The *hp*- Audio Signal Generators

Among the *hp*- line of audio test instruments are four instruments known as audio signal generators. The basic function of these generators is to provide an accurately known audio frequency at an accurately-known and adjustable output level. The generators are specially arranged to simplify gain and response measurements on both high- and low-level equipment.

All of the generators provide a wide range of output powers. Three of the generators have a very high output of 5 watts and are thus suitable for high-level as well as general test work. The fourth is especially suitable for use with broadcast equipment and has a maximum output of 30 milliwatts (+15 dbm). All of these outputs are balanced and center-tapped. A single-ended output having a 600-ohm source impedance is also provided.

One of the special features of the 206A is its very low distortion of less than 0.1%. The circuit arrangement that provides this low distortion is indicated in Fig. 2. The oscillator section (Fig. 2) is a resistance-capacity circuit in which all design factors have been carefully exploited so that distortion in the generated voltage is very low—less than approximately 0.2%. This value represents the practical limit obtainable in the generating circuit itself with present tubes.

To reduce distortion in the generated voltage from 0.2% to less than 0.1%, the oscillator is followed by a frequency-selective amplifier arranged as indicated in Fig. 3. Within the amplifier is located a tuned bridge whose tuning capacitors are tracked with the tuning capacitors for the oscillator. The bridge and the oscillator are always tuned to the same frequency.
The bridge is arranged to separate harmonic voltages from the fundamental. At the frequency for which the bridge is balanced, no output at the fundamental frequency will be obtained between the balance points of the bridge. However, output will be obtained for the harmonic frequencies applied to the bridge. The bridge thus operates as an elimination filter which suppresses the fundamental and passes harmonics.

The harmonic output is amplified in a separate amplifier and applied to the input of the main amplifier as negative feedback. Through this arrangement, negative feedback occurs only for the harmonics, while the fundamental is relatively unaffected. The overall amplifier thus has less distortion in its output than in its drive voltage. A reduction in distortion of approximately 10 db is obtained in the circuit, so that less than 0.1% distortion is obtained at the output of the amplifier at frequencies above 50 cps. Less than 0.25% distortion is obtained at frequencies below 50 cps. This low distortion is sufficient for testing highest quality equipment and permits exacting measurements to be made even at low audio frequencies.

The output of the main amplifier is monitored by a voltmeter with a spread scale that allows the level applied to the attenuator to be metered very accurately. The attenuator has an overall range of 111 db so that outputs as low as approximately 10 microvolts can be obtained. The attenuator is adjustable in steps of 10 db, 1 db, and 0.1 db. The 0.1 db step section is particularly useful in making measurements on high-quality equipment where only small variations in frequency response are involved. The attenuator is accurate within 0.25 db up to 80 db of attenuation at all frequencies within the range of the equipment.

The output attenuator feeds into a specially-designed output transformer which is constructed with a high-permeability core of large dimensions. The quality of the transformer is such that changes in level or operation at low output frequencies cause very little variation in overall accuracy. The output transformer is provided with windings for use with 50, 150, and 600-ohm circuits. All of these windings are center-tapped and balanced.

The output circuit is also arranged to have a single-ended system which by-passes the output transformer. Where the utmost is required in signal purity and frequency response, a slight advantage can be obtained by using the single-ended output. The internal impedance of the single-ended system is 600 ohms.

The frequency response of the output system is constant within 0.2 db over a 30 cps to 15 kc range.

**MODEL 205AG**

The -hp- Model 205AG Audio Signal Generator consists of two separate instruments in one cabinet: a complete audio signal generator and an additional vacuum tube voltmeter (Fig. 4). This arrangement results in an instrument that is a gain-measuring set complete in itself for which no external level-measuring equipment is required.

The 205AG provides a maximum of 5 watts over the range from 20 cps to 20 kc. The instrument has a multi-tap output system to permit this power to be delivered to loads of 50, 200, 600, and 5,000 ohms.

The 205AG has many uses in testing audio systems and because of its high power output is especially useful in applications where a combination of an oscillator and a power amplifier is necessary to obtain a high-level test signal. Such applications include measurements on loud speakers, power amplifiers, high-voltage bridges, transducers, etc.

