G. Lausberg

a drum instead of a keyboard for synthesizers

Why must a synthesizer always have a keyboard? Musicians asked this question of synthesizer manufacturers some time ago. In the meantime there is a considerable number of 'controllers' which allow synthesizers to be played without a keyboard. In addition to the ribbon controllers, with which a steel string determines the pitch (similarly to playing a violon), the percussion controllers are amongst the best known: these are drums with internal electronics which convert the pulses of the drumstick into control signals for the synthesizer. The drum interface is the electronic circuitry for this type of percussion controller. As pop music specialists know, such controllers have been frequently used in recent recordings. 'Disco drums' would be difficult to imagine without this effect.

The most complicated part of a drum controller is the drum itself; the electronic circuitry could almost be accommodated in a matchbox. This compact circuit, however, produces astonishing results: staccato synthesizer sounds in a drum rhythm allowing wide variation. "Playing" the synthesizer with a drum makes the synthesizer far more accessible to many more people: instead of a keyboard there is only one, albeit somewhat unusual, "key" – the drum and a drumstick. This key can be played with great sensitivity. The drumbeat rhythm delivers the triggering pulses and hence the rhythmic structure of the synthesizer action. The dynamic (variable) component is the drumbeat intensity which the drum interface converts to a proportional voltage. This voltage can be applied with great versatility: to control the pitch, filter frequency or amplitude of the synthesizer, depending on whether the drum control voltage drives VCOs, VCFs or VCAs. Apart from the fact that the drum makes the synthesizer accessible to everyone (playing it becomes fun), different and tightly controlled sounds can be obtained from the synthesizer with a little practice.

Simple electronics

There is nothing secret about the way the drum interface operates, on the contrary it is refreshingly simple. The interface begins with a transducer in the form of a microphone or loudspeaker which converts the sound in the drum (or in its immediate vicinity) into an electrical signal. This signal exhibits the characteristic of a damped sinusoidal oscillation whose frequency depends on the drum and whose amplitude depends on the drumbeat intensity. The purpose of the circuit in the block diagram of figure 1 is to act as an interface by processing this signal for the synthesizer. Required at the output are a triggering pulse (gate pulse) and a variable control voltage.

First the signal from the microphone or loudspeaker is greatly amplified. A trigger circuit at the amplifier output generates triggering pulses from the negative half-waves of the signal; these pulses can already be used as gate pulses. However, they also trigger two monostables in the interface which control an analogue memory (sample and hold). This analogue memory accepts the maximum amplitude of the positive half-waves and holds it until the next drumbeat. Thus each drumbeat provides a triggering pulse and a new control voltage. What could be better?

The circuit

Figure 2 shows the practical implementation of the principle sketched in the

1

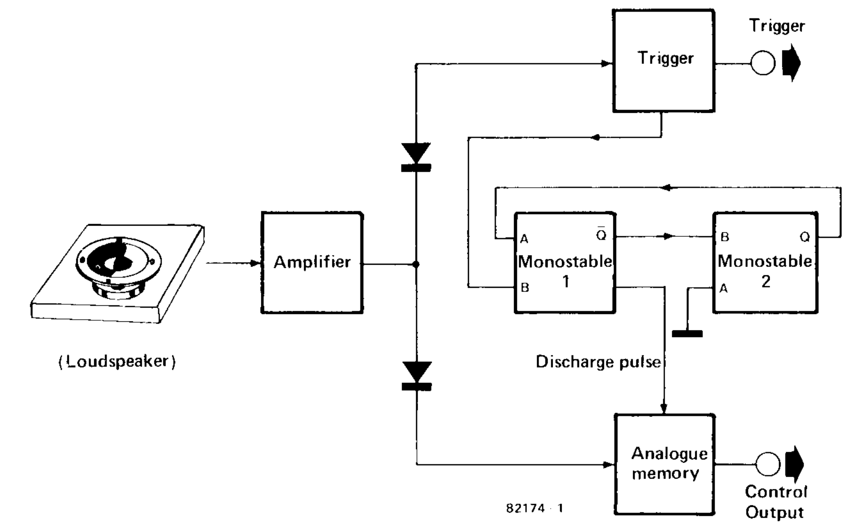

Figure 1. Block diagram of the drum interface. The transducer is a loudspeaker or microphone. From the drum signal obtained in this way, a triggering circuit delivers a trigger pulse with each drumbeat. An analogue memory holds the maximum amplitude of the signal with each beat. The result is a control voltage whose amplitude depends on the drumming intensity.

