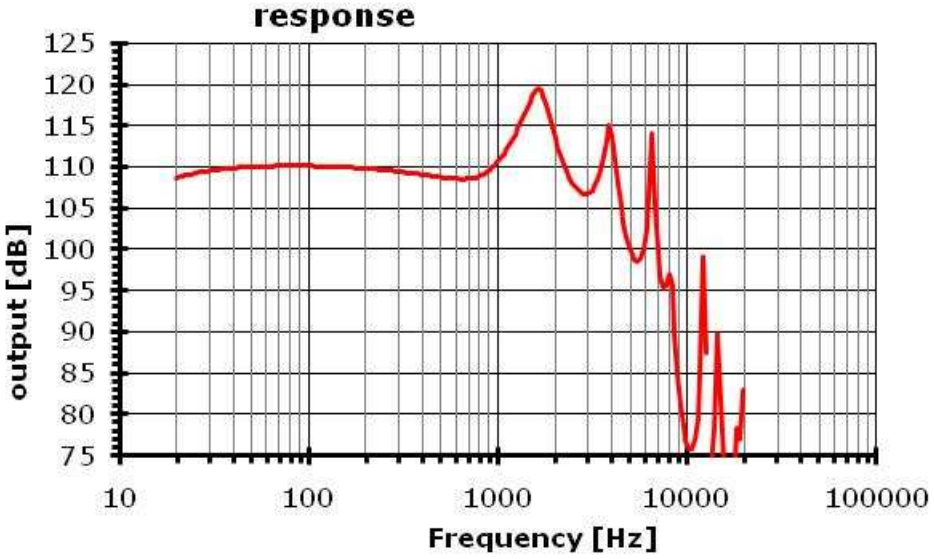
- Features:
  - Proper bandwidth &headroom
  - Neutral sound
  - Works with short nozzle
- Typical applications:
  - Entry level BA earphones
  - Communications
- Backvent option for increased bass



3300 receiver

- High-end dual woofer

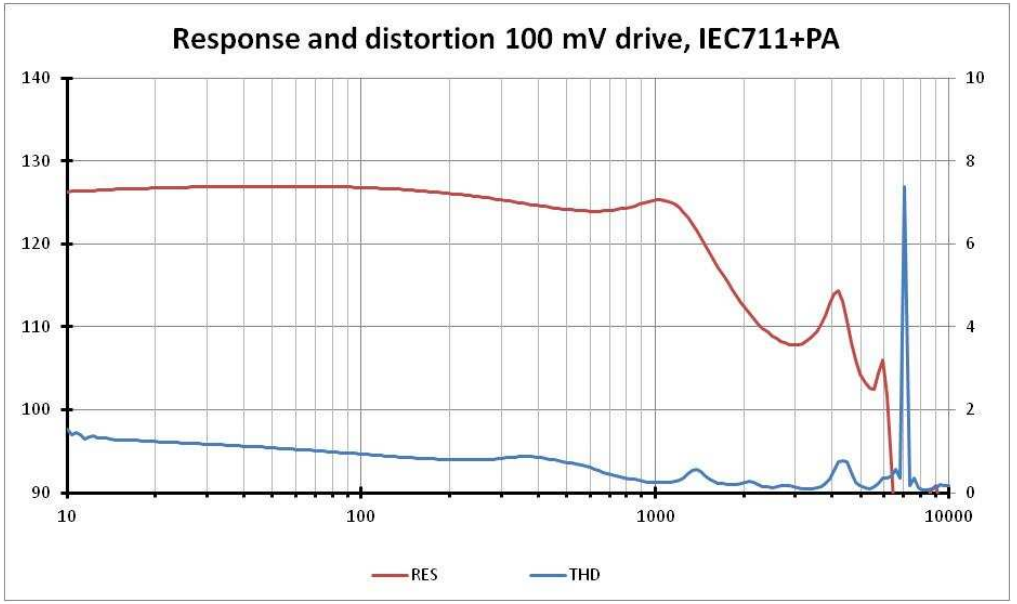
- Features:
  - Acurate sound
- Typical applications:
  - High End PM and IEM as part of a 2 or 3-way
- Backvent option for increased bass



