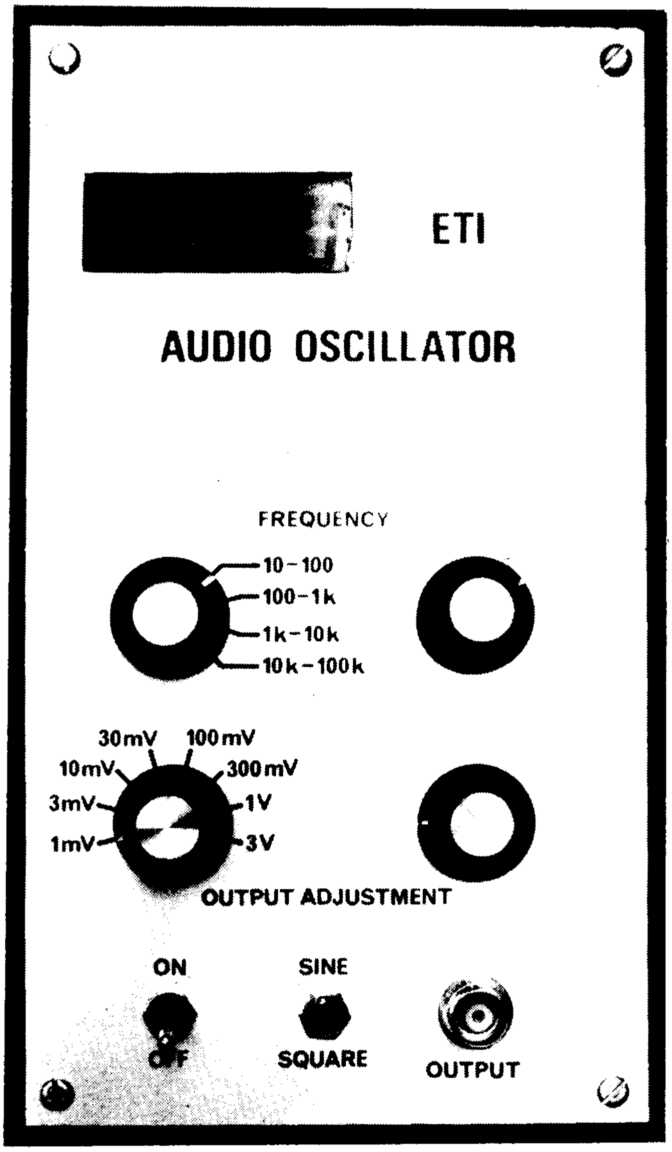
AUDIO OSCILLATOR

WITH LCD DFM OPTION

An audio oscillator combines with a new design in frequency meters that provides accuracy and fast reading rates.

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



THE WEIN BRIDGE oscillator published in our June issue did not provide a performance of adequate standard for many test applications-one would not have expected so from such a simplified design. Since then we have had many requests to provide a high performance oscillator.

This oscillator started life as another wein bridge, started to evolve as a voltage controlled sweep oscillator but when it became too complex reverted to a simple wein bridge.

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 and the high power consumption and the poor resolution, especially at low frequencies, of previous designs led us to develop a completely new design.

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 IC which, due to its liquid crystal display drive circuitry, allows a low power consumption design. 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 ▶