2

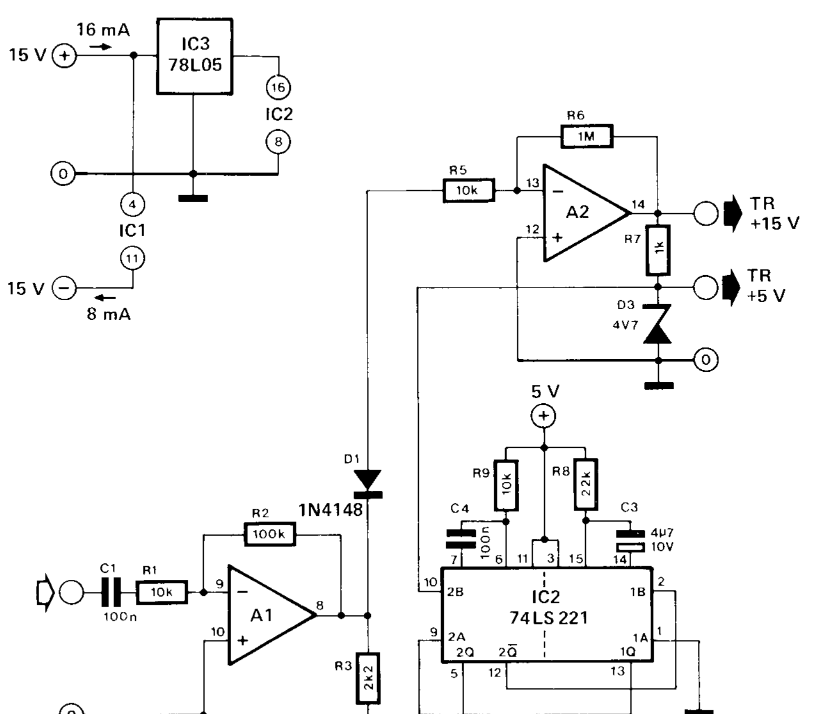

Figure 2. The circuit of the drum interface is simpler than the block diagram implies: the main components are only two low-cost ICs.

block diagram (figure 1). The components required are basically only two ICs: IC1 contains four operational amplifiers, only three of which are utilized; IC2 provides the two monostables. The first operational amplifier serves as an amplifier for the drum signal from the pick-up (loudspeaker or microphone). The amplification is fixed art 10 x, by means of the negative feedback loop R1/R2. It can be varied by using a trimmer potentiometer instead of R2. The low-impedance input of the circuit is intended for connecting loudspeakers and low-impedance microphones (dynamic or electret with integral impedance converter). At the output of A1, two diodes (D1, D2) split the signal path: one for positive and one for negative half-waves. The negative half-waves are fed via D1 to another amplifier A2, which overdrives on account of its very high amplification (100 x) and delivers square-wave pulses at its output. At output TR these pulses have an amplitude of + 15 V and at output TR their amplitude is + 5 V. Thus suitable gate levels are provided for all common synthesizers. The fact that a whole train of pulses appears at the gate output for each drumbeat does not normally cause any problem, because the envelope generators of the synthesizer only trigger on the first leading edge and then allow their envelope to develop without being affected by subsequent triggering pulses. Should there be a problem, however, the signal at pin 9 or pin 13 of IC2 can also be used as the + 5 V gate pulse. As shown in the pulse diagram of figure 3, a longer pulse is present at these points, which only appears once per drumbeat. IC2 is a TTL dual-monostable. The first monostable triggers on the pulse from output TR + 5 V, which is connected to pin 10 of IC2. This first monostable generates a short pulse at its output pin 5 which turns on transistor T1. This causes capacitor C2 to discharge with the first half-wave of the drum signal. When this discharge pulse has ended, T1 turns off again; capacitor C2 is now ready for charging and accepts cia diode D2 the peak voltage of the next positive half-wave from the output of the input amplifier. D2 prevents a discharge of the capacitor and the voltage is maintained until the next drumbeat. The high input impedance of the operational amplifier A3, which is utilized as a buffer for capacitor C2, caters for adequate stability of the storage stage. A buffered control voltage (CV) is present at the output of A3.

The second monostable with the longer pulse ensure that the first monostable only responds to the first pulse at its input with each drumbeat. This rejection of subsequent pulses is explained by the pulse diagram: the first monostable pulse is present in inverted form at pin 12. This output is connected to input pin 2 of the second monostable, which therefore triggers on the trailing