3800 receiver

- High-end dual woofer

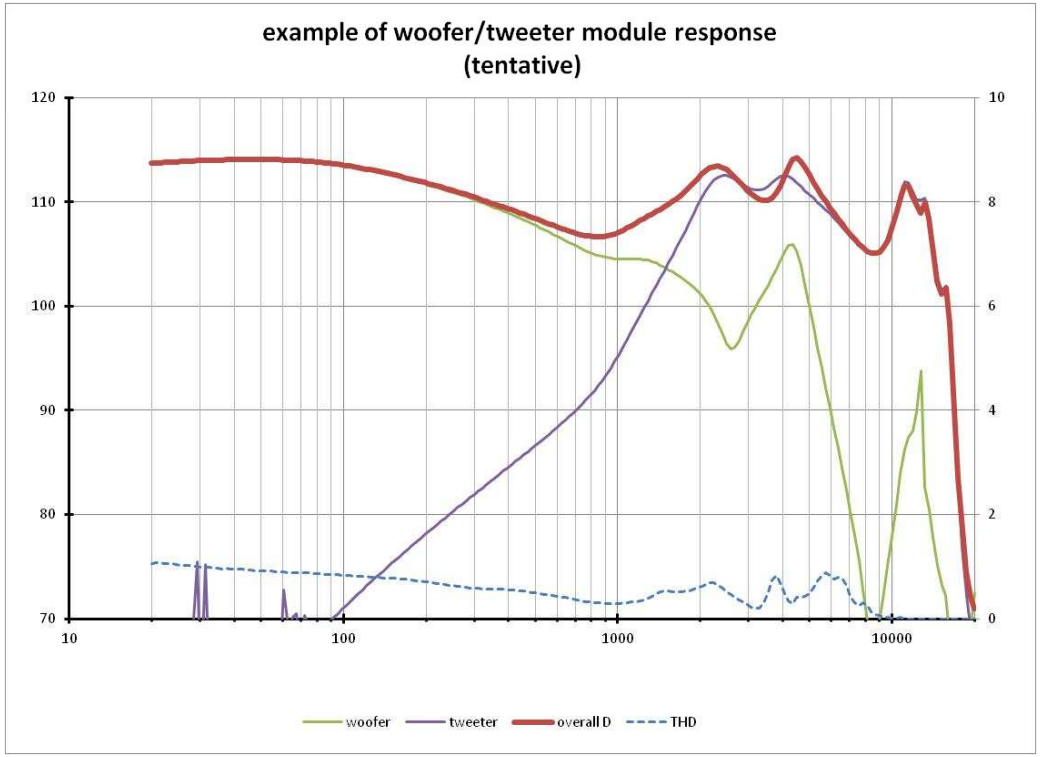
- Features:
  - Very high efficiency
  - Natural roll off
- Typical applications:
  - Great for High-End multiway systems
- Backvented



1723WT module

- Two-way system

- Features:
  - Easy use, one spout
  - Internal acoustic low pass on woofer by Patent pending acupass technology



- Typical applications:
  - Medium and High end Custom and non custom fit.

- Tuned back vent woofer

SSD

Superior Sound Dampers

Features

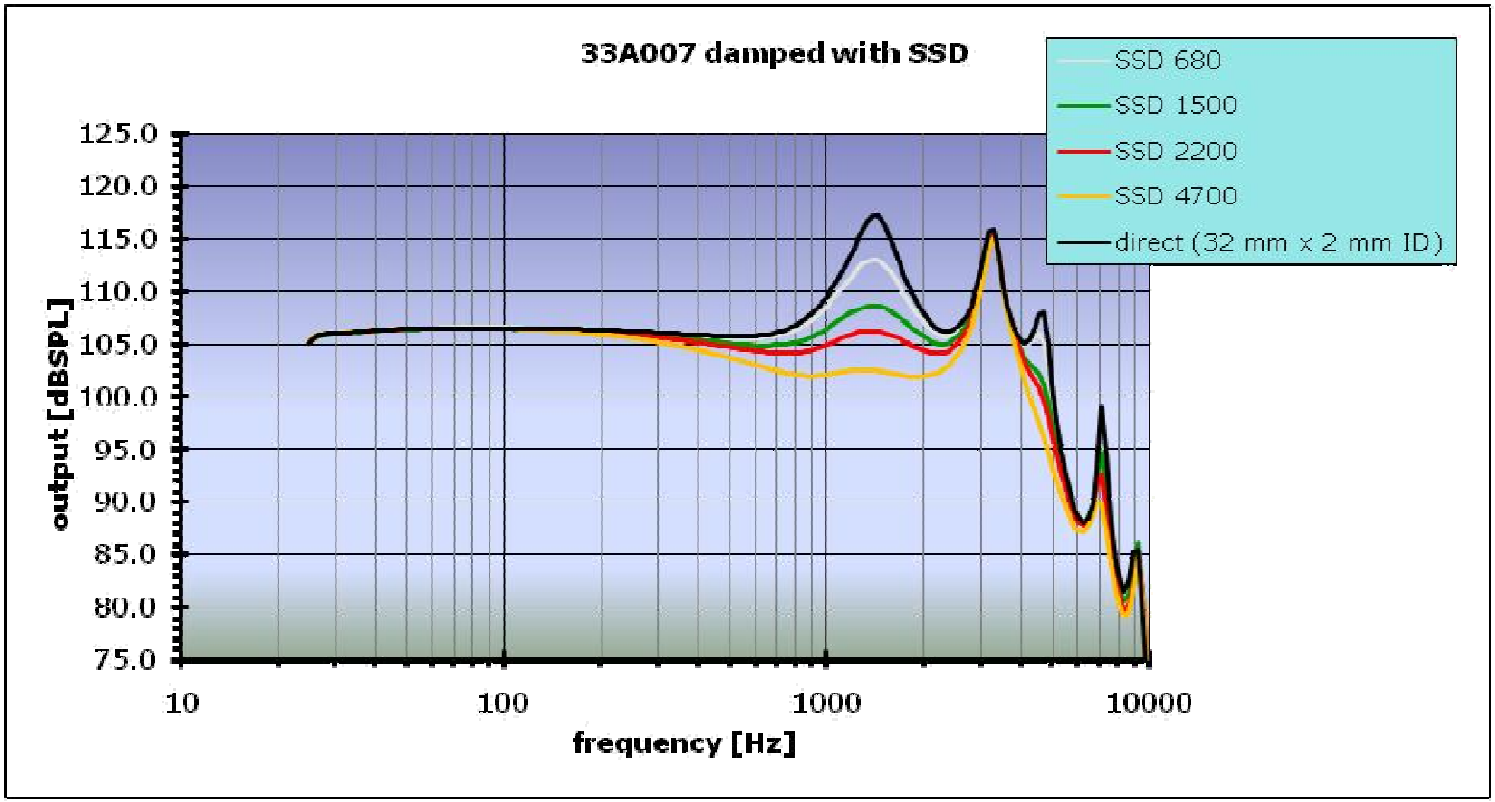
- Can be placed in a tube for damping the acoustical output of a receiver
- ABS housing
- Housing Color identifies the acoustic resistance
- Rounded corners assures easy mounting in tube

