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A 250 CPS - 100 KC Oscillator For High Stability Applications

THE general family of *-hp-* audio oscillators has always been known for stability, but included in this family is one oscillator to which extra measures have been applied to obtain added stability for specialized work such as telemetry. This instrument is rated as being stable within 20 cps *per hour* at 100 kc after warmup and, of course, is generally noticeably better in a typical case. As a result, the instrument is especially suited to high-selectivity work such as checking the response of narrow-band filters and testing selective amplifiers.

SEE ALSO:
How 200T stability was plotted automatically, p. 3
Increased low-frequency accuracy for counters, p. 4

Fig. 2 shows a typical stability characteristic for the instrument when operating at its highest frequency of 100 kc at room temperature after warmup. This curve encompasses a half-hour's operating time and it will be seen that during this time the output frequency remained within a band about 5 cps in width. The instrument was operating from an unregulated power line which did, however, remain within a few volts of its average value.

At other frequencies within the instrument's range the percentage stability is often even higher. Fig. 3, for example, shows the stability at 10 kc. Note that the scale has been changed in this curve and that the frequency remained within a band only 0.2 cps or 0.002% in width.

The key to the use of the Model 200T is provided by the curve shown in Fig. 4. This is a typical warmup characteristic for the instrument when operating at 100 kc at room temperature. In the first hour of warmup the output frequency changed about 118 cps or 0.12%, but about 80 cps or 0.08% of

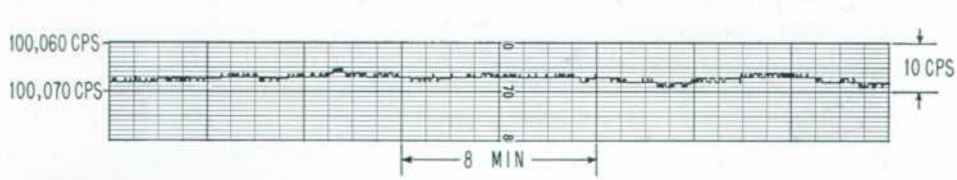

Fig. 2 (above). *Typical stability characteristic of -hp- Model 200T operating at its highest rated frequency of 100 kc after warmup. Even higher percentage stability will usually be obtained at other output frequencies (see Fig. 3).*

Fig. 1 (at left). -hp- *Model 200T 250 cps-100kc oscillator is especially convenient for high-resolution work such as encountered in telemetering field. Instrument has high stability of output frequency, low sensitivity to line voltage changes, and high resolution tuning system.*

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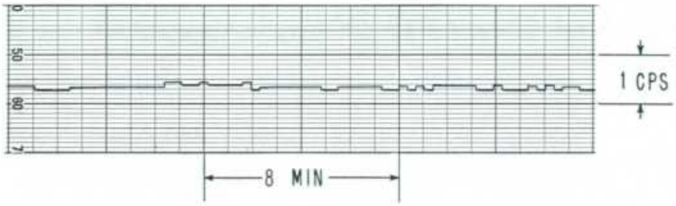

Fig. 3. *Typical stability characteristic of -hp- Model 200T operating at 10 kc after warmup. Note that major division equals only 1 cps of change.*

this occurred in the first half hour. After about an hour the instrument's internal temperature stabilizes and very little frequency change occurs thereafter. Similar or better percentage warmup changes can be expected at other frequencies in the instrument's range.

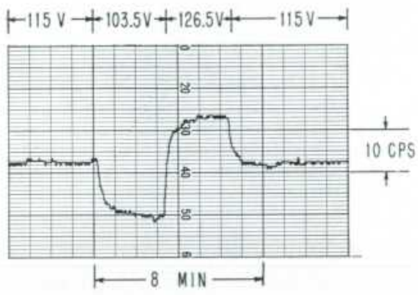

Fig. 5. *Typical influence of line voltage on output frequency of Model 200T when operating at 100 kc. At lower output frequencies less percentage change occurs.*

LINE VOLTAGE EFFECTS

The effect on an output frequency of 100 kc of changing the line voltage ±10% from a nominal 115 volts is shown in Fig. 5. The maximum change that occurred is roughly 15 cps or 0.015% as compared with the rating of ±0.1% for the instrument. At lower frequencies the percentage change is generally less than at 100 kc which is the highest rated frequency for the instrument.

