AUDIO OSCILLATOR

Audio oscillator utilises new design in frequency meters, giving good accuracy and fast reading rates.

THE AUDIO OSCILLATOR is an almost essential piece of test equipment in any test lab be it professional or only the home workshop. Only the multimeter would rate more highly. We first published a simple sine-square oscillator way back in 1971 and this design is still very popular and selling well. We decided however to bring the design up to date adding a few improvements, and present it again.

Design Features

This oscillator started out as a redesign, mainly mechanical, of the earlier design. It then started to evolve as a voltage controlled sweep oscillator but when it became too complex we reverted to a simple Wein bridge oscillator.

One major problem with all home made oscillators is that of scaling the frequency dial. This is not just a problem of positioning the knob but since normally available potentiometers have a tolerance of +/- 20%, the scale length will also vary. In commercial units the use of an expensive wire wound potentiometer solves most of the problems giving reasonably accurate scaling.

We then decided to build in a frequency meter, basing it on the ETI 533 display module. However the high power consumption (we wanted to allow battery operation) and the poor resolution, especially at low frequency, prompted the design of a completely new frequency meter.

This uses what is literally an analogue computer to convert a period measurement into frequency with some digital electronics controlling it and displaying the results. We based this on the Intersil ICL7106 module which, due to its liquid

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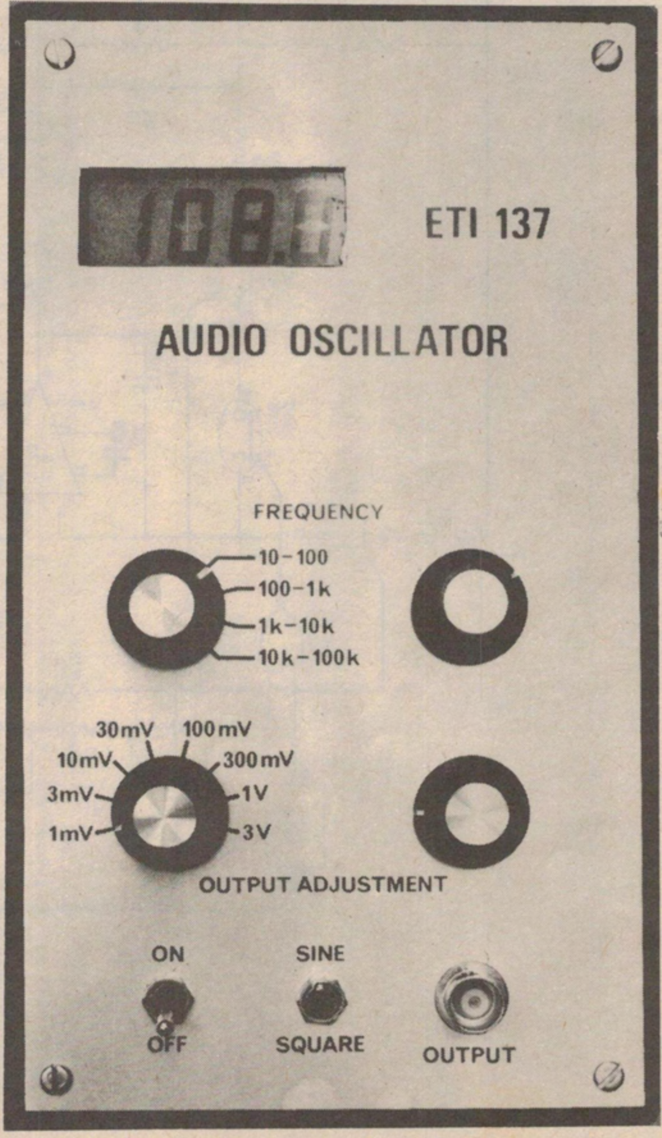

Front view of the audio oscillator. Note that this is an early prototype and the 3V range has been deleted.

