# COMPLEX SOUND GENERATOR

**Not quite a synthesizer, but more than your average stylus organ — that's the ETI project team's musical offering this month**

WHILE WE WOULD not claim that our Minisynth is the latest in polyphonic synthesizers (It'd never stand up in court) we want to emphasise that this is definitely not another in the never ending stream of Rolf Harris multivibrators.

## Complex Chip, Easy Sound

The project is based on a new sound generator IC from Texas Instruments. This device has an on board VCO, low frequency oscillator, noise scource, envelope generator and a number of mixing circuits.

The final instrument can be used to provide a number of sounds, some musical, some not. You can use it to entertain, or, in case of those of us whose talents lie in fields other than music, annoy friends and foe alike.

## Construction

Construction of the project is relatively straight-forward. Carefully follow the component overlay, as usual, noting the orientation of all electrolytic and tantalum capacitors. It makes sense to use IC sockets for the three ICs.

Before starting construction of the electronic components it might be an idea to tin the keyboard area in order that a more reliable contact is made.

Tinning can be carried out by coating the 'keys' with blobs of solder, heating the whole area up (large soldering iron required — we hope you won't use this for the rest of the construction) and quickly wiping away excess solder with a wet cloth.

The probe can be fashioned from an old biro, which has had its innards replaced by a wire that is connected to the original pall point.

The choice case for the project is much up to personal taste. We put our instrument in a case we made ourselves from thin plywood painted black.

## Playing With

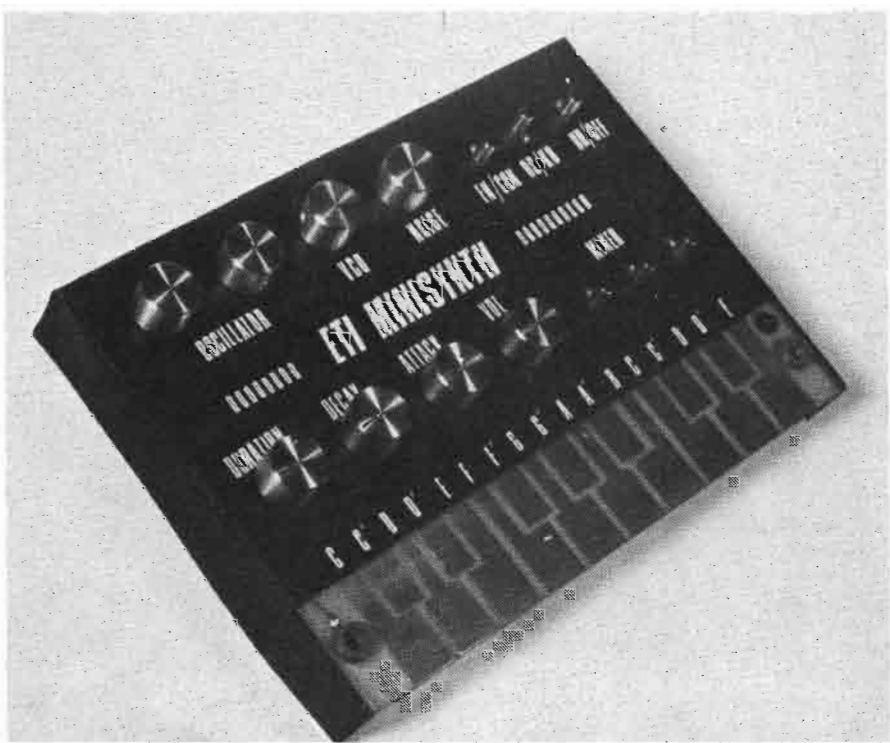
The only way to become familiar with the Minisynth is to sit down with the instrument and play with it. This is a painful experience for all concerned and while it won't make you blind could well make you deaf if the voume is up too far. Some of the sounds produced at this stage are, to say the least, gruesome and for the sake of all concerned this learning period should take place in private. You can expose your talents when the mechanics of playing the machine have been mastered.

A good starting point for the controls is to set the DURATION, ATTACK and DECAY controls to minimum, the SLF OSCILLATOR's course control to the highest frequency range with the fine control set at minimum. Set the VCO and NOISE controls to their mid points and all the MIXER switches down (towards you) — this will select the output from the main VCO. The ENVELOPE/CONTINUOUS control should be down and the OSCILLATOR/KEYBOARD control away from you.

Switching the instrument on should produce a note, the frequency of which can be altered by the VCO control. At this stage the note will be unaffected by the keyboard.