Mounting/removal tool available

Types	Color	Acoustic resistance Nom. [Ω]
SSD 01	White	680
SSD 02	Green	1500
SSD 03	Red	2200
SSD 04	Grey	320
SSD 05	Brown	1000
SSD 06	Orange	3300
SSD 07	Yellow	4700

SSD

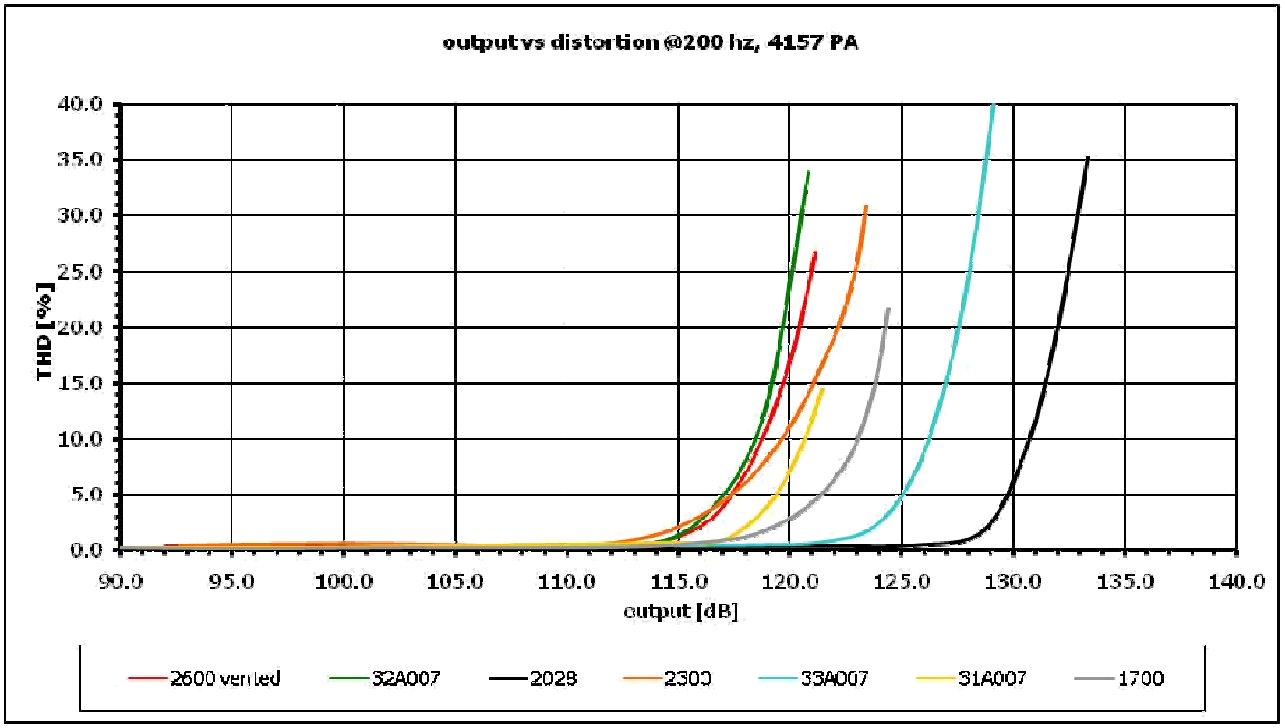
- General notes on use of acoustic dampers:
  - 680, 1000 and 1500 ohms are typically used to smooth response
  - 3300 and 4700 ohms dampers are used for acoustic low pass on woofers



Agenda

- Bigger is better
- Target response discussion
- Tuned venting
- Some design objectives

