The ZX 81 is one of the most popular personal computers but it does leave a lot to be desired in certain respects, one of the most notable of which being its cassette interface. Any ZX 81 user who has had to type in a complete program again because it could no longer be loaded from cassette will confirm this. The pulse cleaner described here is designed to make such problems a thing of the past. This makes it a must not only for ZX 81 users but also for any other computer that uses a similar type of pulse/pause system for the cassette connection.

ZX81 cassette pulse cleaner

a cassette output signal cleaner for computers with single-frequency FSK

The Sinclair ZX 81's cassette interface uses frequency shift keying (FSK) with a single frequency. The signal is built up of a number of pulses, a pause, a number of pulses again, another pause, and so on (see figure la). The number of pulses between two pauses indicates the logic level: four pulses represent a logic zero and eight pulses are used to indicate a logic one. If this signal is stored on a cassette tape the 'digital' shape cannot be properly processed due to limitations in the recorder's electronics and the qualities of the tape itself. When the data is read from the tape it will enter the computer as a signal that looks something like that shown in figure lb. The oscillation on the last pulse before a pause could cause the computer to falsely consider this as an extra pulse, with dire consequences. In order for the computer to be able to process it properly this signal should really be made into a digital signal with all the interference removed.

The layout

The various parts of the circuit are seen in the block diagram of figure 2. The incoming signal from the cassette recorder is first passed through an adjustable attenuator before being amplified and passed through a band-pass filter. This is followed by another amplifier and a high-pass filter. All this is necessary to remove any low frequency oscillations from the signal as the computer could interpret them as extra pulses. The filtered signal is then fed through a negative and positive peak rectifier. A Schmitt trigger compares these output signals with the signal from the high-pass filter to ensure that short noise pulses are also removed. The result is a clean digital cassette signal at the output. The output signal from the positive peak rectifier, incidentally, is also used to control the attenuator at the input.

1

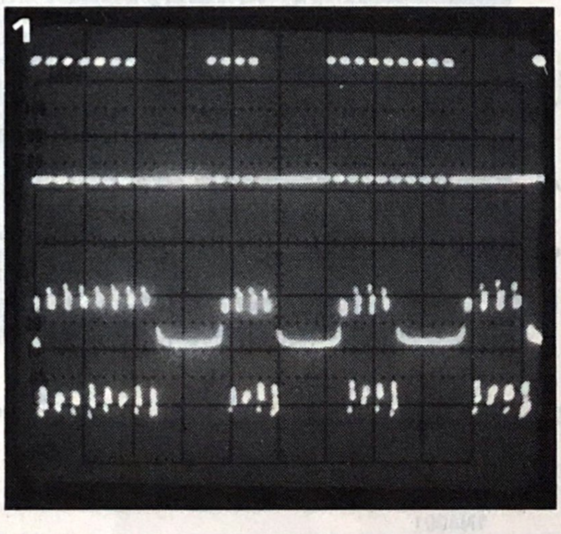


Figure 1. These are the sort of pulses that appear at the ZX 81's cassette output (top). After processing by the cassette recorder the signal (bottom) does not look quite so 'clean'.