LCD FREQUENCY METER

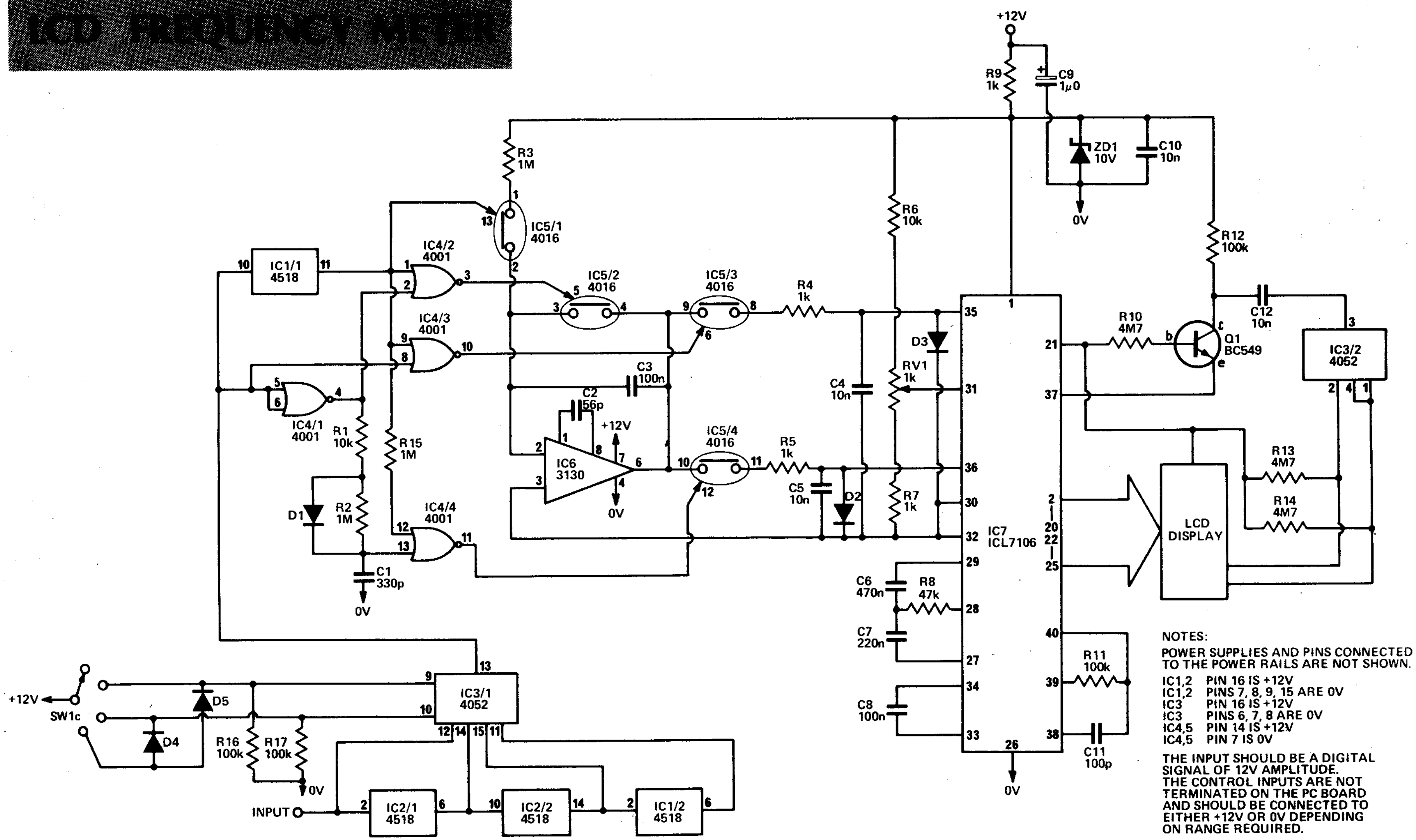
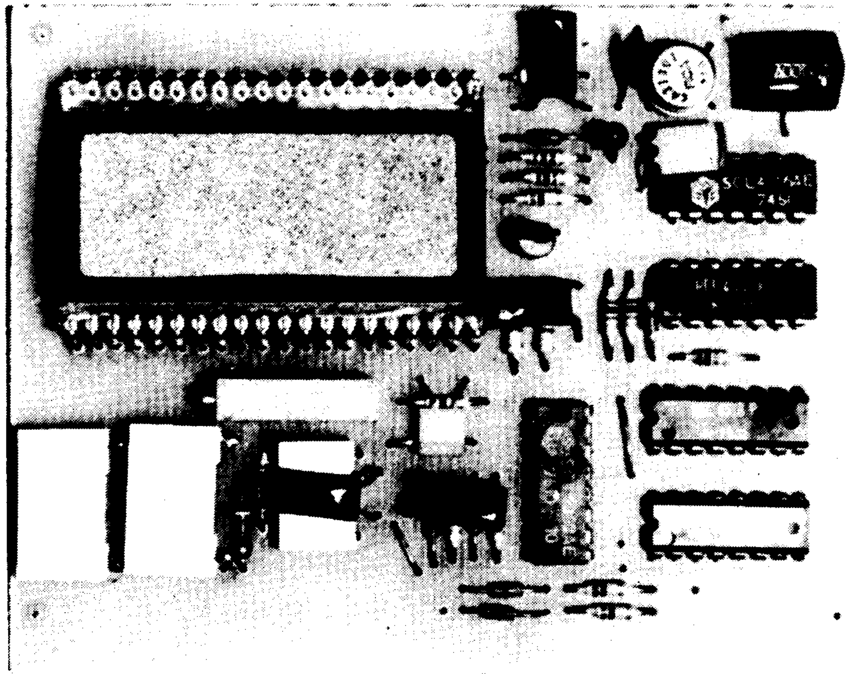


