004 COMPRESSOR

This versatile circuit serves to raise the average output power of an AF amplifier. Its simplicity makes it suitable for applications in intercom systems, public address and discotheque equipment, and also in various types of transmitter.

Compression of music and speech essentially entails reducing to some extent the dynamic range of the AF input spectrum in order to drive an AF power amplifier with a fairly steady signal level just below the overload margin, thus increasing the average output power of the system. However, some distortion is inevitably incurred in the process of amplifying the relatively quiet input sounds and attenuating the louder sounds. It is evident, therefore, that the control of the amplifier/attenuator function in the compressor determines to a large extent just how much distortion is introduced by the circuit.

Before inserting any type of compressor in an AF signal path, due consideration should be given to the *attack time* i.e., the time it takes the circuit to detect and counteract a sudden increase in the amplitude of the incoming signal. Allowing for personal preference and the character of the input signal (speech, popular music, etc.), the attack time of a compressor generally lies in the range from 0.5 to 5 ms. The *release time* of the compressor is the time it takes the circuit to return to the settings that existed before the rise in amplitude occurred. Contrary to the attack time, the release time is usually of the order of seconds. If it is made too short, the compressor's attenuating action may cause interference with the lowest components in the frequency spectrum. On the other hand, too long a release time (10-15 s) is also undesirable as this will give rise to an unrealistic and unpleasant effect caused by the output sound remaining completely muted long after the increase in input ampli-signal amplitude. In practice, the release time of a compressor will need to be adapted to meet the demand of the particular input signal; speech generally requires a longer release time than music. Some compressors have a provision for the setting of the release time, but the one proposed here is an auto-ranging type, that is, it arranges for the release time to change automatically with the instantaneous

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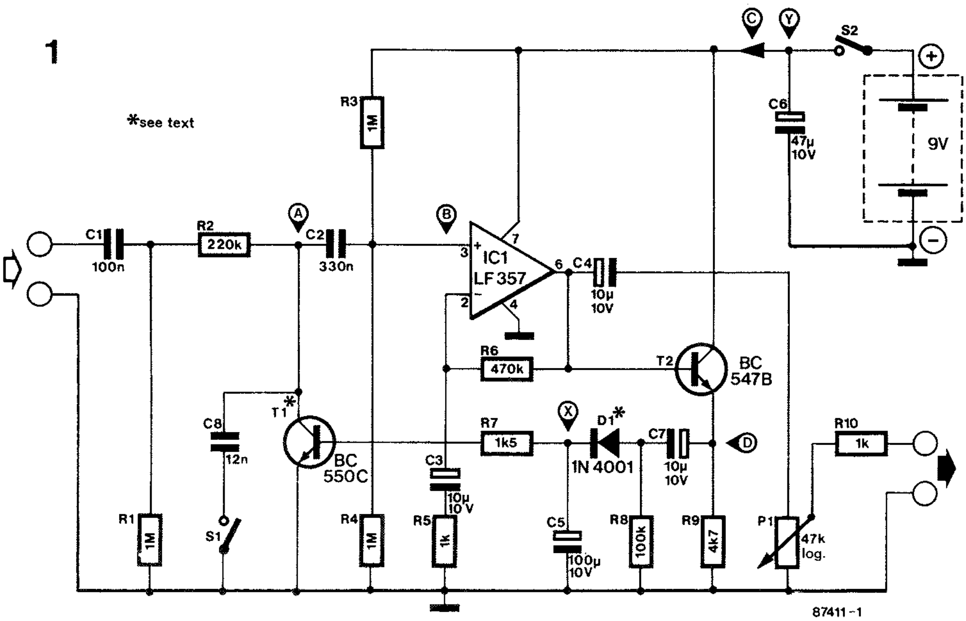
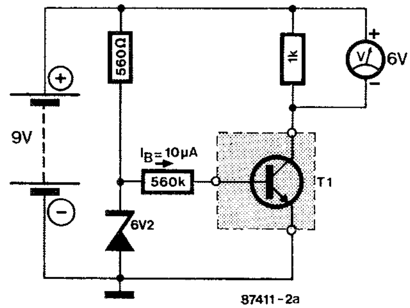


2a



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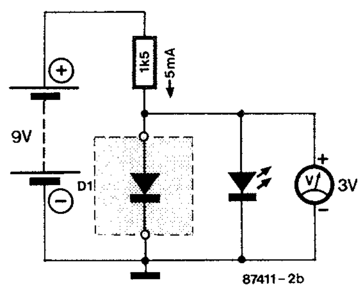

amplitude of the input signal.

