



## Oscillators for Many Purposes



WHEN need arises for a test oscillator, at least one characteristic of the needed oscillator is automatically known. Usually, this known characteristic is the frequency range. In many cases, however, need for an oscillator involves other characteristics as well as frequency range. Power output, output impedance, distortion, and dial resolution are all determining factors for some applications.

The -hp- series of test oscillators includes some 16 separate instruments. Collectively, these oscillators operate from 0.01 cps to 10 megacycles, covering the audio, sub-sonic, ultra-sonic, and low r-f regions. Several of the instruments are general-purpose types, designed to operate over wide frequency ranges and to provide generous output voltages. Others are designed for particular types of applications. In the accompanying table (next page) the oscillators are classified according to their principal distinguishing features. Where appropriate, some of the

oscillators are listed under more than one classification.

These 16 -hp- test oscillators are separate from the -hp- series of audio signal generators which, in general, are distinguished by high output powers, by the ability to generate accurately-known power levels, and by the ability to generate very low audio levels.

When first introduced, the -hp- resistance-capacity oscillator quickly gained leading popularity because of its wide frequency range, high stability, and low distortion. The -hp- Models 200A, 200B, and 200C oscillators were the first commercial test oscillators constructed using the now well-known R-C oscillator circuit. The 200A operates from 35 cps to 35 kc; the 200B from 20 cps to 20 kc. Both instruments deliver one watt to a 500-ohm load and can be used with any higher-impedance load without deterioration of characteristics. The -hp- Model 200C operates from 20 cps to 200 kc and provides 10 volts to 1000 or more ohms.

Need for an oscillator to cover a range from well below to well above the audible range led to the development of the Model 200D, which operates from 7 cps to 70 kc and also provides 10 volts to a load of 1000 or more ohms.

The -hp- general-purpose group of oscillators includes the above four instruments and the Model 650A. The 650A generates the highest frequency of any of the -hp- series of R-C oscillators. It operates up to 10 megacycles and down to 10 cps—a range of one

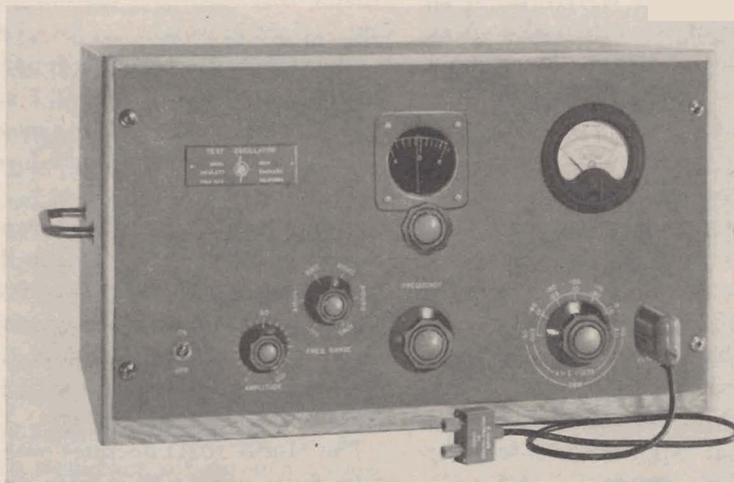


Fig. 1. -hp- Model 650A Test Oscillator operates from 10 cps to 10 megacycles. Step-attenuator controls output power.

## -hp- TEST OSCILLATORS

GENERAL PURPOSE	HIGH FREQUENCY	LOW FREQUENCY	BATTERY-OPERATED PORTABLE	EXTRA LOW DISTORTION	HIGH RESOLUTION	CARRIER TEST
200A	650A	200D	204A	201B	200I	200H
200B	200C	202A				230A
200C	200H	202B				231A
200D	(See also	202D				232A
650A	"Carrier Test")	204A				233A

million-to-one. It is designed with both an output voltage metering system and a controlled output impedance. In these respects, the instrument resembles a signal generator.

The 650A generates a maximum of 3 volts across a 600-ohm load. The internal impedance of the unit is 600 ohms so that a maximum of 6 volts is available across high-impedance loads. The output voltage is controlled by a 600-ohm attenuator whose input is monitored by a voltmeter calibrated on the basis of a 600-ohm load. The attenuator has a range of 50 db in 10 db steps. A continuously-variable control is provided for selecting voltages lying within the 10 db intervals. With this arrangement, voltages from 3 volts to 3 millivolts can be obtained across a 600-ohm load. The output voltage can be further extended downward with a special output cable provided with the instrument. This cable has a built-in resistive network that divides both the output voltage and the output impedance by a factor of 100. Use of the cable reduces the minimum-available voltage across 600 ohms to 30 microvolts and reduces the effective output impedance to 6 ohms.

