M57-1-1

R-390A Audio Output Impedance Matching

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Some people who use R-390As complain about hum, low audio output level, and poor frequency response. However, an R-390A has excellent audio quality and enough audio output power to drive you out of the room when used with an appropriate audio transformer which matches the 600 ohm audio output impedance to a speaker or headphones. The purpose of this note is to discuss appropriate audio impedance matching transformers for use with an R-390A.

The usual reason for hum and low audio output level with an R-390A is that low impedance headphones and a low impedance speaker, usually 8 ohms, are used without an audio transformer to match the 600 ohm audio output impedance to the low impedance load. A common cause of poor R-390A audio frequency response is the use of a military surplus LS-166 speaker. It has a built-in 600 to 8 ohm audio transformer and 8 ohm speaker, but the audio transformer has a limited frequency response of 350 to 3500 Hz. The LS-166 and similar speakers are designed for voice reception only.

The R-390A local audio output is rated as 500 milliwatts with less than 10% distortion into a 600 ohm load, and 1 milliwatt into a 600 ohm headset. The line output is rated as 10 milliwatts with less than 6% distortion into a 600 ohm balanced line. Measured maximum local audio output power before clipping is 1 watt into a 600 ohm load. Measured local audio frequency response is approximately flat from 100 to 10,000 Hz, and drops off slowly below 100 Hz and above 10,000 Hz.

One of the best ways to match the 600 ohm audio output impedance of an R-390A to low impedance headphones or a low impedance speaker is to use an audio line transformer. Line transformers come in two varieties - 25 volt line transformers, and 70.7 volt line transformers. They are designed for use with public address and audio distribution systems. The 25 volt line transformers are intended for use with amplifiers which have a 25 volt RMS maximum output, while the 70.7 volt line transformers are intended for use with amplifiers which have a 70.7 volt RMS maximum output. The 25 volt line transformers typically have primary taps with impedances which are multiples or fractions of 625 ohms (equivalently multiples or fractions of 1 watt). The 70.7 volt line transformers typically have primary taps with impedances which are multiples or fractions of 5000 ohms (equivalently multiples or fractions of 1 watt).

Currently I use a 25 volt line transformer, Stancor type A8089. The Stancor A8089 has primary taps marked 4, 2, 1, and 1/2 watt, and a secondary marked 8 ohms. Since the primary taps of a line transformer are often specified in watts, you will have to convert the watt ratings to ohms. For example, using the formula $R = V^2/P$, where R is the impedance in ohms, V is the voltage rating in volts RMS, and R is the power rating in watts, it follows that the 1/2 watt primary tap is R = 625/0.5 = 1250 ohms, and similarly that the 1, 2, and 4 watt primary taps are 625, 312, and 156 ohms respectively. For a 70.7 volt line transformer with primary taps of 10, 5, 2.5, 1.25, and 0.62 watts, the equivalent primary impedances can be calculated as 500, 1000, 2000, 4000, and 8000 ohms respectively.

In my experience, it does not make any significant difference whether you match the R-390A 600 ohm audio output impedance with the 625 ohm primary tap of a 25 volt line transformer or the 500 ohm primary tap of a 70.7 volt line transformer. In fact, you can use a 1000 ohm or 1250 ohm primary tap of a line transformer; the only noticeable effect is a small decrease in maximum available audio output power

The Stancor A8089 transformer is available from Fair Radio.for $3 plus shipping. Since Fair Radio has a $10 minimum order, if you are not ordering other items from them, you might prefer to use the Radio Shack 70 volt line transformer, catalog number 32-1031, for $5.95. The Radio Shack transformer has primary taps of 10/5/2.5/1.25/0.62 watts and secondary taps of 4/8/16 ohms.

My current audio impedance matching adapter is shown in the following schematic. I used both the 625 and 1250 ohm primary taps of the Stancor A8089. I cut off the two extra primary tap leads flush with the primary windings. A 1 meg ohm half watt resistor was used to provide a tape output. The transformer was mounted in a small metal box.with four standard 1/4 inch headphone jacks for input and output. Audio cables with standard 1/4 inch headphone plugs are used to connect the adapter to a speaker or to the headphone jack of the R-390A or other receiver. A homebrew audio cable with headphone plug on one end and lugs on the other end is required for connecting the adapter to the terminal strip on the R-390A rear panel. You should note that terminal 7 on the R-390A rear panel is audio ground. If you connect the mating audio cable incorrectly, you may experience a strong shock when handling the adapter box or audio plugs, or you may accidentally short circuit the R-390A audio output. For speaker use, the audio cable center conductor should go to terminal 6, and the audio cable braid should go to terminal 7 on the R-390A rear panel terminal strip.

The 625 ohm primary of my adapter is used with an R-390A. The 1250 ohm primary is used with the high impedance headphone jacks of other receivers, such as a Hammarlund HQ-180(A) or HQ-150.

Perhaps it is appropriate to mention here that I have observed unnecessary replacement of power supply electrolytics in two HQ-180A receivers, probably as a consequence of unsuccessful attempts to eliminate hum from headphone audio output. In one case, new electrolytic capacitors were dangled from the wiring which had been disconnected from the original metal can multi-section electrolytic. In another case, an intermittent loss of B+ power was traced to unsoldered connections at the multi-section electrolytic lugs; the unsoldered leads had been stuck back through the solder lugs without recrimping and resoldering them. After the careless and unnecessary tamperings had been repaired, and an audio impedance matching adapter was used, the headphone audio output of these two HQ-180As was excellent.