Although Richard Crawford warned me in the article ("A 1PPM Distortion Analyzer," *aX* March '04) that the project was not for beginners, I felt I was ready, having built a number of other devices. Unfortunately, I got stuck many times, and Dick was gracious enough to bail me out. To show my gratitude, I felt the best way to thank Dick was to write a letter to *audioXpress* and save him the trouble of having to answer numerous questions from other readers building the device. So here it goes.

Don't even think of proceeding without the circuit board. Dick got me one; maybe he can get you one.

You want the Mouser AC Adapter number 412-212103. The one Dick suggested is available only in large quantities.

I suggest you use an isolated DC power jack mounted to the rear of the chassis. I don't like wires hanging out of things. Radio Shack has a good metal one, but you will have to isolate it to avoid ground loops.

I suggest you use IC Dip sockets for all of the ICs. I suggest the following Digi-key parts: Four 16 pin A4002AE-ND; Four 14 pin A401-ND; and nine 8 pin A400-ND.

I suggest using the low-noise TI 5532, Mouser Part No. 595-NE5532AP. I got a .1ppm noise floor rather than the .3ppm that Dick got so maybe they are better.

R108 and R301 do not exist. R302 does not exist separately as it is on the board as R38. R303 goes between the hot pins of the two output phono jacks on the front panel.

R126 is not on the parts list but does exist. See Fig. 13. The value of R126 is relatively unimportant, as it isolates the AC/DC converter from the DC voltmeter. But 4.42kΩis good.

S1 aligns in only one way. S2 can align in any of four different ways, and it doesn't care which of those four. However, for consistency, align S2 the same as S1.

There are five power supply jumpers on the "bottom" side of the PC board. They can be connected to either side of the PC board, but the bottom side keeps them from interfering with the sockets and such.

The first three jumpers connect two –12V points. The first jumper goes from the –12V output of U203 to the round hole marked -12 connected to pin 4 of U8. The second jumper also goes from the –12V output of U203 to the round hole marked -12 connected to pin 4 of U104. The third jumper also goes from the round hole marked -12 connected to pin 4 of U104 to the round hole marked -12 connected to pin 4 of U103.

The fourth and fifth jumper connects +12V points. The fourth jumper goes from the square hole marked +12 connected to the output pin of U201 to the square hole marked +12 connected to pin 8 of U104.

The fifth jumper also goes from the square hole marked +12 connected to pin 8 of U104 to the square hole marked +12 connected to pin 8 of U103.

The correct installation of these jumpers for the +12V supply can be verified by measuring the resistance between the respective pin 8 of the ICs U101(pin 7), U102, U103, U104, U105, U107, U7, U8, and U9, and the output pin of U201, the +12V regulator. The correct installation of these jumpers for the –12V supply can be verified by measuring the resistance between the respective pin 4 of ICs U101, U102, U103, U104, U105, U107, U7, U8, and U9, and the output pin of U203, the –12V regulator. If correctly connected there should be less than 1Ω in these connections, and more than 1kΩ from these connections to ground.

There are also three jumpers on the "top" side of the circuit board:

1. Square hole 1 is a signal hole, *and* is connected to the signal hole 0 by means of a shielded cable, with the shield being connected both to the round hole marked GND near hole 0, and at the other end of the cable to the round hole marked GND near signal hole 1. In effect, a shielded jumper.
2. There is a ground jumper connecting the two round holes near GNDA near the large ICS.
3. There is a ground jumper connecting the two round holes near GNDB at the center of the board connecting the two large ground planes on top of the board.

Holes 4 and 5 are output signal holes to which the wires going to the front panel are attached. Square hole 2 is an output signal hole. Round hole 3 is the hole for connecting P2 and the signal lead coming from the front panel from the 0.75 to 30V phono jack. See Figs. 4 and 12. The 0 to 2V RCA phono jack, the MONITOR phono jack, and the DC VOLTS phono jack are all grounded together and connected via the shield of a shielded cable to the PC ground near square hole 2. The hot lead of this shielded cable connects from square hole 2 to the 0 to 2V phono jack.

The MONITOR phono jack is connected to square hole 4 by means of a shielded cable, the shield of which is grounded only at the round GND near square hole 4, similarly for the DC VOLTS phono jack. The INPUT VOLTS phono jacks have their grounds soldered together, and this ground is connected to the shield of a shielded cable which goes to the grounded lead of P2. The hot lead of this shielded cable connects the 0.75 to 30V phono jack to round hole 3.

The trickiest part is getting a nice-looking top panel. Here is my technique: Photocopy Fig. 12. Enlarge it so that S1 and S2 are exactly 2″ apart. Insert a Mylar transparency into the copy machine and copy the

enlarged Fig. 12. Make two or three so you have a spare. Use an XActo blade and a T-square to cut the Mylar transparency to fit the top of the box. Now buy a 7/16 hole punch from the hardware store to make all of the holes in the transparency. Put the transparency on wood and pound the punch in the correct locations shown on the Mylar. Use the transparency as a template and tape to top panel.

Buy high quality 3/8 drill bit with pilot center and drill holes in top panel. Glue down Mylar onto top of box using Photomat glue spray available from arts supply stores—be careful not to make the ink run. Better yet, don't glue it at all. Simply buy 1/16 Plexiglas, cut to size, carefully drill 3/8 holes by clamping to wood and then simply use the control and jack nuts to hold Plexiglas on top of Mylar. This works great.

Some suggestions for testing:

1. Determine the noise floor by feeding the output of the IM analyzer back into its input, using the input at full gain. Set the output at 0 and determine the voltmeter reading on the most sensitive range. This is the noise floor. Set the output to give the desired set level reading, and read the voltmeter again. This should be higher than the noise floor. If so, this is the IM floor.
2. Start your tests on amplifiers at low power. 2.83V (and less) under load will tell you more about your amplifier quality than high power tests. Keep at low power until you are sure of your techniques and amplifier.

If anyone has any questions on the foregoing feel free to e-mail me at fglabach@linerlaw.com. However, if you have any questions not covered, you would be better off asking Dick since I am not an engineer and it's his baby.

Frank Glabach

Los Angeles, Calif.

I want to thank Frank Glabach for his great help in sorting out the construction problems for the 1PPM IM Distortion Analyzer. I've tried his method of making front panels using thin Plexiglass or Lexan, and it works well. Thanks Frank.—**Richard Crawford**