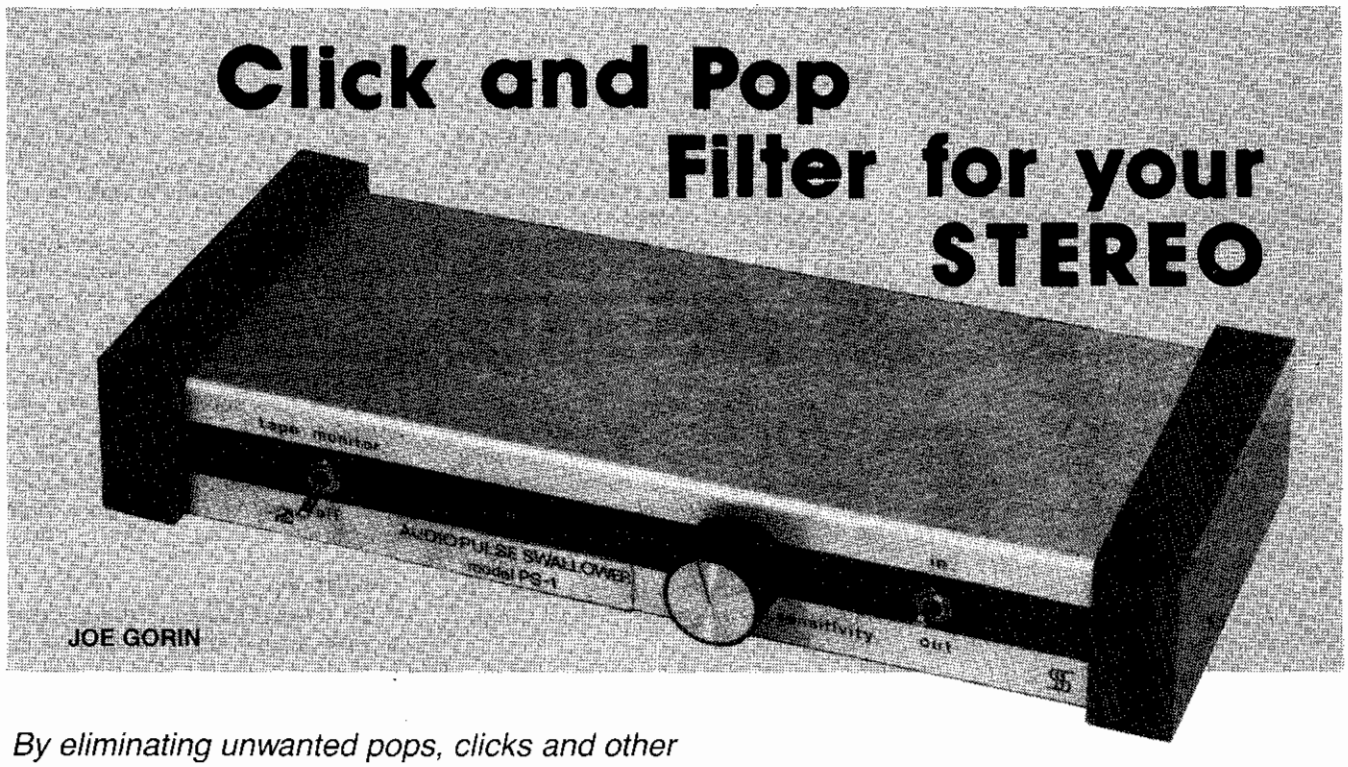
Click and Pop Filter for your STEREO



JOE GORIN

By eliminating unwanted pops, clicks and other surface noise, this inexpensive scratch filter brings you to new heights of audio realism!

Part 2 THIS MONTH, WE'LL show you how to build our click and pop filter. But before we get to that, let's finish up the discussion that we began last time about how the detector circuit works.

Resistors R27–R30 take a statistical sample of variations in level; that sample is detected by IC5-a, which stores short-term peaks on C13 and long-term peaks on C14. The latter is also part of a circuit (including C15 and C16) that prevents transients—either scratches or music—from changing the comparator's threshold too quickly.