Fig. 1. The circuit diagram of the frequency meter section.

HOW IT WORKS

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.

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*, (pro-



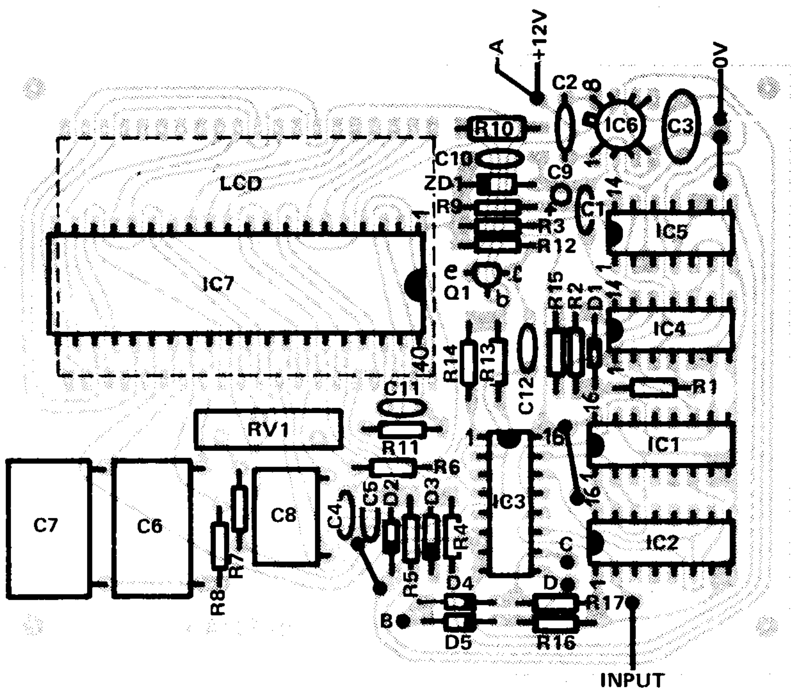
To generate the reference voltage we use an integrator (IC6) which is controlled by IC5. Operation is as follows. Initially C3 is discharged and for one cycle of the input signal IC5/1 turns on. As the IC7 provides a stable voltage between pin 1 and pin 32 of about 2.8V the output of IC6 will fall linearly 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 change to that voltage. After half a cycle IC5/3 will turn off leaving C4 at that voltage portional to frequency) thus eliminating any offset errors in IC6. The pulses which control IC5 are derived from IC1/1 and IC4.

