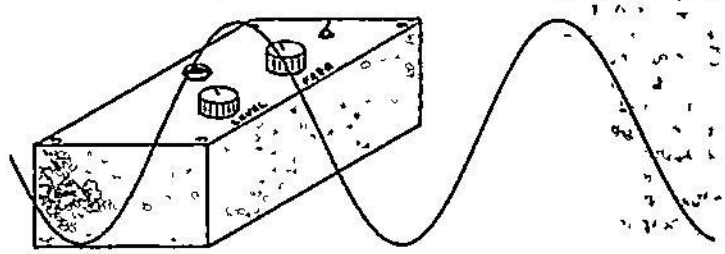
Audio Oscillator

A portable, battery powered oscillator for toolbox or test bench; compact and easy to assemble with low-distortion output. By Bill Markwick.



HERE'S A handy project if you do service calls, or if you want a compact oscillator for the test bench. It features battery power, selected frequencies for repeatability, and a five-position output attenuator in 10 dB steps. The distortion can be trimmed to 0.1% or less, which is more than adequate for anything but critical measurements.

Most oscillators you've seen have probably used a thermistor in the feedback loop to stabilise the output amplitude. These thermistors are very hard to find, so this one uses a precision bridge and a zener diode instead; the bridge is available from RCA dealers as the CA3019, or National Semiconductor dealers as the LM3019. You can substitute any diode bridge, but the distortion will be much higher.

The circuit is designed to cover the audio band of frequencies by changing two resistors; the frequencies given are the ones usually found on audio alignment tapes for setting up tape recorders. You can change these values to any others you prefer using the formula given in Table 1. If you'd prefer using a dual potentiometer for continuous frequency adjustment, the hookup is shown in Fig. 1. There's a catch, though: if you use a linear pot, the higher frequencies will all be crammed into the last few degrees of rotation. The cure for this is to use an anti-log pot; this gives a reasonable approximation of change vs. rotation. These pots are available in the Mod-Pot series from Allen-Bradley dealers, but be prepared to wait for a long time for them. Another cure, should you be persistent about this, is to use a dual log or audio pot to stretch out the dial markings. Naturally, you'll have to wire the pot backwards, so that counterclockwise rotation increases the frequency.

The pot resistances shown give a range of about 15:1. Next you'll have to install a switch to change C1 and C2 to extend the audio range; a value of .01 u for C1 and C2 covers about 16 Hz to 240 Hz, .001 to 2400 Hz, and 100 pF to about 24 KHz.

The output impedance has been chosen as 150 ohms; this will suit almost all input requirements - it can drive low impedance microphone lines, high impedance amplfiiers inputs, console line inputs, and what have you. If you use it with any sort of equipment which absolutely must have a 600 ohm source, you'll have to insert a 430 ohm resistor in series with the output. You could use a switch and wire this resistor into the box permanently, but it's a rarely-used feature.

The output attenuator can be set in 10 dB steps to suit the level to whatever sort of input you're testing; in the 0 dB position, the voltage can be varied up to 4½ volts or so, and in the other positions, resistive attenuation suits the level control's range to microphone inputs, as well as reducing the inherent noise from the amplifiers. Table 2 gives the approximate output levels for the attenuator settings.

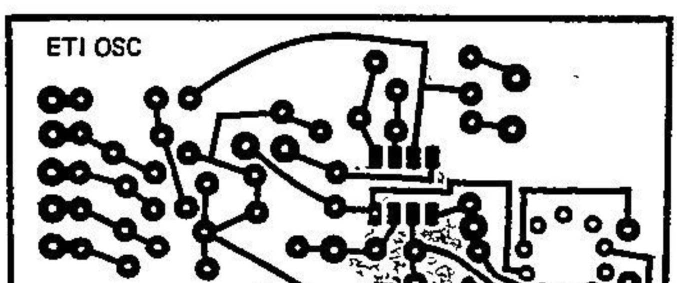
Assembly

Assemble the PC board and mount it in whatever box size you've chosen; the two 9 V batteries can be fitted in proper holders, or you can use battery clips and just tape them in place. The frequency-selecting resistors are mounted on rotary switch S1; you may want to use some spaghetti tubing if it looks like short circuits may happen.