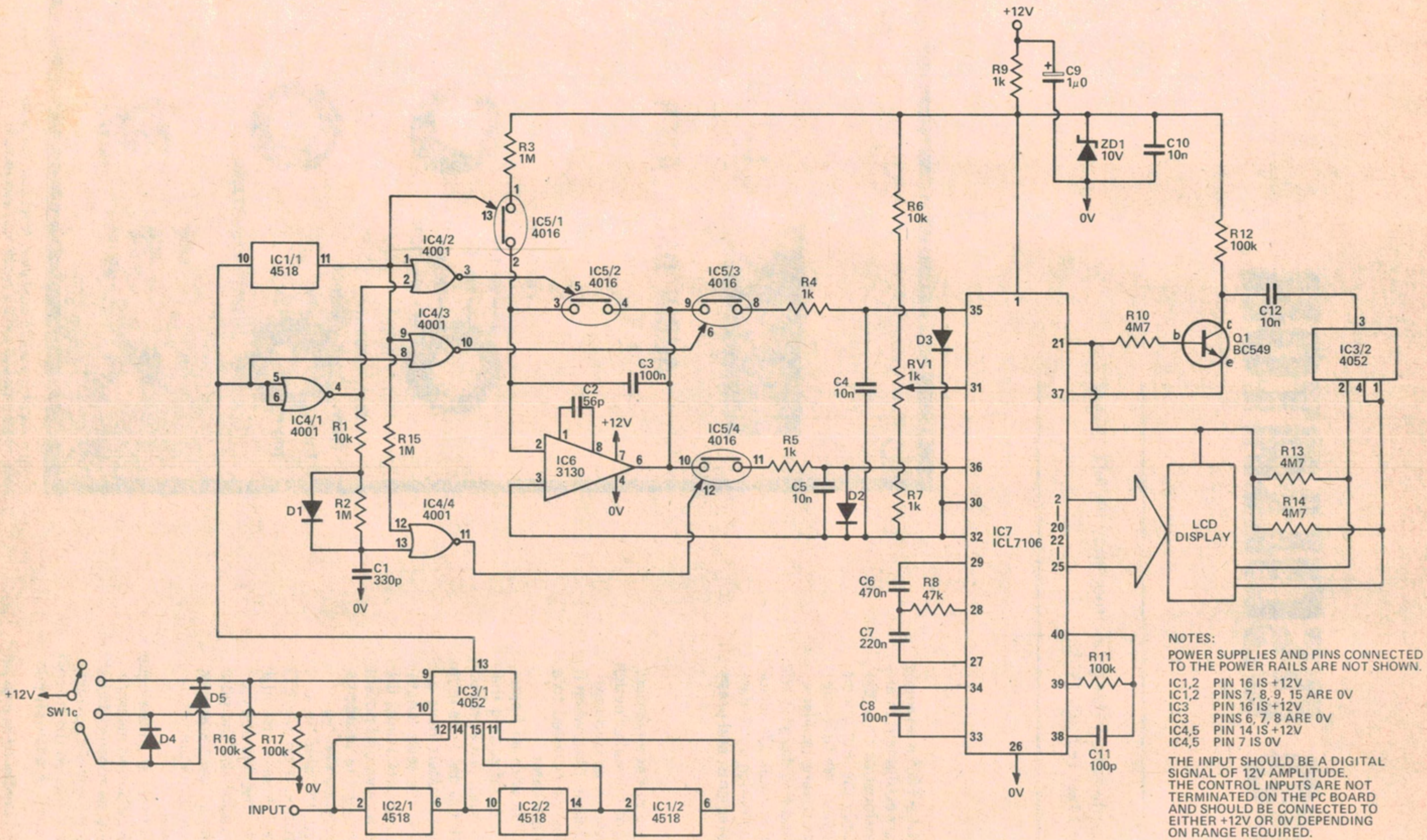

Fig. 1. The circuit diagram of the frequency meter section.

Scotchcals of the front panel are available for $3.50 post paid from Nebula Electronics Pty. Ltd., 15 Boundary St. Rushcutters Bay 2011.

HOW IT WORKS - ETI 137

Oscillator

The oscillator is the conventional Wein bridge type with a differenial amplifier made up by Q1-Q5. Gain stabilization is done by the thermistor TH1. This type of circuit oscillates at the frequency where the impedance of the capacitors equals the resistors in the Wein bridge arms. With this feedback network the attenuation does not vary greatly like that of a twin tee but the phase shift does. The result is a sine wave oscillator with low distortion.