Overview available headroom

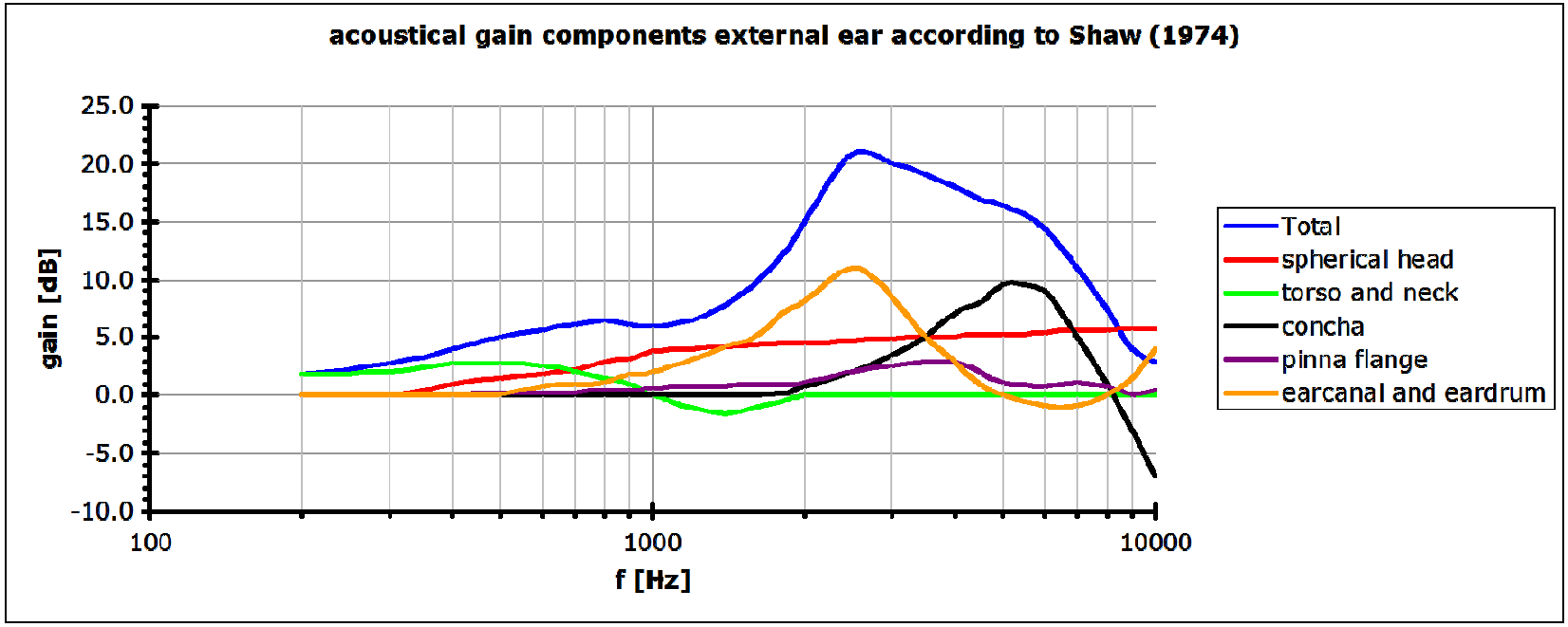


Bigger is better !

- Large receiver has bigger headroom and more "full body" sound.
- ITE receiver: compromise bandwidth vs headroom

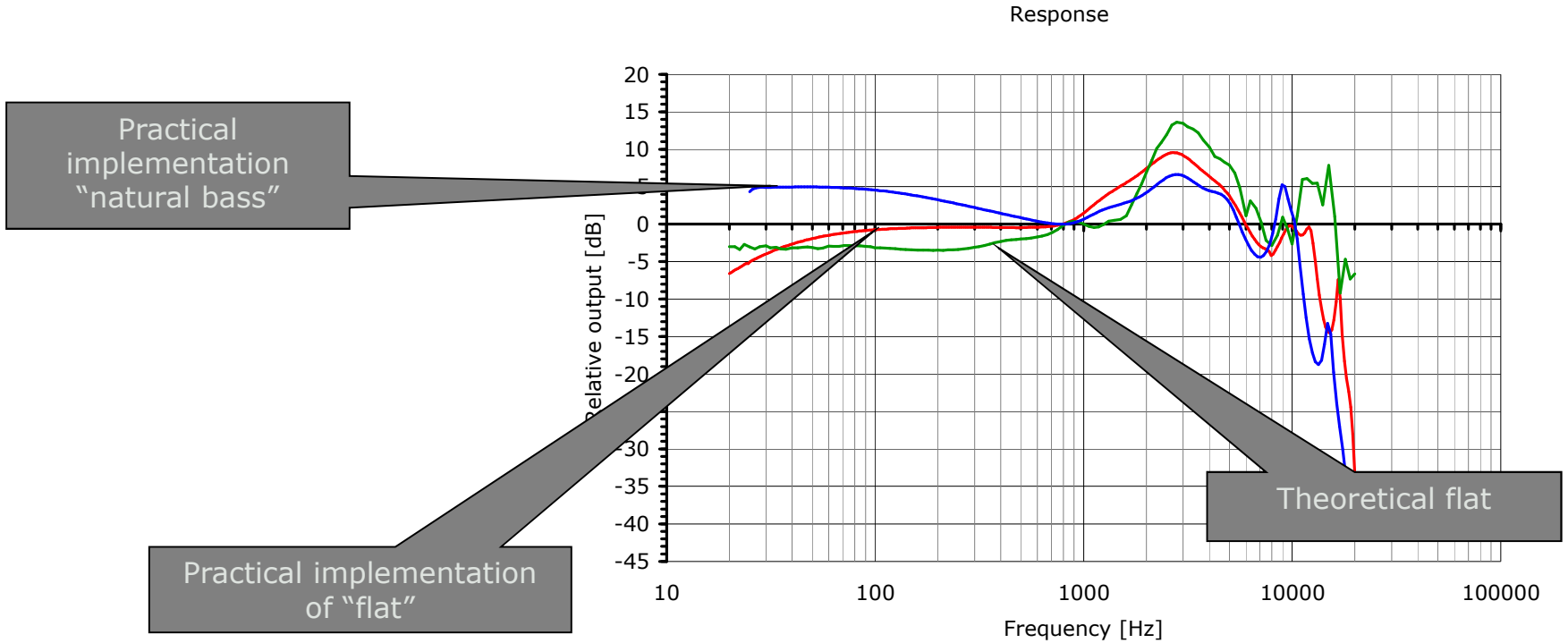
Target response discussion

- What does a flat response look like?
  - By inserting an earphone in the earcanal acoustics of the human ear are changed and need to be compensated by the earphone design