Front-panel SENSITIVITY control R45 varies the gain of IC5-b, whose output sets the comparator's threshold higher when the signal warrants it. For example, signals with much high-frequency content—cymbal crashes, for instance—can cause false triggering. But, in general, very large transients tend to be scratches; a large transient will turn on D8 to slow down threshold changing. Diode D10 allows C16 to discharge rapidly if the transient disappears rapidly, as can happen between wide, two-edged scratches (which are quite common).

When the signal exceeds the threshold, the output of IC6-a goes low and shorts to $-V_{CC}$. And that, finally, is what causes the deleter to delete! The deletion is done by "flipping" the analog switches (electronically, of course) to perform the actions described above.

When the transient ends, IC6-a's output floats high, and C20 delays the return from deletion mode by charging slowly through R41. Capacitor C21 functions as a pulse-stretcher; it charges even more slowly than C20, and that allows LED1 to remain lit long enough to be visible, even if the deletion time was short.

Power supply

The power supply, shown in Fig. 8, is important in this circuit, especially during a deletion, because the gain of the deleter is so high. Our primary design goals were low ripple and freedom from interference by magnetic fields. Low ripple is achieved by filtering the critical negative supply

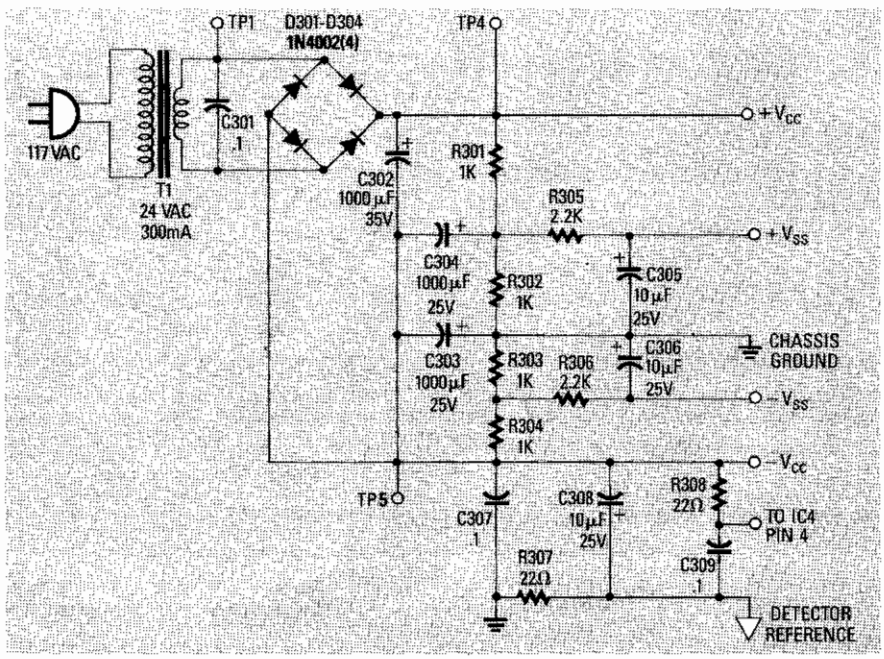


FIG. 8—THE SCRATCH FILTER'S POWER SUPPLY IS SHOWN HERE. Parts are numbered beginning at 300; all components except T1 mount on the PC board. Note the separate detector reference that is derived through R307.

with respect to ground using capacitors C302–C304. Actually, it is the ground that is filtered, not the supply; but the result is the same, except that at low frequencies the ground impedance isn't low.

Magnetic fields are minimized by using a wall-plug transformer and by placing the deleter at the opposite end of the board from the supply. What we get is an inexpensive supply that performs as well as the exotic center-tapped toroidal-transformer supplies often used in high-performance audio equipment. By the way, the $\pm V_{SS}$ supplies are provided to operate the 4016 analog switches, which can't tolerate the ±15 volts used to power the op-amps.