As a basic laboratory tool, the 650A is popular because of its high degree of flexibility. It can be used to test r-f, video, ultra-sonic, and audio equipment.

### HIGH-FREQUENCY OSCILLATORS

The Model 650A, just described, and the Model 200C, described earlier, are included in the high-frequency as well as the general-purpose group because of their high-

frequency ratings of 10 megacycles and 200 kc respectively. A third high-frequency oscillator is the Model 200H, which operates from 60 cps to 600 kc and provides a maximum of 1 volt across loads of 100 or more ohms. The internal impedance of the unit is low, approximately 100 ohms, to permit use with a wide range of load impedances.

The *-hp-* series includes a number of other high-frequency oscillators. These are largely special-purpose types and are described among the carrier test group.

### LOW-FREQUENCY OSCILLATORS

The lowest-frequency *-hp-* oscillator is the Model 202A. Its nominal low-frequency limit is 0.01 cps, although dial overlap is such that a typical instrument is calibrated and operates down to less than 0.008 cps. The upper frequency limit is 1000 cps. The 202A is termed a "Low Frequency Function Generator" and generates sinusoidal, square, and triangular output waveforms at an amplitude of 30 volts peak-to-peak across loads of 1000 or more ohms. The circuit design of the 202A is such that transient conditions caused by range switching or frequency changing is virtually nonexistent, a great convenience in low-frequency work where much time can be required for circuits to stabilize. Another feature of special value is that the instrument supplies a trigger pulse for synchronizing external equipment.

Principal applications for the 202A include geophysical and medical work, and studies of servo and other low-frequency electrical and mechanical systems.

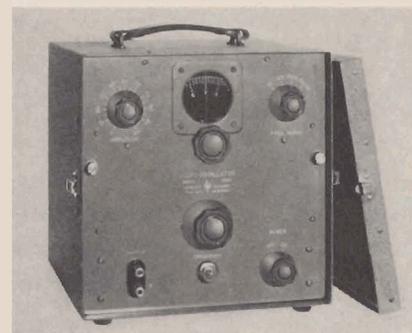


Fig. 2. *-hp-* Model 204A battery-operated oscillator. Splash-proof case facilitates field use.

The next lowest-frequency *-hp-* oscillator is the Model 202B, which operates from  $\frac{1}{2}$  cps to 50 kc. The output of the instrument is sinusoidal with a maximum output of 10 volts across a load of 1000 or more ohms. Applications for this instrument are similar to those for the 202A.

The third low-frequency oscillator, the Model 204A, is a battery-operated type instrument that has been designed for field use. The oscillator is housed in a splash-proof case, is light in weight (24 lbs.), and is otherwise easily portable. It operates at frequencies down to 2 cps and up to 20 kc and provides a maximum output of 5 volts across loads of 10,000 or more ohms.

The remaining two instruments in the low-frequency group are the Models 202D and 200D. The 200D was included as part of the general-purpose group but is listed in the low-frequency group because of its lower frequency limit of 7 cps.

The Model 202D operates over a range from 2 cps to 70 kc, providing 10 volts across loads of 1000 or more ohms. The lowest frequency range of the 202D extends from 2 to 50 cps,

providing a broad, uninterrupted low-frequency sweep suitable for testing low-frequency devices.

#### BATTERY-OPERATED

The usefulness of a portable, battery-operated oscillator is not confined to field applications. For example, a portable oscillator is useful where tests must be made in various parts of the factory where power outlets are not available. Also, a battery-operated oscillator is valuable in the laboratory when a hum-free signal is required.

The portable Model 204A battery-operated oscillator described in the low-frequency group, operates from 2 cps to 20 kc. The instrument is used in a wide variety of applications requiring a strictly self-contained instrument.

#### EXTRA-LOW DISTORTION

In audio work there are a number of applications that require a test voltage having unusually low distortion. Although the R-C oscillator is inherently a low-distortion type generator with usually less than 1% distortion, one of the *-bp-* oscillators is designed to have less than 0.5% distortion\* at power levels up to 1 watt. This oscillator is the Model 201B which operates over a range from 20 cps to 20 kc and has a maximum output of 3 watts into 600 ohms. At the 3-watt output level, the distortion is less than 1%.

The output impedance of the Model 201B is 600 ohms, except at full output, permitting measurements on audio lines. However, the output system is single-ended. A T-pad is used to control the output power, providing a fixed signal-to-noise ratio. A conventional amplitude control is also provided to limit the driving level for the output amplifier when the extra-low distortion output is desired.