By moving the OSCILLATOR/KEYBOARD control to the down position the Minisynth can be played via the keyboard, the VCO control as a tune facility.

With the ENVELOPE/CONTINUOUS control in irs present position the note selected by the keyboard will be maintained until the probe is removed from the keyboard. Moving the switch to the up position will mean that the notes selected will be modified by the output of an envelope generator. The envelope generator is set up by the DURATION, ATTACK and DELAY controls. The control functions are self-explanatory, the only point to

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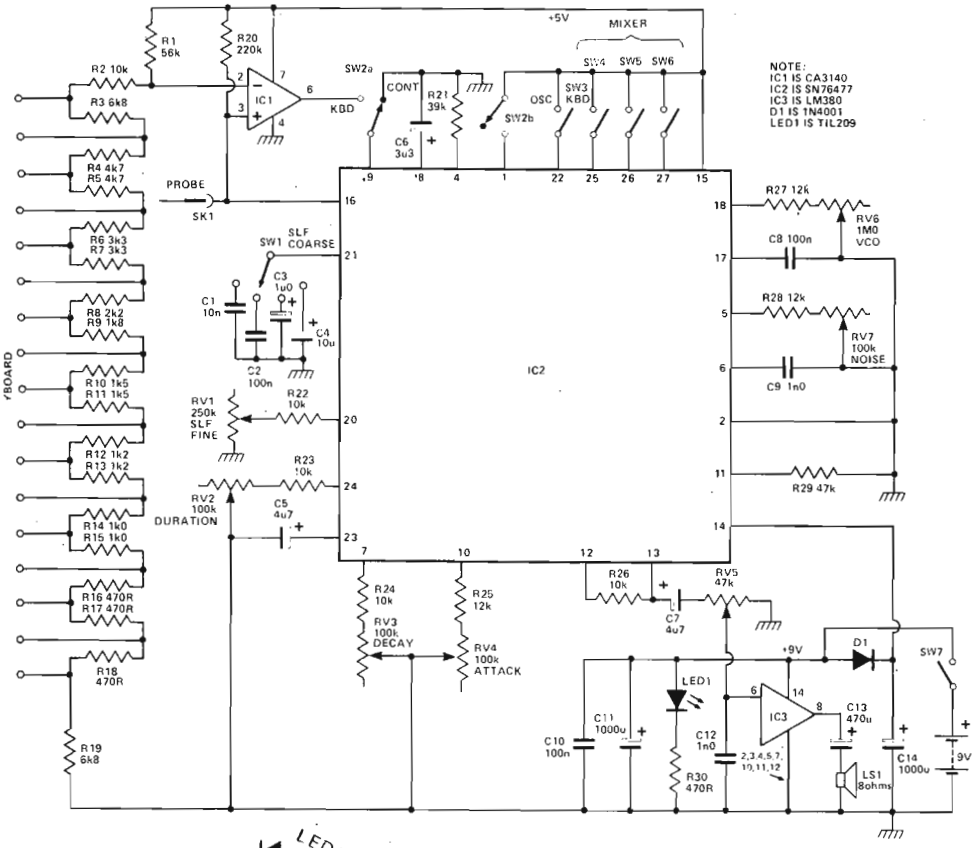
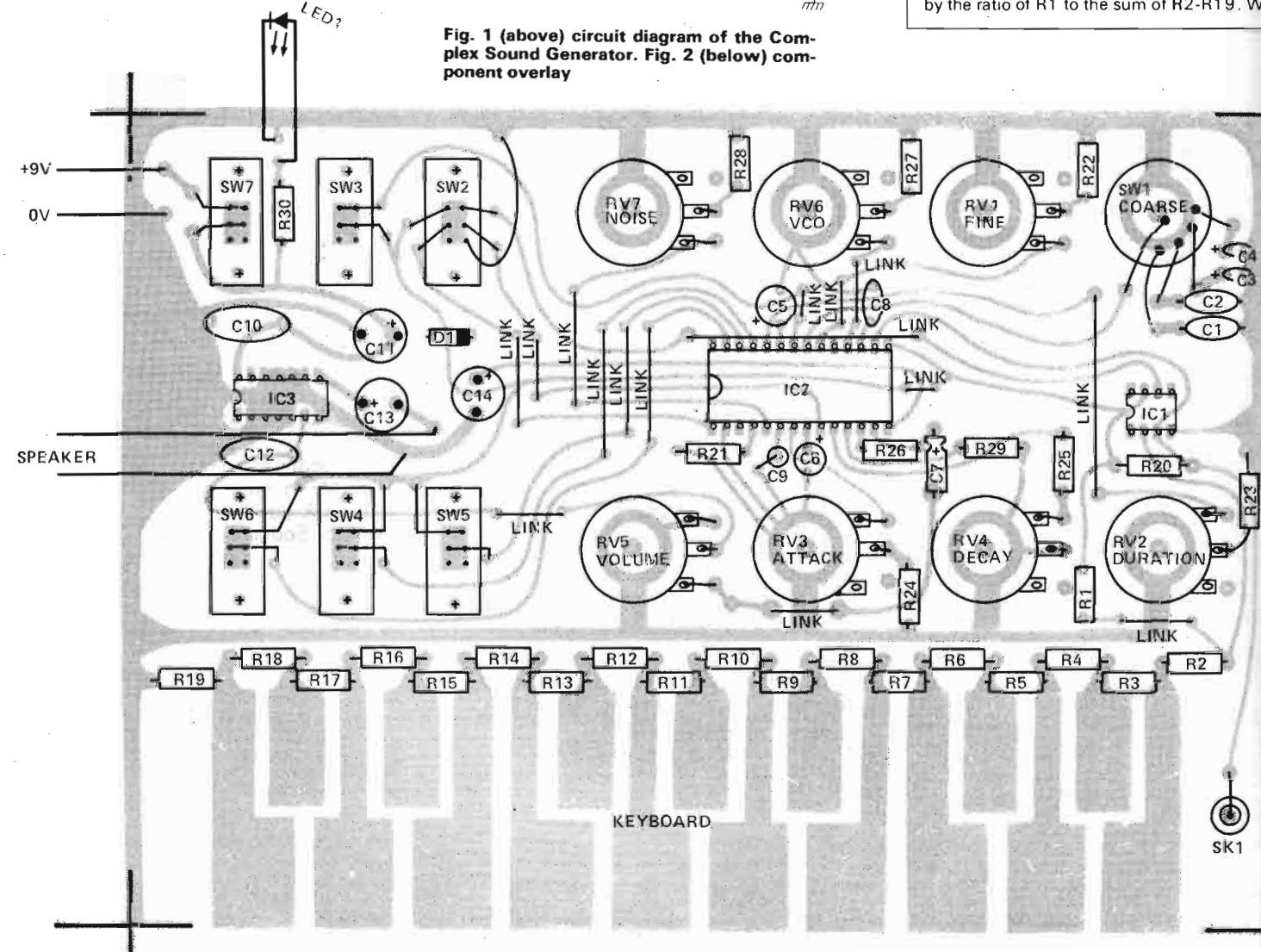



