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A Small, Convenient Frequency Counter For General-Purpose Use

SOME time ago -hp- introduced a small, handy 0 -120 kc frequency counter* which was available with several extra-cost options such as a crystal-controlled time base. The combination of basic counter and options has been so popular, however, that it has been made a standard model at an overall reduction in price. The result is an economical instrument that is light in weight and small in size, and one whose electrical characteristics suit it to general-purpose use in both laboratory and production applications.

SEE ALSO:
A handy way to measure C, L, and f, p. 3

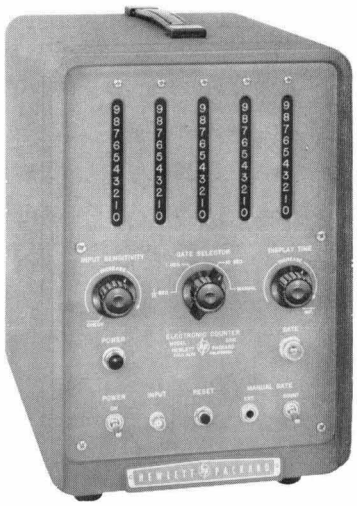
The distinguishing characteristics of the new model are as follows:

- It has a frequency-measuring range from 1 cps to 120 kc.
- Its crystal-controlled time base gives 0.01% accuracy.
- It has gate times of 0.1, 1, and 10 seconds.
- It has a display capacity of 99,999 counts.
- It measures time intervals up to 1667 seconds in cases where external contact closures can be used.
- It occupies only 10″ x 14″ bench area.
- It can be provided to operate with the -hp- Model 560A analog-output digital printer which converts counter readings directly to printed and analog form.
- It provides a standard-frequency output for operating other equipment.

OSCILLATOR MONITORING

One of the popular uses for the instrument has been in applications where it is necessary to set variable oscillators to special frequencies with negligible error. In telemetering work, for example, it is commonly necessary to set an oscillator to a specific point in a channel with not more than a few cycles of error. For this sort of work the counter is valuable as a high-accuracy tuning indicator for the oscil-

*Frank Koziuk, *A New 120 KC Industrial Counter for Measuring RPM, Velocity, Quantity, Flow, Etc.*, Hewlett-Packard Journal, Vol. 6, No. 11, July, 1955.



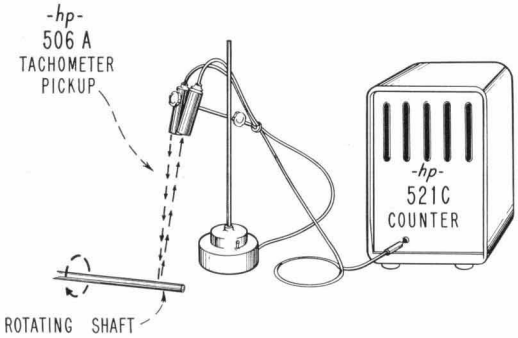


Fig. 2 *(above). Counter is arranged to operate with -hp- 506A Tachometer Pickup to measure very high rotary speeds of up to 300,000 rpm without mechanically loading rotating system.*

Fig. 1 *(at left). -hp- Model 521C Frequency Counter measures to 120 kc with good accuracy, is small and convenient for general-purpose use.*

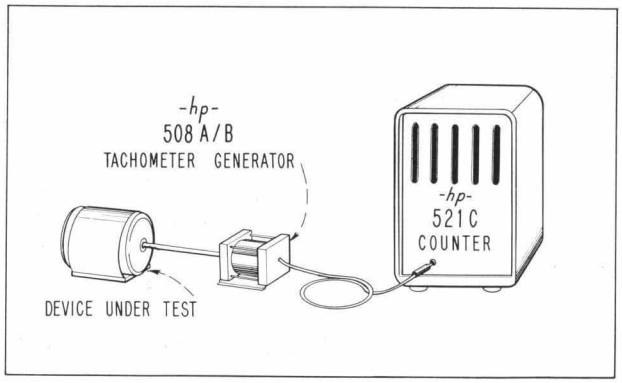


Fig. 3. *Counter can be used with -hp- 508 series of tachometer generators to measure rotary speeds. With 508A generator, readings will be direct-reading in rpm with a 1-second measurement.*

lator, since the oscillator can then be adjusted within accuracies approaching 0.01%.

RPM MEASUREMENTS

For industrial and mechanical applications, the counter has been arranged to simplify measuring rotary speeds and to be used with -hp- accessories to measure very high rpm's. When the counter is used with the -hp- 506A Optical Tachometer Pickup, for example, rotary speeds of up to 300,000 rpm can be measured without mechanically loading the rotating device. Freedom from loading is obtained because the operating signal is obtained from light reflected from the rotating device. Measurements are displayed in rps when the combination of pickup and counter are used.

