

# Build a Distortionless Preamplifier

PREPARING FOR FOUR CHANNEL?  
YOU MAY WANT TO USE THIS PREAMP

BY JAMES BONGIORNO

**T**HE ADVENT of four-channel stereo need not necessarily obsolete your present hi-fi system. Regardless of which four-channel system is finally agreed on as a standard, we feel that it's a safe bet that the conventional two-channel front end will remain and the four-channel decoding will take place after this stage. Therefore, it is more important than ever that the two-channel

front end be of the best quality available. In essence, what you need is a noise-free, distortionless, nonoverloading amplifier that will follow the RIAA curve faithfully.

The phono preamplifier whose schematic is shown in Fig. 1 (only one channel is shown) comes as close to this "perfect" preamp as the state of the art permits. It is virtually impossible to overload this unit with

## PARTS LIST PREAMPLIFIER

*Components common to both channels:*

C10—68- $\mu$ F, 3-volt 20% tantalum capacitor

D1, D2—1N914 diode

R18—43,000-ohm resistor

S1—Dpdt slide switch

*Duplicate components in each channel:*

C1, C4—22- $\mu$ F, 60-volt, 20% tantalum capacitor

C2—56-pF, 5% polystyrene capacitor

C3—33-pF, 5% polystyrene capacitor

C5—0.47- $\mu$ F, 100-volt, 10% Mylar capacitor

C6—330-pF, 5% polystyrene capacitor

C7—5600-pF, 2% polystyrene capacitor

C8—1650-pF, 2% polystyrene capacitor

(1500 and 150 in parallel)

C9—17-pF, 5% polystyrene capacitor

J1, J2—Phono jack

Q1, Q3—2N4250 transistor

Q2—2N5089 transistor

R1, R14, R16—47,000-ohm, 2% resistor

R2, R3—390-ohm, 10% resistor

R4—1-megohm, 10% resistor

R5—62,000-ohm, 5% resistor

R6—Selected (see text)

R7—22,000-ohm, 5% resistor

R8, R17—470-ohm, 2% resistor

R9—681,000-ohm, 1% resistor

R10—3900-ohm, 5% resistor

R11—2700-ohm, 5% resistor

R12—1000-ohm, 10% resistor

R13—2.2-megohm, 1% resistor

R15—2200-ohm, 1% resistor

*Note—For miscellaneous items and availability of parts see Parts List for Power Supply. (All resistors are 1/2 watt.)*

any cartridge presently available (at any frequency). The gain at 1 kHz is 42 dB (125 times) which means that even the most sensitive of cartridges may be used. But along with this high gain, the noise level is 0.7  $\mu$ V referred to the input (63 dB below 1 mV). Since some audio measurements laboratories state noise as so many dB's below 10 mV, this unit has a figure of -83 dB below 10 mV, which makes it a very quiet operator.

The output level is about 12 volts rms; and below 4 volts output, the distortion is just about unmeasurable, rising to 0.1% at the 12-volt output. This high level of output is available across the audio bandwidth of 20 to 20,000 Hz. The feedback loop maintains the frequency response flat to within  $\pm 0.5$  dB of the ideal RIAA curve. There is also a switch to change the feedback loop to provide a flat response for use with an optional microphone input.

**Construction.** The foil pattern shown in Fig. 2 covers both channels of a stereo pair. The component indications are the same for