The high power and frequency coverage of the 205AG also make the instrument suitable for a number of industrial applications. The instrument can be used in fatigue tests of materials as in Fig. 5. Here the 205AG is used to drive a magnetic head which is coupled to magnetic material on the end of the specimen to be tested.

The 205AG is especially useful as a gain-measuring set because of its separate voltmeter for measuring the output of equipment under test. The instrument has advantages over the usual gain- or transmission-measuring set in that it has a self-contained oscillator that covers the complete audio range, in that its voltmeters
are more accurate than the usual copper-oxide type voltmeters used in gain sets, and in that its price is less than the price of the separate components necessary to make accurate measurements of transmission characteristics.

Referring to Fig. 4, the oscillator section in the 205AG is similar to the oscillator in the 206A. Care is taken to maintain high purity of waveform, although the oscillator waveform is not enhanced by the use of a frequency-selective amplifier as in the 206A.

The frequency calibration of the generator is accurate within 2%. Where higher accuracy is desired, provision is made in the oscillator circuit for convenient standardization of frequency calibration. The standardization arrangement consists of a variable resistor for each frequency band. When the frequency calibration is checked against suitable standards, the resistors can be adjusted for best accuracy over each band or for any one area of the band.

The output amplifier is conservatively designed to realize the 5-watt output with low distortion. The output stage of the amplifier consists of two 6L6's operated in push-pull. Overall negative feedback for the amplifier is provided by a tertiary winding on the output transformer.

A second transformer in the output circuit is used for matching to various load impedances. Although this transformer is of high-quality construction, its low-frequency response characteristics (Fig. 6) at low output levels are not equal to the low-frequency characteristics of the 206A. Therefore, where constancy of response at low audio frequencies is important at levels below -10 dbm, the 206A is recommended.

The input to the matching transformer is controlled by a 110-dB attenuator adjustable in 1 and 10 dB steps. To permit the full 5-watt output to be obtained in an economical circuit, the output system is arranged to have a low impedance when the attenuator is set for zero attenuation. A matched source impedance is obtained when the attenuator is adjusted for approximately 20 dB or more of attenuation.

The separate voltmeter for measuring the output of devices under test has an input impedance of 5,000 ohms. The meter face is calibrated from -5 to +8 dB referred to a 0 dB level of 1 milliwatt in 600 ohms. The input voltmeter also includes a 0-40 dB attenuator adjustable in 5 dB.

**-hp- AUDIO SIGNAL GENERATORS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Freq. Range</th>
<th>Max. Power Output</th>
<th>Output Impedances</th>
<th>Distortion</th>
<th>Special Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>205A</td>
<td>20 cps - 20 kc</td>
<td>5 watts</td>
<td>50, 200, 600, and 5,000 ohms</td>
<td>Less than 1% above 30 cps</td>
<td>Includes separate voltmeter for gain measurements</td>
</tr>
<tr>
<td>205AG</td>
<td>20 cps - 20 kc</td>
<td>5 watts</td>
<td>50, 200, 600, and 5,000 ohms</td>
<td>Less than 1% above 30 cps</td>
<td></td>
</tr>
<tr>
<td>205AH</td>
<td>1 kc - 100 kc</td>
<td>5 watts</td>
<td>50, 200, 500, and 5,000 ohms</td>
<td>Less than 1% at 5 watts; Less than 1/2% at 1 watt</td>
<td></td>
</tr>
<tr>
<td>206A</td>
<td>20 cps - 20 kc</td>
<td>30 mw</td>
<td>50, 150 and 600 ohms</td>
<td>Less than 0.1% above 50 cps</td>
<td>Extra low distortion</td>
</tr>
</tbody>
</table>
steps. Thus, the meter can be used to read levels as high as +48 db (195 volts). The lower limit of the voltmeter is 0.45 volt.

**MODEL 205A**

The third -hp- audio signal generator is the Model 205A. This instrument is the same as the Model 205AG, except that no input meter section is included.

**MODEL 205AH—ULTRASONIC RANGE**

The fourth -hp- audio signal generator is the Model 205AH. The general circuitry of this instrument is similar to the Model 205A, except that the 205AH covers a range from 1 kc to 100 kc in two bands. The instrument is used widely in ultrasonic work where a high power output is useful in testing ultrasonic transducers.

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**Fig. 7. -hp- 205AG Audio Signal Generator provides 5 watts over 20 cps to 20 kc range.**