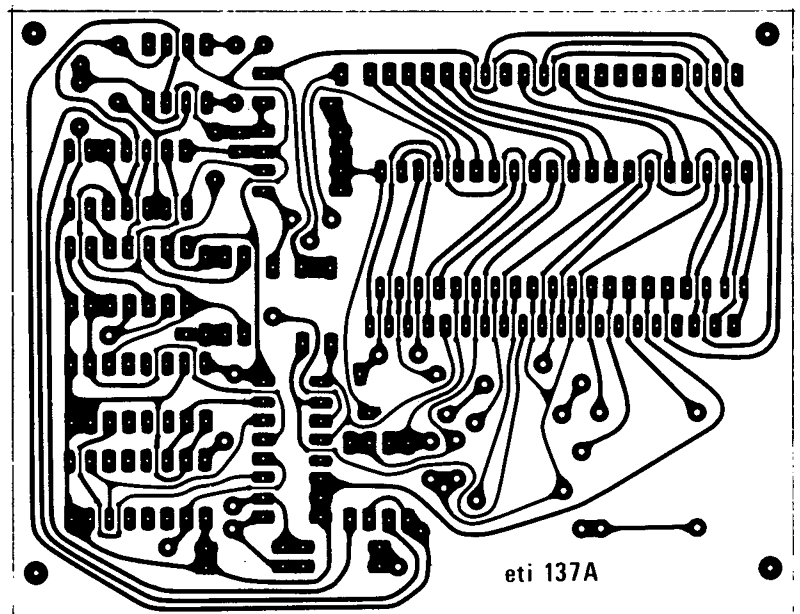
A reference voltage less than half the input voltage will result in the ICL7106 counting past 2000 (over ranging). The two inputs must also lie within the supply rails (less 1.5V). This limits the range of the instrument from 5 Hz to 200 Hz. For the higher frequency ranges, three decade drivers are provided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

PARTS LIST

RESISTORS	all ¼W 5%
R1, 6	10k
R2, 3, 15	1M0
R4, 5, 7, 9	1k
R8	47k
R10, 13, 14	4M7
R11, 12, 16, 17	100k
POTENTIOMETER	
RV1	1k ten turn trim
CAPACITORS	
C1	330p ceramic
C2	56p ceramic
C3, 8	100n polyester
C4, 5, 10, 12	10n polyester
C6	470n polyester
C7	220n polyester
C9	1u0 35 V tantalum
C11	100p ceramic
SEMICONDUCTORS	
IC1, 2	4518
IC3	4052
IC4	4001
IC5	4016
IC6	CA3130
IC7	ICL7106
Q1	BC549
D1-D5	1N914
ZD1	10 V 300mW Zener



Shown on this page are the foil pattern, overlay and photograph of the frequency meter section.



