

## UPDATING THE DH-101

PART OF JOHN ADELSBACH and Howard Lee's update of their 1/81 article on the Hafler DH-101 was not received in our office while one small part was received, the portion we published in *Letters* in 2/81. The full text and diagram are below. Ed.

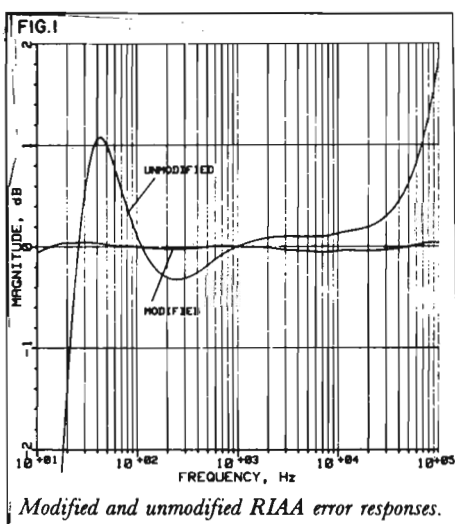
A further improvement in the RIAA equalization accuracy of the DH-101 preamplifier can be made. In our original article on modifying the phono circuitry (*TAA* 4/80), a .068 $\mu$ F capacitor was added for high frequency compensation at the node of  $R_{14}$ ,  $C_7$ ,  $C_8$ , and  $R_{12}$ . This capacitor is

located within the feedback loop and therefore interacts with the other equalization components, somewhat affecting the RIAA time constants. A more effective and more accurate method of eliminating the Hafler's high frequency response rise is to form a passive single pole filter at the phono stage output. To implement this change:

1. Remove the .068 $\mu$ F compensation capacitor, if previously installed.
2. Remove  $C_8$  (or the jumper at  $C_8$ , if previously installed) and replace it with a 220 $\Omega$  resistor.
3. Place a .0047 $\mu$ F polystyrene capacitor in parallel with  $R_{15}$ .

With these changes made, the improved RIAA response is as shown in Fig. 1.

Also, we have received several questions from readers as a result of the article. This seems partly due to the lack of specifics and background infor-



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mation in the article. Originally our comments were intended to appear in the Letters or the Audio Aids section, where our brief comments would have been more appropriate. When presented as a full article, they were probably not detailed enough. This letter is intended to clear up any confusion.

To obtain the error response curves presented in the article we did several things. First, we considered that the phono stage could be modeled as a high gain op amp. Using the appropriate model as derived by Lipshitz ("On RIAA Equalization Networks," *Journal of the Audio Engineering Society*, vol. 27, p. 458, June 1979), we determined what equalization response would result when using Hafler's specified resistor and capacitor values. We also performed a tolerance analysis to find how this curve could be altered by selecting components which are at the tolerance limit of their specified value. We then verified the model by measuring an actual circuit and found close correlation between the two.

Next we measured the response directly with a digital signal analyzer, using a random noise input and a large number of samples to achieve high measurement correlation. This method eliminated the need for an inverse RIAA network and its potential inaccuracies.

To further refine our circuit model, we used a circuit synthesis and analysis program. With this program we made a nodal map of all the components in the Hafler phono section. These components were accurately modeled, including the equivalent internal transistor parameters and secondary considerations such as nonlinear thermal and frequency effects. The results from this program corresponded well with our first model and had nearly exact agreement with the measured circuit.

We then began changing several resistor and capacitor values in the program with the objectives to 1) have a RIAA response error of less than 0.1dB, and 2) make the fewest number of component changes. After the proper values were found, we replaced the stock components with the

modified values in the circuit and measured our results with the signal analyzer.

In evaluating these circuit changes, a prototype circuit was built on a perforated board so that component changes could be made easily.

A power supply was built in a separate chassis to make testing more flexible and to minimize hum. The unregulated voltage and power ground cables were then routed to the signal board chassis. There the voltage regulators were placed close to the circuitry in an effort to minimize noise and keep supply impedance low. Figure 2 shows the schematic of our supply. In this supply the exact value or rating of the capacitors is not as important as using capacitors of low dielectric absorption and low ESR. The LM317 and LM337 regulators are the current generation of IC regulators and have superior line and load regulation and lower current ripple over older types.

The benefit of using the toroidal transformer is that it has a low radiated magnetic field and therefore induces less hum when placed close to low level circuitry. If a separate power supply box is used, this advantage is eliminated.

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