For frequency variation a two gang potentiometer is used to give a 20/1 continuous variation with switched capacitors giving four ranges each a decade apart.

The sine wave output is turned into a square wave by IC1 with the amplitude stabilized by D3-D6.

Frequency Meter

This section works by generating a voltage proportional to the period of one cycle and using this as the reference voltage for the Intersil voltmeter IC with a fixed voltage on the normal input. This gives the inverse function of normal operation and the display therefore is frequency.

To generate the reference voltage we use an integrator (IC6) which is controlled by IC5. Operation is as follows. Initially C3 is discharged and for one cycle of the input signal IC5/1 turns on. As the module provides a stable voltage between pin 1 and pin 32 of about 2.8V the output of IC6 will fall linearly with time and as IC5/1 is on for exactly one cycle the voltage change will be proportional to that period.

After IC5/1 turns off the output of IC6 will stay fixed. IC5/3 is then turned on and C4 will charge to that voltage. After half a cycle IC5/3 will turn off leaving C4 at that voltage and IC5/2 will turn on. This discharges C3 to zero volts. After a short delay to allow C3 to discharge IC5/4 is turned on transferring that voltage level onto C5. After a total of two cycles the process recommences. The voltage difference between the two capacitors is therefore the voltage *change*, (proportional to frequency) thus eliminating any offset errors in IC6. The pulses which control IC5 are derived from IC1/1 and IC4.

A reference voltage less than half the input voltage will result in the ICL7106 counting past 2000 (over ranging). The two inputs must also lie within the supply rails (less 1.5V). This limits the range of the instrument from 5 Hz to 200 Hz. For the higher frequency ranges, three decade dividers are provided and the necessary output selected by IC3. The correct decimal point is also selected by the other half of this IC.