### TECHNICAL SPECIFICATIONS

**Gain:** 60 dB at 20 Hz, 42dB at 1kHz, 23 dB at 20 kHz; all within 0.5 dB of RIAA.

**Gain with Microphone:** within 0.5 dB from 20 to 20,000 Hz.

**Sensitivity:** 0.8 millivolts rms with 100 millivolts output.

**Noise:** 0.7 microvolts unweighted (RIAA bandwidth referred to shorted input).

**Maximum Output before Clipping:** 12 volts rms, 20 to 20,000 Hz.

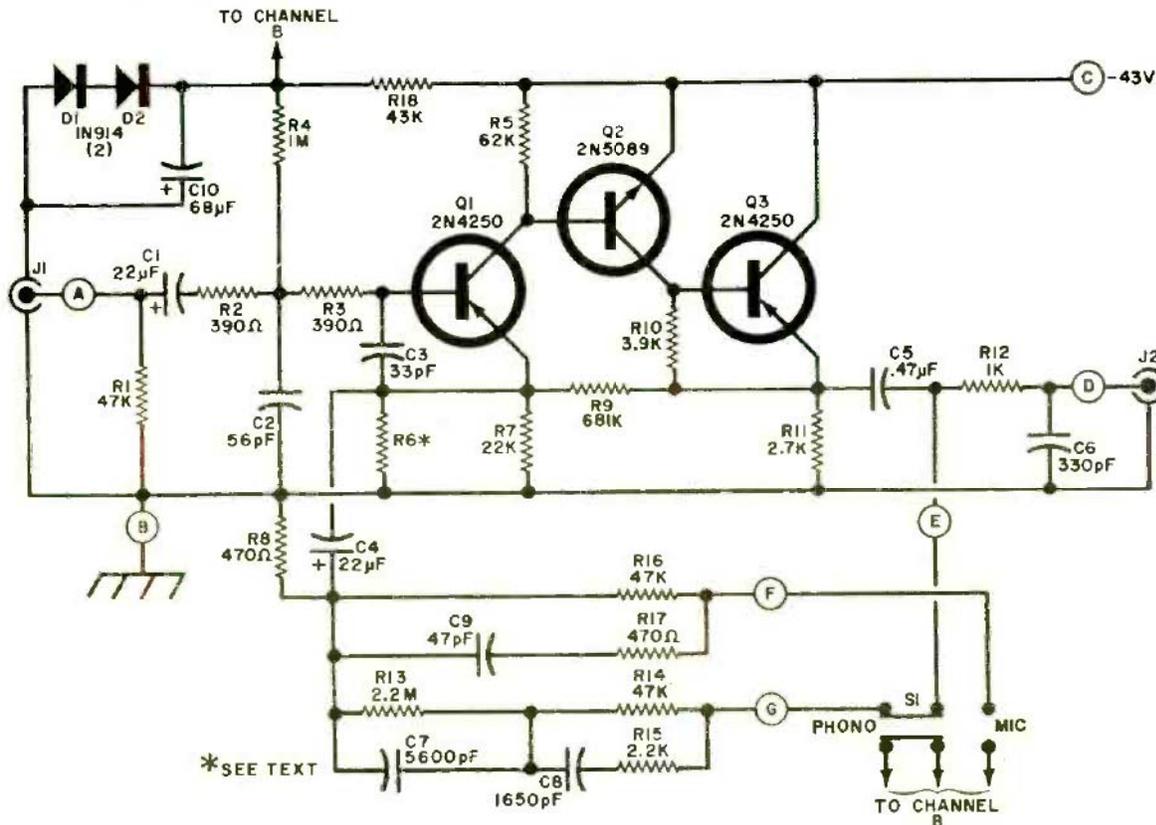
**Input Overload:** 13 mV at 20 Hz, 100 mV at 1 kHz, 850 mV at 20 kHz.

**Distortion:** Unmeasurable at 1-volt output, increasing gradually to about 0.2% at clipping.

both channels, with R18, C10, D1 and D2, and S1 common to both channels.

The schematic of the power supply for the amplifier is shown in Fig. 3. It would appear at first glance to be somewhat elaborate but it is essential that the system be free of hum since the amplifier gain at 60

Fig. 1. This is the schematic for one channel of the preamp, except for components, as mentioned in Parts List, that are common to both.