Figure 1 shows the circuit diagram of this compressor. Despite its simplicity, the design responds adequately to a good number of contradicting requirements. As to its dynamic characteristics, an input signal change from 25 mV_{pp} to 20 V_{pp} (≙58 dB) is compressed into an output signal change from 1.5 V_{pp} to 3.4 V_{pp} (≙7.1 dB). For a less extreme signal change, e.g., from 25 mV_{pp} to 2.5 V_{pp} (≙40 dB), the compressed output signal changes from 1.5 C_{pp} to 2.25 V_{pp} (≙3.5 dB). The circuit has an extended frequency response from about 7 Hz to 67 kHz nominally, thanks to the use of a fast opamp, the Type LF357 (IC_1), which is set up here to provide an amplification of about 471 [(R_6 + R_5)/R_5]. Capacitor C_3 blocks the direct voltage at the inverting input of IC_1, and with R5 sets the low-frequency roll-off of the opamp alone at about 16 kHz.

Resistors R_3 and R_4 bias the non-inverting input of the opamp—and hence its output—at half the supply voltage, ensuring optimum linearity. Capacitor C_2 feeds the input signal to the opamp while blocking the bias voltage at pin 3. Its value is not critical, but it has some effect on the low-frequency response of the compressor. The attenuator section in this circuit is essentially composed of $R_2$and T_1. The collector of this transistor is held at 0 V with the aid of R_1 and R_2. In this way, T_1 is always operated in its saturation region, and its collector-emitter junction acts as a variable resistance controlled with the current fed to the base. The higher this current, the lower the c-e resistance, and the higher the instantaneous attenuation of the signal fed to IC_1. The controlling rectifier is composed of D_1-C_5-R_7. Transistor T_2 functions to provide the charge current for C_7 so as to avoid distortion other-

wise incurred by too heavily loading the IC_1 output. The rectified voltage across C_5 is a direct measure of the output signal amplitude, and forward-biases the base of T_1, which regulates the attenuation as discussed. The use of a diode with a low internal resistance, D_1, and a buffer, T_2, ensures fast charging and slow discharging of C_5, and thus a short attack time and a long release time, respectively. As C_5 is discharged via R_7 and the base resistance of T_1, the release time of the compressor is the product of the value of these three components. When the base bias is reduced, the base resistance of T_1 increases, lenghtening the release time. This is a most welcome feature, especially with speech signals.
The output of the opamp is fed to C_4-P_1-R_{10}, which provide DC insulation and level adjustment.
Two compressors are readily combined to make a stereo version by feeding them from a common battery and connecting points X and points Y (never X to Y!). In this case, T_1 and D_1 in both compressors must be matched types to ensure proper operation. Figure 2 shows two simple test circuits for selecting transistors and diodes with matching DC characteristics. The basic method is to start with noting the voltmeter reading for a particular device, and then find a matching type from an available lot by inserting devices until one is found that gives the preciously noted test voltage. In the diode test circuit, the LED lights to indicate the absence or reverse connection of a diode under test.

A = 0 V
B = +4.5 V
C = 6 mA
D = 3.9 V

All values are typical and within 10%.
All voltages measured with respect to ground with a DMM (Z_{in} = 1M0).

Provision has been made to use the circuit as a noise suppressor. Referring to Fig. 1, closing S_1 connects C_8 across the regulator transistor to form a low-pass filter in conjunction with R_1 and R_2. The cut-off frequency of this LPF is a function of the current sent into the base of T_1. The overall effect thus obtained is an effective elimination of noise from quiet passages in the programme. For louder passages, the suppression of noise is not so important, as it is then virtually inaudible.
Finally, when using this compressor, make sure that your amplifier has ample cooling provision, because it may well be continuously operated at the top of its power rating. For the same reason, check whether the loudspeakers can handle the available power.