3

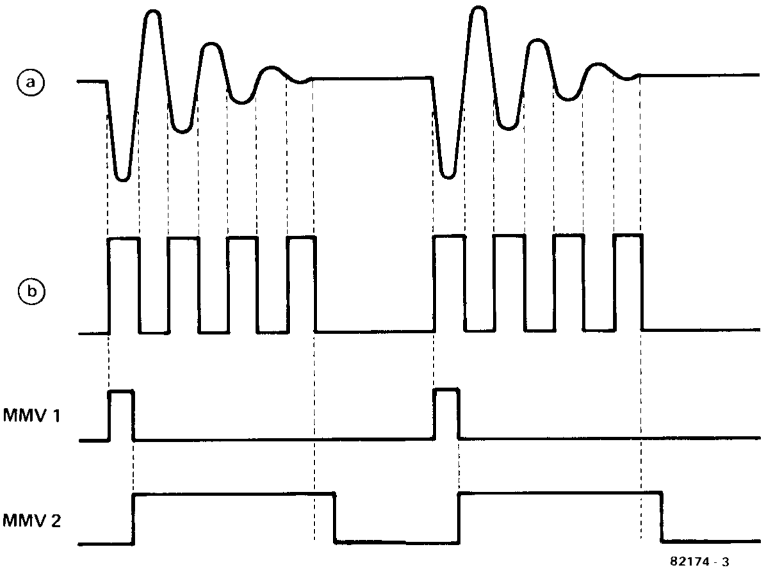

Figure 3. Signals at various points in the circuit:
- a. **The drum signal, a damped sinusoidal oscillation.**
- b. **Triggering pulses at the gate output. These are produced by limiting (clipping) the negative half-waves of the drum signal.**
- c. **Output of monostable 1. These pulses discharge the capacitor of the storage stage before a new value is accepted.**
- d. **Output of monostable 2. This pulse blocks monostable 1 when the first pulse has elapsed, in order to prevent retriggering by subsequent gate pulses (b).**

4

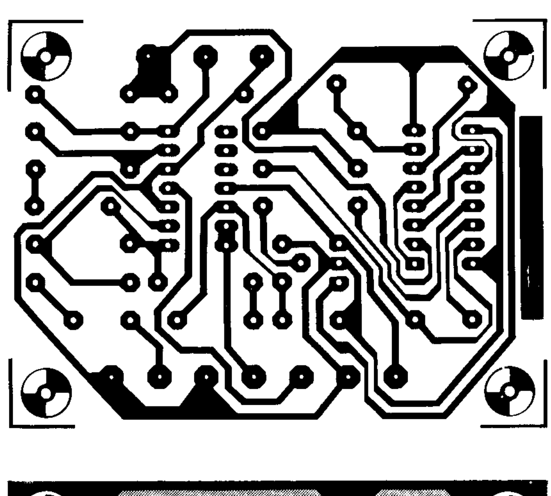

Figure 4. A suggested printed circuit design.

edge of the signal of monostable 1 and then supplies a longer pulse at output pin 13. Via pin 9, this pulse inhibits the first monostable which can only be triggered again when this pulse time has elapsed.
The circuit requires a symmetrical supply voltage of ±15 V which can be taken from the synthesizer power supply. Otherwise a small power supply unit would be needed. A 5 V regulator on the printed circuit board (IC3) generates +5 V for IC2 from the +15 V supply voltage. The current consumption is approximately 16 mA for + 15 V and 8 mA for − 15 V.

Practice

Figure 4 shows a suggested track pattern for the drum interface. All that is missing is a suitable percussion instrument. We found a very simple solution in the Elektor Laboratory: a standard, round loudspeaker of 18 cm in diameter was put to use; plastic foil was stretched over it as a drumskin. With this arrangement the output voltage at the CV output was between 1 and 5 V, depending on the drumming intensity; it was played with the palms of the hands like a conga or bongo drum. The circuit could also be installed in a "proper" drum with a microphone in the immediate vicinity of the drum. It may be necessary, however, to adapt the amplification of the first operational amplifier to the particular arrangement.

Parts List

Resistors:
R1,R5,R9 = 10 k
R2 = 100 k
R3,R4 = 2k2
R6 = 1 M
R7 = 1 k
R8 = 22 k

Capacitors:
C1,C4 = 100 n
C2 = 390 n
C3 = 4µ7/10 V

Semiconductors:
T1 = BC 547B
D1,D2 = 1N4148
D3 = 4V7/400 mW zener diode
IC1 = TL 084
IC2 = 74LS221
IC3 = 78L05