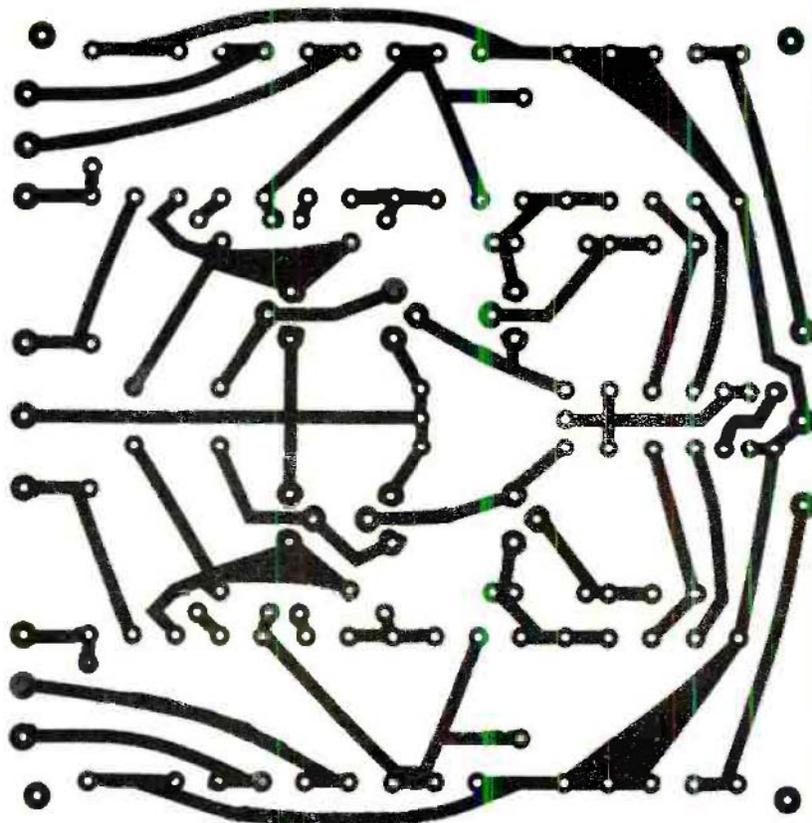
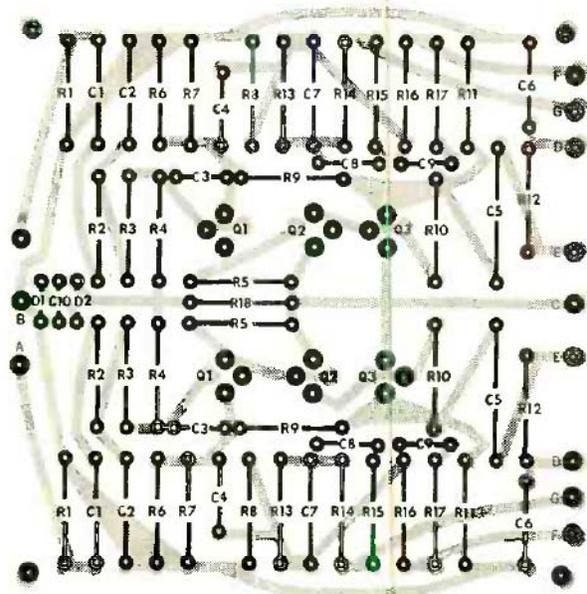
Hz is almost 60 dB. For the same reason, transformer *T1* is a fully shielded toroid. In addition to the -43 volts used in the amplifier, the supply also provides -47 volts for powering other circuits. The regulator will handle up to 100 mA. The foil pattern and component layout for the power supply are shown in Fig. 4 on page 62. The printed circuit boards for power supply and preamp are available as mentioned in the Parts Lists.

With only the power supply operating, connect a voltmeter between terminal K and ground. The indicated voltage should be -47 volts. If it is a little higher, connect a 40,000-to-60,000-ohm resistor across R23 to bring the voltage down to -47. If you have a sensitive millivoltmeter, check to see that the noise at this terminal is below 200  $\mu$ V. There should be no ripple at all when the output voltage of the supply is viewed on a scope.

Before mounting either the power supply or the preamp in the chassis, interconnect the two boards, with terminal L of the supply to terminal C of the preamp, and terminal J of the supply to B on the preamp.

Fig. 2. The foil pattern shown below is for both channels of the preamp. Component layout is shown at right.