STANDARDIZING CONTROLS

The combination of frequency calibration accuracy and long term stability for the instrument is rated as being within ±1% so that a high order of performance is provided. In addition, however, a feature is provided which enables each of the five frequency ranges to be standardized against a frequency counter or other standard for optimum overall accuracy or for optimum accuracy of any specific region of any range. This feature consists of a screwdriver control for each range of the instrument. The standardizing controls are located behind removable hole covers in the left side of the front panel.

DIAL DRIVE

Since one of the important applications for a high-stability oscillator lies in high-resolution work, care has been taken to provide the Model 200T with a dial drive system commensurate with such work. In addition to a 2:1 reduction coarse tuning control the drive is provided with a fine tuning control which provides a 12:1 reduction. The vernier action is further refined by the use of a large knob on the fine control.

The tuning dial itself is shown in Fig. 6. The outer scale which is used on 3 ranges has a length of about 15 inches. The inner scale is used on 2 ranges and has a length of about 10

Fig. 6. *High resolution frequency dial on Model 200T has effective scale length of about 65 inches. Scales are laid out to facilitate RDB telemetering work.*

inches. The effective dial scale length for the complete 250 cps—100 kc coverage of the instrument is thus about 65 inches.

The dial scales themselves have been specially arranged to be convenient for use with RDB telemetering systems. Each of the RDB channels is always fully contained on a single scale so that it is never necessary to change scales while checking a channel.

OUTPUT CIRCUIT ARRANGEMENT

The output circuit arrangement used in the Model 200T is one that has proved popular in a number of other -hp- oscillators because it can be used with balanced as well as single-ended circuits. The output transformer secondary is balanced and is provided with sufficient added resistance to give a source impedance of 600 ohms. This configuration is then followed by a 600-ohm T-pad which offers at least 40 db of attenuation. Since the T-pad is unbalanced, the circuit is unbalanced when the T-pad is in use.

(Concluded on p. 4)

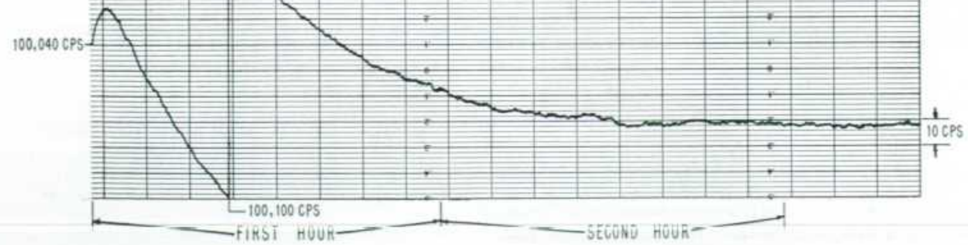

Fig. 4. *Typical warmup characteristic of Model 200T operating at 100 kc at room temperature. Overall drift is small and most of this occurs in first few minutes. Discontinuity or jog in curve occurs because measuring system prevents recorder from going offscale (see page 3).*

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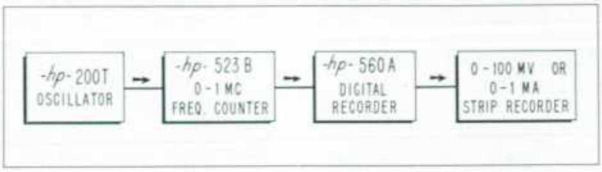
HOW MODEL 200T STABILITY CURVES WERE PLOTTED



Equipment arrangement used to automatically record stability characteristics of -hp- Model 200T.

Because of their high resolution and the fact that they were obviously plotted by a strip-chart recorder, the stability curves in the accompanying article are of special interest to engineers interested in frequency measurement techniques. In one of these curves (Fig. 3) the full scale value of the strip chart represents only 10 cps of frequency change, i.e., one major division represents 1 cps of change and deviations as small as 0.1 cps (the value of one minor division) can easily be read. The recording thus has as much resolution as is provided by the 10-second gate on a frequency counter, since that gate time permits readings down to tenths of a cycle. Although in Fig. 3 the signal of interest is 10 kc, the same 0.1 cps resolution could be obtained just as easily at frequencies well into the megacycle region if the stability of the signal warranted. It could also be obtained at much lower frequencies in the order of a few hundred cps.

The Model 200T stability curves were automatically plotted by using the new -hp- Model 560A Digital Recorder described in the last *Journal* issue. This instrument reproduces the readings of -hp- frequency counters on paper tape and also provides an analog output proportional to the counter reading. The 560A was operated from the -hp- Model 523B Frequency Counter and the output from the 560A was used to drive a strip-chart recorder. The setup is diagrammed in the illustration.