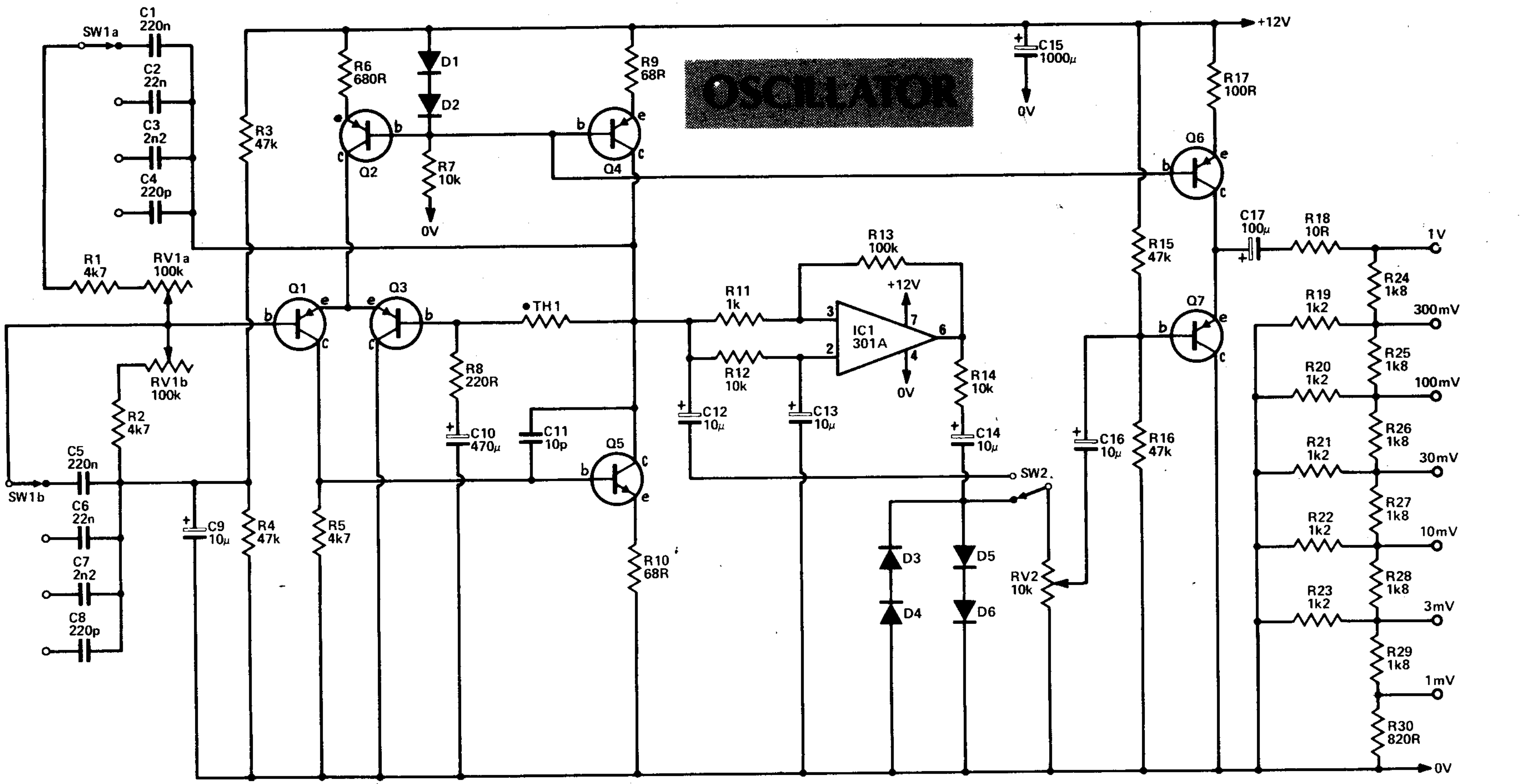


Fig. 2. The circuit diagram of the oscillator section.

PARTS LIST

Oscillator Board

RESISTORS all ½W 5%

R1, 2, 5	4k7
R3, 4, 15, 16	47k
R6	680R
R7, 12, 14	10k
R8	220R
R9, 10	68R
R11	1k
R13	100k
R17	100R
R18	10R
R19-R23	1k2
R24-R29	1k8
R30	820R

CAPACITORS

C1, 5	220n polyester
C2, 6	22n polyester
C3, 7	2n 2 polyester
C4, 8	220p ceramic
C9, 12, 13, 14, 15	10u 25 V electrolytic
C10	470u 25 V electrolytic
C11	10p ceramic
C15	1000u 16 V electrolytic
C17	100u 25 V electrolytic

