

**P**ERHAPS the most important sound characteristic a musical instrument produces is its amplitude envelope. A percussion or a stringed instrument, for example, has a sound with a steep attack and a slow decay time. A wind instrument, on the other hand, has longer attack and shorter decay times. While electronic music synthesizers generally permit the player to exercise full control over the attack, decay, and (usually) sustain of every note played, electric instruments (guitars, pianos, etc.) do not offer this flexibility. The Envelope Modification Unit, or EMU, described here can give the electric musical instrument much the same flexibility.

The EMU interfaces with most electrified instruments and can be used to modify the attack, sustain, and decay times to produce many interesting sound effects. It does not lengthen the intrinsic amplitude envelope, but it can shorten the envelope to produce the sound of a guitar being played while a hand damps the strings—without eliminating the harmonics, as would occur if a hand were actually used. It can also be used to alter the envelope to produce the "whooping" effect one hears when a magnetic tape is played backwards.

The electrical demands of the EMU are so low that a pair of 9-volt batteries can be used to power it. Of course, if you prefer, you can use an appropriate line-operated power supply. Also, if you wish, you can add a foot switch to permit you to bypass the EMU to obtain an unmodified sound envelope.

**About the Circuit.** As shown in Fig. 1, the audio signal from the musical instrument is applied to the EMU via *J1*. It is then coupled to the inverting inputs of *IC1A* and *IC1B*. The *IC1A* circuit is operated as a unity-gain inverting amplifier that buffers the input signal to drive transconductance amplifier *IC2*.

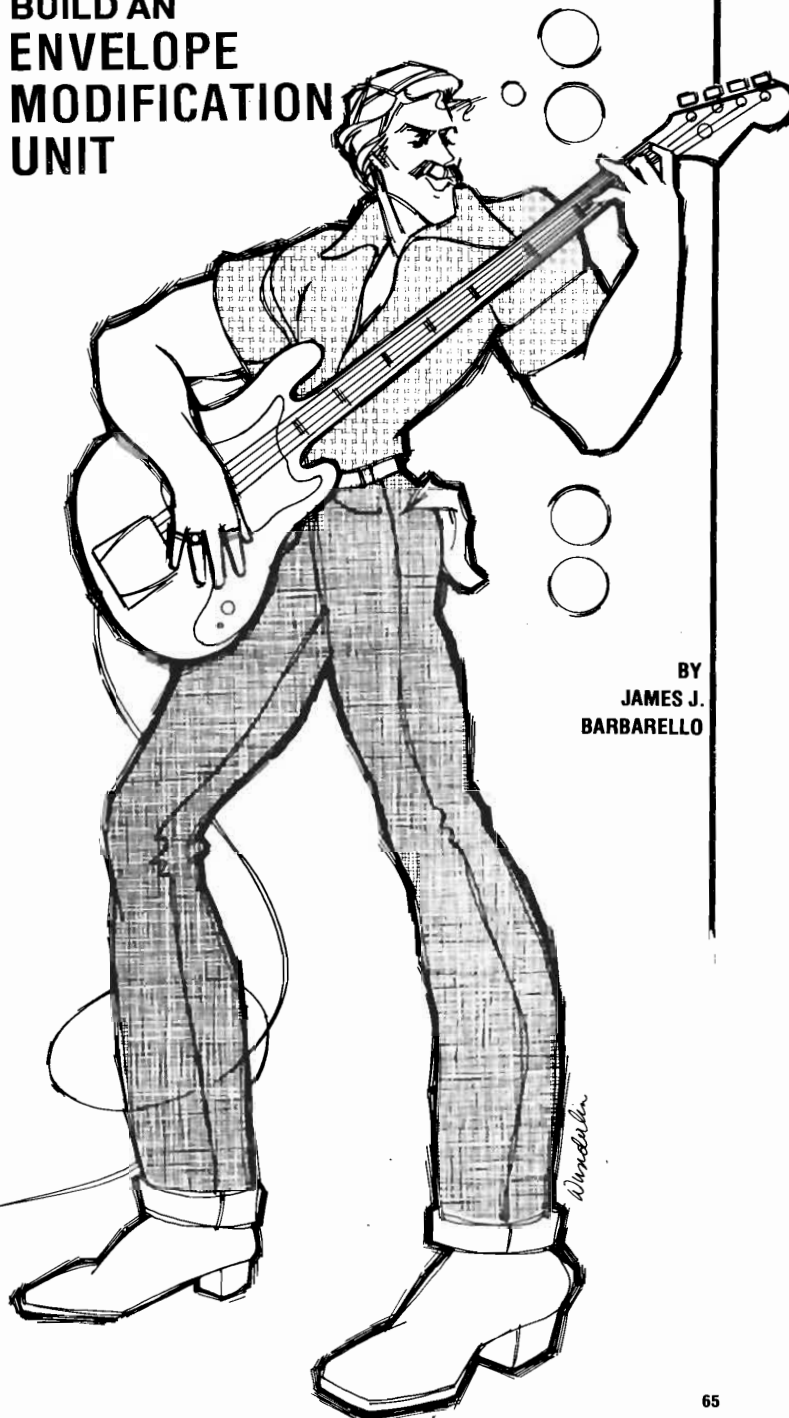
The output from *IC2* is generated across *R4* and buffered by *IC3A*. From here, it is delivered to output jack *J2*. Buffering of both the input and the output of *IC2* eliminates any possible loading and overloading problems usually encountered when using a transconductance amplifier.