The counter can also be used with the -hp- 508 series of tachometer generators to measure shaft speeds of up to 40,000 rpm. These generators provide outputs of 60, 100, 120, or 360 cycles per revolution to enable measurements to be made in convenient units. The Model 508A generator, for example, provides an output of 60 cycles per revolution so that measurements will be direct-reading in rpm.

TIME INTERVAL MEASUREMENTS

Although the counter is primarily designed for making frequency measurements, it can also be used to measure time intervals in the range of those encountered in industrial and mechanical work. A time interval measurement can be started and stopped in either of two ways with the instrument. First, a panel switch is provided for manual control of the measurement. Second, a panel jack is provided so that the measurement can be controlled by a set of external contacts such as from a relay or mechanically-operated switch which in turn is operated from the device under investigation.

Additional flexibility is given to time interval measurements by a choice of the clock frequency that the instrument counts during the measured interval. If the interval is relatively short, the internal clock frequency (10 kc) provided by the crystal time base can be counted. In this case the displayed value will be direct-reading in tenths of a millisecond. Intervals up to 9.9999 seconds in duration can be measured with this method. In most cases this measuring range will be more suited to use of external contacts than manual operation of the panel switch. Operating time of the external contacts should be short compared to the measured interval for most accurate results.

The second clock frequency that can be used is the power line frequency. If a 60-cycle line is used, intervals up to 1667 seconds (27 minutes) can be measured. With these longer intervals it is often practical to start and stop a measurement manually by means of the panel switch, although external contacts can be used equally well. The measured value will be displayed in units equal to the reciprocal of the power line frequency.

STANDARD FREQUENCY OUTPUT

The Model 521C is further arranged so that its crystal time base can be used to control the time base section of one or more of the -hp- Model 521A counters. This arrangement is advantageous for installations where several counters are to be used, since all counters can have the accuracy of the Model 521C at maximum economy of instrumentation.

The standard frequency from the Model 521C is provided from a jack at the rear of the instrument and consists of a 100-cps frequency with the 0.01% accuracy of the internal crystal standard. The output is sufficient to drive up to 10 Model 521A's. The Model 521A is equipped as standard equipment with an input jack to receive an external standard frequency.

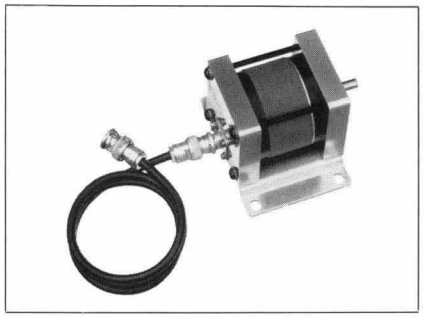


Fig. 4. -hp- *Model 508 Tachometer Generator is available with various frequency multiplications so that measurements can be made in convenient units.*

DIGITAL PRINTER USE

Where it is desired to use the counter with the -hp- Model 560A Digital Recorder*, it is necessary to modify the counter slightly. This modification can be made at the factory as an extra-cost option.

GENERAL

Care has been taken in the design of the counter to achieve convenience in many other ways. Besides

*Alan S. Bagley and Ed A. Hilton, *A Fast Digital Recorder with Analog Output for Automatic Data Plotting*, Hewlett-Packard Journal, Vol. 8, No. 7, March, 1957.

(Cont'd on p. 4)

SOME HANDY USES FOR THE -hp- 650A TEST OSCILLATOR

THE -hp- Model 650A Test Oscillator has always been popular for general test work because of its extremely wide frequency range (10 cps to 10 megacycles) and because of the fact that it provides known and adjustable output levels from a controlled source impedance.

Besides conventional testing, however, there are some additional uses for the instrument which have proved handy on occasion. These include:

1 – measuring small capacitors
2 – measuring small inductances
3 – measuring coil resonances
4 – measuring frequencies

MEASURING CAPACITORS

When working with capacitors of values below about 1,000 mmf, it is often convenient to have available an alternate quick means of verifying or measuring the value of the capacitor. This measurement can be made directly by the Model 650A without need of additional equipment. The measurement is based on the fact that if the Model 650A is set for a high enough frequency, the capacity loads the output system and causes the output meter reading to decrease.

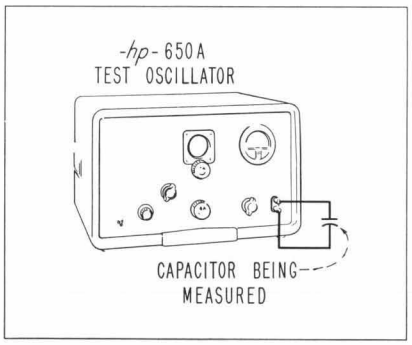


Fig. 2. *Capacitor to be measured should be connected directly across Model 650A output terminals.*

Fig. 3 shows the effect on the output meter reading of a typical 650A for a range of capacities when the 650A is operating at 3 megacycles. This curve was made by setting the 650A to the frequency indicated and adjusting the *Amplitude* control for a full scale output meter reading with the output attenuator set fully clockwise and with the output terminals unloaded. When a capacitor is then connected to the output terminals, the output meter reading decreases as shown.