SEMICONDUCTORS

IC1	301A
Q1-Q4	BC559

HOW IT WORKS

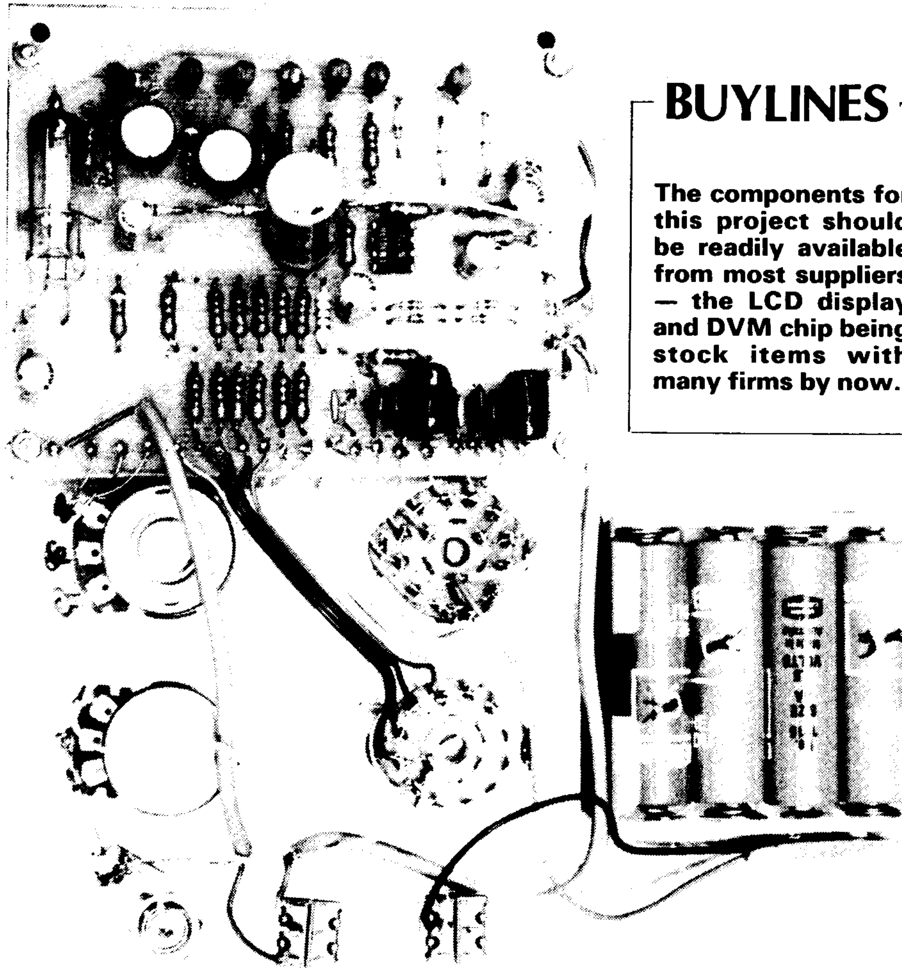
The oscillator is of the conventional Wein bridge type with a differential amplifier made up by Q1-Q5. Gain stabilization is provided by the thermistor TH1. This type of circuit oscillates at the frequency where the impedance of the capacitors equals the resistors in the Wein bridge arms. With this feedback 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 converted to square wave by IC1 with the amplitude stabilized by D3-D6.

		Q5	BC549
		Q6, 7	BC559
		D1-D6	1N914
THERMISTOR		SWITCHES	
TH1	type R53	SW1	Three pole four way rotary
POTENTIOMETERS		SW2	SPDT
*RV1	100k dual rotary	MISCELLANEOUS	
RV2	10k lin rotary	PCB	