Connect a dc voltmeter between the junction of C5 and R11 (negative) and ground (positive) in one channel. Turn on the power and wait until the voltage being measured reaches a maximum—it will take a minute or more. Temporarily connect a fixed resistor (between 50,000 and 80,000 ohms) where R6 is supposed to be in this channel. The resistor should be such that the voltage being measured is as close as possible to -21.5 volts. Do the same for the other channel; then recheck the first chan-



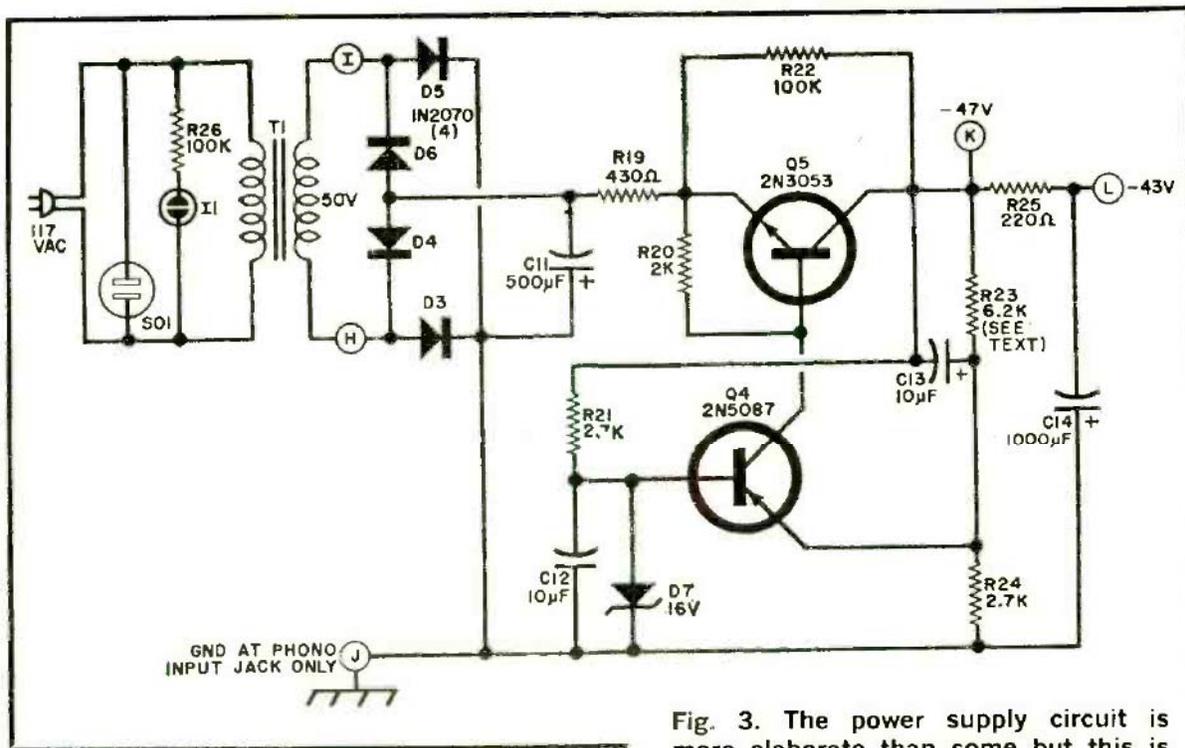
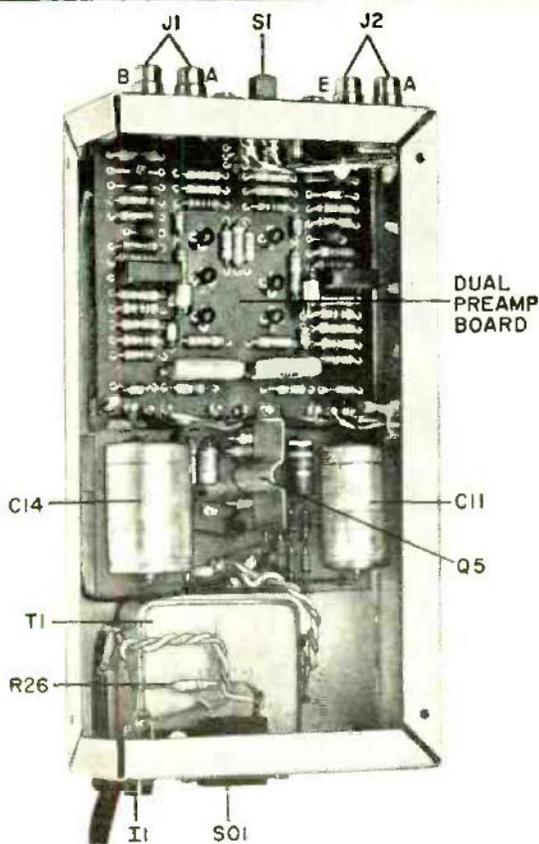