5

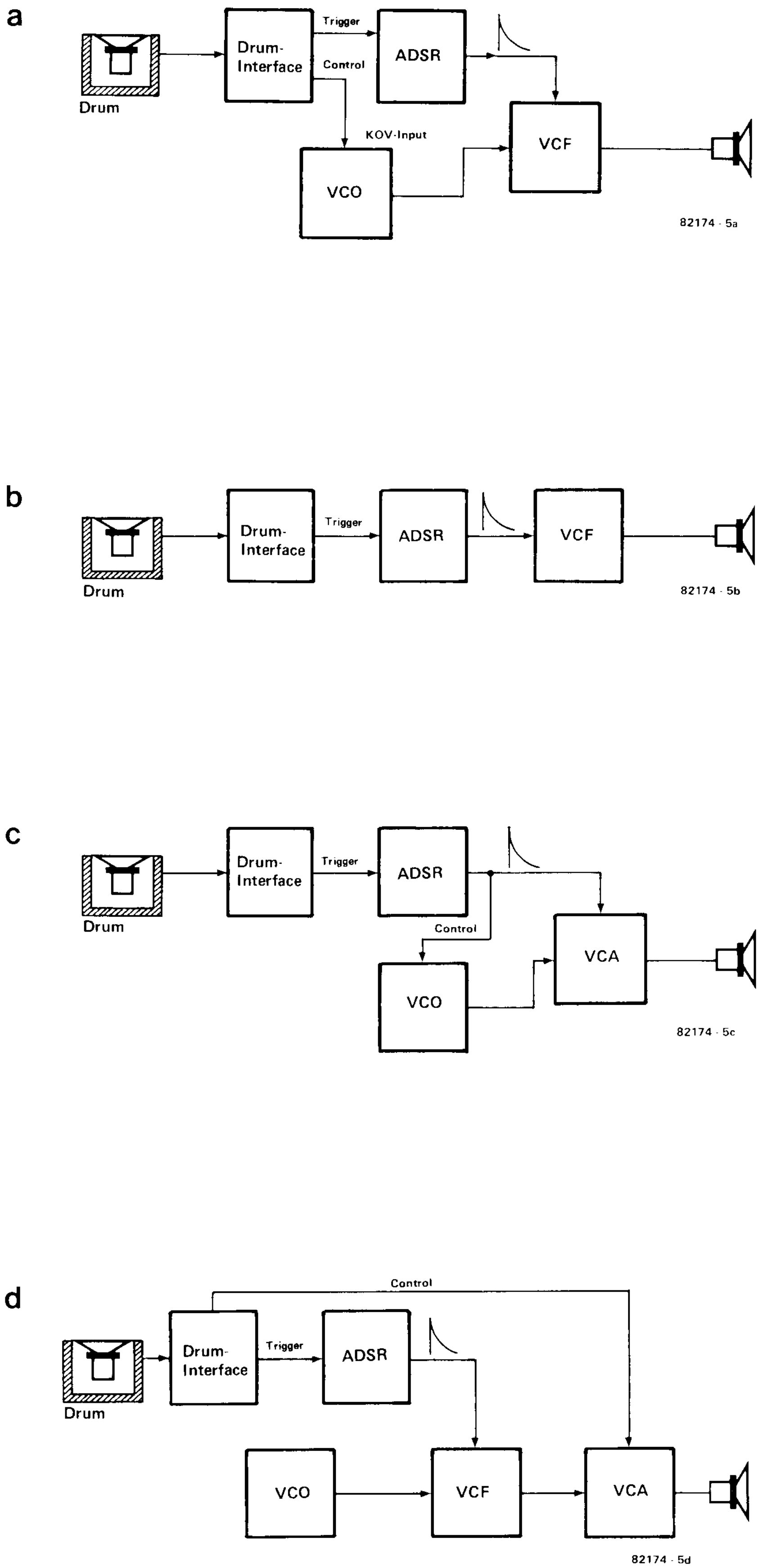

Figure 5. Examples for using of the drum interface with a (modular) synthesizer.

Methods of playing

As with a keyboard, the control signals "CV" and "gate" can be used with great versatility for producing sound with the drum interface. In the following section we would therefore like to present in diagram form some of the methods of playing that were tried out (see figure 5).

The drum interface can be connected to the synthesizer instead of the keyboard. If the synthesizer has terminals for external gate pulse and external control voltage, these can also be used; in this case the keyboard can remain connected.

With the drum interface instead of a keyboard, all adjustments can be tried out on the synthesizer which more or less apply to the keyboard. Driving the VCO with the "CV" of the drum interface (figure 5 a) results in a new pitch with every drumbeat. The effect obtained is similar to that with a sample and hold circuit (random value generator 1). The "disco drums" effect is achieved by driving as shown in figure 5 b: the triggering pulse from the drum interface triggers an ADSR generator which, in turn, drives a VCF; the latter is adjusted as an oscillator with natural oscillation. The ADSR is adjusted as follows: attack, zero; decay, any; sustain, maximum; release, any. The effect is a sudden sinusoidal sound with decreasing pitch and amplitude during the decay. If a non-oscillating VCF is available, the same effect can be obtained by driving the VCO with the envelope curve, as shown in figure 5 c.

Figure 5 d shows another interesting variation.

As one can see, the drum interface offers many creative possibilities at a low cost. We can also assure you that "drumming" with the synthesizer is a lot of fun.