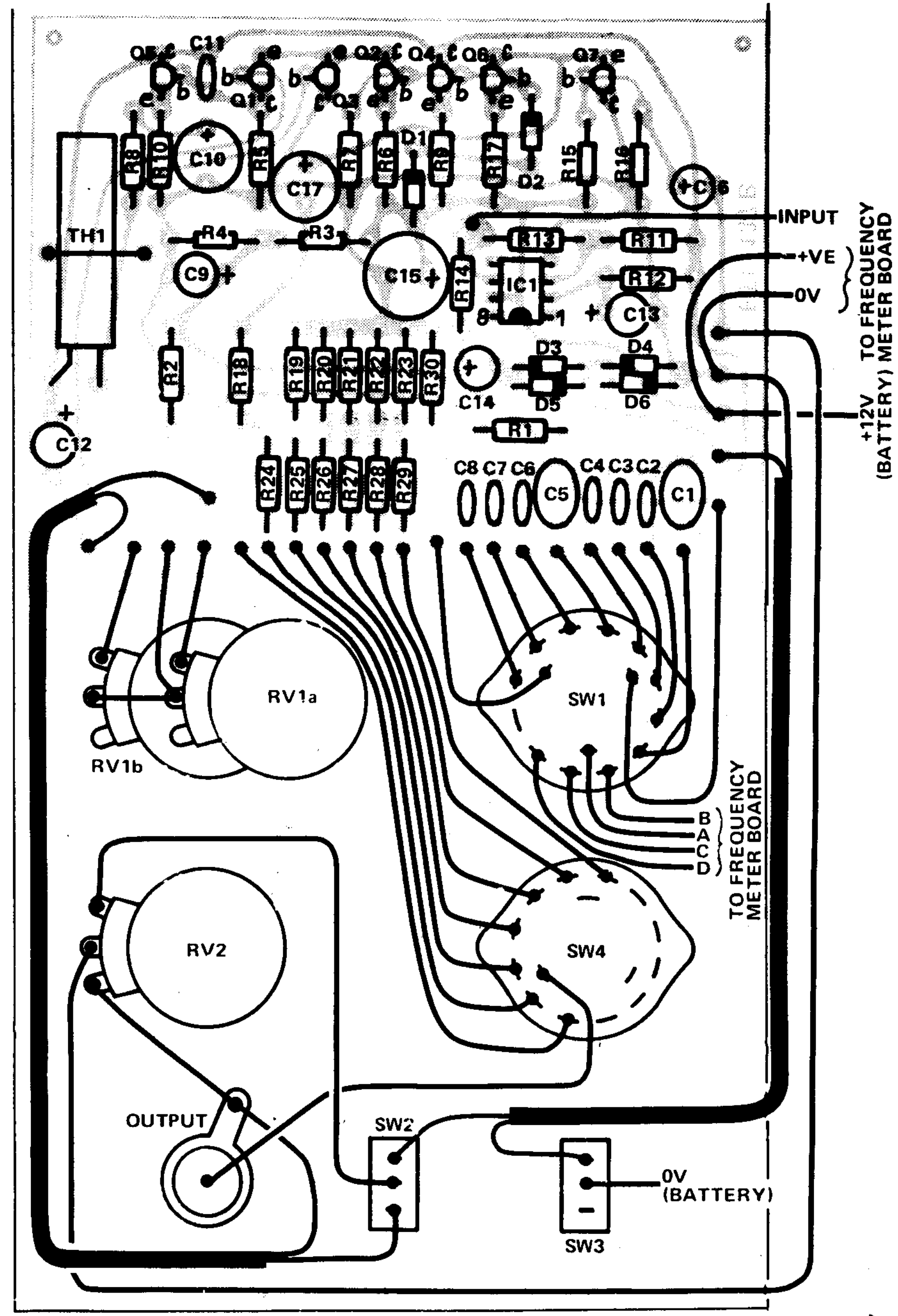
*RV1 — the preferred curve giving best resolution is antilog. If reverse rotation is acceptable log is as good. Otherwise use a linear curve.