The output jack is a stereo type with the ring contact grounded; this will let you use the unit with balanced inputs. It's particularly useful with balanced patch bays using three-conductor patchcords. You may prefer to fit binding posts.

Calibration

The only calibration necessary is to set gain control VR1 for minimum distortion. Monitor the output of IC1b with a scope and rotate VR1 through its travel; the output should go from no oscillation at full counter-clockwise to a sine wave of about 3.2 V rms with flattened peaks at full clockwise. Rotate counter-clockwise until the oscillation just stops, and then the minimum amount clockwise to get it oscillating again. This will be the point of minimum distortion. If the unit should occasionally fail to start on power-up, you've set the gain a bit too low; slight



The foil side of the printed circuit.

HOW IT WORKS

IC1a is configured as a conventional Wien bridge oscillator, with the value for C1 and C2 chosen to keep the resistance values from loading the output of IC1a at the high frequencies. For operation at much higher frequencies than the ones shown, C1 and C2 may be considerably decreased.

A characteristic of the Wien bridge is that it has zero phase shift at the frequency where R = C's reactance; at this frequency the feedback to IC1a's non-inverting input becomes positive, and the circuit begins to oscillate. As the output rises, it is rectified by IC2 and applied to the zener diode. When the zener diode breaks over, more negative feedback is applied to the inverting input, and the output voltage is held constant.

The amplitude could be stabilised with back-to-back zener diodes, or even regular diodes, but mismatching of the positive and negative cycles causes noticeable distortion. A single zener diode is used with a precision bridge in which the diodes are matched to each other within about one millivolt.

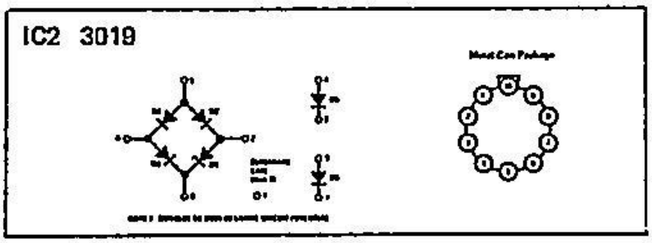
One of the extra diodes included in the 3019 could have been used in place of the zener diode, but breakover voltage is in excess of six volts, and would have resulted in clipping of the output signal. The circuit as shown has a peak output voltage equal to the zener voltage plus the 1.2 V drop across the rectifier.

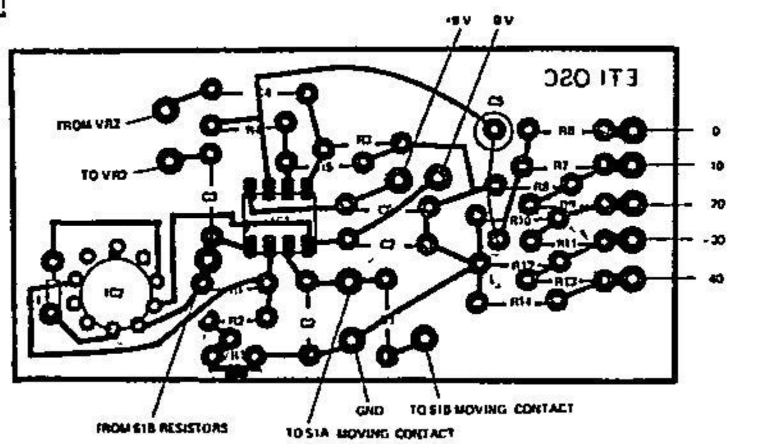
The signal from the oscillator is applied to the level control, and then amplified to about 4½ volts by IC1b. This is about the maximum available output when using two fresh 9 V batteries; if the unit is used permanently on a test bench, it can be powered by any supply up to ±15 volts.

The output from IC1b is applied to the ladder attenuator. This has steps of 10 dB, or 0.316 times, and is chosen to have constant output resistance of 150 ohms regardless of the switch position. The output is short-circuit proof.

variations in resistance due to temperature may be preventing oscillation. Increase the gain with a very small clockwise rotation of VR1.

If you have a harmonic distortion analyser, the job is even easier. You should be able to adjust R1 for a distortion reading of less than 0.1%; if it refuses to drop below this, monitor the output of the analyser with a scope to see if hum and noise are obscuring the distortion products. Shielding and filtering out frequencies above 20 KHz may be necessary to get very low distortion readings.