**Fig. 1 (above) circuit diagram of the Complex Sound Generator. Fig. 2 (below) component overlay**




The SN76477 IC that forms the basis of project is a bipolar/$I^2L$ device that provid VCO, low frequency oscillator, noise source filter, an envelope generator plus various o mixing and control logic all in a 28 pin package. The block daigram shows the inte arrangement of the various blocks within th and the pins to which external control netw are connected. For full data on the dev consult the data sheet published in Februa ETI.

Although the SN76477 does most of work, we require two additional ICs, IC3 provide adequate audio output and IC1, wh forms part of the keyboard circuit — the sec we shall now look at in detail.

### VCO and Keyboard

A voltage applied to pin 16 of IC2 will, if external VCO select (pin22) is Low, determ the frequency of oscillation of the IC's on VCO. The Higher the external control volt the lower the frequency produced. The rang the VCO is internally set at a ratio of 10:1, w the minimum frequency of operation is de mined by C8 and by the series combinatio RV7 and RV6(tune). The duty cycle of oscillator is set at 50% by leaving pin 19 o

The external control voltage is derived f the potential divider chain formed by resistors R1-R19, the particular value b tapped off by the stylus.

IC1 provides an indication that the stylus touched the keyboard. The inverting input 2) of IC1 is held at a voltage that is determ by the ratio of R1 to the sum of R2-R19. W

# HOW IT WORKS

the stylus is not in contact with the keyboard R20 ensures that the non-inverting input (pin 3) is above this fixed voltage, the output of IC1 is thus high.

As the stylus touches the keyboard, the voltage at pin 3 will be pulled down to a level below that on pin 2 by the relatively low impedance voltage determined by the lower leg of the resistor chain. This will cause the output of IC1 to go low. The output of IC1 is taken to SW2a which selects either this signal or O V as the output to pin 9 of IC2.