Input and output circuits

The signal into our Scratch Filter should come after your amplifier's phono preamp via the TAPE OUT jacks that are normally used to connect a tape recorder. Most signal processors (such as graphic equalizers) replace those TAPE OUT jacks by connecting the processor's input jacks in parallel with a *new* TAPE OUT jack. In our case, we chose to locate the TAPE OUT jack, and the TAPE MONITOR switch *after* our processor, so that you can tape record albums with the full benefit of our Scratch Filter.

Construction

Due to the critical nature of the deleter's layout-matching requirements, a PC board is necessary to get good performance from this Filter. If you want to etch your own board, a foil pattern is shown in "PC Service;" you can also purchase a board from the source mentioned in the Parts List. Refer to the component-placement diagram in Fig. 9 and the chassis photo in Fig. 10 during the following discussion.

Begin construction by inserting the resistors. You can bend the leads of most resistors as necessary, but the following resistors in the deleter circuit should be bent as shown in the photo: R114, R222, R215, R216.

Next insert the capacitors, followed by the diodes, and then the transistors. Be careful to get the polarity of those components correct.

Next you can install the IC's. As mentioned above, you must cut off pin 5 of IC4. If you use a metal-can version of that IC, the tab is by pin 8. Be sure to insert that IC—and all the others—correctly. Connect short lengths of wire for the panel-mounted components to the appropriate pads on the board. Carefully check over your work, remove flux from the board, and then install the board in your enclosure.

The chassis used for our prototype is built from a thin piece of aluminum bent in a "U" shape. We used two stained pieces of wood for endpanels. The endpanels are attractive, and they keep the aluminum from scratching the surface of whatever you set the Filter on. The printed-circuit board should be mounted close to the sheet metal so that the circuitry will be shielded from electromagnetic fields that may be radiated from nearby equipment.

Installation

The Scratch Filter must be connected in the tape-monitor loop of your amplifier.