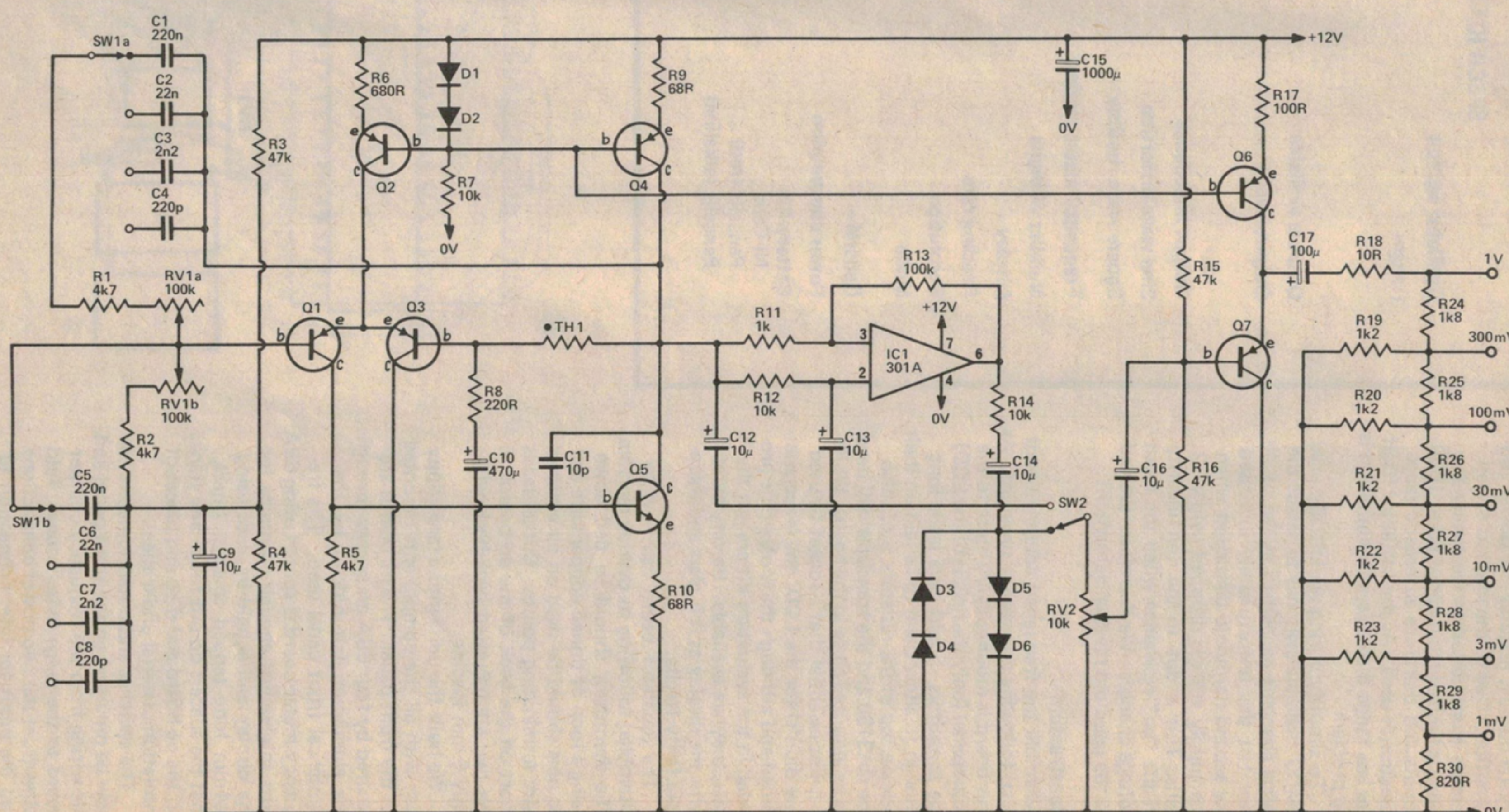

Fig. 2. The circuit diagram of the oscillator section.

crystal display, features low power consumption. Due to the method of conversion from period to frequency the range is limited from about 50 to 1999 counts and therefore automatic range selection is used. As the oscillator itself has less range than this, this limitation is no problem.

To simplify wiring we initially used CMOS analogue switches to select the range changing capacitors in the oscillator but this unfortunately increased the second harmonic distortion when the supply voltage dropped below 12 volts. This is due to the non-linearity of the "on" resistance when the input voltage changes. We therefore reverted to the good old mechanical switch!

Construction

Assemble the frequency counter board first, following the overlay provided. As this board is mounted very close to the front panel (only the height of the LCD) the capacitors should have leads long enough to allow them to be laid on their side on top of the resistors, etc. Also the CA3130 and the transistor will have to be mounted close to the board. While it is not essential that a socket be used (we didn't) for the LCD, one is recommended and although the Molex pins provided in the evaluation kit are not the best, they are available. Be very careful with the display as it is glass and therefore fairly fragile.

The oscillator board can now be assembled following its overlay diagram. The thermistor should be tied down using a loop of tinned copper wire and pc pins should be used on all external wire terminating points. Cut all leads short on the back of the pc boards as the two are mounted back-back with only 6 mm spacing.

We built the units into a large zippy box with all the components mounted on the front panel. The pc boards are secured by four 6BA c/s screws through the aluminium but hidden by the Scotchcal front panel used. The frequency meter board is spaced using 6BA nuts to give just enough clearance for the display and is held in place using 6.4 mm long tapped spacers. Check that the spacers do not touch any tracks on the pc board and if so add pieces of insulation material under them.

The switches and potentiometers can now be mounted on the front panel and the wiring from the frequency counter board to the range switch done. Add wires from the two power connections and the input for later connection to the oscillator board.