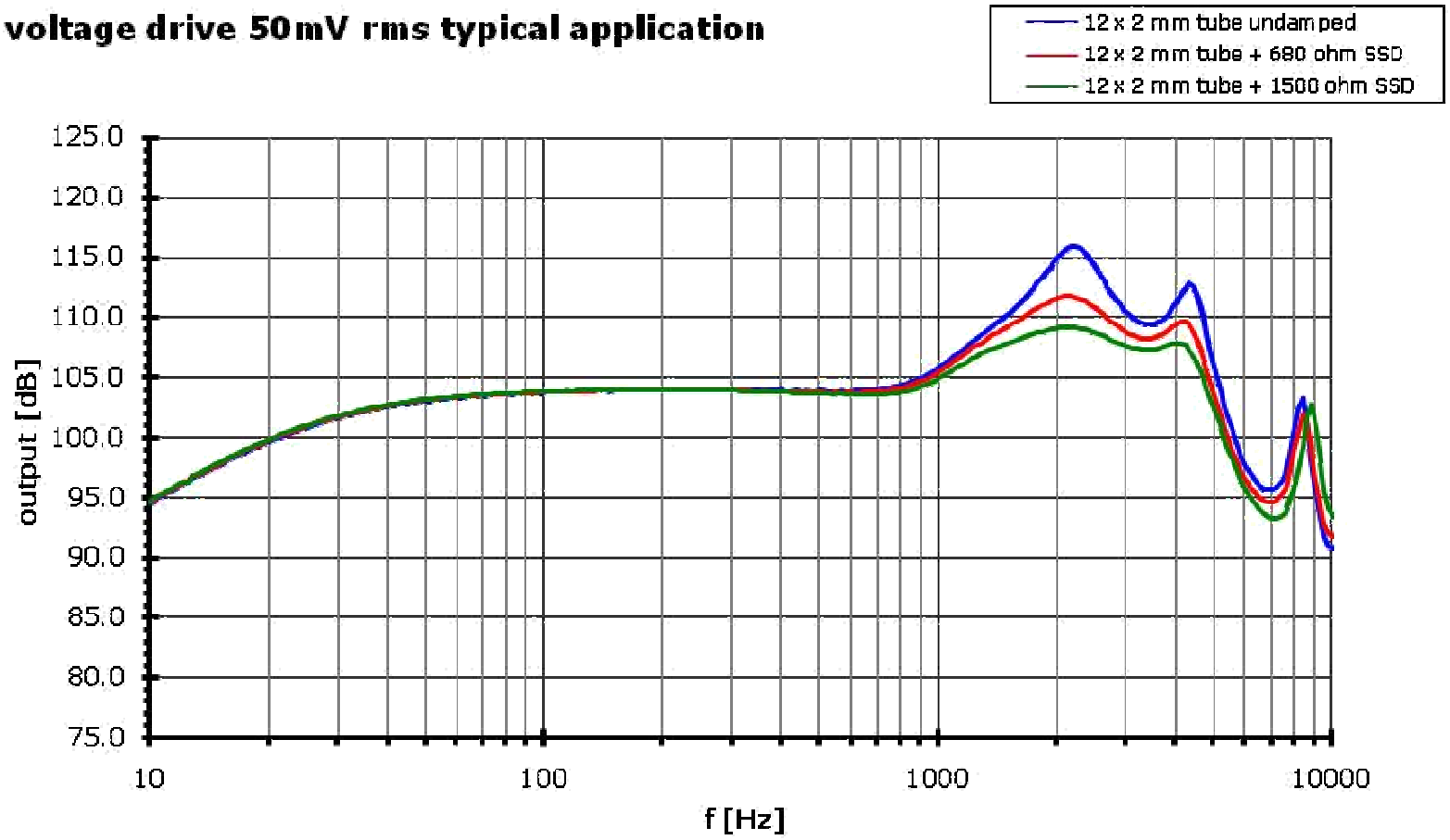
Target response discussion

- Practical examples of earphone target response
  - A 4-10 dB peak at aprox. 3 kHz is required to compensate earcanal resonance
  - “Theoretical flat” will sound harsh due to sharp peaks
  - “natural bass” will sound like a flat normal room speaker
  - “flat” will sound lean to most people



