variable fuzz-box

A simple circuit for musical sound effects

Particularly in modern pop music, electronically-produced sound effects are an extremely common device. One only has to think, for example, of the widespread use of the 'wa-wa' pedal and the fuzz-box. With this in mind, Elektor have designed a super simple circuit which, by employing signal clipping techniques, can produce a large variety of manually controlled sound effects.

Using only a handful of components it is possible to construct a highly effective variant of the well-known fuzz box. This type of circuit commonly employs a pair of anti-parallel connected diodes, which are inserted in the amplifier (be it IC – or transistorised) so as to clamp the output signal above certain values of the input signal. This process is illustrated in figure 1, where for the sake of clarity the amplifier is assumed to have unity gain over the linear portion of its transfer characteristic. As can be seen, above an input voltage U_1, the output voltage shows no further increase; similarly, the output voltage will not fall below the input value $-U_2$. If U_1 is equal to U_2 (which is typically the case in fuzz-box circuits) and the input signal is sufficiently large, then the input and output signals will differ from one another as shown in figure 1b.
When, as is the case in figure 1b, the output signal clips *symmetrically* (i.e. $U_1 = U_2$), it contains only *even* harmonics, and it is this which gives the

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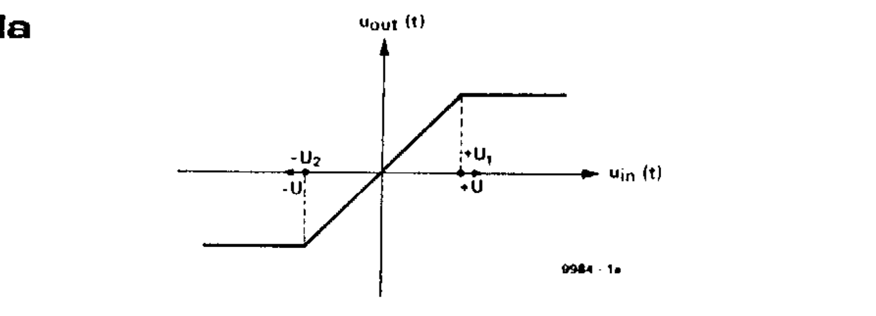
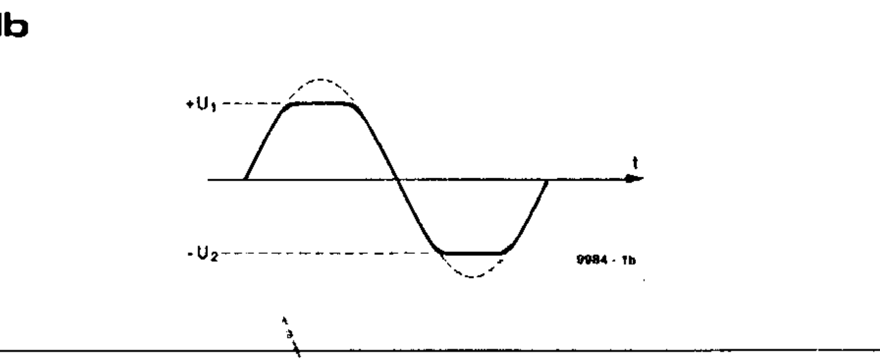


1b



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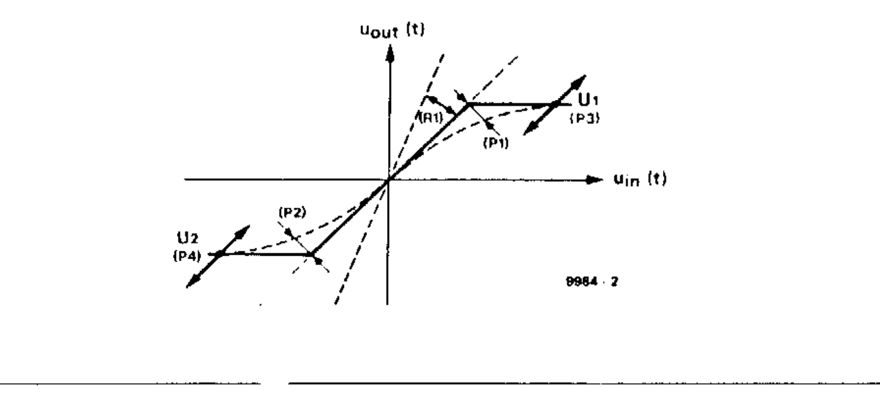


Figure 1. The response of an amplifier which is driven into 'hard' clipping (a) and the corresponding input and output waveforms.

