system for the precise measurement of capacitance over the range of 10 μpf to 1 μf (10^{-17} to 10^{-6} farads). Frequency range is approximately 50 cps to 10 kc. The system has sufficient sensitivity to realize the full six-place resolution of the bridge for all measurements except for very small capacitances at the lower frequencies.

Oscillator and detector are mounted side by side as shown in the photograph. The end frames are bolted together to make a rigid assembly without the use of a relay rack. Connection cables are supplied.

The oscillator operates from the power line, the detector from internal batteries.

Type		*Code Word*	*Price*
1620-A	**Capacitance-Measuring Assembly**.....	ORBIT	**$2080.00**

HIGH PERFORMANCE, LOW-COST AUDIO OSCILLATOR WITH SOLID-STATE CIRCUITRY

Modern solid-state circuitry is used in the new TYPE 1311-A Audio Oscillator to produce a self-contained, compact, inexpensive instrument with many desirable features. Among these are high-power output into a wide range of load impedances, low-distortion even when the load impedance is short-circuited, excellent stability, low noise, and very small size.

The TYPE 1311-A Audio Oscillator supplies power at eleven commonly used

Figure 1. Panel View of the Type 1311-A Audio Oscillator.

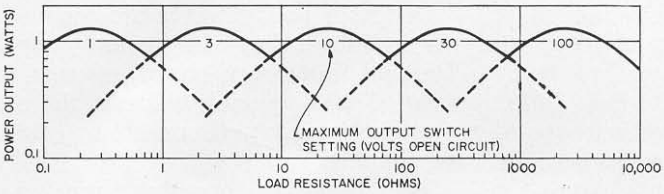


Figure 2. The output transformer allows matching a wide range of load impedances. Data were taken at 1 kc, but are representative of performance at all frequencies.

fixed frequencies: 50, 60, 100, 120, 200, 400 and 500 cps and 1, 2, 5 and 10 kc as selected by a rotary switch. A continuously adjustable incremental-frequency control provides a range of ±2% about the nominal frequency. One additional frequency can be provided by the user at a twelfth switch position by the addition of two resistors.

The output transformer has a tapped secondary winding, so that an output power of at least one watt can be delivered to five different load impedances, and at least one-half watt to any resistive load between 80 milliohms and 8 kilohms, as shown in Figure 2.

In most oscillators, overloading and waveform clipping occur when the load impedance is very low compared to its optimum value. In contrast, the TYPE 1311-A Audio Oscillator can supply a low-distortion signal to any load impedance from an open circuit to a short circuit, independent of the setting of the tap on the output transformer. The over-all distortion is always low, less than 0.5% at a 1-watt output level and typically less than 0.1% over much of the frequency range, as shown in Figure 3. Hum and noise components are less than 0.003% of the maximum output.

CIRCUIT

The oscillator makes use of the familiar Wien bridge network and a multistage, Class-B, transistor amplifier to provide the necessary power output without additional buffer amplifiers. A simplified schematic diagram is shown in Figure 4. The frequency of oscillation is determined by the capacitors and one of eleven pairs of resistors in the positive feedback path. A thermistor is part of the negative feedback path and assures a very stable output signal, as shown in Figures 5 and 6, without the distortion associated with many amplitude-limiting systems.

Six transistors are incorporated in a single direct-coupled feedback loop. The high loop gain results in an oscillator which is substantially independent of transistor characteristics, with low distortion and long-term reliability. Noise and short-term amplitude and frequency variations are minimized by the use of low-noise circuitry for the input am-

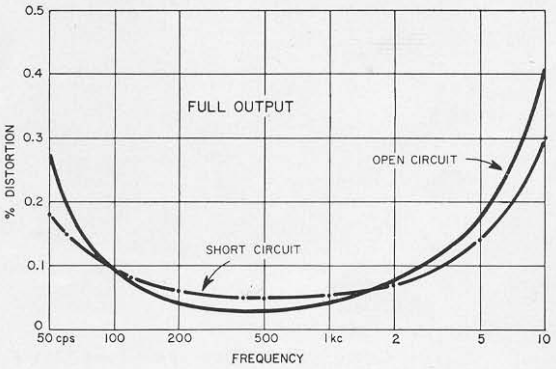


Figure 3. The Type 1311-A Audio Oscillator will drive any impedance with low distortion.

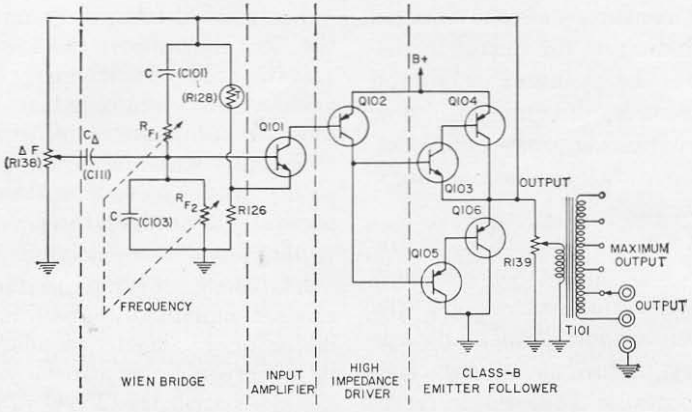


Figure 4. Elementary schematic diagram of the oscillator.

plifier, Q101. The transistor, Q102, provides a high-impedance drive circuit for operation of the Class-B output stage with a minimum of crossover distortion, without the use of complicated temperature-sensitive bias networks.[1]

Since the RC-network capacitors are too large (0.1 μf) to be made adjustable, the incremental-frequency adjustment is produced by a variation in the voltage across part of one of the capacitors by means of a potentiometer. This has the same effect on the circuit as a variation in capacitance, and, since the potentiometer impedance is low compared to that of the capacitor, the control can be calibrated in percentage frequency change.