2

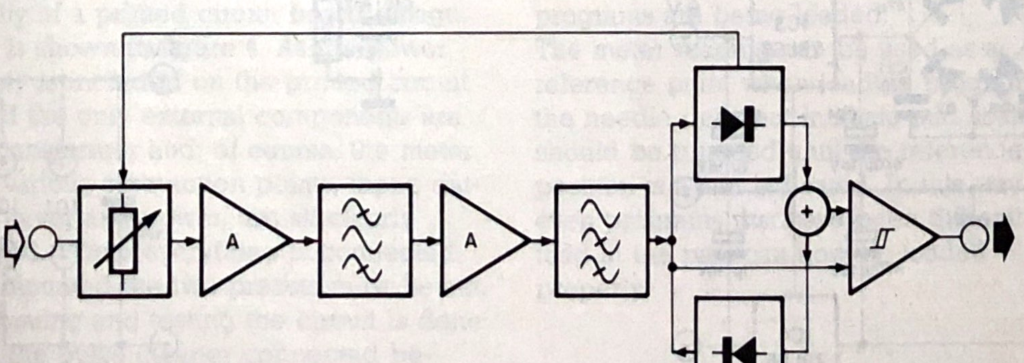


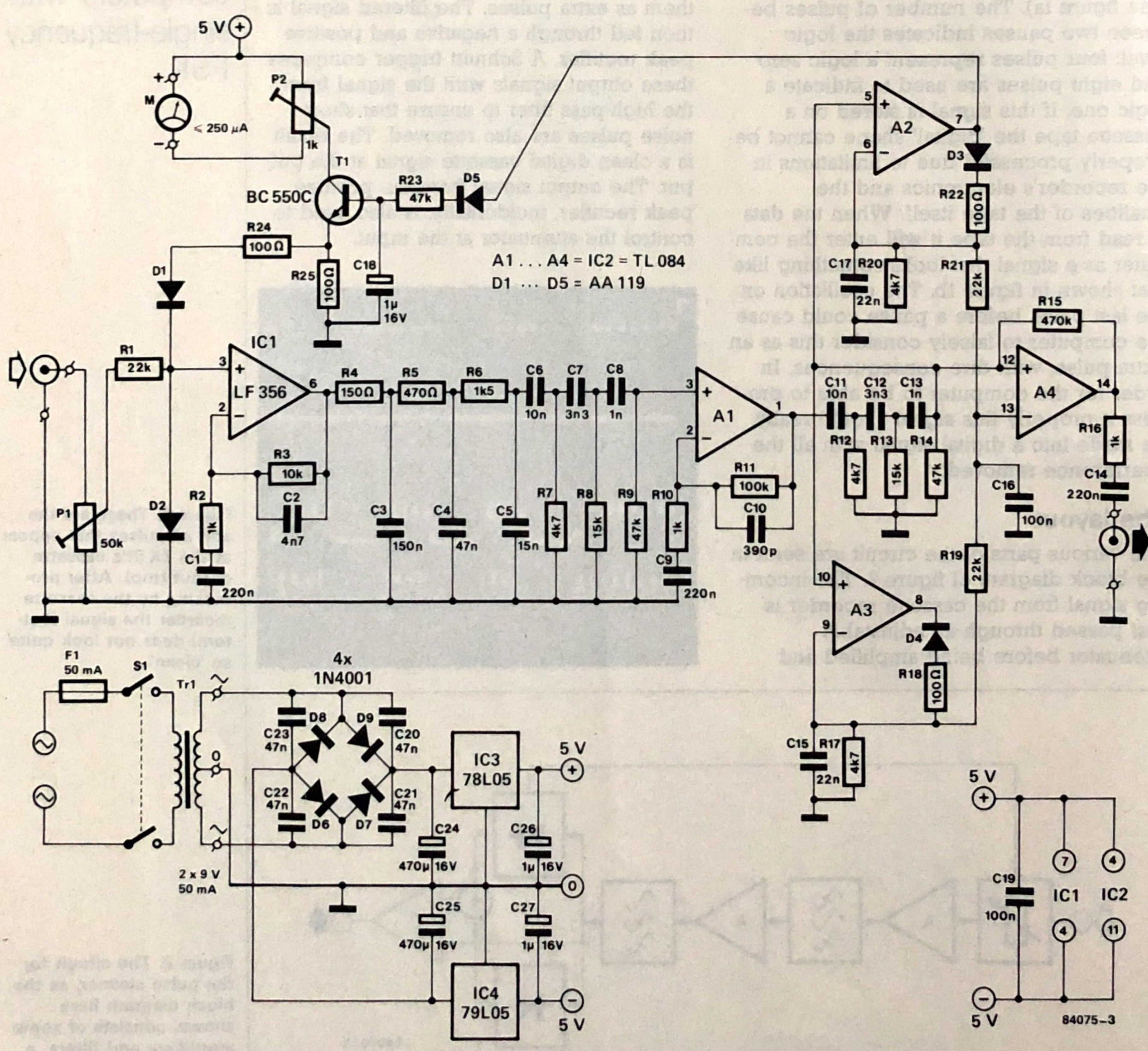
Figure 2. The circuit for the pulse cleaner, as the block diagram here shows, consists of some amplifiers and filters, a pair of peak rectifiers, a comparator section and an attenuator.