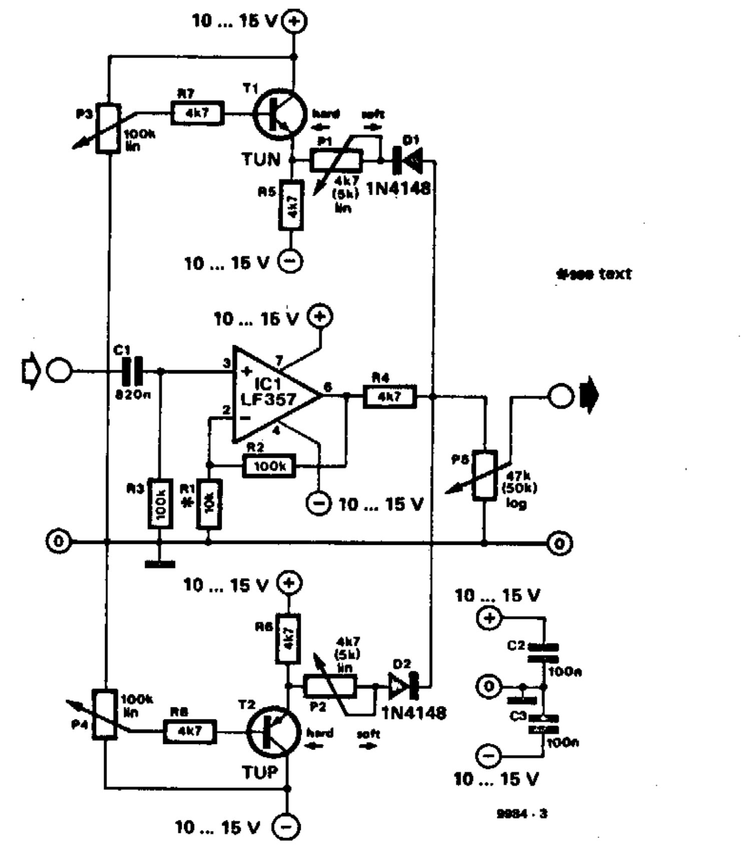
Figure 2. There are five parameters of the clipping response of an amplifier which can be independently varied.

Figure 3. The circuit diagram of a variable fuzz-box for a symmetrical power supply.

Figure 4. The circuit of a variable fuzz-box for an asymmetrical power supply.

Figure 5. Example of a suitable power supply for the circuit of figure 3 (a) and of figure 4 (b).

3



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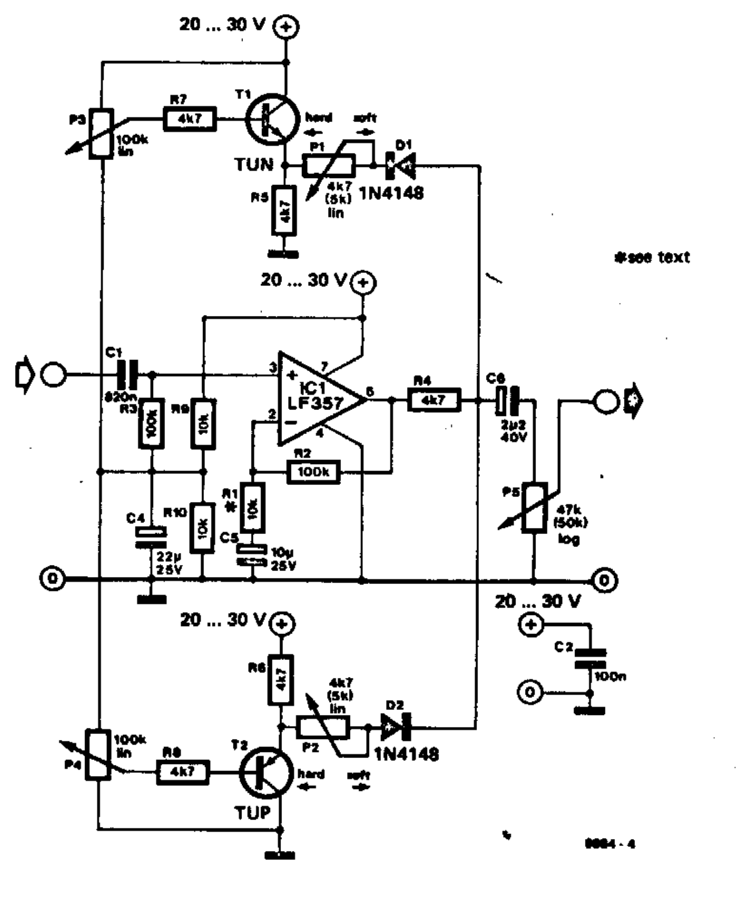