The input signal is amplified by *IC1B* and then rectified and filtered by *D1*, *R7*, and *C1*. The amplitude of the negative-going signal generated across *R7* is proportional to the amplitude of the input signal. This signal voltage is then used to toggle Schmitt trigger *IC3B*, whose reference at pin 2 is set to  $-0.8$  volt by

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*Can be used to vary attack, sustain, and decay of any electronic instrument*

## BUILD AN ENVELOPE MODIFICATION UNIT



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divider network  $R8/R9$ . With no input, the output of the trigger is high and applies about +0.8 volt to noninverting input pin 3 of  $IC3B$ .

When the detected potential goes below the -0.8-volt reference, the output of  $IC3B$  goes low. Resistors  $R7$  and  $R10$  set the quiescent input level of  $IC3B$  and provide some hysteresis. The negative-going step voltage produced when the output potential goes low is differentiated and level shifted by  $C2$ ,  $R11$ , and  $R12$  to trigger conventional timer  $IC4$ , which is operated as a one-shot monostable multivibrator.

When the detected potential drops to zero, the output of  $IC3B$  returns to high. The resulting positive pulse has no ef-

fect on  $IC4$ . (This IC is not wired in the conventional manner. Instead, it is arranged to operate between -9 volts and ground, to provide signal compatibility for transconductance amplifier  $IC2$ .) When  $IC4$  is triggered, its output at pin 3 rises from its negative voltage toward ground. This allows  $C3$  to charge through  $D2$  and  $R14$ . The rise time is determined by the values of  $C3$  and  $R14$ . Capacitor  $C5$  eliminates the turn-on spike that could be transmitted through the circuit and be heard as a "pop."

When the timing cycle of  $IC4$  is completed, pin 3 returns to -9 volts and the potential across  $C3$  decays through  $R15$ ,  $D3$ , and pin 3 of  $IC4$ . The time constant here is determined by the values of

$C3$  and  $R15$ . The voltage across  $C3$  provides the programming current for  $IC2$  via  $R13$ , whose value determines the maximum gain.

When the ground connection to  $R16$  and  $R17$  is broken via  $J3$ ,  $C4$  cannot charge. This keeps  $IC4$  on indefinitely and results in a constant gain through the system. When the ground is restored, normal operation resumes.

**Construction.** Although any method of construction can be used to assemble the EMU, a printed-circuit board is recommended. The actual-size etching and drilling and the components-placement guides for such a board are shown in Fig. 2. When completed, the pc assem-