The circuit

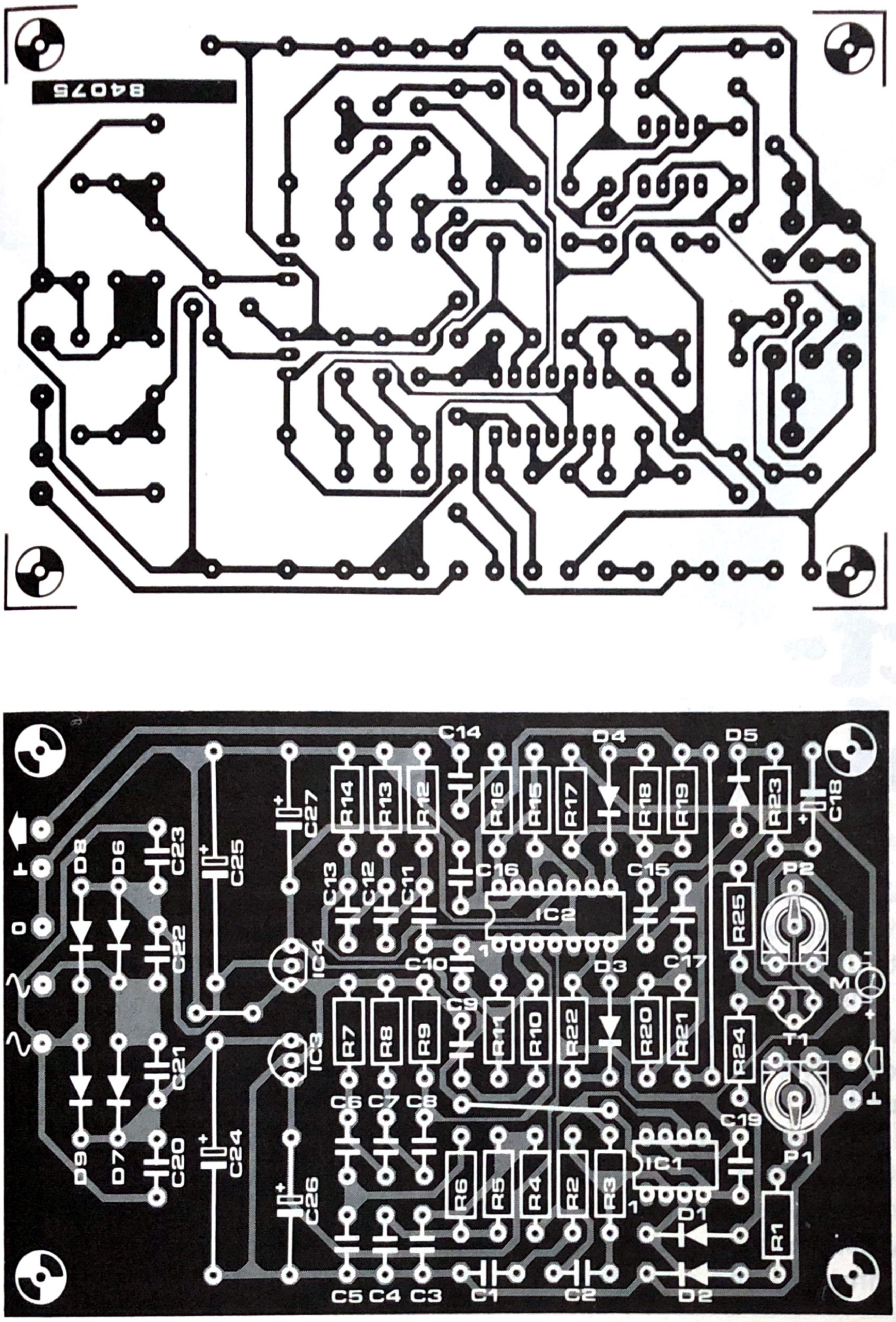
The circuit diagram for the pulse cleaner is shown in figure 3. The input signal is first of all attenuated by preset P1 and then passes to the adjustable attenuator. The output of positive peak rectifier A2 determines the d.c. voltage at the base of transistor T1, which, in turn, decides the current passed through diodes D1 and D2 and therefore the impedance (or, strictly speaking, the differential resistance) of the diodes. When the output voltage of A2 is high the attenuation of the input signal will be correspondingly high. The moving coil meter in the collector line of T1 gives a visual indication of the strength of the signal.
The attenuator is followed by op-amp IC1 which amplifies the signal by a factor of eleven and then feeds it to the band-pass filter consisting of R4 . . . R9 and C3 . . . C8. The filtered signal is amplified by a factor of 100, by A1, to compensate for the attenuation introduced by the band-pass filter. The low frequency part of the signal is then removed by high-pass filter R12 . . . R14/C11 . . . C13 whose cut-off point is at about 9 kHz.
The treated signal is fed to the inputs of the two peak rectifiers, A2 and A3, and the non-inverting input of Schmitt trigger A4. Each rectifier consists of an op-amp with a diode at the output. A 22 n capacitor (C15 or C17) is charged to the maximum value of the input voltage via the diode, which is part of the op-amp's feedback loop. The 100 Ω resistors are needed to limit the charging current that the op-amps provide.
The output signals from the two rectifiers are added via resistors R19 and R21 and then go to the inverting input of A4. The other input of the Schmitt trigger, as we have already noted, is connected to the output of the high-pass filter so that A4 compares the rectifier signals with the differentiated cassette pulses provided by the filter. The output of the circuit is a clean rectangular waveform that can be fed directly to the ZX 81 cassette input.