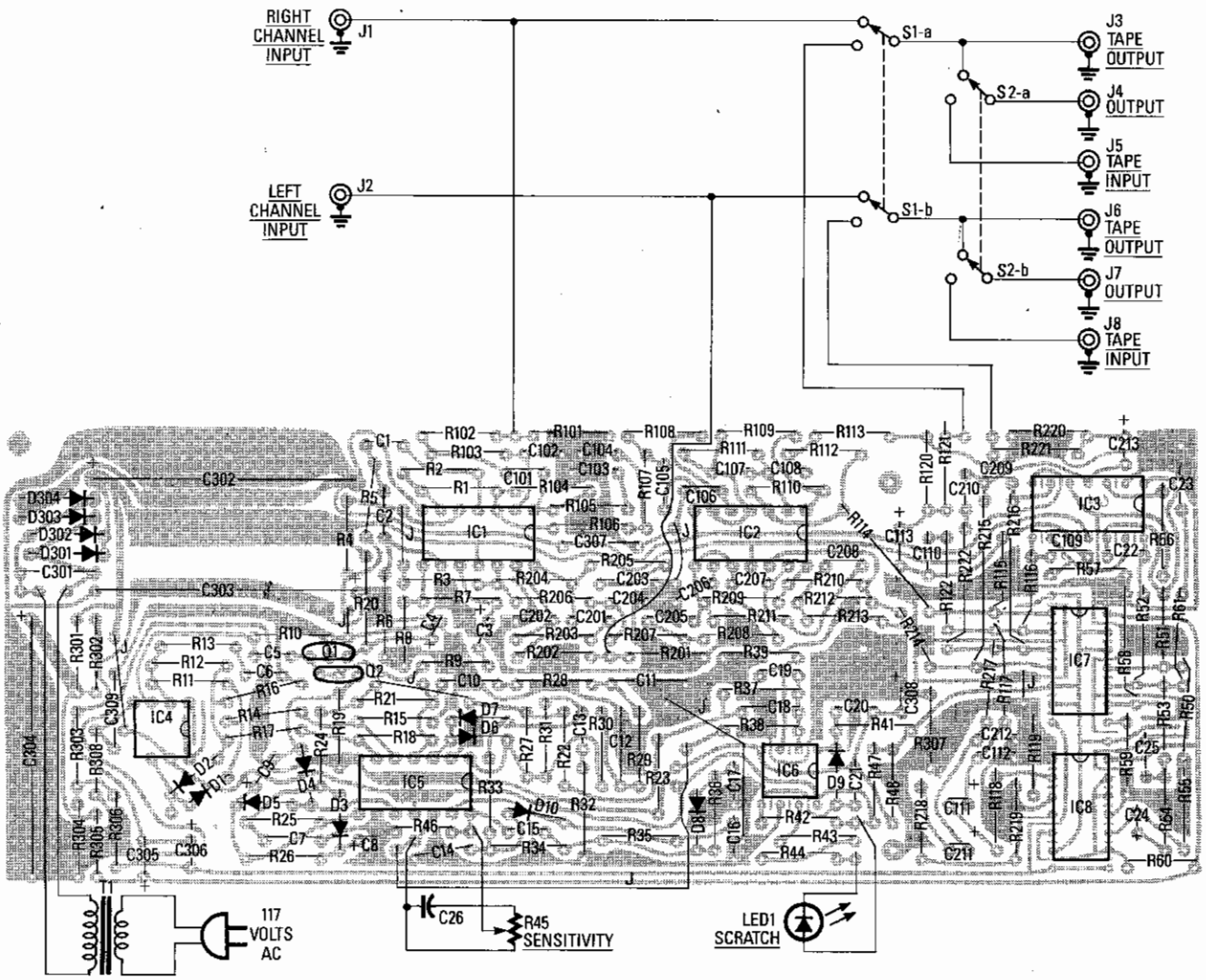


FIG. 9—STUFF THE PC BOARD and wire the front-panel components as shown here. Resistors R114, R222, R215, R216 must be bent as shown in Fig. 10.

PARTS LIST

All resistors ¼-watt, 5% unless noted.
R1–R4, R11, R12, R26, R54, R102, R103, R118, R202, R203, R218—22,000 ohms
R5, R107, R207—2400 ohms
R6—7500 ohms
R7, R24—4700 ohms
R8, R9, R14, R43, R44, R50, R51, R114, R115, R214, R215, R301–R304—1000 ohms
R10, R34, R35—150,000 ohms
R13—150 ohms
R15—1200 ohms
R16, R39, R56, R104, R204, R305, R306—2200 ohms
R17, R18, R25, R29, R30, R37, R38—10,000 ohms
R19—4.7 megohms
R20, R57, R59, R121, R221—560 ohms
R21—470 ohms
R22, R106, R206—1800 ohms
R23—68,000 ohms
R27, R60—180,000 ohms
R28—3300 ohms
R31—330,000 ohms
R32—220 ohms
R33—15,000 ohms
R36—470,000 ohms
R40, R49, R62–R100, R123–R200, R223–R300—not used
R41, R46—39,000 ohms
R42—22 megohms
R45—100,000 ohms, linear potentiometer
R47, R101, R201—100,000 ohms
R48, R61, R122, R222—270,000 ohms
R52, R116, R216—36,000 ohms
R53, R58, R111, R117, R211, R217—6200 ohms
R55, R119, R219—91,000 ohms
R105, R205—100 ohms
R108, R208—2700 ohms
R109, R209—3000 ohms
R110, R210—12,000 ohms
R112, R120, R212, R220—33,000 ohms
R113, R213—8200 ohms
R307, R308—22 ohms