Pin 9 is the system enable input. IC2 is inhibited when this pin is held high, taking it low enables the various sections of the IC. The transition of this pin from high to low (IC1's action as the keyboard is touched) also initiates the one shot logic (enabled by SW2b) that can provide sounds of short duration — this is described in detail below.

**SLF Oscillator**

The on chip VCO, as well as being controlled from the external voltage derived from the potential divider chain, can be modulated by an on chip Super Low Frequency oscillator. The VCO is controlled by this oscillator when the VCO select (pin 22) is high.

The SLF can be operated in the range 0.1-30 Hz, the particular frequency being set by the capacitors C1-C4 (selected by SW1) and by the combined resistance of R22 and RV1 (oscillator fine).

As well as providing a sawtooth output for control of the VCO, the SLF oscillator provides an output that is taken to the mixer section of IC2 described below.

**Noise Generator and Filter**

The on chip noise oscillator's input is taken, via R21, to ground. This sets up the conditions for correct operation of this section the output of which is fed to a noise filter. This modifies the noise generator's output by reducing the high frequency content of the signal. The specific 3dB point is set by C9 and by the value of R28 and RV7 (filter) in series.

**Mixer**

Outputs from the noise filter, VCO and SLF oscillator are fed to a mixer circuit. This combines the three signals in a manner determined by the logic levels on pins 25, 26 and 27 of the IC2 (mixer select). The particular output or combination of outputs corresponding to the eight possible states of these pins is shown in table 1. The output of the mixer is fed to the envelope generator and modulator.

It should be noted that as opposed to TTL ICs, unconnected inputs of the SN76477 assume a low state.

**One Shot Logic**

The one shot logic is used to provide sounds of a short duration. The circuit is triggered by a negative going edge on the system enable input, the duration of the "one shot" being determined by C5 and R23 plus RV2 (duration).

**ADL**

The attack/decay logic determines the envelope of the IC's output controlling as it does the envelope generator.

The ADL mode is selected by logic level signals on pins 1 and 28. In our circuit pin 28 is left unconnected while pin 1 is taken to SW2b. This selects the output of the one shot when held high and of the VCO when taken low.

**Envelope Generator and Modulator**

The attack/decay characteristics of the output are determined by C8 in conjunction with R25 and RV4 (attack) and R24 and RV3 (decay).

**Output Amplifier**

The output of the envelope generator is taken internally to an on chip amplifier the gain of which is set by the ratio of R26:R29. The output of the amplifier appears at pin 13 and is taken via C7 and the volume control RV7 to IC3 an LM380. This IC acts as a power output stage. C11 ensures that the LM380 is stable under all operating conditions, while C12 provides DC isolation between IC3's output and the loudspeaker LSI.

**Power Supply**

The 9 V input is used to power IC3 directly and is then taken via D1 (to drop 0.6 V) to pin 14 of IC2. This is the input to an internal voltage regulator that powers the IC and also provides a stable 5 V at pin 15 for use elsewhere in the circuit. C10, C11 and C14 provide supply decoupling while LED1, together with current limiting resistor R30, provide an indication that power is applied to the circuit.

# PARTS LIST

RESISTORS (all ¼W 5%)

| | |
|---|---|
| R1 | 56k |
| R2,22,23 | |
| 24,26 | 10k |
| R3,19 | 6k8 |
| R4,5 | 4k7 |
| R6,7 | 3k3 |
| R8 | 2k2 |
| R9 | 1k8 |
| R10,11 | 1k5 |
| R12,13 | 1k2 |
| R14,15 | 1k0 |
| R16,17, | |
| 18,30 | 470R |
| R20 | 220k |
| R21 | 39k |
| R25,27, | |
| 28 | 12k |
| R29 | 47k |

POTENTIOMETERS

| | |
|---|---|
| RV1 | 250k linear |
| RV2,3, | |
| 4,7 | 100k linear |
| RV5 | 47k log |
| RV6 | 1M0 linear |

CAPACITORS

| | |
|---|---|
| C1 | 10n polyester |
| C2,8,10 | 100n polyester |
| C3 | 1u0 35 V tantalum |
| C4 | 10u 35 V tantalum |
| C5,7 | 4u7 10 V electrolytic |
| C6 | 3u3 35 V tantalum |
| C9,12 | 1n0 polystyrene |
| C11 | 1 000u 16 V electrolytic |
| C13,14 | 470 16 V electrolytic |

SEMICONDUCTORS

| | |
|---|---|
| ICI | CA3140 |
| IC2 | SN76477 |
| IC3 | LM380 |
| D1 | 1N4001 |
| LED1 | TIL209 |

SWITCHES

| | |
|---|---|
| SW1 | single pole, four way rotary |
| SW2 | DPDT |
| SW3-7 | SPST |

MISELLANEOUS

PCB as pattern, case to suit, probe, 8 ohm loudspeaker, battery eliminator.