(right) The component location drawing.

(below) The circuit schematic. Note that the frequency-selecting resistors Ra, Rb are mounted on S1.

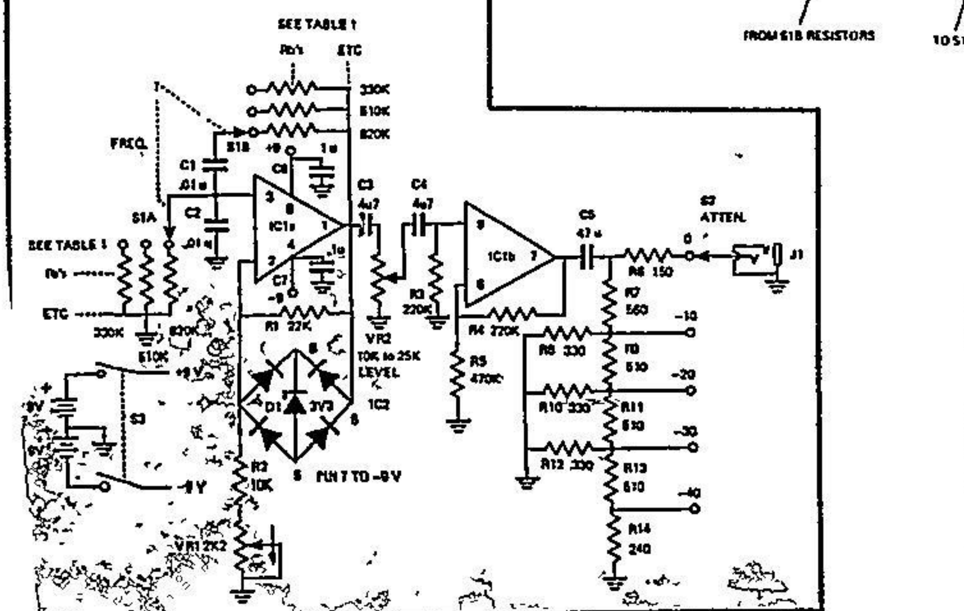


Table 1

Frequencies are approximate due to component tolerances.
For other frequencies, $R = 1/(6.28 \times .01 \times 10^{-6})$

Frequency-selecting Resistors

f	Ra,b
20	820K
30	510K
50	330K
70	220K
100	160K
400	39K
700	22K
1 KHz	16K
4 KHz	3K9
10 KHz	1K6
15 KHz	1K1

Table 2
Attenuation Setting vs. Output Voltage

Setting, dB	Max. Voltage
0	4.5
–10	1.42
–20	.45
–30	.142
–40	.045

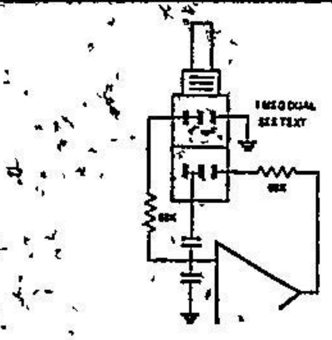


Fig. 1 Substituting a potentiometer for the switch. This is fraught with difficulties — see text.

PARTS LIST

Resistors ¼W, 5%	
Ra,b	see table 1
R1	22K
R2	10K
R3,4	220K
R5	470K
R6	150
R7	560
R8,10,12	330
R8,11,13	510
R14	240
VR1	2K2 miniature vertical mount trim pot, such as Philips 410 series
VR2	10K to 25K linear pot
Capacitors	
C1,2	.01 u film type, any voltage rating
C3,4	4u7, 35 V electrolytic or tantalum
C5	47 u, 16 V or larger electrolytic or tantalum
C6,7	.1 u film type, any voltage rating greater than 10
Semiconductors	
IC1	TL 072 dual FET op amp
IC2	LM3019 or CA3019 diode array
D1	3V3 400 mW zener diode, 1N746A or equivalent
Switches	
S1	2 pole, 11 position shorting rotary switch such as Centralab PA-1004
S2	1 pole, 5 position shorting or non-shorting rotary switch such as Centralab PA-1000
S3	DPST or DPDT subminiature toggle switch

Miscellaneous

3 conductor output jack or binding posts, battery clips or holders, two 9 V regular or alkaline batteries, knobs, PC board, suitable case.