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SPECIFICATION – ETI 137

Oscillator section	
Ranges	10.0 – 100.0 Hz 100 – 1000 Hz 1.00 – 10.00 kHz 10.0 – 100.0 kHz
Outputs available	sine or square
Output level	1 V maximium continuously variable plus 10 dB steps down to 1 mV
Output impedance	nominally 600 ohms
Sine wave distortion	<0.1%
Square wave risetime	200 ns
Frequency meter section	
Number of digits	3½
Display	LCD
Reading rate	5 per second
Resolution	0.1 Hz on lowest range
Mode	Period measurment computed to read frequency
General	
Power consumpion	26 mA @ 12 V dc
Battery life	
Ni Cads	20 hours
Pencells (red)	30 hours
Pencells (alkaline)	50 hours

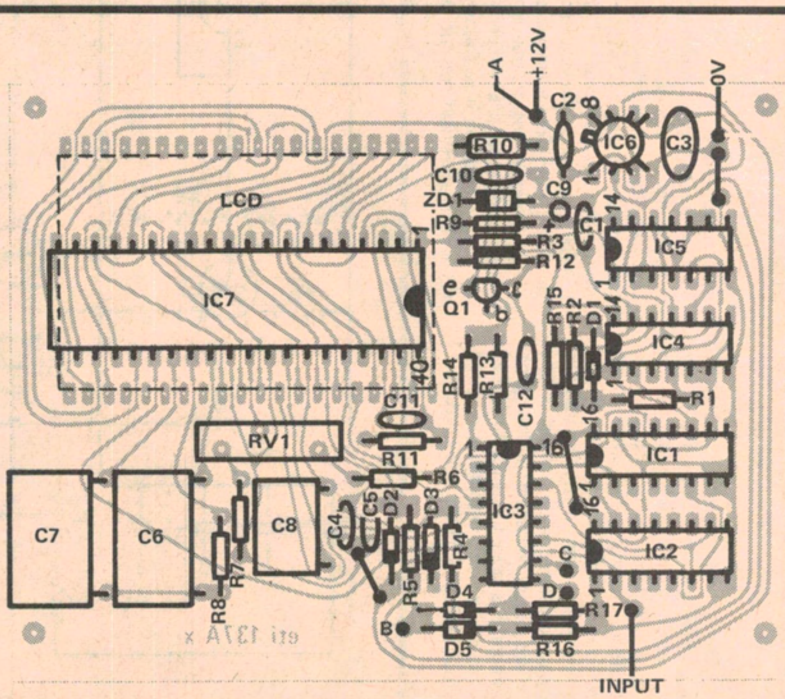


Fig. 3. Component overlay of the frequency meter board. Insert the LCD such that the +1 digit is on the left.

PARTS LIST – ETI 137

General
Plastic box UB
1 One pole 12 position rotary switch
1 Three pole 4 position rotary switch
2 STDP toggle switches
4 knobs to suit
12V battery (8xdry cell or 10xNicads)
External power socket
Scotchcal front panel
Wire, screws etc.

Frequency Counter Board – ETI 137A

Resistors all ¼W 5%
R1 . . . . . . 10k
R2,3 . . . . . 1M
R4,5 . . . . . 1k
R6 . . . . . . 10k
R7 . . . . . . 1k
* R8 . . . . . . 47k
R9 . . . . . . 1k
R10. . . . . . 4M7
* R11. . . . . . 100k
R12. . . . . . 100k
R13,14. . . . 4M7
R15. . . . . . 1M
R16,17. . . . 100k

Potentiometer
* RV1 . . . . . 1k ten turn trim

Capacitors
C1. . . . . . . 330p ceramic
C2. . . . . . . 56p ceramic
C3. . . . . . . 100n polyester
C4,5 . . . . . 10n polyester
* C6. . . . . . . 470n polyester
* C7. . . . . . . 220n polyester
* C8. . . . . . . 100n polyester
C9. . . . . . . 1µ0 35V tantalum
C10. . . . . . 10n polyester
* C11. . . . . . 100p ceramic
C12. . . . . . 10n polyester

Semiconductors
IC1,2 . . . . . 4518 (CMOS)
IC3 . . . . . . 4052 (CMOS)
IC4 . . . . . . 4001 (CMOS)
IC5 . . . . . . 4016 (CMOS)
IC6 . . . . . . CA3130
* IC7 . . . . . . ICL7106
Q1 . . . . . . BC549
D1–D5. . . . 1N914
ZD1. . . . . . 10V 300mW Zener

Miscellaneous
PCB ETI 137A
* LCD display

* These parts are provided in the Intersil ICL7106 Evaluation Kit.

