EVER DREAM of owning a good frequency counter? The $500-and-up instruments are tops for all sorts of experimental and industrial work, but the accurate clock and complex decoding circuitry they use puts them well out of reach of most experimenters. But how about a frequency meter? About $12 worth of semiconductors, integrated circuits, and other parts can put you in command of a five-range, linear scale meter, good from 5 Hz to 1 MHz. It has an input sensitivity of 30 millivolts r.m.s., accepts any waveshape with no loss of accuracy, and automatically calibrates itself simply by borrowing the 60-Hz reference belonging to the local power company. The integrated circuits and a printed board make it a snap to put together.
This frequency meter is perfect for checking the performance of experimental audio oscillators, tone generators, and square-wave signal sources, and is particularly handy if you're working with RTTY, FM multiplex decoders, tone-signaling circuits, or electronic musical instruments. It's a "must have" instrument for working with transistor or SCR power inverters when it comes time to set—and keep—the operating frequency right on 60 Hz, and it's useful for checking out the performance of engine-driven emergency power units.

Add an external oscillator, and the unit becomes an accurate LC bridge for determining the value of an inductance or capacitance. And, finally, you can make the meter count anything you can convert into repetitive electrical pulses by adding a small generator and a photoelectric pickup, or something similar; then the meter is an accurate, wide-range linear-scale tachometer.

How It Works. The input signals are amplified and inverted by transistor Q1, as shown in Fig. 1. This transistor drives a Schmitt trigger circuit (IC1) whose output snaps from ground to +3.9 volts the instant the input signal goes positive above a certain threshold level. The rise time of IC1's output (from pin 6) is independent of the shape of the input signal, so a rectangular waveform of identical frequency to the input results.

Capacitor C8 and resistor R15 differentiate the square wave to produce a positive trigger pulse every time IC1 snaps on. These pulses trigger IC2 (a monostable multivibrator), which also snaps on, and stays on for a precise time interval determined by R8, R15, and a selected range capacitor (from C9

![Image of circuit diagram](image-url)
PARTS LIST

C1—2.µF, 200-volt paper or Mylar capacitor
(NG on electrolytic)
C2—0.01 µF, 25-volt electrolytic capacitor
C3—100-µF, 15-volt electrolytic capacitor
C4—100-µF, 6-volt electrolytic capacitor
C5—0.01-µF, 50-volt Mylar or paper capacitor
C6—10-µF, 10-volt electrolytic capacitor
C7—500-µF, 15-volt electrolytic capacitor
C8—150-µF, nica or disc ceramic capacitor
C9—2.2-µF, 50-volt Mylar or paper capacitor

(±1% on electrolytic)
C10—0.022-µF, 50-volt Mylar or paper capacitor
C11—0.022-µF, 50-volt Mylar or paper capacitor
C12—2200-pF Mylar, paper, nica, or disc ceramic capacitor
C13—203-pF nica or disc ceramic capacitor

(allows for 15-µF of stray and circuit capacitance)
D1, D2, D3—Silicon diode, 200 mA, 50 PIV
(1N4001 or similar)
D4—Zener diode, 3.9 volts, 1 watt (1N4730A or similar)**
R1—1k ohm fuse base (out fuse holder)
R2—3k ohm lamp
C1, C2—AL519A epoxy integrated circuit (Fairchild)
J1—Phono jack
M1—100-µF, 50-volt electrolytic, 4x3 rectangular

(Knight SL A7206, or similar)
R1—Silicon transistor (Gallat 1N3523 or M13523)**
R1—10,000-ohm, 1/4-watt carbon resistor
R2—15,000-ohm, linear-taper carbon potentiometer
R3—2000-ohm, &-watt resister (any be part of 11)
R4—39-ohm, 1/4-watt carbon resistor
R5—330-ohm, 1/4-watt carbon resistor
R6—300-ohm, linear-taper carbon potentiometer
R7—3300-ohm, 1/4-watt carbon resistor
R8—1500-ohm, 1/4-watt carbon resistor
R9—1500-ohm, 1/4-watt carbon resistor
R10—1000-ohm, 1/4-watt carbon resistor
R11—R12—1000-ohm, 1/4-watt carbon resistor
S1—S.p.s.t. slide switch (Wirt G123, or similar)
S2—S.p.d.t. slide switch (Wirt G124, or similar)
S3—Single pole, throw-position, non-shorting selector switch (Jalloy 1115, or similar)
T1—Filament transformer, 6.3 volts, 0.6 ampere
(Knight 34 A 1416, Statcon P6465, Thordarson 32P2, or similar)
T2—10M x 22K x 33K single-sided copper printed circuit board***
T3—IN74 x 6 x 9 alumina base (Brd C14207, or similar)
Misc.—L ine cord and strain relief, bands, knobs
(4), rubber cord (4). PC terminals (11), mounting hardware for M1 and 11, wire, solder, etc.