Capacitors
C1, C15, C16—0.0033 µF, 10%, polyester film
C2, C5, C20, C22, C107–C109, C207–C209—0.001 µF, 10%, polyester film
C3, C4, C8, C24, C111, C113, C211, C213, C305, C306, C308—10 µF, 25 volts, aluminum electrolytic
C6, C7, C14, C18, C103, C203—0.033 µF, 10%, polyester film
C9—3.3 µF, 35 volts, aluminum electrolytic
C10–C12, C301—0.1 µF, 10%, polyester film
C13, C17, C23, C25, C26, C110, C112, C210, C212—0.01 µF, 10%, polyester film
C19, C21—680 pF, 10%, ceramic disc
C27—see text
C28–C100, C114–C200, C214–C300—not used
C101, C201—330 pF, 10%, ceramic disc
C102, C106, C202, C206—220 pF, 10%, ceramic disc
C104, C204—0.0047 µF, 10%, polyester film
C105, C205—0.022 µF, 10%, polyester film
C302—1000 µF, 35 volts, aluminum electrolytic
C303, C304—1000 µF, 25 volts, aluminum electrolytic
C307, C309—0.1 µF, ceramic disc

Semiconductors
IC1–IC3, IC5—RC4136, quad op-amp
IC4—LM301A, op-amp
IC6—LM393, op-amp
IC7, IC8—4016, quad analog switch
Q1, Q2—2N3904, NPN transistor
D1–D10—1N4148, switching diode
D301–D304—1N4002, power diode
LED1—standard LED

Other components
J1–J8—RCA Phono Jacks
S1, S2—DPDT toggle Switch

Note—The following parts are available from Symmetric Sound Systems, Inc., 856 Lynn Rose Ct., Santa Rosa, CA 95404, (707) 546-3895: Complete Kit (No. PS-1) $79.95; PC Board (No. PS-1PC) $12.00; All semiconductors (No. PS-1SC) $13.00; All resistors and capacitors (No. PS-1RC) $16.00; Transformer (No. PS-1XF) $7.50; Chassis, endpanels, switches, hardware, jacks and instructions (No. PS-1ETC) $42.50. Free UPS shipping in U.S. with check; MasterCard and Visa orders must add shipping. PS-1SC, PS-1RC and PS-1ETC will not be available after January 31, 1987. California residents must add appropriate sales tax.

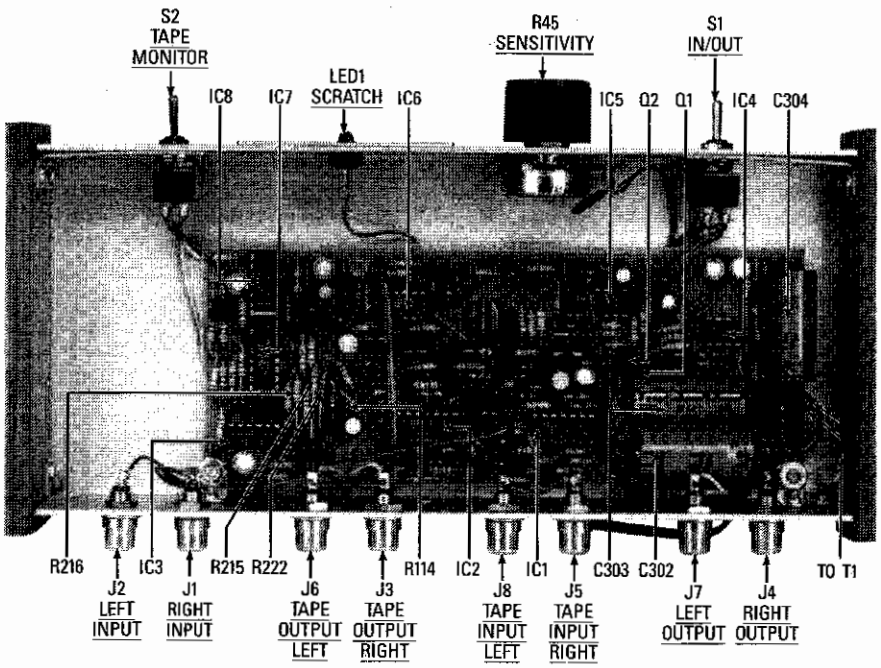


FIG. 10—THE CHASSIS IS BENT from a thin piece of aluminum; small wood blocks are attached to the ends with angle brackets.