Oscillator Board – ETI 137B

Resistors all ½W 5%
R1,2 . . . . . 4k7
R3,4 . . . . . 47k
R5 . . . . . . 4k7
R6 . . . . . . 680R
R7 . . . . . . 10k
R8 . . . . . . 220R
R9,10. . . . . 68R
R11. . . . . . 1k
R12. . . . . . 10k
R13. . . . . . 100k
R14. . . . . . 10k
R15,16. . . . 47k
R17. . . . . . 100R
R18. . . . . . 10R
R19–R23 . . 1k2
R24–R29 . . 1k8
R30. . . . . . 820R

Thermistor
TH1. . . . . . type R53

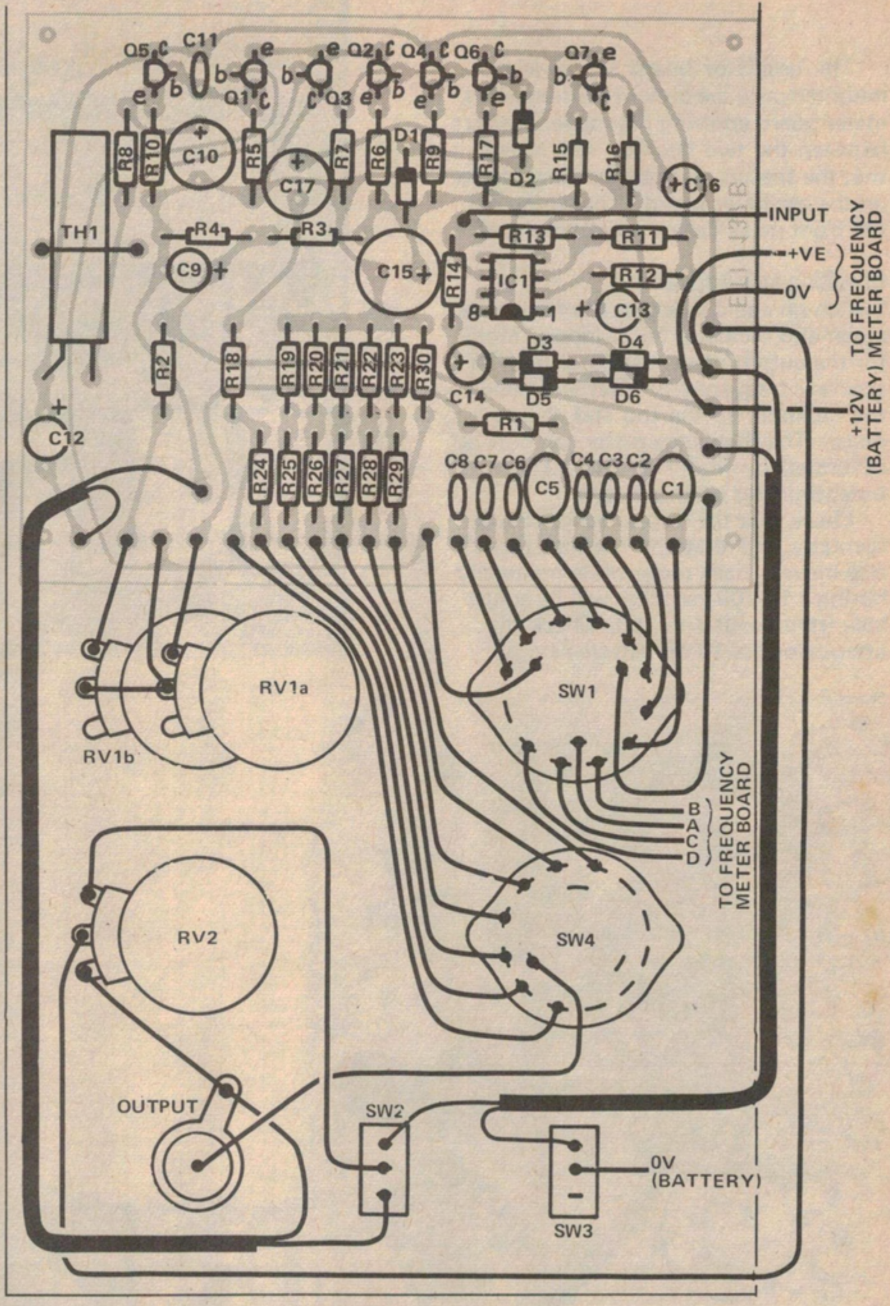


Fig. 4. The component overlay of the oscillator board and the wiring of the front panel.