[1]J. J. Faran and R. G. Fulks, "High-Impedance Drive for the Elimination of Crossover Distortion," *The Solid-State Journal*, August, 1961.

APPLICATIONS

Although the TYPE 1311-A Audio Oscillator was designed primarily for use as a generator for bridge measurements, its superior performance and many features make it well suited to almost any application where a high-quality audio oscillator is needed.

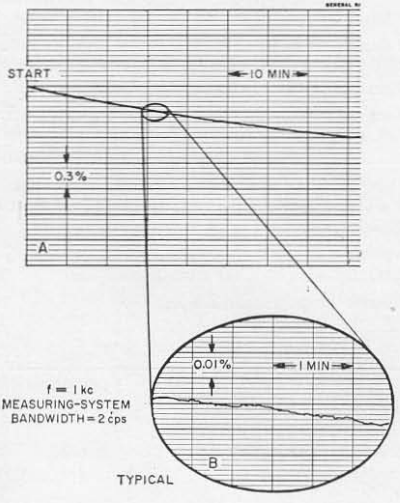
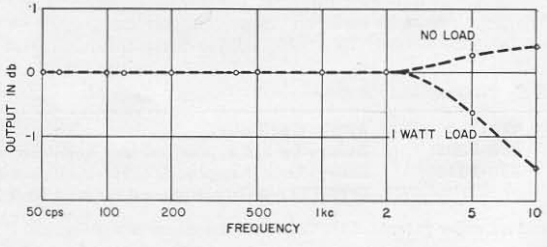


Figure 5. Typical output amplitude stability of the oscillator, showing warmup drift (A) and short-term variation (B).

Figure 6. The flat frequency response of the oscillator eliminates the need for rechecking the level in frequency-response measurements.



For bridge measurements the shielded secondary winding on the output transformer permits the oscillator to be used as a floating source, thus minimizing or eliminating circulating ground currents. This feature is also important in other low-level systems.

For many applications, such as the calibration of high-speed level recorders and analog-to-digital converters, the very low level of short-term amplitude and frequency variations in this oscillator are important. Appreciable errors can be caused by the cycle-to-cycle variation found in most oscillators.

For general laboratory measurements the floating output, the low distortion, and the ability to drive any load impedance without clipping are among the most useful features of this oscillator, while the small size, simplicity, reliability and excellent stability are important advantages for production-test applications.

The oscillator is mounted in a compact cabinet which can be used either on the bench or, by means of adaptor panels, in a relay rack. It can be conveniently mounted with the TYPE 1232-A Tuned Amplifier and Null Detector[2] as a complete oscillator-detector combination for relay-rack mounting. Relay-rack adaptor sets for this purpose are listed below.

— R. G. FULKS

[2]A. E. Sanderson, "A Tuned Amplifier and Null Detector with One-Microvolt Sensitivity," *General Radio Experimenter*, 35, 7, July, 1961.

SPECIFICATIONS

FREQUENCY

Range: 11 fixed frequencies from 50 to 10,000 cps.

Control: 50, 60, 100, 120, 200, 400, 500, 1000, 2000, 5000, 10,000 cps selected by rotary switch. A vernier provides a ±2% adjustment about nominal.

Accuracy: ±1% when Δf control is at zero.

OUTPUT

Power: One watt into matched load. (Taps provide at least one-half watt output into any resistive load between 80 milliohms and 8 kilohms.)

Voltage: Continuously adjustable from 0 to 1, 3, 10, 30, or 100 volts, open circuit.

Current: Continuously adjustable from 0 to 40, 130, 400, 1300, 4000 milliamperes, short circuit (approx).

Impedance: Between one and two times matched load, depending on control setting. Output circuit is isolated from ground and, hence, can be used to drive balanced circuits.

DISTORTION AND NOISE LEVEL

Distortion: Less than 0.5% under any load condition. Typically less than 0.1% over much of range. Oscillator will drive a short circuit without waveform clipping.

AC Hum: Typically less than 0.003% of output voltage.

GENERAL

Terminals: Jack-top TYPE 938 Binding Posts with standard ¾-inch spacing. Separate ground terminal holds TYPE 938-L Shorting Link which can be used to ground adjacent OUTPUT binding posts.

Power Input: 105 to 125 (or 210 to 250) volts, 50 to 400 cps. Total power input varies between 7 and 22 watts, depending on load.

Mounting: Aluminum panel and cabinet, in gray-crackle finish, for bench use. Panel adaptor sets are available to permit mounting in standard 19-inch relay rack.

Accessories Supplied: TYPE CAP-22 Power Cord, spare fuses.

Dimensions: Width 8, height 6, depth 7¾ inches (205 by 155 by 200 mm), over-all.

Net Weight: 6 pounds (2.8 kg).

Type		*Code Word*	*Price*
1311-A	**Audio Oscillator**	TIPSY	**$175.00**
480-P308	**Relay-Rack Adaptor Set (for oscillator only)**	EXPANELDOG	**7.00**
480-P316	**Relay-Rack Adaptor Set (for oscillator and TYPE 1232-A Tuned Amplifier and Null Detector)**	EXPANELHUM	**6.00**

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