Fig. 3. The power supply circuit is more elaborate than some but this is essential to proper preamp operation.

#### PARTS LIST POWER SUPPLY

- C11—500- $\mu$ F, 70-volt electrolytic capacitor
  - C12—10- $\mu$ F, 16-volt tantalum capacitor
  - C13—10- $\mu$ F, 35-volt electrolytic capacitor
  - C14—1000- $\mu$ F, 50-volt electrolytic capacitor
  - D3-D6—1N2070 diode
  - D7—16-volt, 1-watt, 2% zener diode
  - I1—117-volt neon lamp
  - Q4—2N5087 transistor
  - Q5—2N3053 transistor
  - R19—430-ohm, 2-watt, 5% resistor
  - R20—2000-ohm, 10% resistor
  - R21, R24—2700-ohm, 5% resistor
  - R22, R26—100,000-ohm, 20% resistor
  - R23—6200-ohm resistor (see text)
  - R25—220-ohm resistor
  - S01—117-volt chassis mount receptacle
  - T1—Shielded toroid transformer: 50V at 100 mA
- M.i.c.—Pilot lamp holder, line cord, rubber feet, (4), suitable chassis (Bud CU-482), heat sink for Q5 (Wakefield 296-4), terminal strip, mounting hardware, etc.
- Note—The following are available from Southwest Technical Products, 219 W. Rhapsody, San Antonio, TX 78216: Transformer T1, #17221-1 for \$13.00 plus postage and insurance for 1 lb.; preamplifier PC board, #LL118 for \$3.15; power supply PC board, #LL119 for \$2.45; complete kit of parts for \$39.95, plus postage and insurance for 5 lb.



Preamp board and power supply should not be mounted in chassis before conducting tests as described in text.

nel as the two are slightly interactive. Once both channels have 21.5 volts at the junction of C5 and R11, solder in both R6's. When installing the amplifier board, use one of the input jack chassis connections as the

common ground, making this the only chassis connection. The ground wire to the power supply should be removed and a ground wire run from the power supply point J to the selected input jack.