To use this technique, a curve should be plotted for the individual 650A by using capacitors of previously-established values. The exact frequency at which the 650A should be set will depend on the capacity range of interest, but it can be seen from Fig. 3 that a frequency in the region of 3 mc is generally convenient.

Capacitors of values much larger than 1,000 mmf or so can also be measured with this method by suitably lowering the 650A frequency.

Fig. 1. *-hp- Model 650A Test Oscillator operates from 10 cps to 10 megacycles, provides 3 volts across 600 ohms from 600-ohm source.*

MEASURING INDUCTANCES

The same general arrangement can be used for measuring inductances. Fig. 4 shows a typical curve of 650A meter drop for inductors in the range from 10 to 100 mh when a typical 650A is operated at 2 kc. Smaller inductances can be measured by suitably increasing the 650A operating frequency.

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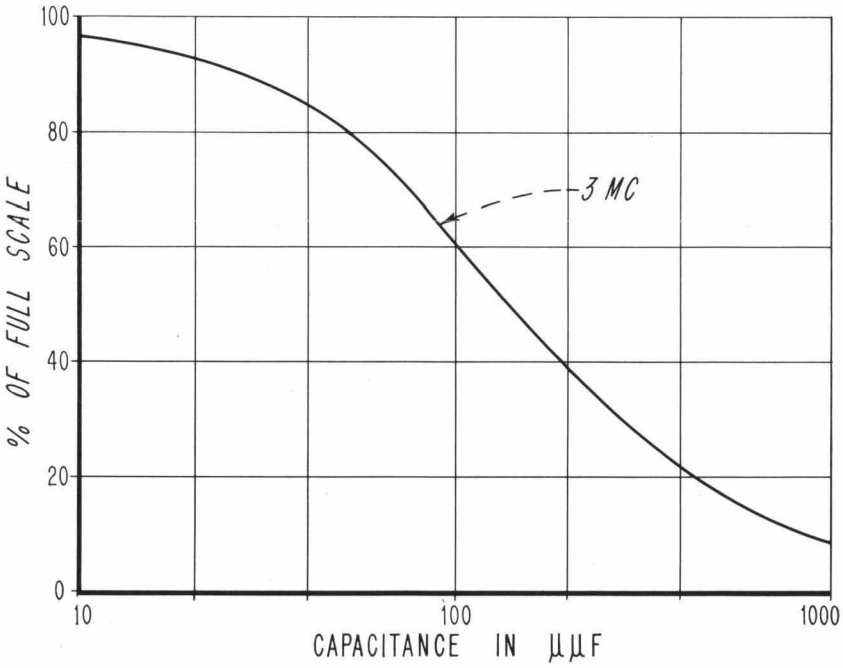

Fig. 3. *Typical effect on Model 650A output meter when various capacities are connected while unit is operating at 3 mc.*

120 KC COUNTER

(Cont'd from p. 2)

being small in size and easy to carry, the counter is provided with tilting bails so that it can be tilted up or down for easy viewing when it is located at other than eye level. The instrument is fan-cooled and provided with a washable type permanent air filter. Finally, the cabinet is provided with guide channels which accept nylon glides on the chassis for convenient cabinet removal and replacement.

—Frank Koziuk

SPECIFICATIONS
-hp-
MODEL 521C
FREQUENCY COUNTER

Range: 1 cps to 120 kc.

Accuracy: ±1 count ±0.01%

Registration: 5 columns. Total count capacity: 99,999 counts.

Input requirements: 0.2 v rms minimum or output from 1P41 Phototube (or equal). Phototube bias provided at *Phototube* jack.

Input Attenuator: Adjusts sensitivity from 0.2v to 100v rms to overcome noise.

Input Impedance: Approximately 1 megohm shunted by 50 μμf (½ megohm at *Phototube* jack).

Gate Time: 0.1, 1, and 10 seconds. Panel neon lamp indicates when gate is open.

Manual Gate: Controlled by panel switch or external contacts.

Display Time: Variable from 1/10 to 15 seconds; or display can be held indefinitely.

Reset to Zero: Controlled automatically by display time generator; or manually by reset button for "infinite" display time.

Reads In: Cps; or directly in rps or rpm with -hp- 506A or 508A/B Tachometer Accessories.

Self-Check: Counts internal standard frequency for any selected gate time.