* Accuracy of instrument depends directly on accuracy with which C10 through C13 are exact decade multiples of C9.
** A kit of all semiconductors is available from

Hamilton Electra of Arizona, 1744 N. 28 St., Phoenix, Ariz. $500, postpaid in USA. Stock #7X-23.
*** The printed board in this catalog and drilled G-10 board is available for $2.30 from Southwest Technical Products Corp., 219 W. Raleigh, P.O. Box 200, Artesia, Texas 78316. Most of the other parts as well as complete kits are also available—write to Southwest Technical for complete list and prices.

through C13). Each capacitor provides a
time delay ten times that of its neigh-
bor, resulting in five decade frequency
ranges. Calibrate control R15 sets the
time delay to a value that causes a 60-Hz
input signal to read exactly 60 on the
100-Hz range.

How often IC2 snaps on is determined
by the input frequency, while how long
it stays on is determined by the range
switch-selected capacitor. The ratio of
on time to off time linearly increases
with increasing frequency. Resistor R7
charges up C4 and C5 (an integrator) to
a voltage whose average value equals the
ratio of on to off time. Meter M1 then
indicates this average voltage as fre-
quency.

Zero control R6 provides a small d.c.
voltage to buck out the saturation effect
of IC2, while D2 protects the meter from
overload if an input frequency higher
than full scale is applied. A conven-
tional zener-regulated -1.5-volt d.c. sup-
ply is used. Switch S1 and resistor R1
route the 60-Hz power to the input for
calibration.

The 100-Hz scale accuracy depends
solely upon how closely you can read the
meter, while the scale-to-scale accuracy
depends upon how closely the range ca-
pacitors (C9 through C13) are exact
decade multiples. An accuracy of better
than ±3% should be easily obtained
with a quality meter and careful capaci-
capacitor selection.

Construction. The two IC's together re-
place five transistors and nine resistors,
which, if bought separately, would cost
eight dollars, or well over twice that of
the IC's, not counting the extra assem-
ly time and trouble.

Buy (see Parts List), or etch, cut, and
drill the printed circuit board and mount
the components as shown in Figs.
2, 3, and 5. Watch the polarity on all
semiconductors and electrolytic capaci-
tors. On IC1 and IC2, make certain lead
8 (center lead of flat side, having a red
dot) goes to the +1.5-volt supply.

Mount the meter, pilot lamp, Range
switch S3, Gain control R5, input jack
J1. Zero control R6, on/off switch S2,
calibration switch S1, and calibration
potentiometer R15 on a suitable front
panel as shown in the photo on page 53.
Mount the PC board and the remainder of
the components within the selected
metal enclosure. Use Fig. 3 as a guide for interconnecting the PC board with the remainder of the system.

The accuracy of the instrument on the four upper scales depends entirely upon how closely range capacitors C10 through C13 are exact decade submultiples of C9. One source of matched capacitors is given in the Parts List. Otherwise, by using an LC bridge, a quality oscilloscope, or a good audio oscillator, you can trim the capacitance (and therefore, the on time of IC2) so that the frequency indication on M1 has exact scale-to-scale calibration.

When the capacitors are accurate, you'll have a correct frequency reading on any scale without having to retouch the Calibrate control, and with a power-line calibration, you can rest assured that all scales will be accurate.

Operating Hints. Always turn the gain control fully counterclockwise before you make any measurement or connect the instrument to a live circuit, or you might risk damage to Q1. Calibrate the instrument each time you use it by zeroing the meter (with front-panel Zero control R6), selecting the 100-Hz range, and setting the Freq/60 Hz switch (S1) to 60 Hz. Bring the Gain control up a quarter turn and adjust the meter to a steady "60" reading using the Calibrate potentiometer. Set the Freq/60 Hz switch to Freq, and you're all set to measure.

Keep the input amplitude under 3 volts r.m.s. maximum. If you're working with higher signal levels, add a resistive divider to cut the level down. You may safely connect the input to any d.c. level within the breakdown rating of C1.

(Continued on page 98)
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Mosley Electronics Inc. Bridgeton Missouri 63042

Avoid pegging the meter by always starting one range above the frequency you want to measure. Best operation occurs when the Gain control is advanced 1/2th of a turn beyond the point where the meter first produces a steady indication.

For power inverter work, there's a different way to use the frequency meter. Calibrate the instrument against the 60-Hz power line and then plug the frequency meter's power line cord into the inverter, leaving the Freo/60 Hz switch in the 60 Hz position. Now, read the frequency directly. The zener-regulated supply automatically takes care of any inverter voltage from 70 to 160 volts, at any frequency from 30 to 1200 Hz.

In cases where you're measuring pulses or other low duty cycle signals, you'll get best results with a narrow, negative-going input waveform.

Fig. 5. Actual-size layout of PC board. Drill as shown in Fig. 2; mount components as per Fig. 3.