

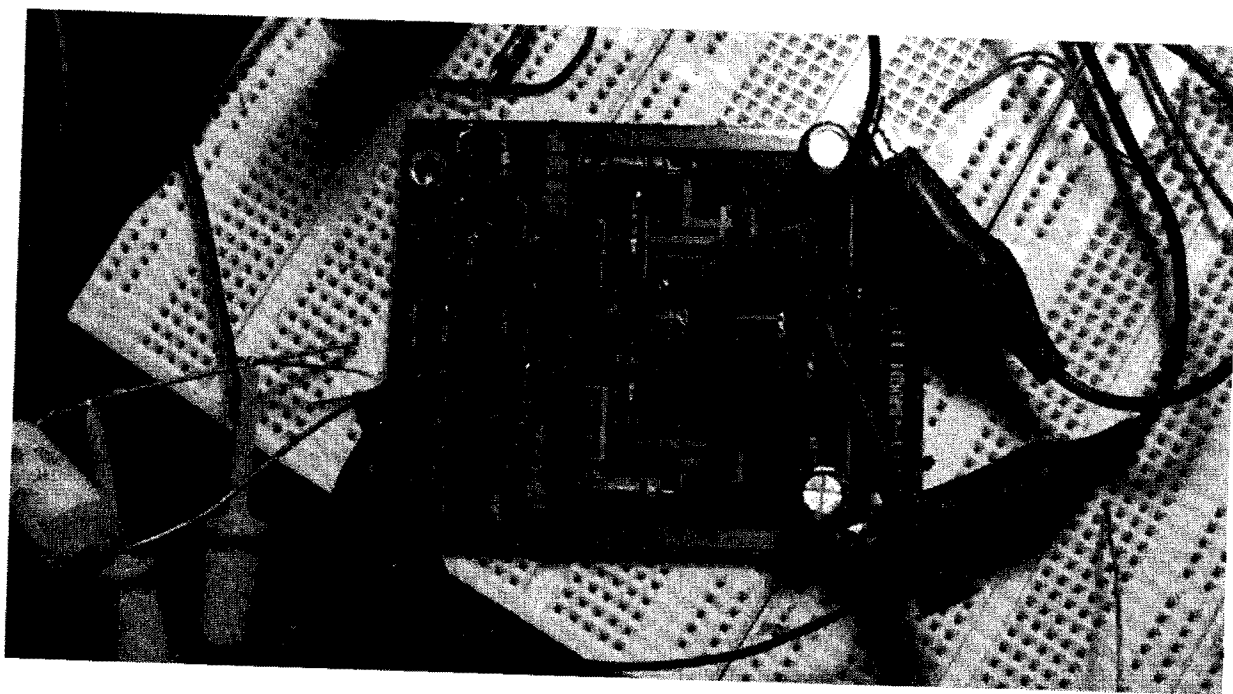
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## The Headphones

What good is a low distortion signal when you still have to listen to 'lumpy' frequency response errors from the headphones? Very few headphones are flat in frequency response at the ear canal. Can anything be done about that? Fortunately, the room correction products, such as those made by Audyssey are now included within low cost AV receivers and they can be used to automatically adjust the headphone response to flat. Or, you could use a separate stand alone auto-room EQ system. I will tell you how, later.

In the past we had to use graphic equalizers with microphones and swept sine waves or spot frequencies and plot the response on paper. Or, measured with filtered octave and 1/3-octave bands of noise. There was no consumer RTA available when I started doing room measurements and speaker measurements. So, I conceived of one and with my coworker, Bob Jones, we designed and made our own RTA that connected to an oscilloscope for the display and we were ready to go. That design was the very first consumer RTA and was published in Popular Electronics, September and October 1977, as a DIY project for the advanced constructor. Soon, afterwards there became many consumer products with RTA displays (using LED bar graph displays) which still exist today. But, now we can download an application for an RTA into our iTouch or iPad and have the same thing for less work and effort and low cost. And, much smaller than a rack mount chassis full of parts.