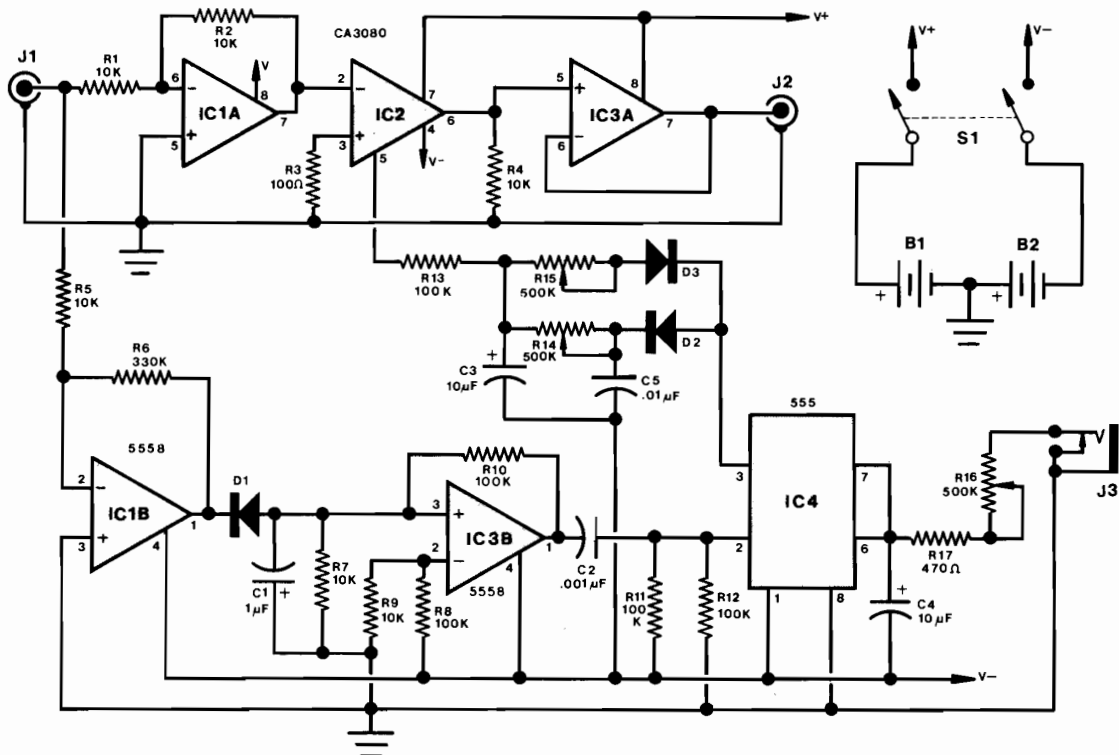


Fig. 1. Transconductance amplifier  $IC2$  has its input and output buffered by  $IC1A$  and  $IC3A$  respectively. Gain of  $IC2$  is varied by circuit containing  $IC4$ , which is triggered by  $IC3B$  and  $IC1B$ .

#### PARTS LIST

B1, B2—9-volt battery  
 C1—1- $\mu$ F, 25-volt electrolytic  
 C2—0.001- $\mu$ F disc capacitor  
 C3, C4—10- $\mu$ F, 25-volt electrolytic  
 C5—0.01- $\mu$ F disc capacitor  
 D1, D2, D3—1N914 or similar switching diode  
 IC1, IC3—5558 or MC1458 dual op amp  
 IC2—CA3080 transconductance amplifier  
 IC4—555 timer  
 The following are 1/4-watt, 10% tolerance:

R1, R2, R4, R5, R7, R9—10,000 ohms  
 R3—100 ohms  
 R6—330,000 ohms  
 R8, R10, R11, R12, R13—100,000 ohms  
 R10—100 ohms  
 R17—470 ohms  
 R14, R15, R16—500,000-ohm linear-taper potentiometer  
 J1, J2—Phono jack  
 J3—Closed-circuit jack

Misc.—Suitable enclosure; battery holders (2); control knobs (3); machine hardware; hookup wire; solder; etc.

Note: The following items are available from BNB Kits, RD#1, Box 241H, Tennent Rd., Englishtown, NJ 07726: Complete kit of parts, not including case, No. EMU-E for \$21.50; printed-circuit board No. EMU-PC for \$6.50. Postage and handling included for U.S. and Canada only. New Jersey residents, please add 5% sales tax.