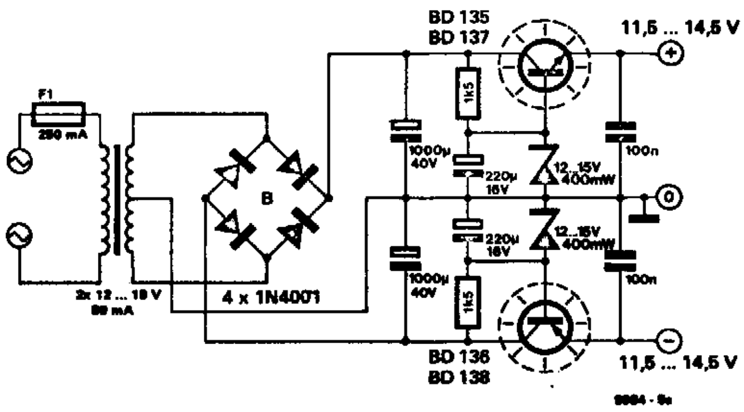
resultant musical signal its characteristically rough and 'fuzzy' edge. However the tonal character of the music signal can be considerably enriched by arranging that the output signal clips *asymmetrically* (i.e. $U_1 \neq U_2$). In this way it is possible to influence the sound of the fuzz-box to produce more varied effects. The circuit described here is designed to offer the best of both worlds by allowing the clipping levels U_1 and U_2 to be altered independently of one another, thus permitting the type of effect to be varied as desired.

Varying the clipping levels is not, however, the only way of influencing the sound of the (clipped) output signal. A further factor determining the type of effect produced is whether the amplifier starts clipping almost immediately it reaches a particular level (hard clipping), or whether the transition between non-limiting and limiting is more gradual (soft clipping). In the circuit described here it is possible to continuously vary the response of the amplifier between these two extremes. The various control facilities offered by the 'variable fuzz-box' are illustrated in figure 2.

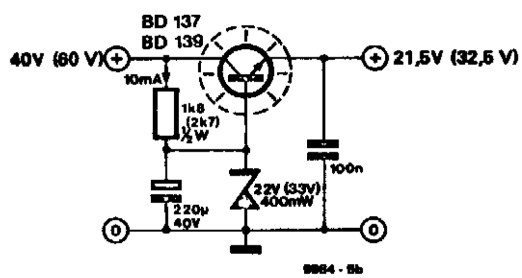
Circuit diagram

The complete circuit diagram of the fuzz-box is shown in figures 3 and 4; figure 3 gives the circuit for a symmetrical power supply (plus, minus and earth), whilst figure 4 is designed for an