However, here is how I do it now — There are a couple ways (**Photo 2, 3**). Both ways worked well. The first way is to take a small diameter microphone — such as the 1/4 inch diameter Panasonic electret cap-



*Photo 1: the PCB for the prototype was made by ExpressPCB.com; signal and power ground planes are on the bottom side.*



*Photo 2: Use a small electret microphone capsule attached inside the headphone's ear cup.*

sule and mount it inside the headphone ear cup and with fine gauge wires attached to the capsule; they come out to a cable and plugs into the AV receiver's microphone Auto-EQ input. Wear the headphone and run the auto-EQ response correction as per the receiver's instructions and you will have

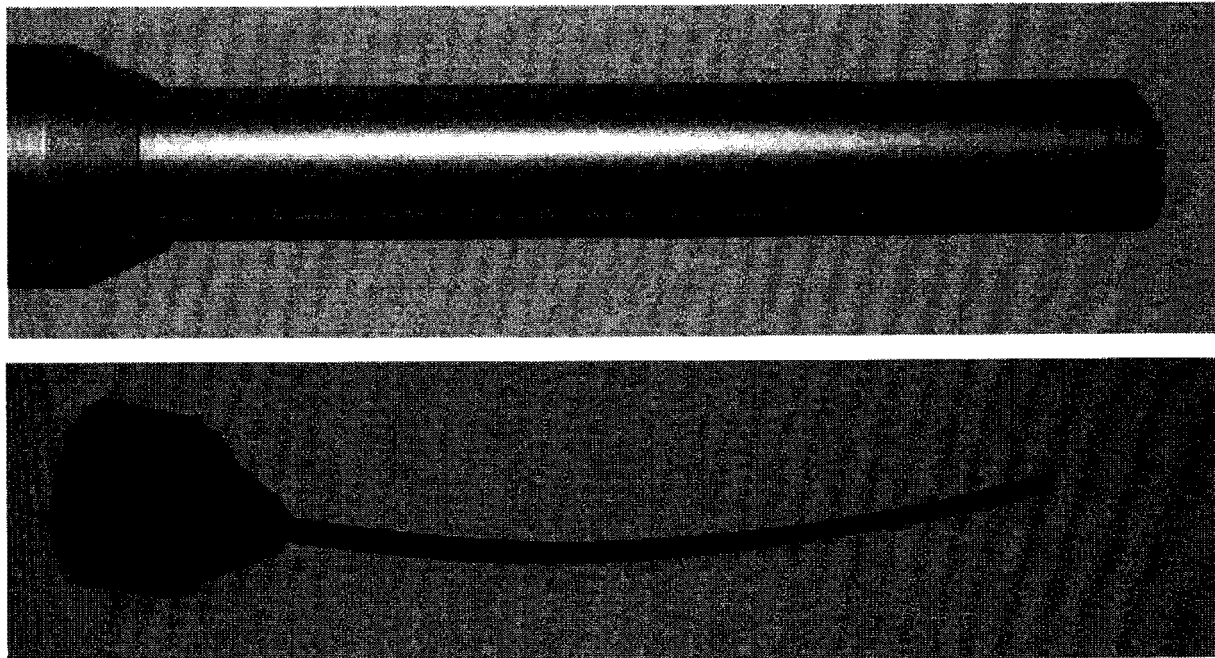
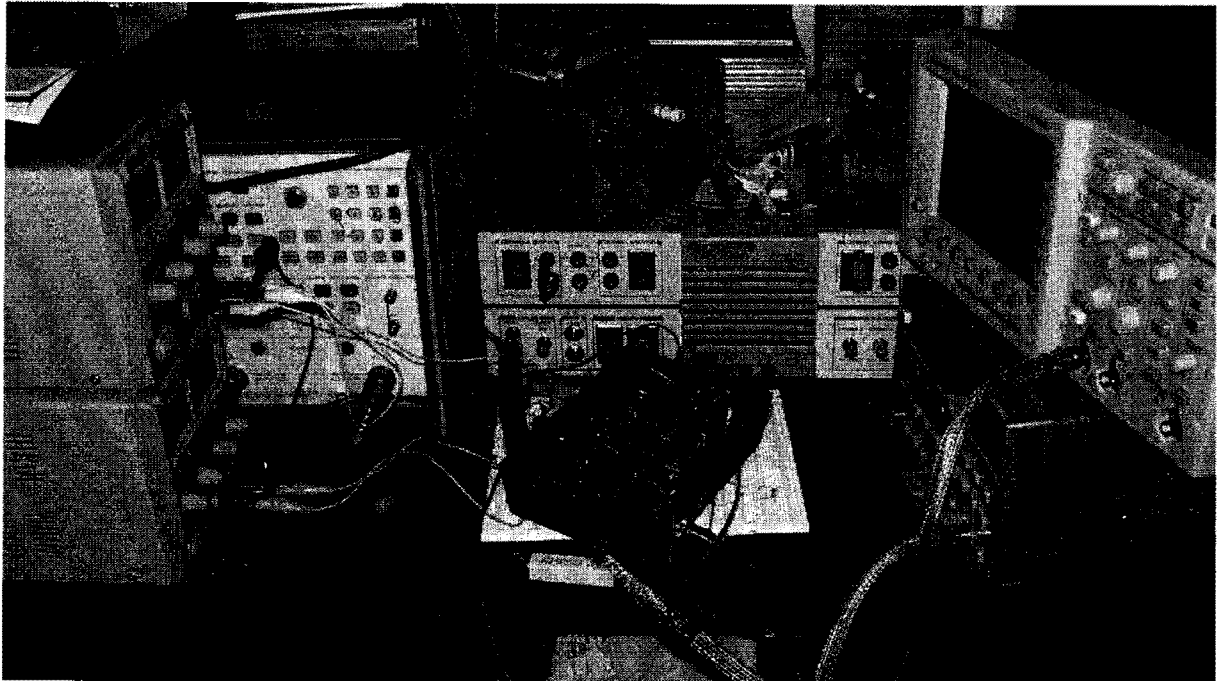
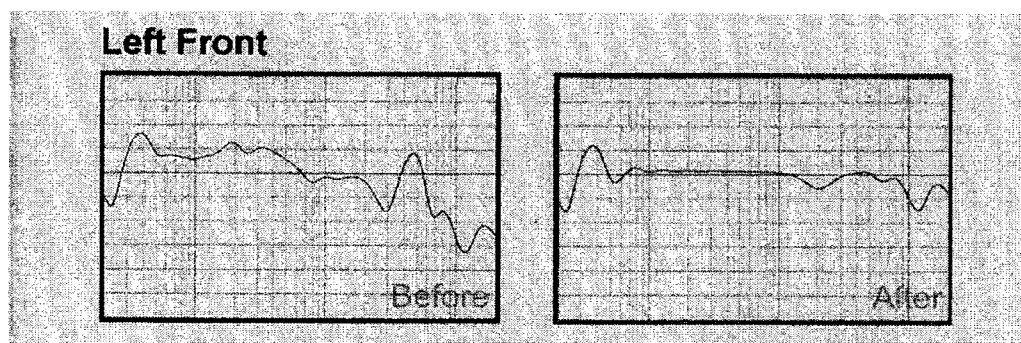


Photo 3: Microphone (a) and the probe tip (b) to be slipped over the microphone.



*Photo 4: The prototype headphone amplifier being tested.*

a pretty flat response using your own ears and your headphone of choice. If you have a separate or 'stand alone' auto-EQ system (Audyssey, XTZ, ARC etcetera), you can use the microphone included in that system or one of the many high quality microphones advertised and fit it with a 'probe' tip. Make a 'probe' adapter as shown in Photo 3 [14] and place it on the end of the microphone (a tube of .05 inch inner diameter) and place it between your ear and the headphone ear pad and run the auto-EQ system. Any minor corrections in microphones for flatness can be done but the microphones are so flat compared to any headphone that it will be a big improvement anyway. These approaches flatten the whole path – ear shape and size, headphone, air seal/leakage and cable/amp responses. It is fast - so a new auto-EQ can be quickly done with someone else using the headphone. Make your microphone "probe" fit over a 1/4 or 1/2 inch microphone end, tightly. The probe tip then goes under the headphone ear pad (while you are wearing the headphone) to receive the acoustic signal and send the response to the Auto-EQ system. The data shown next (**Fig.9**) is a before and



*Figure 9: Before and after auto-EQ of the headphone response.*