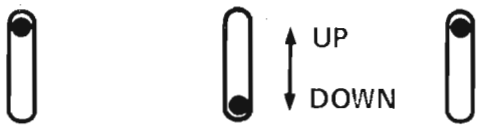
# BUYLINES

All the components except IC2 should be widely available while IC2 will be stocked by Watford, Technomatic and other Texas suppliers. Watford are also to supply a complete kit for the project.

We do not have enough space to reproduce the foil pattern but it will be available on ETIPRINTS or can be obtained by sending an SAE to our offices. Please mark your envelope Complex Sound Foil Patterns.

note is that because the Minisynth does not have a sample and hold facility in the keyboard section, the note required must be maintained throughout the period of the envelope.

The mixer controls select the outputs from the various noise sources and oscillators on the instrument. At present it is the output of the main VCO that we are hearing. By setting the ENVELOPE/CONTINUOUS control back to its former position and moving the leftmost mixer control up the output from the SLF OSCILLATOR can be heard. This oscillator is controlled by the fine and course controls at the top right hand corner of the instrument. ▶




| | | | OUTPUTS SELECTED |
|---|---|---|---|
| DOWN | DOWN | DOWN | VCO |
| DOWN | DOWN | UP | SLF/NOISE |
| DOWN | UP | DOWN | NOISE |
| DOWN | UP | UP | SLF/VCO |
| UP | DOWN | DOWN | SLF |
| UP | DOWN | UP | SLF/VCO/NOISE |
| UP | UP | DOWN | VCO/NOISE |
| UP | UP | UP | INHIBIT |

**TABLE 1**

Set the leftmost mixer switch to down again and move the right hand switch up, the output from the noise generator will now be heard.

The various combinations of the oscillators and noise source corresponding to the settings of the mixer controls are shown in Table 1.

That then is a run down of the various controls and their effects, its now up to you to put them together and hopefully make a little music.

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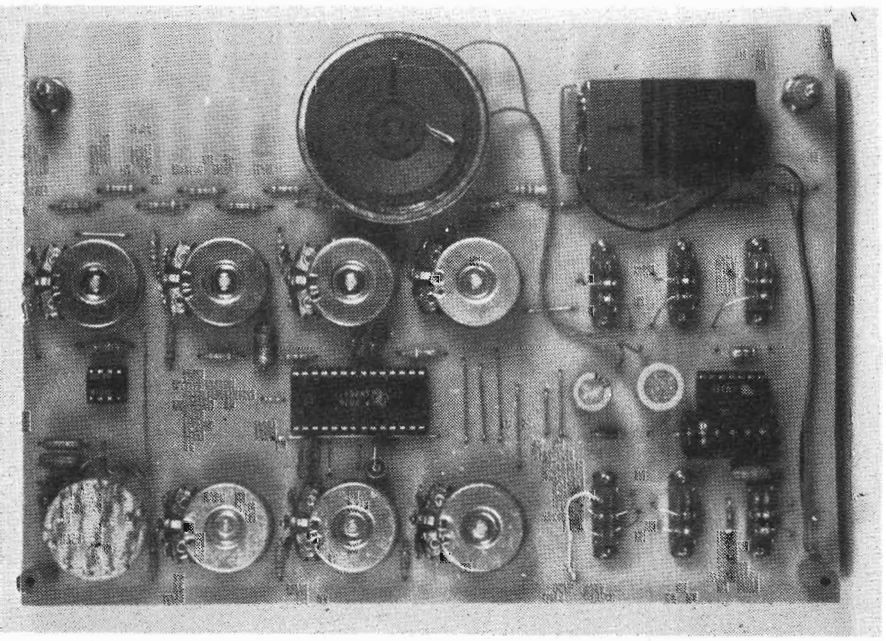

**Two photographs showing the PCB from above and below. Note the front panel lettering on page 17 is in error — the attack and delay designations being reversed.**