External Standard: Can be operated from any multiple of 10 cps from 10 to 100 cps.

Phototube Input: Supply voltage for 1P41 (or equal) phototube provided at phone jack on rear.

Accessory Socket: At rear; supplies 6.3v ac, 0.6a; +300v dc, 10 ma; −150v dc, 5 ma.

Connectors: BNC and standard phone jacks.

Power Supply: 115/230v ±10%, 50/60 cps, 185 watts.

Size: Cabinet Mount: 9¾" wide, 15¼" high, 14½" deep. Rack Mount: 19" wide, 8¾" high, 14½" deep.

Weight: Cabinet Mount: 28 lbs. net; shipping weight 41 lbs. Rack Mount: 26 lbs. net; shipping weight 43 lbs.

Accessories Provided: 1 each -hp- AC-16D Cable Assembly, 44" RG-58/U Cable terminated one end with UG-88/U Type BNC connector.

Accessories Available: Factory installed modification to adapt -hp- 521C Counter to use with -hp- 560A Digital Recorder: $45.00.

-hp- Model 506A Optical Tachometer Pickup, $100.00.

-hp- Model 508A/B/C/D Tachometer Generators, $100.00.

Price: -hp- Model 521C Industrial Electronic Counter, Cabinet Mount, $650.00. -hp- 521C Industrial Electronic Counter, Rack Mount, $655.00.

All prices f.o.b. Palo Alto, California

Data subject to change without notice.

USES FOR THE -hp- 650A

(Cont'd from p. 3)

MEASURING COIL SELF-RESONANCE

When winding or inspecting small inductances, it is often desirable to check that the self-resonant frequency of the inductance is above some minimum acceptable frequency. This can be done with the Model 650A by connecting to its output terminals with a set of test leads a small coil to use as a probe coil. The inductance of the probe coil should be enough to enable a high scale reading to be obtained on the 650A output meter in the frequency range of interest. The 650A output attenuator should be set for zero attenuation (fully clockwise). By then bringing the probe coil physically close to the coil under investigation in such a way as to obtain maximum coupling between the two, a dip in the 650A meter reading will usually be obtained when the 650A is tuned to the coil's resonant frequency. The amount of the dip depends on the degree of coupling but is typically 5% — 20% of the full scale meter value.

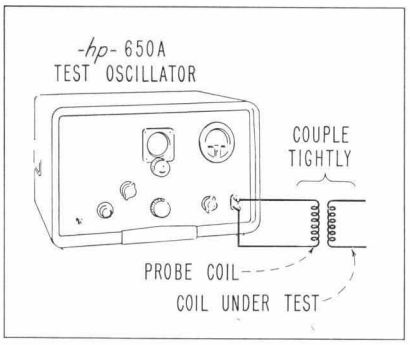

Fig. 5. *Self-resonant frequency of small coils can usually be found by coupling coil to Model 650A through a probe coil and sweeping frequency dial for meter dip.*

FREQUENCY MEASUREMENTS

External frequencies within the 10 cps to 10 mc range of the 650A can be measured by applying them to the 650A terminals. If the external voltage is in the order of ½ volt or more, it will produce a reaction in the nature of a beat on the 650A output meter when the 650A is tuned to the same frequency as the external frequency. The value of the external frequency can then be read from the 650A's frequency dial. The 650A should initially be adjusted to have a sizable deflection of its output meter and the output attenuator should be set for zero attenuation.

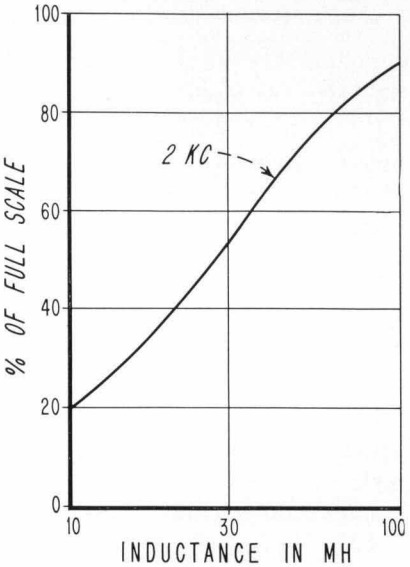

Fig. 4. *Typical effect on output meter when measuring inductances at 2 kc.*

The arrangement can be used for measuring frequencies over the full 10 cps to 10 mc range of the 650A. At the frequencies in the megacycle region the tuning naturally becomes more critical, and the unknown must therefore have a reasonable order of stability so that the beat can be obtained.

The voltage level applied to the 650A should not exceed about 15 volts so that excessive power is not applied to the 650A output system. With voltages larger than about 3 volts, however, the setting of the output attenuator should be suitably increased to retain an on-scale meter reading.

—Arthur Fong