Figure 3. The circuit diagram for the pulse cleaner. As the circuit is quite straightforward all the sections from the block diagram can easily be found here.

3



4



Parts list

Resistors:
R1,R19,R21 = 22 k
R2,R10,R16 = 1 k
R3 = 10 k
R4 = 150 Ω
R5 = 470 Ω
R6 = 1k5
R7,R12,R17,20 = 4k7
R8,R13 = 15 k
R9,R14,R23 = 47 k
R11 = 100 k
R15 = 470 k
R18,R22,R24,R25 = 100 Ω
P1 = 50 k preset
P2 = 1 k preset

Capacitors:
C1,C9,C14 = 220 n
C2 = 4n7
C3 = 150 n
C4,C20 . . . C23 = 47 n
C5 = 15 n
C6,C11 = 10 n
C7,C12 = 3n3
C8,C13 = 1 n
C10 = 390 p
C15,C17 = 22 n
C16,C19 = 100 n
C18,C26,C27 = 1 μ/16 V
C24,C25 = 470 μ/16 V

Semiconductors:
D1 . . . D5 = AA 119
D6 . . . D9 = 1N4001
T1 = BC 550C
IC1 = LF 356
IC2 = TL 084
IC3 = 78L05
IC4 = 79L05

Miscellaneous:
F1 = fuse, 50 mA slow blow
M1 = moving coil meter, ⩽250 μA f.s.d.
S1 = double pole mains switch
Tr1 = mains transformer, 2× 9 V, 50 mA

Figure 4. The printed circuit board for the FSK pulse cleaner can be fitted into its own case or there may be room for it within either the computer or the cassette recorder.

In practice

Small though this circuit is we thought it worthy of a printed circuit board design. This is shown in figure 4. As the power supply is included on the printed circuit board the only external components are the transformer and, of course, the meter. The various connection points, input, output, meter and power, are all clearly marked. When everything is connected and mounted the two presets must be set. Calibrating and testing the circuit is done with the pulse cleaner connected between ZX 81 and cassette recorder. Now, while trying to load some (well recorded) programs from the cassette, trim preset P1 until all programs are received correctly. When this is done set P2 so that the needle of the meter is in mid scale while programs are being loaded.

The meter reading can be used as a reference point when loading programs. If the needle does not indicate mid scale P1 should be trimmed until the reference position is again indicated. In this way even programs that have been difficult to load in the past can now be loaded properly. ◼