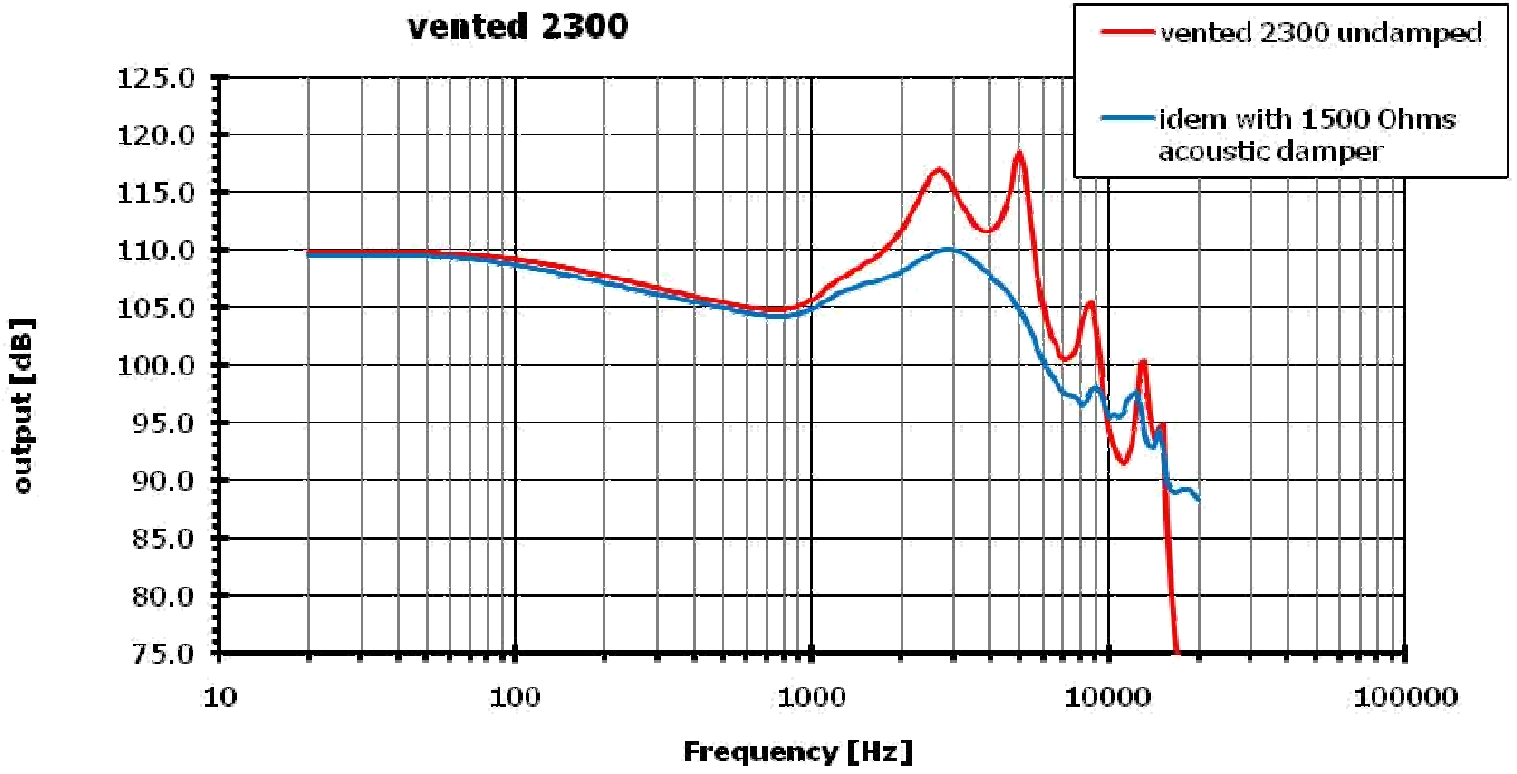
Basic Single Receiver IEM

- Practical example 1700 based IEM response
  - Use SSD dampers to smooth response to target