5a



5b



asymmetrical supply (plus and minus/earth). The current consumption of the circuit is 10 to 15 mA, whilst in both figures 3 and 4 the input impedance is 100 k.
The operation of the circuit is fairly straightforward. The input signal is first amplified by IC1, the gain of which is $1 + \frac{R2}{R1}$. The gain can be altered by varying R1; with the value given the gain is 11. The output signal of IC1 is fed via R4 (and C6 in figure 4) to the volume control P5, the wiper voltage of which forms the output signal of the circuit.
The clipping is controlled as follows: as soon as the voltage at the right hand end of R4 exceeds the wiper voltage of P3 (or falls below the wiper voltage of P4) the output signal is attenuated. The degree of attenuation is determined by the ratio of R4 to P1 (P2). With P1 (P2) set to its minimum resistance value the output signal is completely attenuated, i.e. is 'hard' clipped. With P1 set to its other end stop (minimum resistance) 'soft' clipping is obtained. Thus by adjusting the four potentiometers P1 . . . P4 which control both the levels at which the amplifier starts to clip and the degree of clipping, it is possible to vary the tonal character of the resultant sound as desired.
As far as a power supply is concerned, various possibilities exist. Figures 5a and 5b show a suitable arrangement for the circuits of figures 3 and 4 respectively.

Other applications

Apart from its use as a variable special effects generator the circuit also has other possible applications. For example, it can be used to limit the input signal of a power amplifier to the value which just produces maximum output. In this way one obviates the danger of current limiting or clipping occurring in the power amp and its undesirable consequences for the listener. At the same time the circuit thus represents a type of overload protection for the power amp.
Another interesting idea would be to use the circuit in conjunction with P.A. systems. There are various theories which claim that it is possible to increase the volume of the signal by clipping it in a certain way. The increase in the harmonic content of the signal is said not to impair the intelligibility of the address. It has also been suggested that different clipping characteristics may explain some of the oft-debated differences between 'transistor-sound' and 'valve-sound'. The circuit described here seems ideally suited to test the truth of these ideas. However readers wishing to experiment in this field would do well to spare a thought for their neighbours!

P.C.B. for variable fuzz box

The design for the 'variable fuzz box' was first published in the December 1978 issue of Elektor. Such is the popularity of this circuit, that we have decided to produce a printed circuit board for it.

The variable fuzz box is a special effects unit for guitarists, which by allowing the amplifier signal to be clipped in a variety of different ways (symmetrically, asymmetrically, soft, hard, etc.) offers a greater degree of control over the resultant sound. The circuit of the fuzz box was described in detail in the original article, hence will not be repeated here. However one correction to the original description has to be added: *symmetrical* clipping of the output signal produces only *uneven* (not even, as was stated) harmonics, whilst asymmetrical clipping generates both even and uneven harmonics in the output signal.
The alternative circuit diagrams of the fuzz box for symmetrical (figure 3 of original article) and asymmetrical (figure 4 of original article) power supplies are here combined into one (see figure 1). The circuit diagram contains a number of lettered connection points (a . . . h, j, k, m . . . w) which are marked on the printed circuit board shown in figure 2. The circuit diagram and accompanying parts list provides the relevant details on which connections should be made for either symmetrical or asymmetrical power supply requirements.
The current consumption of the circuit is less than 20 mA. A 741 can be used for IC1, however an LF 356 is a better choice. ■