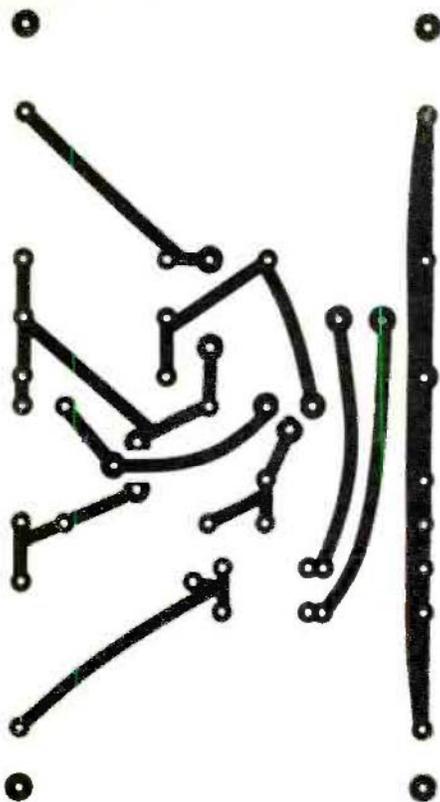
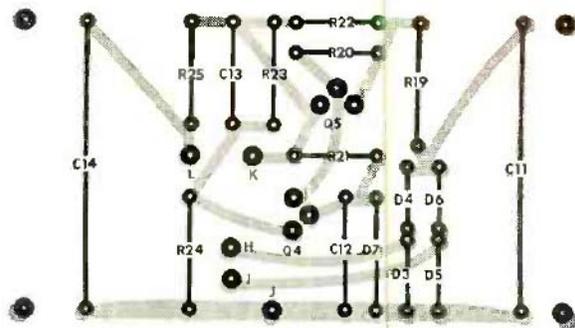
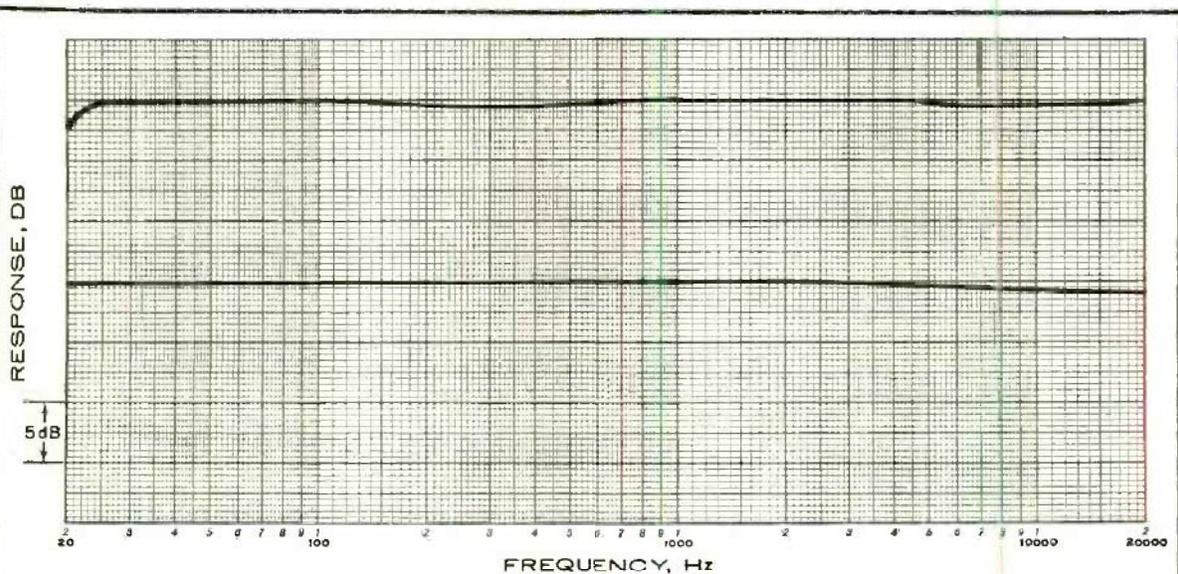


Fig. 4. Except for T1 and components in its primary, power supply is laid out (above right) on the board above.



Mount the shielded transformer on the chassis, and place the heat sink on transistor Q5 of the power supply. The physical arrangement of the other chassis components and connectors is not critical.

**Operation.** To use the preamplifier in your present stereo system, simply plug the turntable signal cables into the input jacks (J1) and run the output jacks (J2) to the AUX inputs of your amplifier. Don't forget to phase all the ac plugs to get the lowest hum. If you find that you need a ground on the turntable chassis, run a wire from it to the mounting screw closest to the preamplifier input jack that was selected as the common ground. ♦



### PROJECT EVALUATION HIRSCH-HOUCK LABORATORIES

The preamplifier does just about what the designer claims for it. Gain measurements, in general, were within 0.5 dB of the author's claims and show a loss of only 1.4 dB at 20 Hz relative to the extrapolated RIAA curve. Phono overload occurs at a very safe 110 millivolts, and

the clipping level from the output is 14.7 volts, something of a record in our experience.

Distortion is really negligible, typically 0.013 to 0.03% over most of the useful range of the amplifier (even up to 10 volts output). The measurement of 0.31% at 125 millivolts output was partly hum and partly noise, but both were extremely low. The combined hum/noise output was about 100 microvolts.