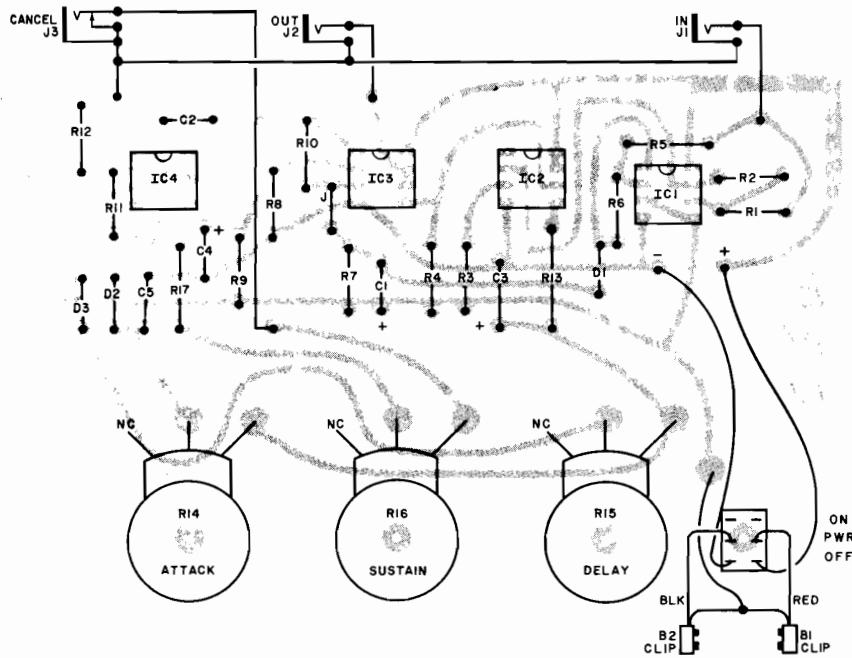
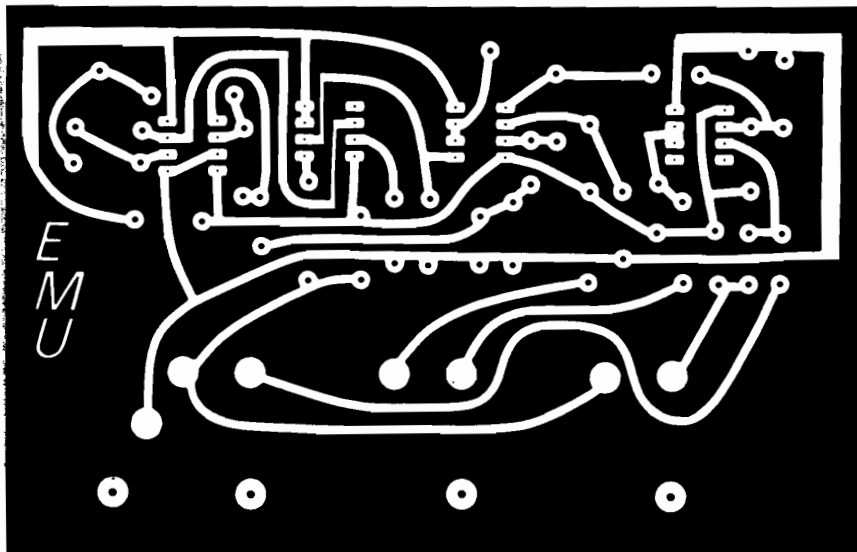


Fig. 2. The actual-size etching and drilling guide for a suitable pc board is shown at left below. Component placement guide is at top.



bly can be mounted inside any conventional case that can accommodate it, the batteries and their holders, and the jacks and controls.

**Using the EMU.** The proper attack, sustain, and decay settings for each different sound effect must be arrived at by experimenting with the EMU.

The SUSTAIN control sets the time from the onset of the attack to the onset of the decay. Accordingly, if the sustain time is set too short, it will override the ATTACK setting. For example, when set-

ting a short staccato envelope, the sustain may be shorter than the attack. This would result in no output from the EMU because IC4 will not be on long enough to allow C3 to charge. If this occurs, increase the SUSTAIN setting enough to obtain an output.

In another situation, if the controls are set for a short-duration envelope, a high-level input may cause multiple triggering. If this occurs, decrease the input signal level until the multiple triggering just ceases.

If at any time distortion appears in the

output, decrease the level of the input signal until it disappears.

Jack J3 (see Fig. 1) is provided for plugging in an optional footswitch. When the footswitch is open, the EMU is effectively cancelled and the input signal passes through IC1A, IC2, and IC3A pass through without modification. (These three stages operate as a simple unity-gain amplifier in this case.) Closing the footswitch completes the circuit from R16 and ground to allow timer IC4 to operate, placing the sound-modifier circuits into the system. ◇