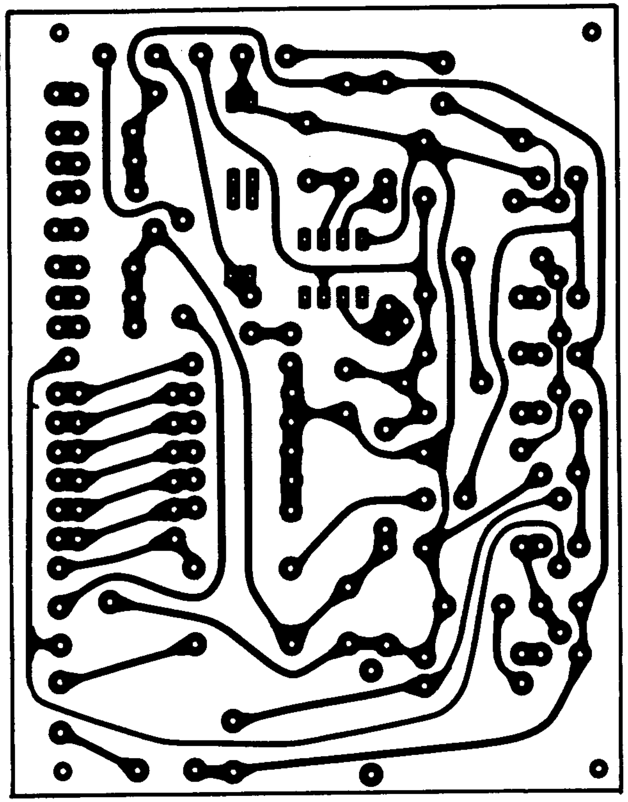


BUYLINES

The components for this project should be readily available from most suppliers — the LCD display and DVM chip being stock items with many firms by now.

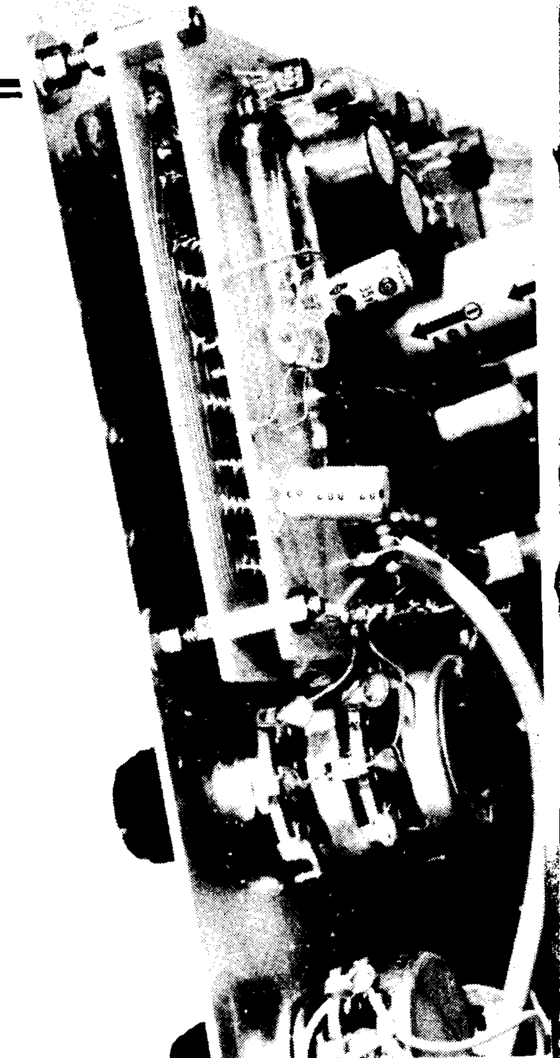
Fig. 3. Component overlay of the frequency meter board. Insert the LCD such that the +1 digit is on the left.





SPECIFICATION

Oscillator Section	
Ranges	**10.0—100.0 Hz**
	100—1 000 Hz
	1.00—10.00 kHz
	10.0—100.0 kHz
Outputs available	**sine or square**
Output level	**1 V maximum**
	continuously variable plus
	10 dB steps down to 1 mV
Output impedance	**nominally 600 ohms**
Sine wave distortion	**<0.1%**
Square wave risetime	**200ns**
Frequency Meter Section	
Number of digits	**3 ½**
Display	**LCD**
Reading rate	**5 per second**
Resolution	**0.1 Hz on lowest range**
Mode	**Period measurement**
	computed to read frequency
General	
Power consumption	**26 mA @ 12 V DC**



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. 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 pins should be used on all external wire terminating points. Cut all leads short on the back of the PCBs as the two are mounted back-back with only 6 mm spacing.

We built the units into a large box with all the components mounted on the front panel. The PCBs are secured by four 6BA c/s screws through the aluminium but hidden by the front panel. 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 track on the PCB 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 connections to the oscillator board.

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 the 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.