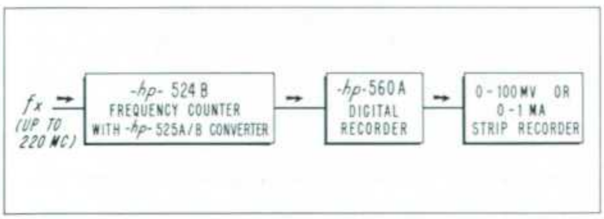
The high resolution of the strip record is made possible by a special selector switch on the new Digital Recorder. This switch was set so that the Recorder provided an output current that was proportional to the reading represented by the final two readout columns (units and tens columns) of the frequency counter. Thus, by plotting the final two columns and further by setting the counter for a 10-second gate, the full-scale value of the analog record becomes 100 cycles *per 10 seconds* or 10.0 cycles per second. Actually, since the final two columns of the counter readout can reach a maximum reading of only 99, the strip recorder will never be driven to more than 99% of full scale. If the readout goes beyond 99, the analog recorder will return to 0 and continue from there. The strip recorder is thus prevented from going off-scale and recordings can be made automatically and unattended.

Besides selecting the final two columns, the 560A switch can be used to provide an output proportional to the readings of any three adjacent columns on the counter. This arrangement was used for three of the stability curves (Figs. 2, 4, and 5). Strip recordings can thus be obtained with full scale values of 1,000, 10,000, 100,000, etc., counts to suit the stability of the signal being measured.

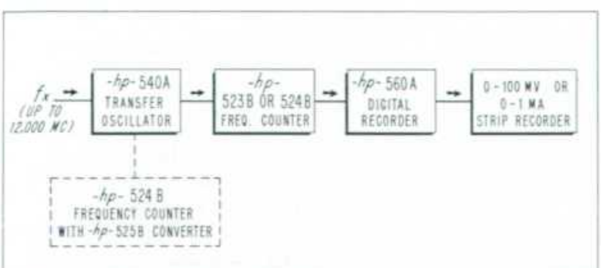
When the switch is used to obtain a two-column output, the minimum plottable increment becomes 1 unit out of 100, i.e., 1% of full scale. Since the Digital Recorder is working with digital units, the analog record is then made up of discrete steps as can be seen in Fig. 3.

When the switch is used to obtain a three-column output, the minimum plottable increment becomes 1 unit out of 1,000 or 0.1% of full scale. This increment is below the resolution of most strip recorders and the plotted curve does not ordinarily exhibit a discrete-step character.

Setups which will permit automatic analog recordings of frequencies up to 12,000 megacycles are shown in the illustrations.



Equipment arrangement for recording stability of frequencies up to 220 megacycles.



Equipment arrangement for recording stability of frequencies up to 12 kilomegacycles. Counter shown in dashed block is often omitted in stability measurements although it is necessary for frequency measurements. In stability measurements Transfer Oscillator is usually set to give a small difference frequency output for recording.

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MODEL 200T

(Continued from p. 2)

The pad is constructed, however, so that in its minimum attenuation position the series arm shorts while the shunt arm opens. The pad is thus effectively removed from the circuit and a balanced 600-ohm source is obtained. An external balanced pad can then be used for control of the output level. The arrangement permits a balanced source to be conveniently obtained while obviating the expense of a balanced attenuator for applications where it is not required.

The output circuit provides a maximum of at least 20 volts open circuit or 10 volts across an external 600-ohm load. The output attenuator reduces this to at least 0.1 volt across 600 ohms.

—Albert Ennor and Edna MacLean

SPECIFICATIONS
-hp- MODEL 200T
TEST OSCILLATOR

Frequency Range: 250 cps to 100 kc with wide overlap at both ends of each range.

Ranges: 250 cps to 1,000 cps;
800 cps to 3,200 cps;
2,500 cps to 10 kc;
8 kc to 32 kc;
25 kc to 100 kc.

Calibration Accuracy: ±1% long term. Screwdriver adjustments on front panel for precise calibration of each range.

Frequency Response: ±1 db entire range (reference: 5 kc).

Frequency Stability: Short Term: Less than 0.02% +0.5 cycle drift per hour at constant ambient temperature after one hour warmup. Temperature: Less than ±0.5% change, for ambient temperatures 10°C to 50°C (reference: 20°C). Power Supply Voltage Stability: Less than ±0.1% frequency change for variations of ±10% from nominal 115 volt line (103½ volts to 126½ volts).

