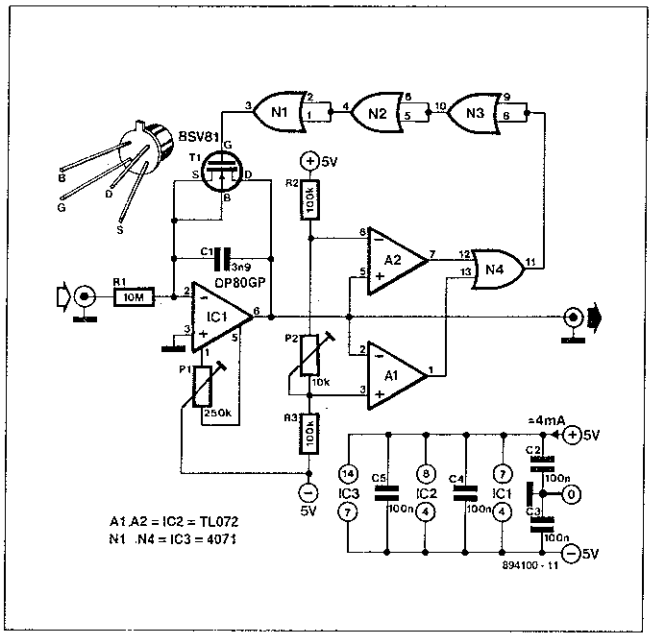
048 TEST & MEASUREMENT

VOLTAGE-CONTROLLED OSCILLATOR



The voltage-controlled oscillator (VCO) presented here is based on a Type OP80 operational amplifier This opamp has an exceptionally low bias current of, typically, about 200 fA (femto-ampere = 10^{-15} amp) and 2 pA maximum, so that any off-set caused by this current is minute It is, therefore, ideal for use as an integrator, because the operation of that kind of circuit is affected readily by off-sets

The OP80-based integrator in the diagram is used as a VCO that is not affected by the polarity of the control voltage A direct voltage at the input of the circuit will cause C1 to charge Depending on the polarity of the input voltage, the potential across C1, and thus the output voltage of IC1, will be positive or negative The speed with which C1 charges depends on the magnitude of the input voltage: this characteristic is used to generate a signal at a voltage-dependent frequency. To that end, the outp ut signal of IC1 is applied to a window comparator that has a switching threshold for both the positive and the negative maximum signal. These maxima are set to ±100 mV by P2 In some cases, it may be advantageous for symmetry to split R2 or R3 into a fixed resistor in series with a preset potentiometer

When one of the comparators toggles, I1 is switched on via N1–N4 so that C1 discharges. This results in a neat sawtooth signal at the output of the circuit, whose frequency depends on the input voltage. Gate N4 ensures that the FET reacts to both comparators. The other three gates delay the switching signal slightly to ensure that the FET is switched on long enough to allow C1 to dicharge completely

The Type BSV81 MOSFET is provided with a separate substrate connection that must be linked to the source. Since the substrate is already connected internally to the housing, the device is very sensitive to random radiation, so that the oscillator is best fitted in a small metal enclosure.

If a BSV81 is not obtainable, another MOSFET with very low R_{DSon} and very small C_{rs} may be used If that also is not possible, a junction FET may be tried, but in that case a diode must be connected in series with the gate and a resistor of about 10 kΩ between the gate and the negative supply line. It is important to ensure that the pinch-off voltage level is reached readily It may well be necessary to experiment with the value of C1.

Correct dimensioning of R1 will enable the relation between input voltage and frequency to be set at, say, 1 Hz/mV. With the input short-circuited, adjust P1 for the lowest possible frequency of the output signal (ideally, $f = 0$). The maximum input voltage is determined by the peak output current of IC2 (15 mA) and amounts to $15 \times 10^{-3} \times R1$.

The output signal of the VCO is a clean sawtooth signal at a frequency of up to 10 kHz, although higher frequencies are possible The frequency as a function of the input current is given by:

$$f = I_{in} / (U_{top} \times C_1) \qquad [Hz]$$

With values as shown in the diagram,

$$f = I_{in} / (3.9 \times 10^{-10}) \qquad [Hz]$$

Finally, note that the supply voltage to the OP80 must under no circumstances exceed ±8 V The circuit draws a current of typically 4 mA.

049 COMPUTERS

MONITORING TEMPERATURE WITH THE C64

Maplin s module Type FE33L provides an inexpensive and convenient means of monitoring temperature. The module has a built-in A-D converter and an LC display and works from a single 1 5 V battery Since it is often impractical to take frequent readings manually, the module provides a serial data output that can be used with most microprocessor systems The combination of hardware and software given in this article enables a C64 computer to use the serial data, within BASIC, via the USR function.

The hardware consists of nothing more than a simple TTL level driver and may be mounted on a small piece of prototyping board This may be connected to the module by three short wires, while the outputs go to a two-by-twelve 0 156" pitch edge connector for the C64 s user port. Pins 5 and 16 of the module should be short-circuited to obtain the maximum sampling rate of one per second Check all connections before switching the computer on.

The listing provided loads a machine-code program into the small section of RAM above the BASIC ROM at location 49152 ($C000) Note that some lines are very similar to others thus assisting entry. Once this has been RUN (without errors), and SYS 49152 has been entered, the temperature is obtained as follows:

```
TEMP = USR(0) : PRINT TEMP
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This line can be incorporated into any BASIC program.