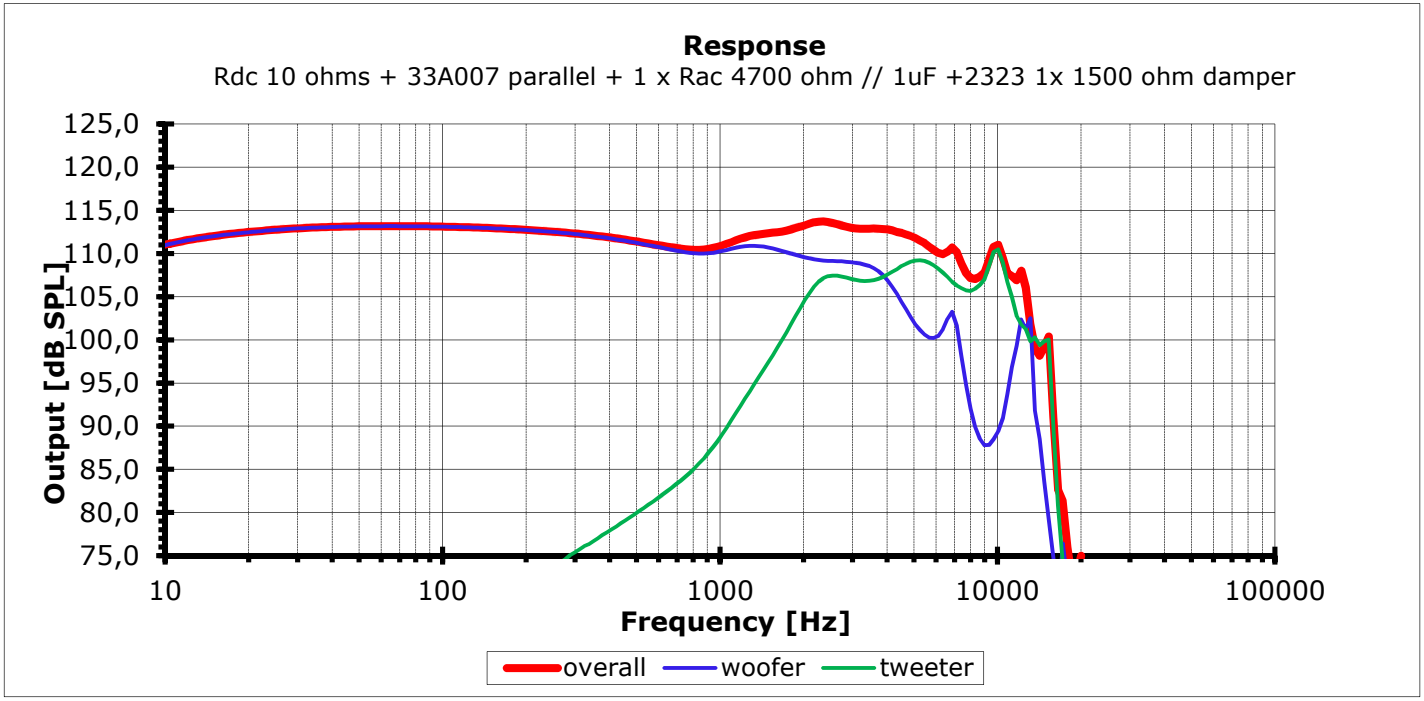


Basic Single Receiver PM

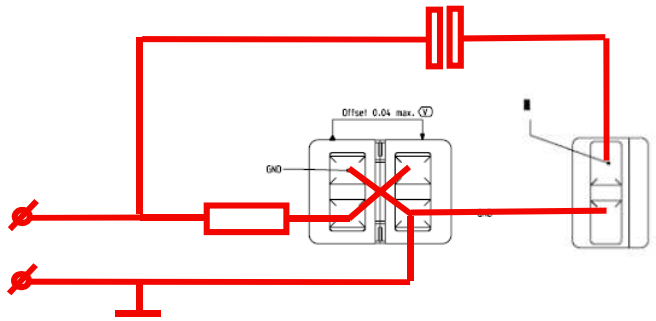
- Practical example 2300 based IEM response
  - 12 x 2 mm tube



Basic Two Way Design



- Tweeter: 2323 through 1 uF series cap, response smoothed with SSD 1500 Ohms
- Woofer: 33a007 in parallel, 10 ohms series resistor, acoustic low pass by 4700 ohms SSD
- 12 mm x 2 mm ID tubing