Output: 160 milliwatts or 10 volts across 600-ohm rated load, or 20 volts open circuit.

Internal Impedance: 600 ohms. Output is balanced to ground within 1% for zero position of output attenuator. Unit may be operated one side grounded.

Distortion: Less than 0.5% entire frequency range. Distortion not affected by load impedance.

Hum and Noise: Less than 0.03% of rated output voltage.

Power Supply: 115/230 volts ±10%, 50/1,000 cps, approximately 100 watts.

Dimensions: Cabinet 18¾" wide, 8¾" high, 11½" deep. Rack mounting on 19" by 8¾" panel.

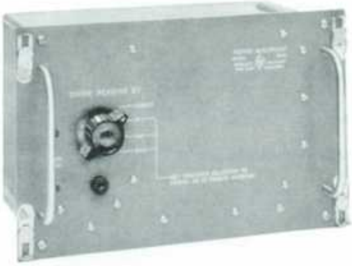
Weight: Cabinet Mount: 27 lbs.; shipping weight, approx. 42 lbs. Rack Mount: 28 lbs., shipping weight, approx. 43 lbs.

Price: -hp- Model 200T Precision Telemeter Test Oscillator, Cabinet Mount, $350.00. -hp- Model 200TR Precision Telemeter Test Oscillator, Rack Mount, $355.00.

Prices f.o.b. Palo Alto, California.
Data subject to change without notice.

HIGHER ACCURACY IN MEASURING AUDIO AND SUB-AUDIO FREQUENCIES

In some critical low-frequency work it is advantageous to be able to measure the frequencies encountered to even higher accuracies than the 0.03% tolerance that the *-hp-* Model 524B frequency counter offers on frequencies below 316 cps. For such applications a new plug-in unit has been designed for the Model 524B which enables the accuracy of such measurements to be improved by from one to three orders of magnitude.



-hp- Model 526C Period Multiplier Unit can be used with -hp- Model 524B Frequency Counter to obtain higher accuracy period measurements of frequencies below 10 kc.

The new unit improves low-frequency accuracy by increasing the number of periods over which a measurement can be made. Since the Model 524B measures low frequencies by counting the number of cycles of an internal precision clock frequency that occur in 1 or 10 periods of the frequency being measured, higher accuracy can be obtained by counting for more than 10 periods because the effect of voltage discriminator tolerances and other factors are averaged over a larger total count. Hence, the new plug-in unit has been designed to permit measurements over 100, 1,000, or 10,000 periods of the frequency being measured in addition to the 1 or 10 period measurements that the 524B offers. These measurements will give theoretical accuracies of 0.003%, 0.0003%, and 0.00003%, respectively, although with the two longest measurements the basic crystal stability (2 ppm per week) of the Model 524B begins to become significant.

As an example of a typical measurement, a frequency of 800 cps can be measured to an accuracy of ±0.0003% (± Model 524B stability) by setting the plug-in unit for a 1,000-period average measurement and counting the 10 mc internal clock frequency from the 524B. The measurement would be made in 1¼ seconds. The reading obtained on the counter would be 1,250.000 microseconds (average value of 1,000 periods), whereas a 10-period average measurement with the 524B alone would have given a reading of 1,250.0. A 100-fold increase in the resolution of the measurement is thus obtained.

The new plug-in unit is usable over the frequency range from 0 to 10 kc and will operate from signals of 1 volt rms or more. The above accuracy specifications for the plug-in unit apply for 1-volt signal levels, but if higher signal levels are used, higher accuracies will result.

To use the new plug-in unit with some Model 524B's may require a slight modification. This consists only of adding one piece of hook-up wire in the instrument and can be done in a few minutes.

—Albert Ennor

SPECIFICATIONS
-hp- MODEL 526C
PERIOD MULTIPLIER UNIT
FOR PERIOD MEASUREMENT

(Plugged into -hp- 524B Electronic Counter)

Range: 0-10 kc.

Gate Time: 1; 10; 100; 1,000; and 10,000 cycles of the unknown frequency.

Accuracy: ±0.3% ÷ gate time in cycles of the unknown ± stability of 524B.

Standard Frequency Counted: 10 cps, 1 kc, 100 kc, 10 mc or externally applied frequency.

Reads In: Seconds, milliseconds, microseconds.

Input Voltage: 1.0v rms minimum.

Input Impedance: 1 megohm paralleled by 40 μμf.

Size: Fits into panel recess in -hp- Model 524B.

Price: $225.00 f.o.b. Palo Alto, California.

Data subject to change without notice.

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