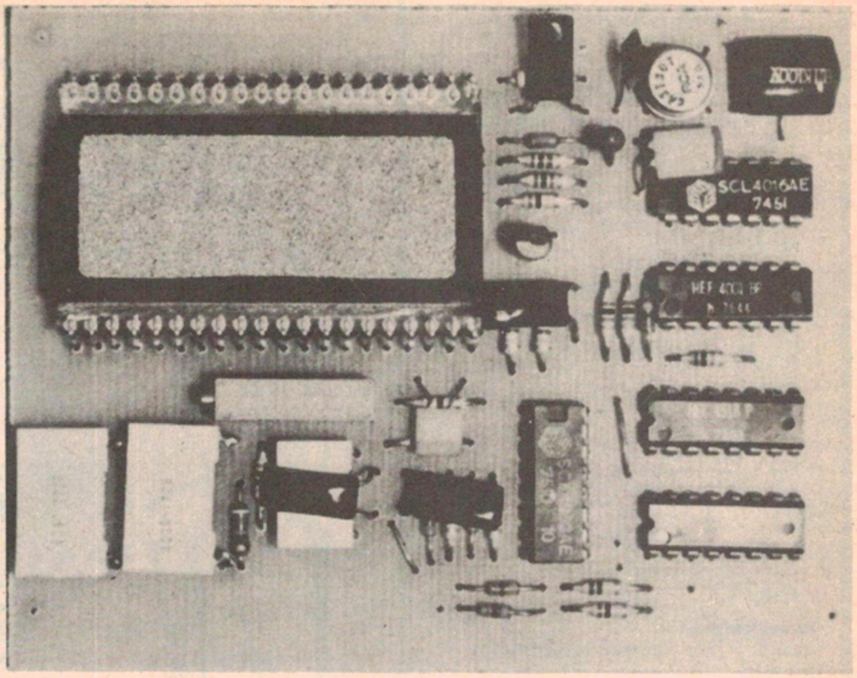
Potentiometers
* RV1 . . . . . 100k dual rotary
RV2 . . . . . 10k lin rotary

Capacitors
C1. . . . . . . 220n polyester
C2. . . . . . . 22n polyester
C3. . . . . . . 2n2 polyester
C4. . . . . . . 220p ceramic
C5. . . . . . . 220n polyester
C6. . . . . . . 22n polyester
C7. . . . . . . 2n2 polyester
C8. . . . . . . 220p ceramic
C9. . . . . . . 10µ 25V electro
C10. . . . . . 470µ 25V Electro
C11 . . . . . . 10p ceramic
C12–C14 . . 10µ 25V electro
C15 . . . . . . 1000µ 16V electro
C16. . . . . . 10µ 25V electro
C17. . . . . . 100µ 25V electro

Semiconductors
IC1 . . . . . . 301A
Q1–Q4. . . . BC559
Q5 . . . . . . BC549
Q6,7 . . . . . BC559
D1–D6. . . . 1N914

Miscellaneous
PCB ETI 137B

* RV1 – the preferred curve giving best resolution is antilog. If reverse rotation is acceptable log is as good. Otherwise use a linear curve.



The oscillator board can now be mounted onto the back of the frequency meter board ensuring that no leads short between the two boards. Also check that the spacers do not touch any tracks on the oscillator board. The wiring of the front panel can now be completed.

Checking and Adjustment

Switch on and check that the frequency meter and oscillator are working. Monitor the output of the oscillator with an accurate frequency counter and adjust the oscillator to the top end of one range. The frequency meter can now be calibrated by means of the 10 turn potentiometer on that board.

Check that the display range changes correctly and that the decimal point also moves. Each range while nominally having a 10-100 variation will be adjustable from about 7 to 150. Check the attenuator has 10 dB between steps.