Literature:
Variable Fuzz Box, Elektor 44, December 1978

1

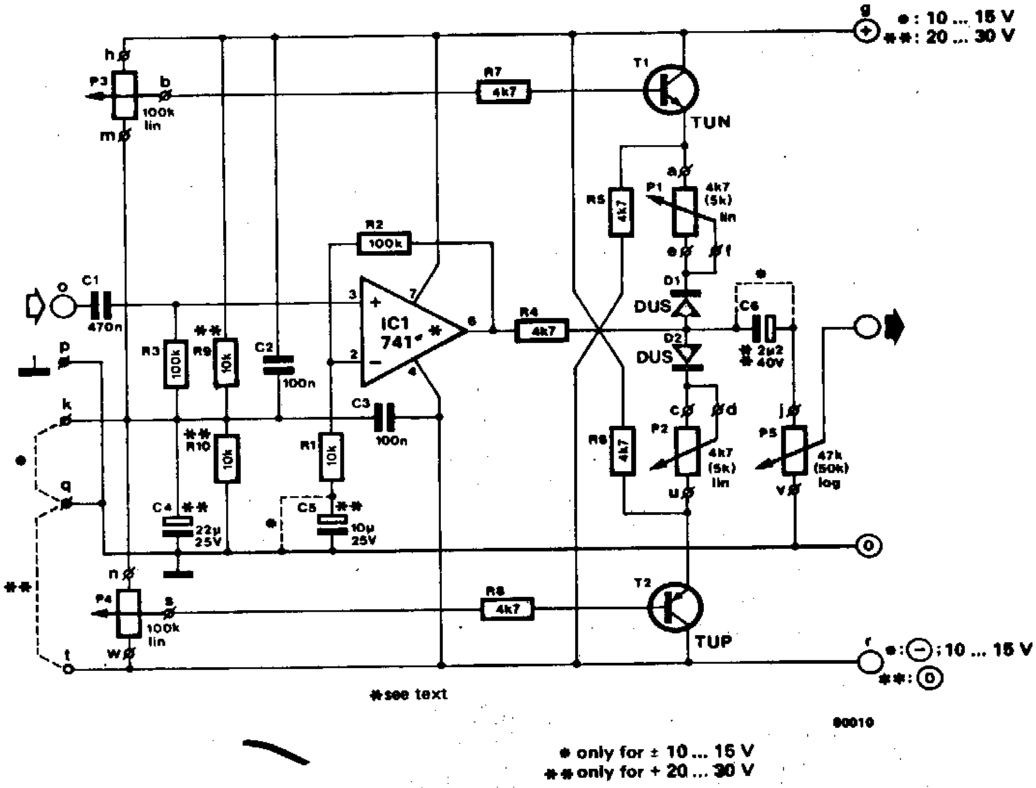


Figure 1. Circuit diagram of the variable fuzz box for symmetrical and asymmetrical power supply stages.

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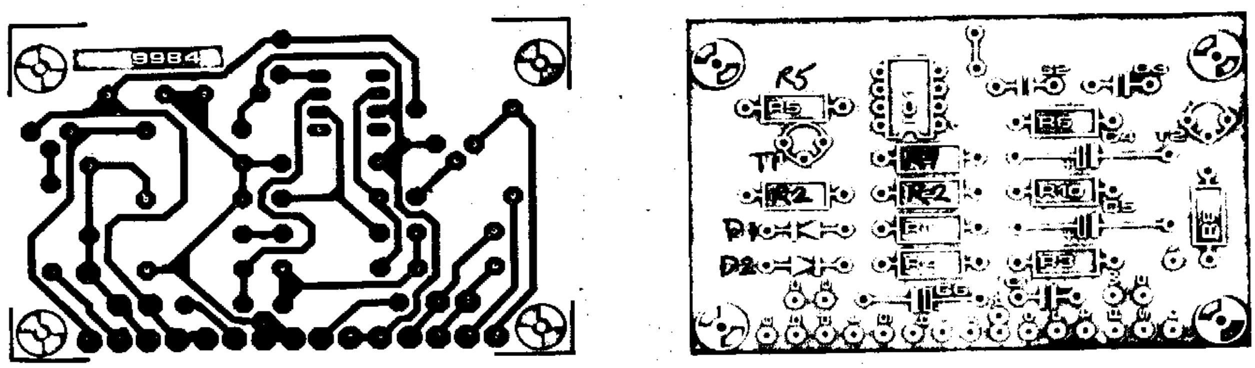

Figure 2. Printed circuit board for the variable fuzz box. The one board is suitable for both versions of the circuit.

parts list

Resistors:
R1,R9[1],R10[1] = 10 k
R2,R3 = 100 k
R4,R5,R6,R7,R8 = 4k7

Potentiometers:
P1,P2 = 4k7 (5 k) lin.
P3,P4 = 100 k lin.
P5 = 47 k (50 k) log.

Capacitors:
C1 = 470 n
C2,C3 = 100 n
C4[1] = 22 µ/25 V
C5[2] = 10 µ/25 V
C6[2] = 2µ2/40 V

Semiconductors:
IC1 = 741 or LF 356 (see text)
T1 = TUN
T2 = TUP
D1,D2 = DUS

Wire links:
asymmetrical supply voltage
+ 20 . . . 30 V: points q and t
symmetrical supply voltages
± 10 . . . 15 V: points q and k
C5 replaced by link
C6 replaced by link

Remarks:
[1] omitted in the case of symmetrical supply voltages.
[2] replaced by wire link in the case of symmetrical supply voltage.