In other words, the Scratch Filter's inputs must be connected to your amplifier's TAPE OUT jacks, and the Scratch Filter's outputs must be connected to your amplifier's TAPE IN jacks. Your amplifier's TAPE MONITOR switch must then be thrown to the ON or TAPE position.

That wiring scheme routes all signals from your amp's preamp output through the Scratch Filter, and then back to your amplifier. A tape recorder, or any other equipment that used to be connected to your amplifier's jacks should now be connected to the corresponding jacks on the Scratch Filter.

Operation

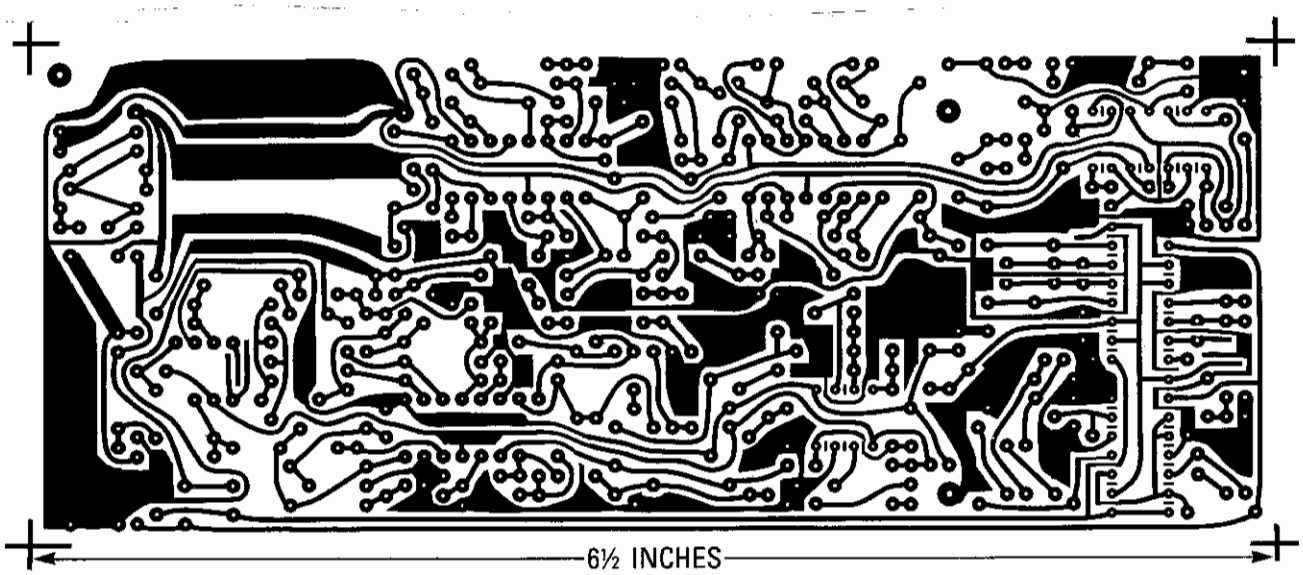
You can use the IN/OUT switch to switch the Scratch Filter in and out of your audio loop for testing and evaluating. Once you hear the dramatic improvement the Filter provides, you'll probably leave it "in circuit" permanently. The TAPE MONITOR switch on the Filter works just as the one on your amplifier used to.

Initially the SENSITIVITY control should be set to the middle of its range. Due to the wide dynamic range of the ALC circuit you may never need to change the setting of that control. However, for very scratchy records, you may want to turn up the sensitivity. You risk making deletions audible, but by careful adjustment, you can achieve a good balance between scratch noise and deletion errors.

Conclusions

There are many ways to improve the

continued on page 90



HERE'S THE FOIL PATTERN for our Click and Pop Filter.