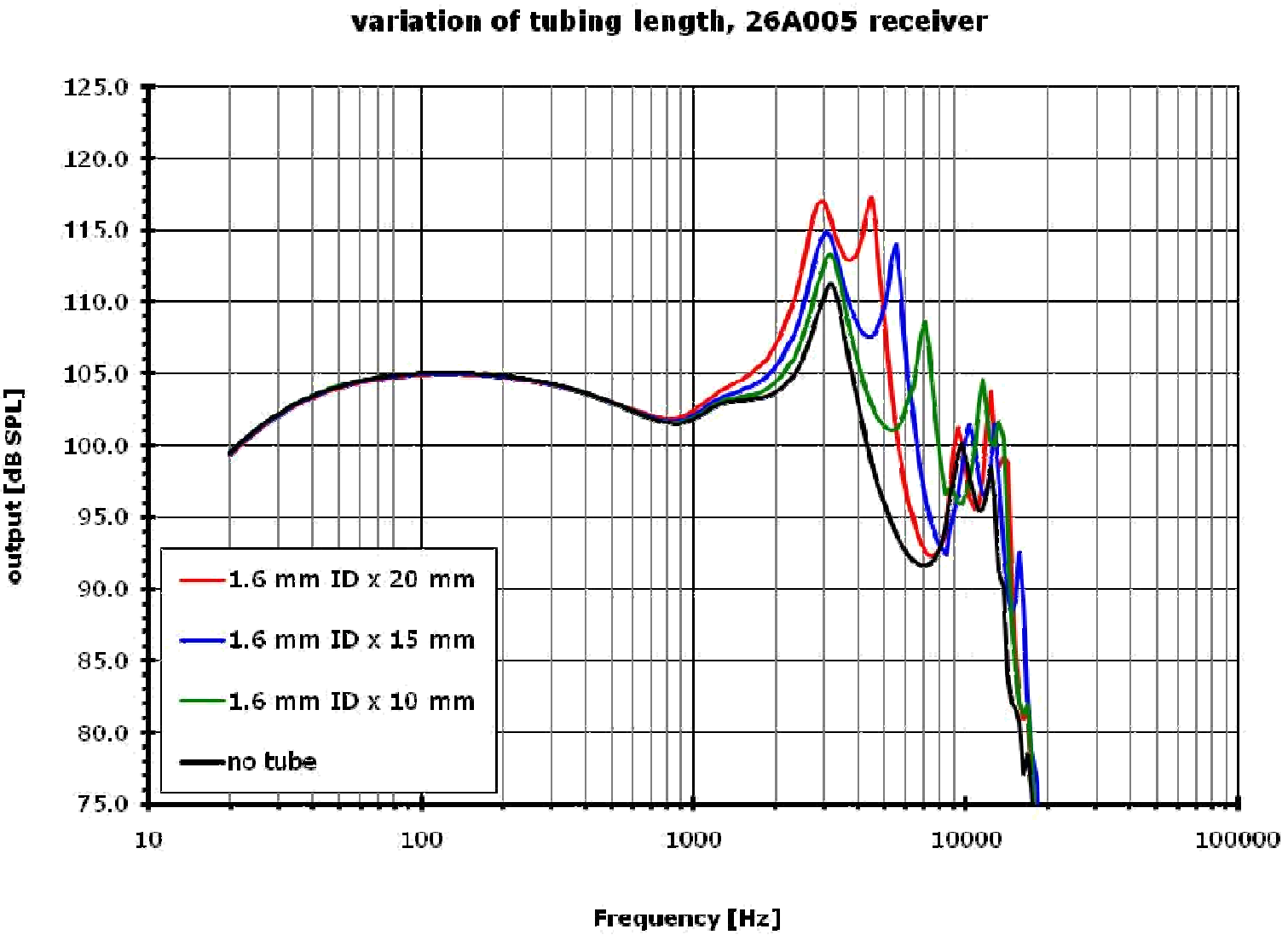


Crossovers and acoustic filters

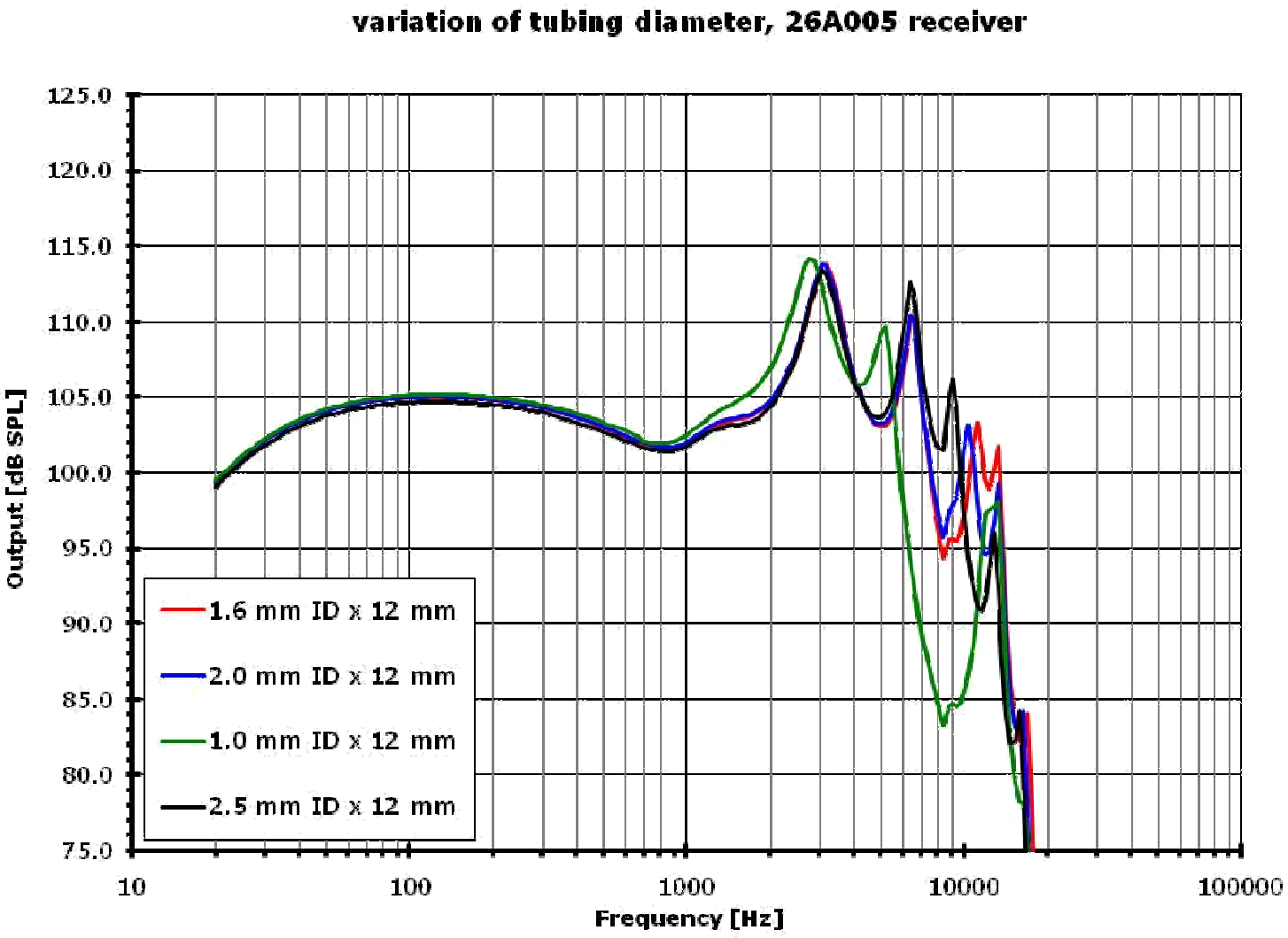
- Electrical crossover networks considerations
  - About the same rules as for Loudspeakers:
    - Caps roll off the LF's (high pass)
    - Resistors in series with Woofers pull out the LF bump
    - A BA receiver is highly inductive: low pass by inductors not very effective
    - 6 and 12 dB per octave crossovers are common

- Acoustic filtering and response shaping
    - Internal dimensions of nozzle:
      - length and diameter
      - Internal shape of nozzle
    - Acoustic dampers with medium resistance to smooth response
    - Acoustic dampers with high resistance to create acoustic low pass on woofer

Response shaping: effect of nozzle length



Response shaping: effect of nozzle diameter



Other Factors that affect the sound:

- Transient Response (ring overshoot damping / vented versus un-vented)
  - Two PM's can have the same Target Curve but still sound very different
- Max SPL (headroom)
  - More headroom is almost always perceived as being better (even with novice users at reasonable listening levels)
- Crossover points and slope (electrical and acoustic)
  - High order crossovers will not fit (also large values of C and L won't fit)
  - Low order filters and small values of L and C equate to less freedom in crossover design
- THD and IMD
  - Lower distortion levels are always better
  - Good crossover design can help (for example try to keep the kick drum out of the vocals)
- Comfort (going deep works better but comfort and customer reaction/fear is a factor)
- Looks
  - Consumers often hear with their eyes

Some remarks on design:

- A balanced armature receiver is not leak tolerant:
  - Make sure the design seals well to allow a good low frequency / bass performance
  - Trade off seal and comfort

- Make sure the design looks good because typical PM customers buy with their eyes

- Typical failures:
  - The number one reason for return is buyers remorse (fit is a big issue)
  - The number two reason is cable failure
  - The number three reason is mechanical shock
  - The number four reason is wax