DESIGN IDEAS

Voltage-controlled attenuator

Although Aphex's Type 1537A voltage-controlled attenuator has been on the market for some time, it appears that the device is not generally known. A pity, because it offers very low distortion, high stability, low noise, and a wide dynamic range. Its attenuation can be controlled precisely from 0 dB down to −100 dB.

Characteristics	
Frequency range:	0...50 MHz
Total harmonic distortion:	0.04%
Intermodulation (SMPTE):	0.03%
Signal/noise ratio (peak, CCIR 468):	90 dB
Modulation noise:	6.5 dB
Slew rate:	10 V/µs
Input impedance:	0 Ω (current driven)
Maximum attenuation:	≥ 96 dB (20 Hz... 50 kHz)
Offset voltage:	≤ 5 mV
Current consumption:	33 mA at 25 °C

Note: $U_b = \pm 15$ V; T (ambient) = 25 °C; 0 dBm = 0.775 V.

Moreover, the 1537A is designed for a high slew rate, resulting in low transient intermodulation and a wide bandwidth, so that it can be used over the frequency range DC to 50 MHz.

The very good performance characteristics of the 1537A make it suitable for use in a wide range of audio applications, such as voltage-controlled filters, synthesizers, compressors, and others, as well as in, for instance, tone burst generators, robotics, servo-controlled machines, and many other general electronic applications.

In general, voltage-controlled attenuators, which normally use log-antilog multiplier circuits, exhibit high non-linear dis-

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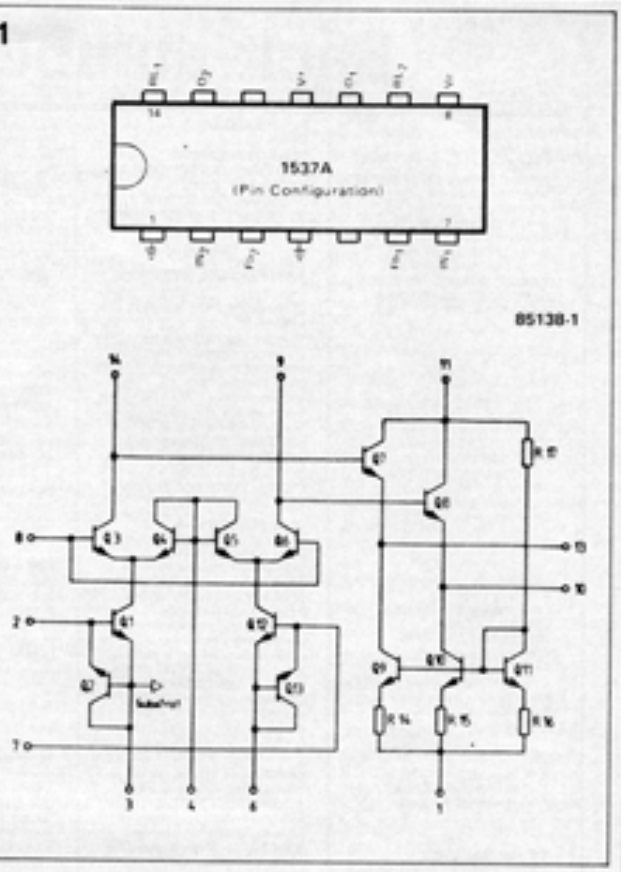

Fig. 1. Pin configuration and internal circuit layout of the 1537A.

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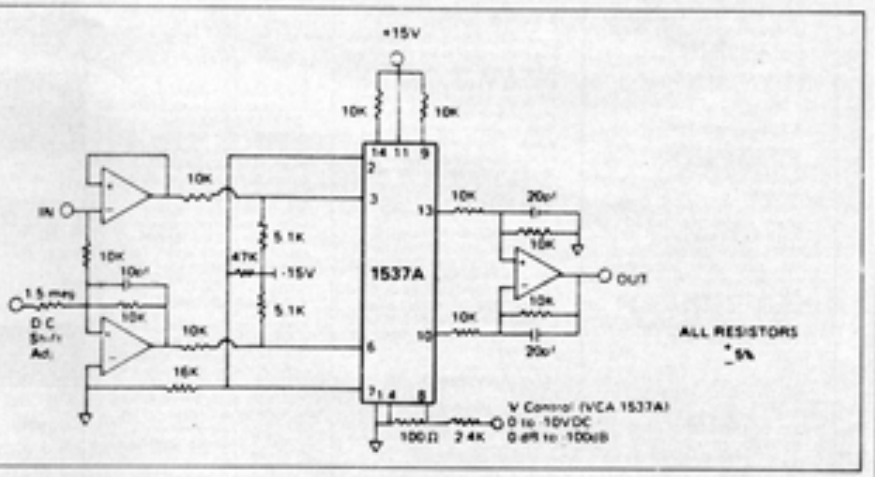

Fig. 2. A simple practical circuit is obtained by combining the 1537A with two additional opamps.