#### HIGH-RESOLUTION OSCILLATOR

In frequency measurement work there is often a need for an oscillator

\*For use in highest quality applications, the *-hp-* Model 206A Audio Signal Generator, not described here, is designed with less than 0.1% distortion.



Fig. 3. Dial used on *-hp-* Model 200I Spread-scale oscillator.

having high dial resolution. The principal requirements for such an instrument are that the dial have a large number of calibrated points, that the calibration be accurate, that the instrument operate down to low frequencies of a few cycles per second, and that a generous output voltage be provided.

Such an instrument is the *-bp-* Model 200I Spread-Scale Oscillator. It operates from 6 cps up to 6 kc, covering this range in six bands. The frequency control dial is a large six-inch diameter disc with two range calibrations. One range has approximately 160 calibrated points, while the second has approximately 110, giving a total of approximately 270 calibrated points for the band from 6 cps to 60 cps.

The 200I is specified to be accurate within 2%. However, screwdriver adjustments are provided for standardizing the calibration against a known frequency. After standardizing, the calibration is accurate within 1%. Dial resolution and mechanical quality of the tuning system are such as to give the 200I a resetability well within 1%.

Maximum output from the 200I is 10 volts across loads of 1000 or more ohms. A conventional amplitude control adjusts the output.

#### CARRIER TEST OSCILLATORS

Five of the *-bp-* oscillators are widely used in testing carrier-communications equipment. The most versatile of these is the *-bp-* Model 233A. This instrument has many features that make it suitable for testing and adjusting the most advanced types of carrier equipment.

The Model 233A operates from 50 cps to 500 kc and provides a maximum output of 3 watts into a 600-ohm load at frequencies above 5 kc. The output system is balanced, permitting operation directly into balanced lines.

In addition to the 3-watt output system which is designed for use at frequencies above 5 kc, the 233A has a second set of output terminals. This system is single-ended and is designed to permit testing at frequencies lower than 5 kc. The single-ended output system provides a maximum of approximately 6 volts across a 600-ohm load. The internal impedance of the low-frequency output is approximately 6 ohms, thus providing a constant-voltage type test signal.

The versatility of the 233A is further increased by the use of an internal modulator. This circuit allows the generated frequency to be modulated by a standard telephone set, permitting voice communication between the test point and the terminal. A panel jack is provided on the oscillator for connecting the microphone.

The maximum power of 3 watts available from the balanced output is usually sufficient to test lines more than one hundred miles long. To obtain this power economically, the internal impedance of the 3-watt system has been kept moderately low. However, the system is balanced and a generator impedance of 600 ohms can easily be obtained by inserting suitable resistors in series with each generator terminal. The voltage

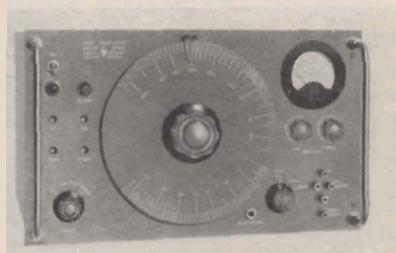


Fig. 4. *-hp-* Model 233A Carrier Test Oscillator operates from 50 cps to 500 kc. Operating features include balanced, metered output and high resolution dial.

across the terminals is monitored by a voltmeter calibrated both in voltage and in dbm referred to a 600-ohm level. Other features of the 233A include a large 9-inch tuning dial that gives high resolution and a convenient arrangement for standardizing calibration, when desired.

A second high-power type carrier test oscillator is the *-hp-* Model 232A. This instrument is somewhat similar to the Model 233A, but provides even more power—5 watts into 500 ohms—and operates over a somewhat different frequency range—20 cps to 200 kc. A modulator is also included so that voice communication can be used to aid in testing.

#### LOW POWER CARRIER OSCILLATORS

Three of the *-hp-* carrier test oscillators are low-power instruments. Of these, two have balanced output circuits and one is single-ended.

The single-ended instrument is the Model 200H, described earlier with the high-frequency group. The 200H operates from 60 cps to 600 kc and provides a maximum output of 1 volt across 100 or more ohms.

One of the balanced output instruments is the Model 230A, which operates from 35 cps to 35 kc. Maximum output from the instrument is +14 dbm (approximately 4 volts) into a 600-ohm load. The internal impedance is also 600 ohms. An ar-

range for standardizing the frequency calibration is included to give 1% dial accuracy after standardization.