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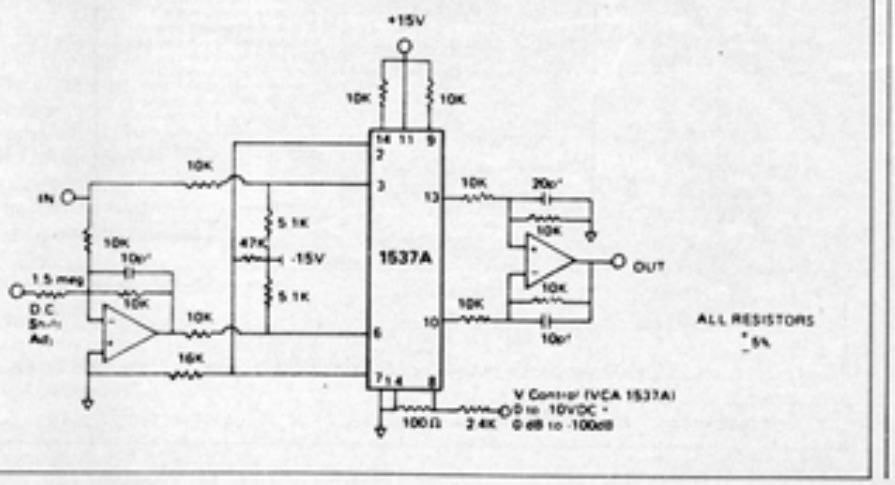

Fig. 3. This rather more elaborate circuit than that in Fig. 2 has an additional input buffer.

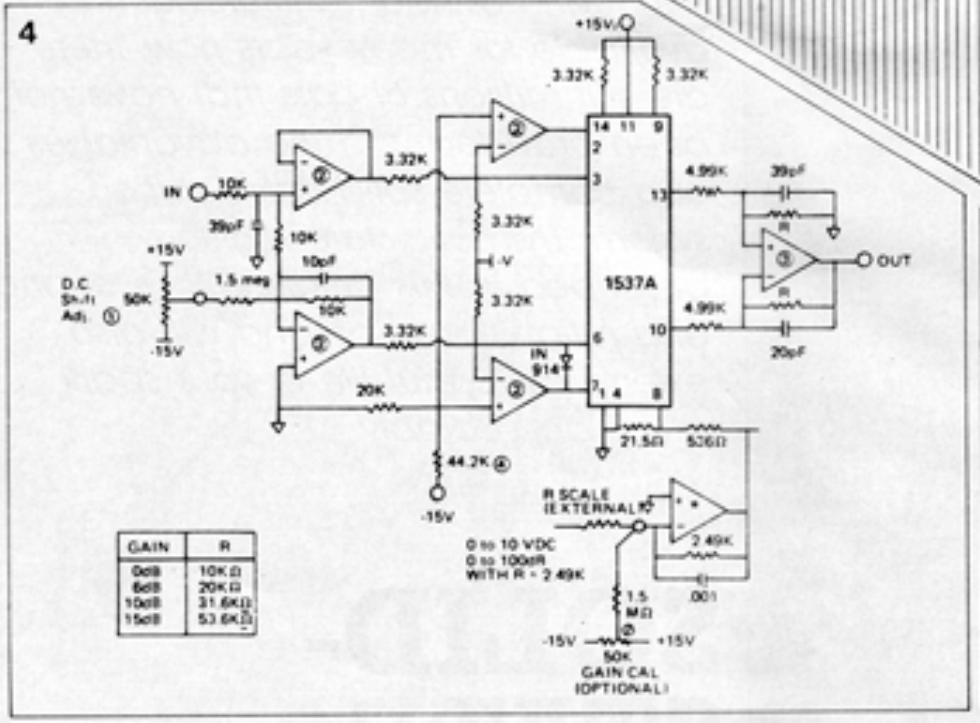

Fig. 4. A typical full implementation circuit of the 1537A.

Fig. 5a. Voltage-controlled resistor.

Fig. 5b. Voltage-controlled high-pass filter.

Fig. 5c. Voltage-controlled band-stop filter.

Fig. 5d. Suggested automatic gain control circuit.

tortion and high noise. The 1537A uses new proprietary techniques that result in much lower levels of these characteristics. Moreover, since it is a true class A device, its crossover distortion is much lower than that of most other voltage-controlled attenuators.

The 1537A is housed in a 14-pin dual-in-line package. The pin configuration and internal circuit are shown in Fig. 1. Current sources Q_1 and Q_2, driven by the input signal, control amplifiers Q_3 and Q_4. The gain of these amplifiers is controlled via their base voltage (since that voltage controls the transconductance of the transistors). The output is buffered by transistors Q_7 and Q_8.

Some practical circuits using the 1537A are shown in Figures 2, 3, and 4. The circuit in Fig. 2 is the simplest, requiring only two additional opamps. It is suitable for source impedances up to about 150 Ω. Where the source impedance is higher, but does not exceed 2 kΩ, the circuit of Fig. 3 should be used. This is comparable to that of Fig. 2, but has an additional input buffer.

For optimum utilization of the 1537A, the circuit shown in Fig. 4 is suggested. This uses even more additional opamps, and these should be of the low-noise type, such as the TL027, LF353, or NE5534.

Some typical applications of the 1537A are shown in Fig. 5. The voltage-controlled resistance in Fig. 5a has a value, $R' = R/(1-\alpha)$, where α is the attenuation of the 1537A.

The high-pass filter of Fig. 5b has a cut-off frequency

$$f_c = (1-\alpha)/2\pi RC$$

where f is in hertz, and α is the attenuation of the device.

The circuit in Fig. 5c is a band-stop filter, whose centre frequency of the attenuation band F is

$$f_c = 1/2\pi\sqrt{R_1R_2C_1C_2} \quad \text{(Hz)}$$

Finally, Fig. 5d shows a suggested automatic gain control (AGC) circuit.

Literature:

1537A *voltage-controlled attenuator*
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