The third low-power carrier oscillator is the Model 231A, which has a balanced output and operates from 7 cps to 70 kc. The 231A is provided with both a 600-ohm and a low-impedance output system. The 600-ohm system is brought out to a pair of telephone jacks at a maximum output level of +14 dbm. The 600-ohm system is balanced and can be used at frequencies down to 100 cps. The low-impedance system is single-ended and provides a maximum output of 10 volts across 1000 or more ohms. This output can be used down to 7 cps for testing relays, etc.

#### AUDIO MATCHING TRANSFORMER

Many of the *-hp-* audio oscillators are provided with a single-ended type output system in which one of the output terminals is grounded. To permit such oscillators to be used with balanced systems, a special balanced universal matching transformer is available as a separate *-hp-* accessory. This transformer, the *-hp-* 912-17, is in every way a high-quality device, having low distortion, a wide frequency range, and good balance.

The measured distortion characteristic for a representative 912-17 transformer is shown in Fig. 5. The

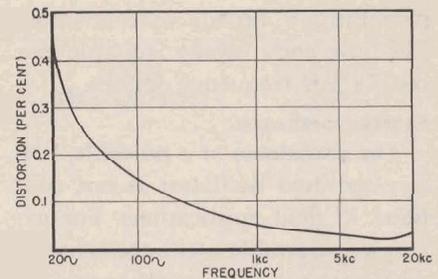


Fig. 5. Typical distortion characteristic of *-hp-* 912-17 Universal Matching Transformer operated at +15 dbm.

transformer is specified to have less than 1% distortion at 20 cps, although typically the distortion is substantially less than this figure. The rated frequency range is from 20 cps to 20 kc, and the response is within  $\pm\frac{1}{2}$  db over this range. Maximum rated power level is +15 dbm (4.4 volts across 600 ohms).

The transformer is arranged to match 600 ohms to impedances of 600, 250, 150, 62.5, or 37.5 ohms. Impedances of 500 ohms can be matched to 500, 208, 125, 52, or 32 ohms. Complete application data is supplied with each unit.

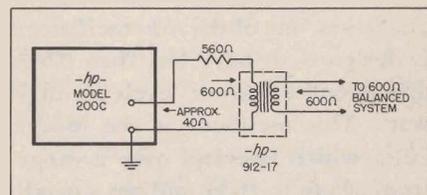


Fig. 6. Typical set-up using *-hp-* 912-17 transformer to match single-ended oscillator to balanced system.

### *-hp-* TEST OSCILLATORS

<i>-hp-</i> MODEL	FREQUENCY RANGE	PRINCIPAL APPLICATIONS	MAXIMUM OUTPUT	NOTES
200A	35 cps-35 kc	Audio tests	22.5 v across 500 or more ohms	
200B	20 cps-20 kc	Audio tests	22.5 v across 500 or more ohms	
200C	20 cps-200 kc	Audio and ultrasonic tests	10 v across 1000 or more ohms	
200D	7 cps-70 kc	Audio and ultrasonic tests	10 v across 1000 or more ohms	
200H	60 cps-600 kc	Carrier, telephone tests	1 v across 100 or more ohms	
200I	6 cps-6 kc	Interpolation, frequency measurements	10 v across 1000 or more ohms	High resolution, spread-scale oscillator
201B	20 cps-20 kc	High fidelity audio tests	42.5 v (3 w) across 600 or more ohms	Distortion less than 0.5%
202A	0.01 cps-1 kc	Low frequency measurements	30 v p-p across 1000 or more ohms	Sine, square, and triangular output wave forms
202B	0.5 cps-50 kc	Low frequency measurements	10 v across 1000 or more ohms	
202D	2 cps-70 kc	Low frequency measurements	10 v across 1000 or more ohms	
204A	2 cps-20 kc	Low frequency, audio tests in field and factory	5 v across 10,000 or more ohms	Battery-operated; portable
230A	35 cps-35 kc	Audio, carrier communications tests	4 v across 600 or more ohms	Balanced, 600-ohm output
231A	7 cps-70 kc	Audio, carrier communications tests	4 v across 600 or more ohms	Balanced 600-ohm output; also has low Z, 10-volt output system
232A	20 cps-200 kc	Carrier communications, ultrasonic tests	5 watts into 500 ohms	Metered output
233A	50 cps-500 kc	Carrier communications, ultrasonic tests	3 watts into 600 ohms	Metered output; balanced
650A	10 cps-10 mc	Audio, ultrasonic, video, r-f tests	3 v across 600 or more ohms	Metered output and output attenuator
912-17	20 cps-20 kc	Universal matching transformer	+15 dbm maximum input	Balanced; matches various Z's to 600 and 500 ohms